PRAIRIE STEWARD

FARMING FOR YOUR FUTURE ENVIRONMENT

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THE ECONOMIC BENEFITS AND COSTS OF ZERO TILL RESEARCH

Lana Awada, Richard Gray, Cecil Nagy, University of Saskatchewan

INTRODUCTION

The widespread adoption of zero tillage (ZT) in the last 30 years has led to a profound transformation of cropping systems on the Canadian Prairie landscape. This transformation has embodied a new understanding of the biophysical environment, numerous mechanical innovations, and innovative ways of managing land. The following article is a summary of the results of a study concerning this adoption and subsequent economic returns, recently published in the Canadian Journal of Agricultural Economics by Lana Awada, Richard Gray and Cecil Nagy from the University of Saskatchewan.

As shown in Figure 1, the adoption of ZT was driven by many factors that improved the economic viability of the cropping system over time. Today we have widespread use of ZT that has significantly improved productivity while enhancing soil quality, and reducing net greenhouse gas (GHG) emissions.

Despite the apparent large and widespread impacts of ZT technology, little is known about the economic return to ZT research development and extension (RD&E) investments, therefore we decided to use a benefit–cost framework to evaluate ZT-related RD&E on the Canadian Prairies. In our study we used a large number of data sources and the Prairie Crop Energy Model to estimate the costs and benefits.

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THE DEVELOPMENT OF ZT TECHNOLOGY

As many of your readers will know very well, the ZT innovation was driven by investments in RD&E by entrepreneurs, larger private firms, many NGOs, and many public sector organizations for many years. In large part, it was the complementary impact of all of these activities that led to development, adaptation, and successful adoption of the transformative cropping system. Public research was critical in identifying the issue and underlying causes of soil erosion. Notably, many of the important breakthroughs in the development of ZT technology did not occur as a result of big projects or big science, but rather were made by farmers who understood the issue and the constraints they needed to address. Having a network of public researchers, a larger supportive environment for private development, and public funds to support producer-driven extension, accelerated the development and adoption process.

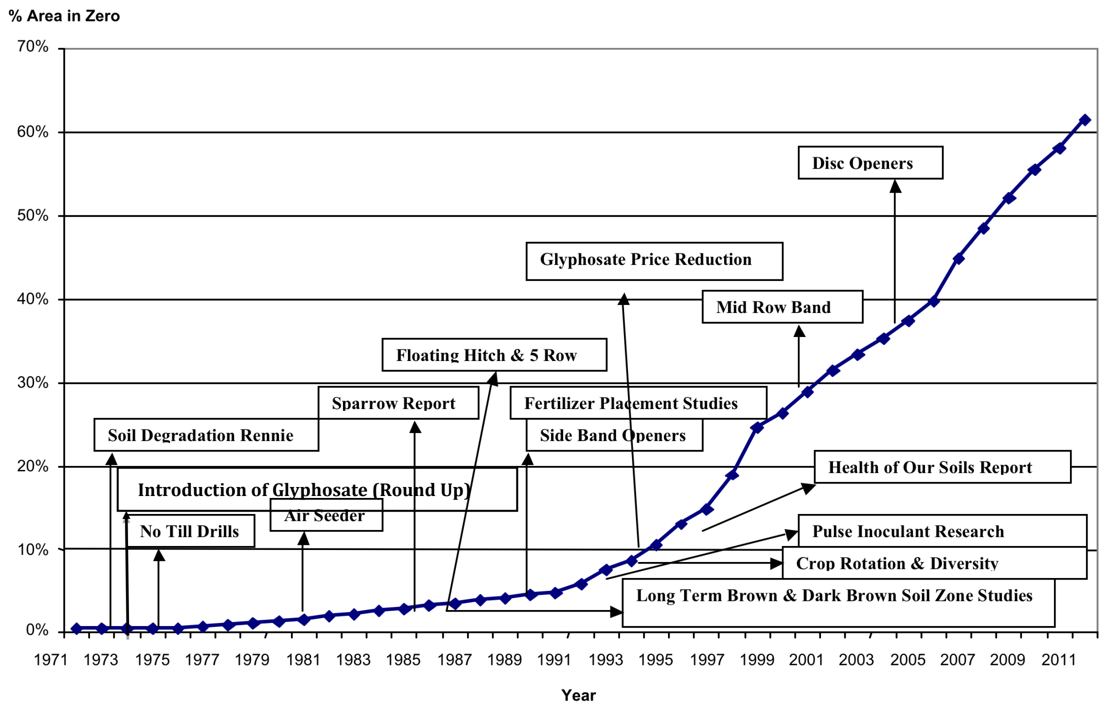
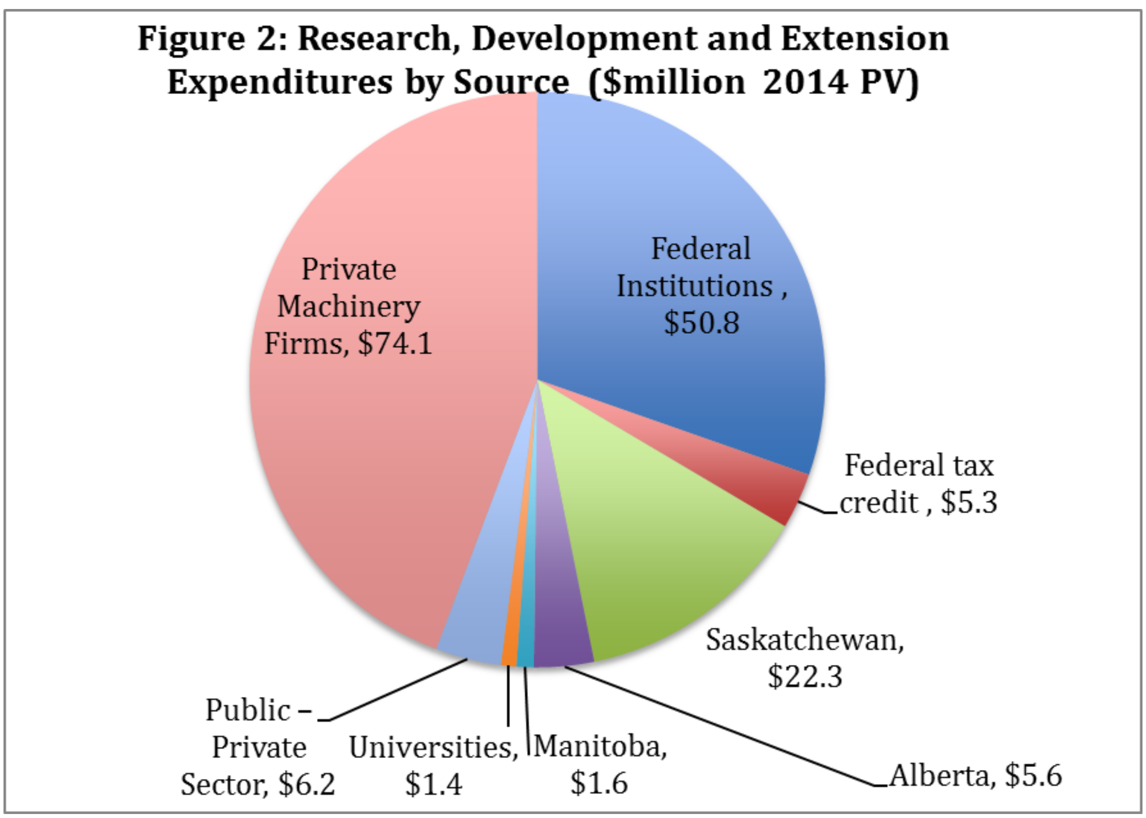


Figure 1. The development and adoption of ZT on the Prairies: 1971 – 2011

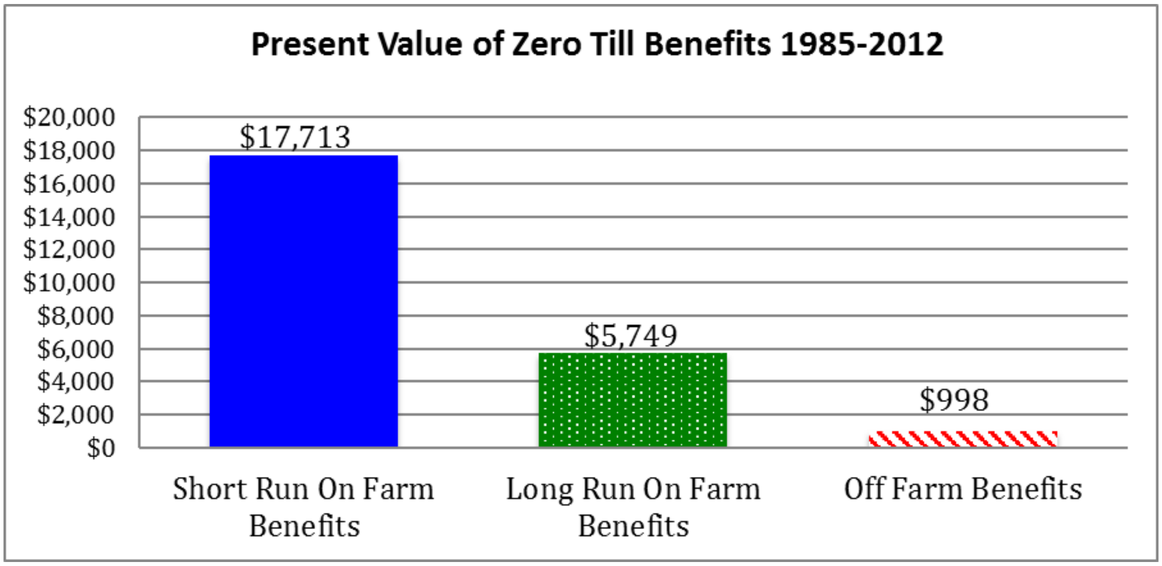
HOW MUCH WAS INVESTED IN ZT RD&E?

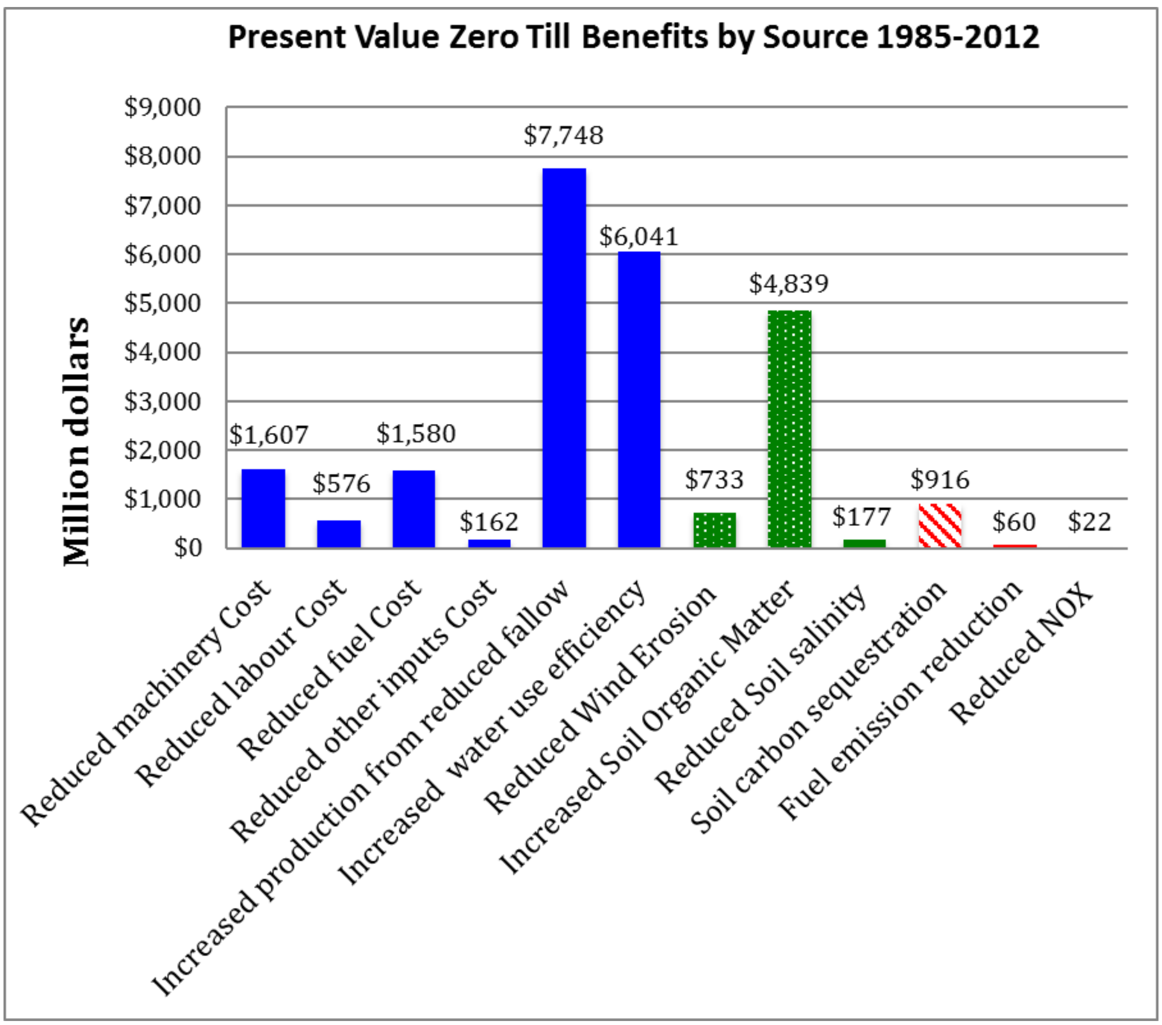
The present value public and private investments in ZT RD&E is summarized in Figure 2 below. We estimate the total expenditure on ZT RD&E projects equal to $167.4 million, with approximately 60% of the investment from public sources ($93.3 million) and 40% from private sources ($74.1 million). While NGOs were important in garnering public support, their direct research expenditures of less than $2.5 million were a small proportion of RD&E. Of the direct public RD&E investors, the Federal Government was the largest funder with $34.3 million in RD&E expenditures, followed by the Province of Saskatchewan with $21.7 million in investment. Indirect RD&E investment was estimated to be an additional $22.6 million all from public sources.



HOW LARGE ARE THE ECONOMIC BENEFITS FOR THE ADOPTION OF ZT ON THE PRAIRIES?

The benefits of ZT adoption are summarized in Figures 3 and 4 below. Each of these numbers are expressed in present value terms. For example, the fuel savings are estimated for each year depending on the extent of ZT adoption. These annual benefits are then added up for the 1985 to 2012 period and expressed in 2014 dollars using a present value formula that recognizes that money has a time value.





The short-run on farm benefits is the largest category of benefits totaling $17.7 billion. Within this category the increased production from reduced summerfallow and the increased water use efficiency make the largest contributions to benefit. The long-term on-farm benefits are also very sizable totaling more than $5.7 billion. Within this category the largest contribution comes from the accumulation of organic matter that is reflected in higher crop yields. The off-farm benefits of nearly $1 billion comes from the estimated reduction of greenhouse gases valued very conservatively at $5 per ton of CO_2.

Saskatchewan, having the largest proportion of arable land and highest adoption rate of ZT on the Prairies, received $15.0 billion, the greatest benefits between 1985 and 2012. Total benefits from ZT adoption in Alberta and Manitoba are $7.33 billion and $2.06 billion, respectively. Manitoba has notably lower adoption rates as spring flooding in the Red River Valley often necessitates tillage to prepare the land for seeding.

HOW MUCH OF THE ZT BENEFIT CAN BE ATTRIBUTED TO RESEARCH?

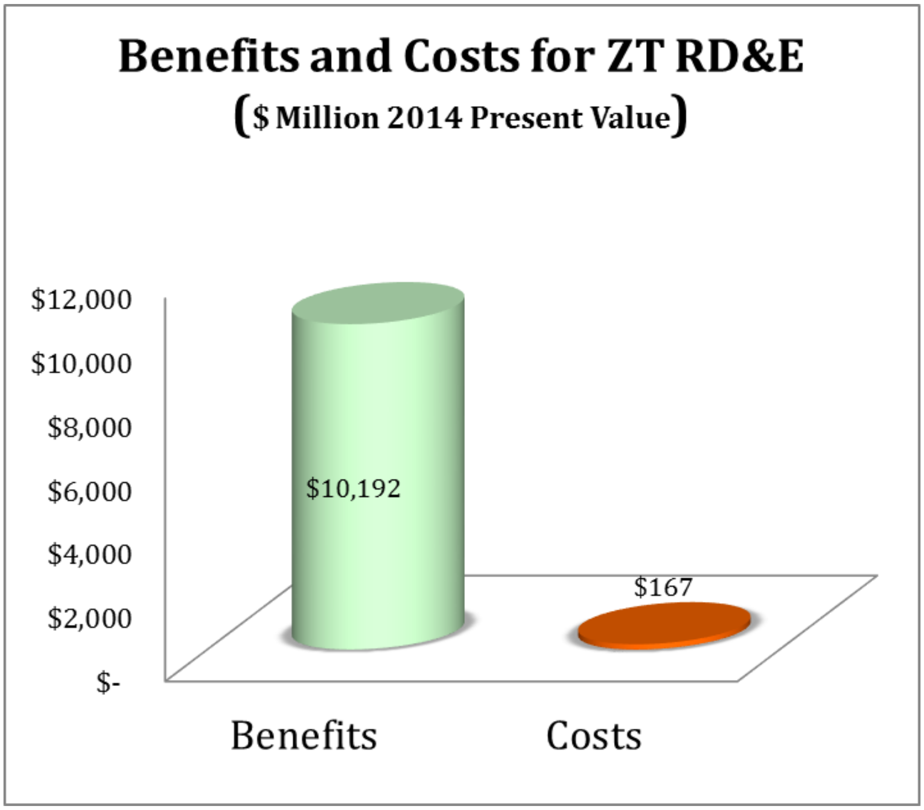
To assess the value of the ZT Research, Development and Extension investments we asked the question of what would have happened in the absence of these expenditures. This is referred to as a counterfactual scenario. In an attempt to be conservative we assumed the ZT adoption would have occurred in the absence of the RD&E expenditures but adoption would have been delayed by five years. In other words, we assumed the RD&E investments served to accelerate the development and adoption of ZT by five years. The benefit from accelerating ZT RD&E adoption by five years has a 2014 present value of just over $10 billion with an overall benefit–cost ratio of 60.8:1. As shown in Table 1, an even more conservative assumption of a two year acceleration effect has a value of $3.65 billion and a ten year acceleration effect is a $19.3 billion benefit.

Table 1. 2014 present value of benefits from zero tillage RD&E prairies 1985–2012

	Counterfactual Scenarios		
	5-Year Delay	2-Year Delay	10-Year Delay
	(Million $ 2014)		
Total short-run on-farm benefits	$ 5,747	$1,873	$12,142
Total long-run on-farm benefits	$ 4,027	$1,612	$ 6,513
Total off-farm benefits	$ 417	$ 165	$ 662
Total Zero-Tillage benefits	**$10,192**	**$3,650**	**$19,317**
Present Value total ZT RD&E Costs	**$ 167**	**$ 167**	**$ 167**
Benefit/Cost Ratio	*60.88*	*21.80*	*115.39*

The 60:1 benefit cost ratio is a very large number. Even after accounting for interest costs and the long lag between investment and return, each dollar invested created $60 in benefits. It is also worth noting that the present value of off-site benefits (social benefits) of ZT RD&E due to the net reduction in GHG emissions, valued at $5/t of CO_2, is equal to $417.2 million. Although these benefits are much lower than on-site benefits, they are still much greater than the total RD&E resources required to induce the change, suggesting the ZT RD&E investment was a cost effective means of reducing greenhouse gas emissions. The significant on-farm benefits also provide farmers with opportunities to gain a competitive advantage in local and international markets by producing high yielding crop varieties at lower costs, while improving the environmental sustainability of agriculture.

The 60:1 estimated benefit cost ratio for ZT RD&E supports the general view that the return to agricultural RD&E has been high. These high rates of return suggest public and private sectors have underinvested in agricultural research and that additional funds should be allocated to agricultural research to align its rate of return with the returns of other sectors. The benefits from the adoption of ZT will continue to accrue not only from the readily observable input cost savings, but also from the changes to the soil resource, not easily quantified.



The future vitality of Canadian agriculture depends on the ability to continue to solve complex problems of continually evolving agro-ecological issues. New combinations of improved crop genetics, precision agriculture, robotics, and yet undiscovered agronomics offer a great deal potential to continue to transform cropping systems. These efforts must be supported with continued research on integrated multi-tactic weed management, cultivar selection, crop rotations, pest and disease suppression, and nutrient management, to enhance the sustainability of this system. From a policy perspective, the overwhelming success of ZT development provides some important lessons for the funding and the development of these new cropping systems.

VARIABLE RATE PHOSPHORUS - GOOD FOR THE ENVIRONMENT AND FOR THE BOTTOM LINE?

Stewart Brandt, Research Manager, Northeast Agriculture Research Foundation, Melfort, SK
and Tom Jenson, Director, International Plant Nutrition Institute (IPNI)

Phosphorus (P) is an essential nutrient. This nutrient is essential for all life, including the crops we grow for food. In plants P has roles in cell division, stimulation of early root and stem growth, hastening maturity, energy transformations within cells and seed production. Most soils contain total quantities of P in the order of about 900 lb P/ac (1000 kg P/ha), although this can vary widely depending on soil properties. A small amount of soil P is in soluble forms that crops can use, while another portion is in forms that will come available to crops as the soluble portion is depleted by crop root uptake. Most soil P exists in forms that must undergo natural weathering before it can become available to crops. This process is very slow, releasing only enough P annually to supply the needs of a 2-4 bu/ac (135-270 kg/ha) crop of wheat.

We cannot continue to deplete P from our soils. Nutrient balances can tell us whether or not we are maintaining the fertility status of our soils. This can be done on a field basis or even regionally. The balance calculation accounts for nutrients added in the form of fertilizers or other sources like manure minus those removed in harvested crops. A positive value indicates that nutrients are being built up, while negative values indicate deficits. In Saskatchewan we have run large deficits since the land was first broken. While fertilizers have reduced these deficits, they have not come near to eliminating them, and an examination of fertilizer trends shows that P fertilizer use has remained fairly constant. The result is that in Saskatchewan in 2015, 81% of soils tested below a level considered sufficient for available P (IPNI 2015 North America Soil Test Summary). Soil test P levels are low in this province as well, averaging 14 ppm in 2010, while in Manitoba and Alberta they are much higher at 21 ppm and even higher in Ontario at 41 ppm.

When soil P levels are very low, fertilizer P is used less efficiently than when soil P is at moderate levels. In a long-term rotation study at Swift Current SK, Selles and others found that during 1967 to 1979 when soil test P was 28 lb P_2O_5/acre (31 kg P_2O_5/ha), P use efficiency averaged 53.8%, but increased to 61.9% during 1980-1993 when soil test P averaged 45 lb P_2O_5/acre (50 kg P_2O_5/ha) and increased further to 88.3 % during the period 1994 to 2005 when average soil test P had increased to 53 lb P_2O_5 (59 kg P_2O_5/ha). Another important finding from this work was that when soil test P was above 48-58 lb P_2O_5/acre (54-65 kg P_2O_5/ha), there was very little net conversion of added fertilizer P to immobile forms. However, as soil test P dropped below the level of 48-58 lb P_2O_5/acre (54-65 kg P_2O_5/ha), amounts of fertilizer P that were immobilized increased as available P declined. The take home message from this is that if we deplete soil P much below 51 lb P_2O_5/acre (57 kg P_2O_5/ha) we will need to apply significantly more fertilizer P to increase yield than we would if we maintained soil P at this level.

Yield potential of new crop cultivars is increasing. An evaluation of the yield potential of new cultivars indicates that since 1995, yield potential of canola increased by more than 90%; pea by up to 60%, and wheat by 33%. However provincial yield averages of these crops have not increased as much as advances in yield potential would suggest. This could reflect a large number of factors, of which inadequate soil P is an important contributing factor. If genetic yield advancement continues, it is clear that P inputs will need to increase as well.

Soil P status and yield will come into balance. There are things we can do to increase uptake of soil P without adding P to the soil. These include ensuring crops have adequate nitrogen to enhance the ability of crop roots to explore the soil for P; using microorganisms to acidify the soil near roots making P more available and growing crops that form associations with soil fungi called mycorrhizae that effectively increase the root area of the crop thereby increasing nutrient uptake. These strategies while moderately effective do help to meet the P needs of high yielding crops. They also increase the rate of removal of soil P resulting in a reduction in the P status of the soil. Ultimately soils with low P status will support lower yields while those with adequate P will support higher yields.

The "paradox" of P deficits and surpluses. A recent publication in the Prairie Steward (Spring 2016) did an excellent job of outlining this "paradox" as it relates to areas of feed production vs areas of feed grain consumption. However that is not the only paradox of P deficits and surpluses in the region. Areas of P deficits and surpluses also exist within most fields.

Soil available P varies widely across landscape positions. In NE Saskatchewan 10 fields were zoned for variable rate nitrogen management in 2008, and nutrient status of each zone was determined. The upper to mid slopes of these fields constituting 62-78% of the area the fields tested low at 6 to 16 ppm of available P on 9 fields. One field that was manured in the past tested at 20 ppm. Depression areas covering 22-38% of field area tested between 22 and 43 ppm on 6 of these fields, and 10-17 on the other four fields. The implications of these differences are that if we apply fixed rates of P across these fields based on field average available P levels, we will fail to build up areas of the field that need extra P while applying excessive amounts to areas that are already very well supplied with this nutrient. These areas of over application could potentially contribute to runoff losses of soluble P and the environmental damage that it contributes to.

Mapping fields based on soil available P opens up 2 options for more efficient management of P. One is to increase annual application rates of fertilizer P to greater than crop removal on zones that require building of soil P, balancing removal with replacement on areas of adequate soil P, and reducing rates on areas of high soil P. This option may fit with some equipment designed to vary fertilizer rates from prescription files, but must place P in a way that seed is not damaged by the highest rates used. This could involve placing up to the safe rate of fertilizer P in the seed-row with any additional amounts applied in the sideband or mid-row band locations. The second option would be to apply relatively high quantities of fertilizer P on zones that test low to make a one-time correction to soil P. This could be done by banding P fertilizer, or broadcasting and using light tillage incorporations. A study conducted by Wager and others at the U of S demonstrated the effectiveness of this strategy. Available soil P was elevated from low levels to adequate levels with high rates of P. Additionally, wheat yields were higher over the 5 years following application, compared to where the same amount of total P was applied in annual increments.

The benefits of building soil P by applying high rates of fertilizer P was demonstrated in an ADOPT project in Northeastern Saskatchewan. During 2012-13 we applied fertilizer P on strips in 5 fields at rates that we estimated would be required to elevate soil available P to 15 ppm or more in zones testing under 15 ppm. The applications all increased soil available P to levels above 15 ppm. After application the fields were cropped by the co-operating farmers using practices they would normally use. This included applying fertilizer P at the same rate across the entire field. We were only able to get usable yield maps from 2 fields in 2013, 3 in 2014 and 2 in 2015. Yield responses from these fields indicated that the cost of these P applications could be more than offset in as little as 2-3 years. The demonstration is ongoing, and results from subsequent years will confirm whether benefits continue to accrue. A secondary benefit is that if soil P supplies are built up, growers could reduce application rates in years when fertilizer P costs are high while building soil P when P costs are lower.

THE SASKATCHEWAN SHELTERBELT CARBON LEGACY

Beyhan Amichev and Ken Van Rees
Centre for Northern Agroforestry and Afforestation, University of Saskatchewan, Saskatoon, SK

PROJECT DESCRIPTION

For the past five years we have been working on an Agriculture Greenhouse Gases Program (AGGP) project through AAFC to understand the role of shelterbelts in Saskatchewan in mitigating greenhouse gases (GHG). The project focused on several different questions including:

- shelterbelt inventory techniques
- biomass growth and carbon pools and fluxes
- radial tree growth
- carbon sequestration under future climate change scenarios
- economic and environmental benefits of shelterbelt planting
- shelterbelt carbon monitoring field protocols; and
- legacy shelterbelt design summaries for six common shelterbelt species.

Of the many shelterbelts species planted in Saskatchewan, six shelterbelt species were studied in this project: caragana (*Caragana arborescens* Lam.), green ash (*Fraxinus pennsylvanica* Marsh), Manitoba maple (*Acer negundo* L.), Scots pine (*Pinus sylvestris* L.), white spruce (*Picea glauca* Monch Voss.), and hybrid poplar (*Populus spp.*).

<u>AGGP and the people involved</u>

Canada signed onto the Copenhagen Accord in December 2009, where it committed to reduce its greenhouse gases (GHG) emissions to 17% below 2005 levels by 2020. As a part of this commitment, the Government of Canada created the AGGP program to support projects that will create technologies, practices and processes that can be adopted by farmers to mitigate GHG emissions. These projects were aimed to help farmers increase their understanding of GHG emissions and how they can help to mitigate GHG on their farms.

This project was facilitated through the Centre for Northern Agroforestry and Afforestation (www.saskagroforestry.ca) in the College of Agriculture and Bioresources at the University of Saskatchewan and the research team consisted of experts from the Geography Department at the University of Regina (Joe Piwowar), and Department of Agriculture and Resource Economics (Suren Kulshreshtha) and the Department of Soil Science (Colin Laroque, Murray Bentham, Beyhan Amichev and Ken Van Rees) at the University of Saskatchewan.

History of shelterbelts in the province

Saskatchewan has a long history with planting trees on the agricultural landscape starting back in 1870. Planted shelterbelts are the prevalent temperate agroforestry system used in the Canadian Prairies (Fig. 1). Shelterbelts have prevented soil erosion and reduced soil fertility loss, provide wildlife habitat and sequestered significant amounts of carbon from the atmosphere for more than 100 years. Up until the 1960s, shelterbelt establishment was uniform, situated immediately next to roadways, and in the 1970s and 1980s, shelterbelts were planted at cross road areas to control snow accumulation, while in the 1990s and 2000s, the use of field shelterbelts increased.

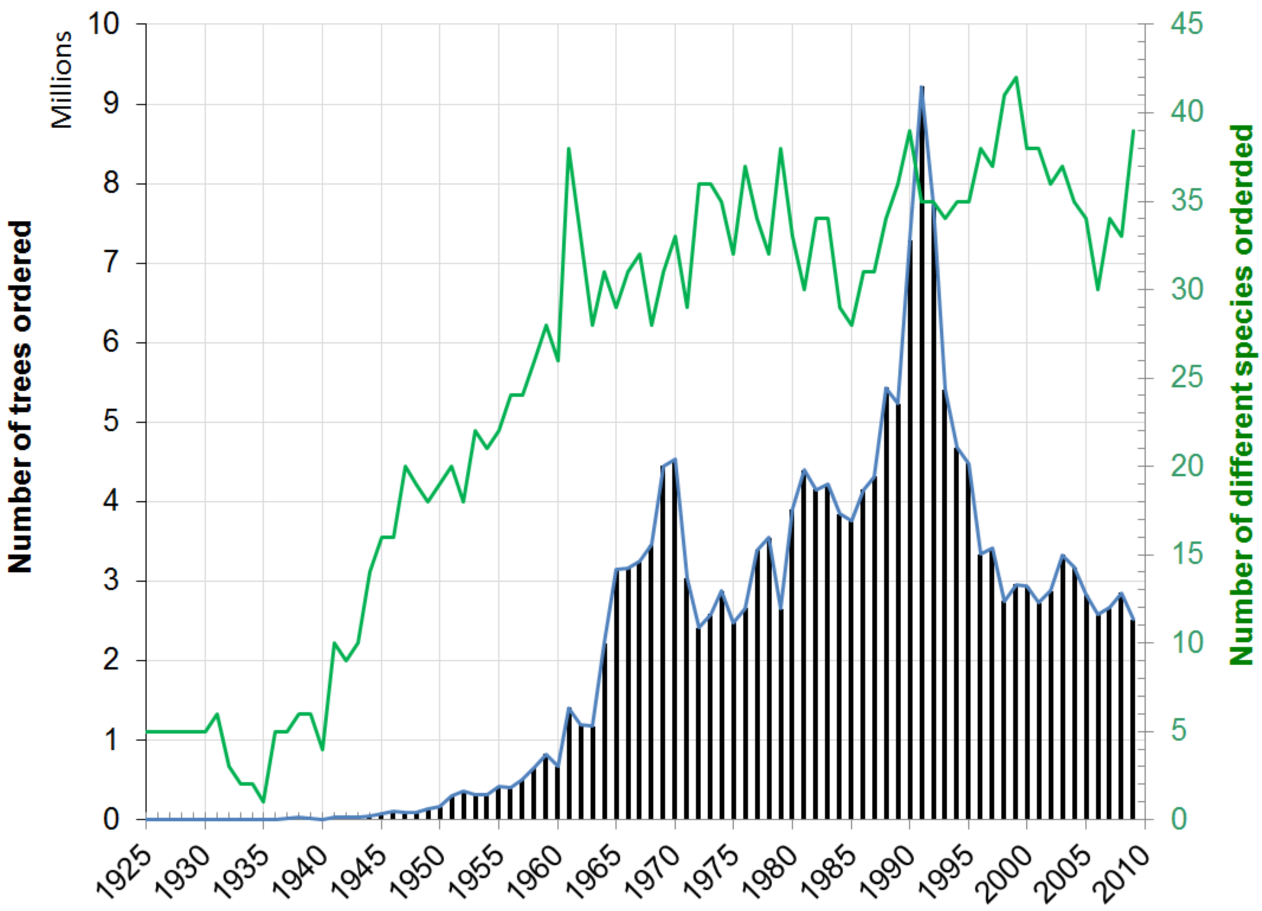


Fig. 1 Historical records of the number of shelterbelt trees and shrubs (bars) and number of different species (line) ordered through the Prairie Shelterbelt Program Centre in Indian Head, Saskatchewan.

PROJECT RESULTS

There are four major ecosystem services and environmental benefits of shelterbelts: (1) carbon sequestration, (2) biodiversity conservation, (3) soil enrichment, and (4) air and water quality improvement. This report will focus on quantifying the shelterbelt inventory in the province and how much carbon is stored in these shelterbelts.

The Saskatchewan shelterbelt inventory

There is a total of 51,653 km of shelterbelts (both farmyard and field shelterbelts) in Saskatchewan determined by digitizing existing shelterbelts from high-resolution aerial imagery. Surprisingly, farmyard shelterbelts (29,754 km) were more frequently planted than field shelterbelts (21,899 km). The majority of farmyard shelterbelts were planted with deciduous species (74%) such as hybrid poplar, followed by conifers > shrubs > mixed species. The majority of field shelterbelts were planted with shrub species (71%) such as caragana, followed by deciduous > mixed > conifer species.

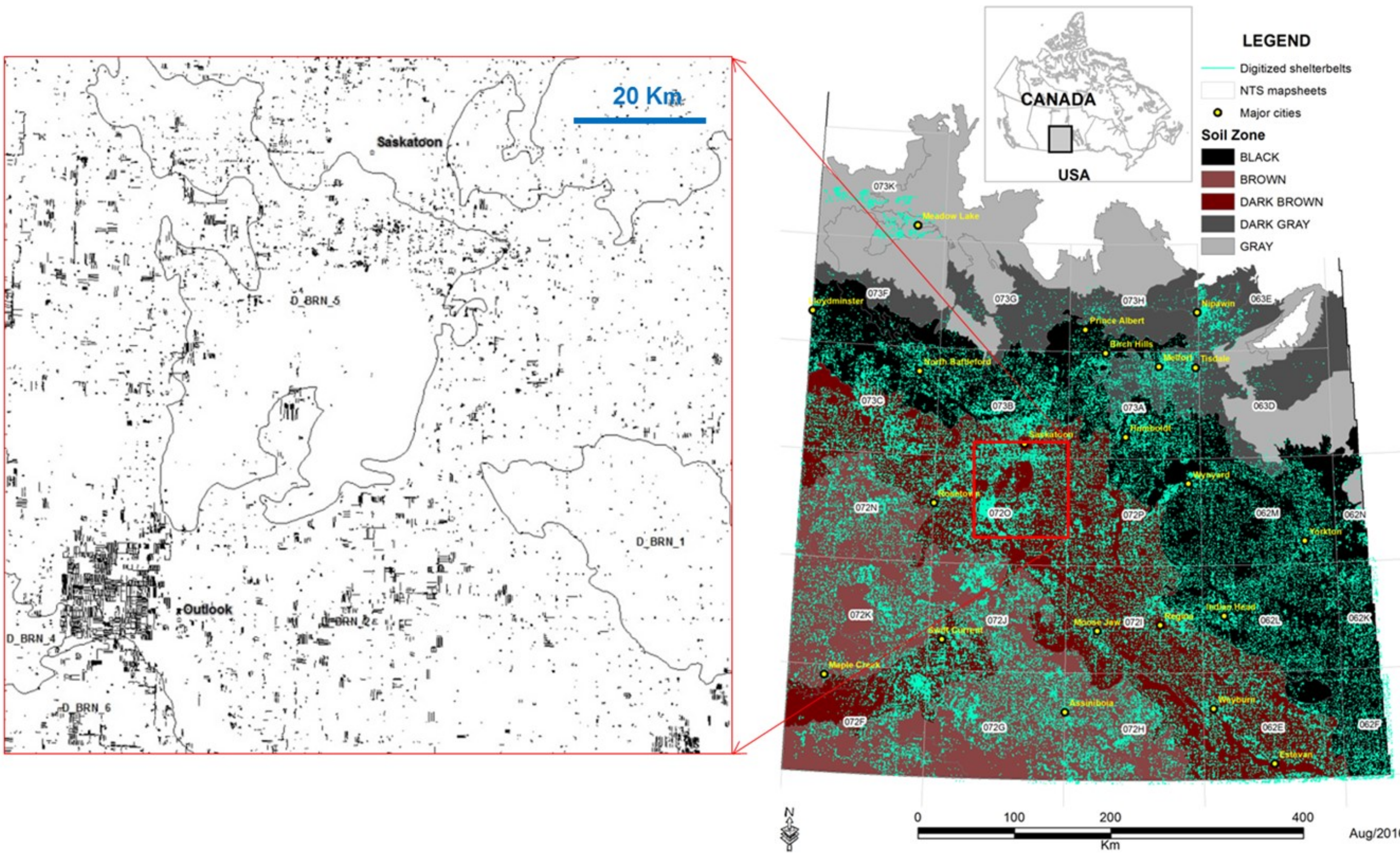


Fig. 2 Distribution of digitized shelterbelts across the five soil zones in Saskatchewan, and an example of an enlarged map of the shelterbelts around the Outlook/Saskatoon area.

Deciduous species were consistently the preferred choice for farmyard shelterbelt planting across all soil zones. Shrub species were preferred for field shelterbelts in the Brown, Dark Brown and Black soil zones, while conifer and deciduous species were found in the Dark Gray and Gray soil zones. The total length of planted shelterbelts within a soil zone ranged from 23,274 to 21 km in (descending order) the Dark Brown (23,274 km) > Brown (16,347 km) > Black (10,940 km) > Dark Gray (1,071 km) > Gray (21 km) soil zones. For the six species studied in the project, we estimated that shelterbelts that were planted in the last 25 years (since 1990) as a percent of those planted in the last eight decades (between 1925 – 2009) were as follows:

- 20% (7,053 km) of all caragana shrub shelterbelts (total of 35,245 km)
- 42% (2,482 km) of all green ash shelterbelts (total of 5,841 km)
- 23% (942 km) of all hybrid poplar shelterbelts (total of 4,144 km)
- 14% (375 km) of all Manitoba maple shelterbelts (total of 2,646 km)
- 30% (479 km) of all Scots pine shelterbelts (total of 1,573 km), and
- 35% (347 km) of all white spruce shelterbelts (total of 991 km)

The Saskatchewan shelterbelt carbon legacy

The carbon storage in the shelterbelts was calculated through destructive sampling of the shelterbelts and using carbon models developed for shelterbelts, and its distribution in Saskatchewan was mapped for the six shelterbelt species planted from 1925 to 2009. Shelterbelts were quantified within each of the 31 clusters which were created by combining ecodistricts of similar climate and soils. In general, a distribution analysis from south to north showed that shelterbelts consisted of mainly caragana in all of the Brown, Dark Brown, and half of the Black soil zones, followed by green ash and hybrid poplar shelterbelts. Conifer shelterbelt species (white spruce and Scots pine) were found mainly in the Gray and Dark Gray zones (latitude > 52°), (Fig. 3).

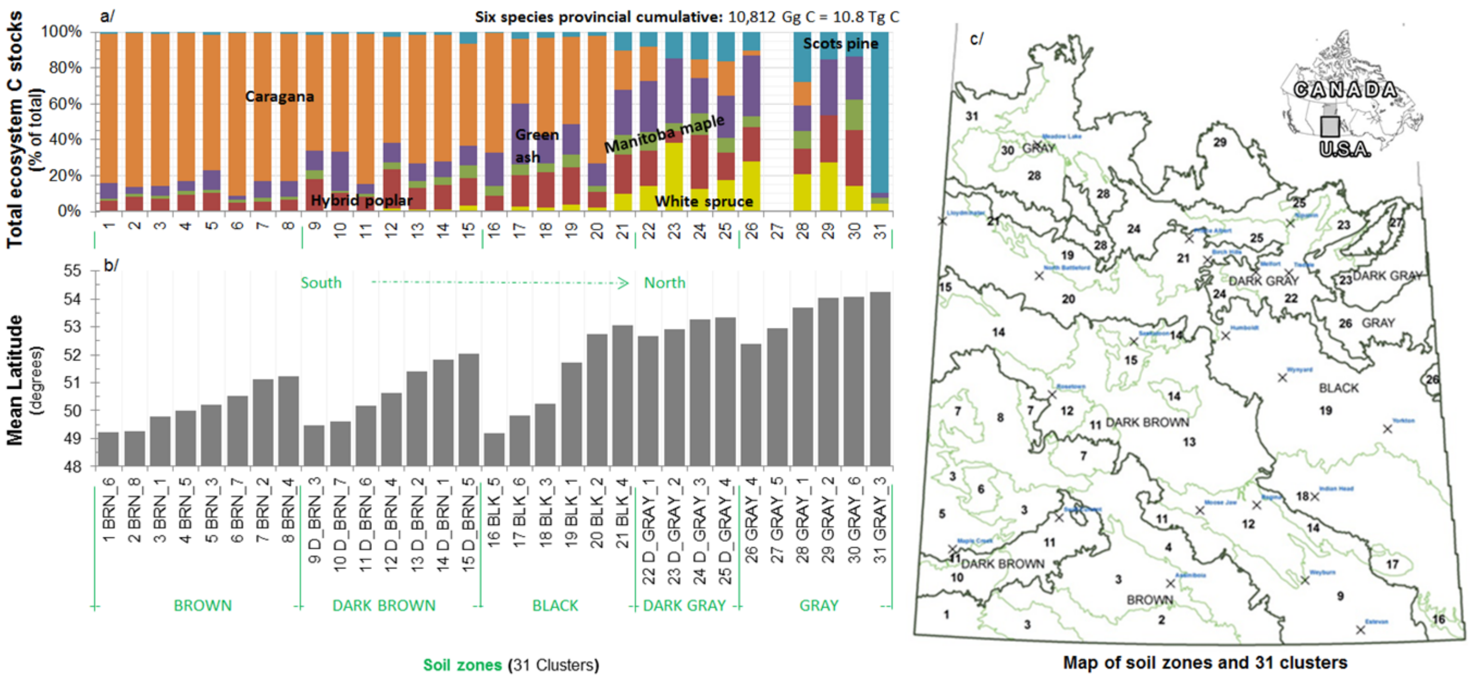


Fig. 3 Prevalence of six common shelterbelt species planted from 1925 to 2009 in Saskatchewan estimated as a percent of the provincial total ecosystem carbon stocks of each species by cluster (a), the mean latitude of the 31 clusters (b) and the location of the clusters by soil zone (c).

The amount of carbon in the soil (initially as well as that added over time) and in the shelterbelt biomass is referred to as total ecosystem carbon (TEC) stock and ranged from 0.13 to 7.86 Tg C (1 Tg, teragram = 1 million Mg) depending on the species. The cumulative amount of TEC stocks for all six species was 10.81 Tg C, and if you considered just the additions of C added to the soil and growing biomass from the time of planting the shelterbelts, there would be 4.85 Tg of C stocks additions (which could potentially be worth $267 million if C was worth $15 per Mg CO_2-eq.). About 78% of these C stocks additions (3.77 Tg C) occurred for shelterbelts that were planted since 1990. About 69% of the C stocks additions occurring since 1990 were from the large plantings of caragana shelterbelts, followed by hybrid poplar (15%) and green ash (9%). The estimated average C sequestration rate on a length basis (1 km single-row) for the six species studied in the project was as follows:

- 1.73-2.03 Mg C km^{-1} yr^{-1} in caragana shelterbelts
- 1.78-1.98 Mg C km^{-1} yr^{-1} in green ash shelterbelts
- 6.03-6.54 Mg C km^{-1} yr^{-1} in hybrid poplar shelterbelts
- 2.39-2.60 Mg C km^{-1} yr^{-1} in Manitoba maple shelterbelts
- 1.90-2.17 Mg C km^{-1} yr^{-1} in Scots pine shelterbelts; and
- 2.43-2.75 Mg C km^{-1} yr^{-1} in white spruce shelterbelts

FUTURE SHELTERBELT PLANTING AND C SEQUESTRATION

The estimated rate of C sequestration and the species distribution data were used together to identify the best locations for future planting of these six shelterbelt species. The projected C sequestration rates for future shelterbelt planting in the five soil zones of Saskatchewan are as follows:

Shelterbelt species	**Future predicted C sequestration rate** (Mg C km^{-1} yr^{-1})	**Soil zone** (with highest C rates)
Caragana	>2.0	Brown, Gray
Green ash	>1.8	Black, Gray
Hybrid poplar	>6.3	Brown, Dark Brown, Gray
Manitoba maple	>2.5	Black, Gray
Scots pine	>2.1	Black, Gray
White spruce	>2.6	Black, Dark Gray, Gray

Our results suggest that planting trees whether it is for shelterbelts or some other agroforestry system can be an important strategy for mitigating GHGs. If sequestering carbon in shelterbelts is going to be a mitigation strategy used by farmers then long-term maintenance and rejuvenation of these shelterbelts should also be considered. Future work will need to consider how climate change could impact shelterbelt species selection in order to maximize the carbon sequestration potential of this agroforestry system.

Saskatchewan
Soil Conservation
Association Inc.

Box 37029 North Park PO, Saskatoon, SK S7K 8J2 306.371.4213 info@ssca.ca

SUMMARY OF SPEAKING POINTS / KEY MESSAGES (Version 2)

Carbon Advisory Committee – October 2016

Saskatchewan growers using minimum or zero till are sequestering 8.75 million new tons of CO_2 every year on more than 23 million acres of farmland. That is the equivalent of taking 1.83 million cars off the road.

These figures come from the Prairie Soil Carbon Balance (PSCB) Project – a collaboration of the Saskatchewan Soil Conservation Association and soil scientists with Agriculture and Agri-Food Canada – that analyzed thousands of samples, taken at intervals over a 15 year period, from farms in all of the soil zones across Saskatchewan's grain growing regions.

The PSCB also proves that carbon sequestration does not decline over time as previously thought, but continues at a high rate deep into the prairie soil year after year, creating long-term carbon soil sinks. The Kyoto Protocol and Paris Agreement both recognized the role of anthropogenic carbon sinks as one of the most important long-term solutions to climate change.

The Federal government is proposing the year 2005 as an arbitrary baseline from which to begin measuring Canada's future emission reduction targets and its associated offsets and removals. The Carbon Advisory Committee (CAC) is very concerned about the baseline issue because that decision will determine how much soil carbon sequestration will be eligible under the climate change plan. The current 2005 proposal will eliminate any Saskatchewan soil carbon sequestration eligibility because our producers were early adopters of zero till. It is important to note that soil carbon sequestration is new sequestration each and every year and that we are not proposing any retroactive recognition for past sequestration. We make the technical argument that each offset requires a unique baseline, which will need further discussion subject to accepted international protocol development procedures.

The CAC proposes that a Soil Carbon Registry/Bank be developed to ensure a fair return to farmers by enabling them to register and to 'bank' the offsets they generate until they decide to sell them. The Saskatchewan Crop Insurance Corporation (SCIC) would be a natural partner in this project because of its long working relationship with growers and its previous expertise in the area of soil carbon offsets. The Soil Carbon Registry/Bank would be self-financing, with no cost to government over the long term.

If emitters of GHGs are penalized through the imposition of a carbon tax or emission reduction limits, it is reasonable that those who remove GHGs, through carbon sequestration or capture, should be compensated in equal measure.

The CAC is not advocating for either a carbon tax or a carbon trading system. The CAC wants to ensure that soil carbon sequestration is fully recognized and rewarded for its contribution to climate change reduction goals.

SPEAKING POINTS / KEY MESSAGES (Version 2)

Carbon Advisory Committee – October 2016

• In all of the discussion about soil sinks in Canada, the single most important fact is that the basic science is well established, conclusive and respected by soil scientists around the world.

• The 0.38 tons of CO2 per acre being sequestered every year by Saskatchewan growers using minimum or zero till (direct seeding) is the average of the scientific analysis of thousands of samples taken in 1996, 1999, 2005 and 2011 from all of the soil zones across the Saskatchewan grain growing regions.

• The total of 8.75 million new tons of CO2 being sequestered each and every year in Saskatchewan soil is the result of 23,034,000 acres (2011 Census) of minimum or zero till crop management in this province.

• The 8.75 million tons of CO2 being sequestered is the equivalent of 1.83 million cars being taken off the road (or well over twice the number of light motor vehicles registered in all of Saskatchewan in 2015).

• That research, the Prairie Soil Carbon Balance (PSCB) Project, was the result of the partnership and international leadership of the Saskatchewan Soil Conservation Association (SSCA) and the soil scientists with Agriculture and Agri-Food Canada (AAFC) in the early 1990s.

• Much of the previous scientific thinking about soil sequestration of CO2 was based on small plot research and incorporated into soil system computer models, the most notable one being the Century Model. The PSCB Project was initiated to move the science from small plots to the field scale.

• One of the early assumptions made in the Century Model, now proven false by the PSCB Project, was that carbon sequestration into the soil under zero or minimum tillage would decline over time and that soil would become saturated with the CO2 after a period of 20 to 30 years. The PSCB Project and other research in Saskatchewan proved that, in fact, the sequestration was going much deeper into the prairie soil than initially believed and that sequestration rates were continuing at a high level. Scientific clarification of the saturation issue, which is essential for the long term projections and use of the soil sink in meeting Canada's emission reduction goals, will depend on further research.

• More research is also required to establish the management practices that will maximize carbon sequestration in hay and pasture land.

• If emitters of GHGs are penalized through the imposition of a carbon tax on pollution or emission reduction limits, it is reasonable that those who are removing GHGs, through carbon sequestration or capture, should be compensated in equal measure.

• Grower ownership of the soil carbon offset, and the option to 'bank' that offset for sale at some future date, are the two critical elements necessary to ensure a fair return to farmers. The Alberta carbon offset trading experience, which required the use of aggregators for the sale of offsets, is a clear illustration of a system that did not provide a fair return to producers.

• We propose that a Soil Carbon Registry/Bank, for growers to register and to hold their offsets until they are sold, could be developed in Saskatchewan by a partnership between producers and the Saskatchewan Crop Insurance Corporation (SCIC). Saskatchewan growers will own a majority of the soil carbon offsets created in Canada and have a long history of involvement in the research and policy development for soil carbon. SCIC has experience with soil carbon offsets and a long working relationship with producers so they would be a natural partner in the development of the model.

• The Soil Carbon Registry/Bank should be self-financing, with no cost to government over the long term.

• The protocol to define a soil carbon offset or removal, whether it is developed by Canada or Saskatchewan, needs to be one that it is based on science and is accepted by international regulators. (It should be noted that the Carbon Advisory Committee will emphatically oppose any attempt to adopt the Alberta soil carbon protocol. It is an integral part of the systematic approach by Alberta to transfer value to the aggregators and to minimize the return to growers. We will also oppose any suggestion for retroactivity in the soil carbon offset program. Such an approach will so seriously complicate the administration and verification of the offsets that it would reduce the credibility and value of the offset.)

• On a separate but related topic, there will likely be serious consideration for an exemption from a carbon tax for the agricultural sector (as is the case in British Columbia). Significant research and analysis will be required so that growers can fully understand the financial implications of any potential national carbon tax exemption compared to a potential revenue stream through a carbon offset program. Any carbon tax exemption must consider all farm inputs, not just fuel alone.

• It is important to note that the Carbon Advisory Committee is not advocating for either a carbon tax or a carbon trading system. We do want to ensure that soil carbon sequestration is fully recognized and rewarded for its contribution to climate change reduction goals in either system.

• One of the comments often heard is that “farmers are doing direct seeding anyway, why should they get paid for it?” Grain growers are business operators with significant risks and highly variable income and as such, they need to be developing every possible revenue source from their farming activities, including payment for soil carbon sequestration. Look at slaughter plants and how they use every possible part of the animal being slaughtered to maximize revenue. And remember, society will have placed a value on the importance of carbon removal.

• A frequent criticism of soil carbon payment for direct seeding is the ‘business-as-usual’ (BAU) argument which says that any practice that involves well-established and widely-used technology is not creating ‘new’ sequestration to meet emission reduction goals and is therefore not eligible for offset or removal payment.

- The BAU language is not part of any of the text of the United Nations Framework Convention on Climate Change (UNFCCC or ‘the Convention’), the Kyoto Agreement or the Paris Agreement. It appears to have originated early in the climate change discussion by environmental activists who opposed the concept of offsets because they thought it was just an excuse for large emitters to avoid making changes.

- Many who make the BAU comment do not understand that direct seeding is creating new sequestration each and every year.

- But the key argument against the BAU criticism of carbon soil offsets for soil sinks is that it does not take into account the very high importance that the Kyoto Protocol and the Paris Agreement place on anthropogenic sinks and the need to maintain and increase those sinks if a long term solution to climate warning is to be found. For example (from a number of different references to sinks in the Paris Agreement):

Parties strive to include all categories of anthropogenic emissions or removals in their nationally determined contributions and once a source, sink or activity is included, continue to include it

Parties should take action to conserve and enhance, as appropriate, sinks and reservoirs of greenhouse gases as referred to in Article 4, paragraph 1d, of the Convention, including forests

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• But the most immediate and important concern is our understanding that federal officials, working with the federal-provincial climate change committees authorized by the First Ministers meeting in February, are considering the year 2005 as the baseline not only for Canada's climate change reduction targets <u>but for all other offset reductions</u> <u>and removals</u> that might become part of that climate change plan.

• A 2005 baseline for soil carbon removals will essentially eliminate the opportunity for the Province of Saskatchewan and our growers to make a significant contribution to the national climate change strategy. With the very high number of early adopters of direct seeding in Saskatchewan, as the result of promotion of direct seeding by SSCA and AAFC as a climate change initiative and as an effective soil management practice in the 1990s, Saskatchewan achieved a high level of sequestration by 2005 which will be ineligible for the climate change strategy.

• Our research of the climate change policy literature has found a credible argument that each offset and removal should have a <u>unique</u> baseline. The fundamental premise is that each baseline should be determined by the specific policy intervention that was the reason (but not the only reason) for the increased activity in that particular project or removal. (Refer to the paper entitled: "What is Additionality? Part 1: A long standing problem" Discussion Paper No. 001, January 2012. Version 03, authored by Michael Gillenwater, and published by *GHG Management Institute*)

• It might be useful to look at a forest as an analogy for Canada's emission reduction activities to meet its climate change goals. The federal use of 2005 as a baseline for all offsets envisions a forest with all the trees the same age. We expect that everyone would agree that is clearly a less than optimum ecosystem. A healthy forest would have a variety of trees with a range of age that provides a better foundation for the forest to maintain itself over time. The unique baseline criterion allows for that variety of long term emission reduction activities, reinforcing the Paris Agreement's vision for the role of anthropogenic sinks and removals.

• It is clear that if the arbitrary decision to assign a 2005 baseline for carbon soil offsets is not corrected, the Province of Saskatchewan and its growers will have lost the opportunity to make a major long-term contribution to Canada's climate change strategy.

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Box 37029 North Park PO		Gerry Burgess	
Saskatoon, SK S7K 8J2		306-371-4213	info@ssca.ca

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Disclaimer: The opinions of the authors do not necessarily reflect the position of the Saskatchewan Soil Conservation Association.

MANAGING FOR SOIL HEALTH – WHAT DOES IT MEAN TO YOU?

The 29th Annual Conference of the
Saskatchewan Soil Conservation Association

Monday, January 9th, 2017

Western Development Museum – Saskatoon

8:00 am	**Registration Opens**
8:45 am	**Welcome and Opening Remarks**

Soil Health Management Session

9:00 am	**Can You Tell if Your Soil is Healthy?** Dr. Reynald Lemke, Research Scientist, Agriculture & Agri-Food Canada, Saskatoon
9:30 am	**Creating Regenerative Agriculture with Holistic Management** Blain Hjertaas, Farmer, Redvers, SK
10:00 am	**Crop Rotations with Pulse Crops – Optimizing Nitrogen Fixation Benefits** Dr. Diane Knight, Department of Soil Science, University of Saskatchewan
10:30 am	**Refreshment and Networking Break**
10:45 am	***Keynote Speaker:* Regenerating Landscapes for a Sustainable Future** Gabe Brown, Rancher, Brown's Ranch, Bismarck, North Dakota, USA
12:00 pm	**Luncheon**

Diversity Session

1:00 pm	**Multi-Species Cash-Cropping on My Farm** Colin Rosengren, Producer, Midale, SK
1:15 pm	**Cow/Calf Operation on My Farm** Tim Nerbas, Producer, Waseca, SK
1:30 pm	**Mixed Farming with Cows, Perennial Pastures & Crops on My Farm** Ryan Boyd, Producer, Forrest, MB
1:45 pm	**Integrating Livestock, Grain, and Cover Crop Cocktails on a Mixed Farm** Garry Richards, Producer, Bangor, SK
2:00 pm	**Producer Panel** Moderated by Paul Thoroughgood, Ducks Unlimited Canada & SCCC
3:00 pm	**Refreshment and Networking Break**
3:15 pm	***Closing Speaker:* Maximizing Your Farm** Gabe Brown, Rancher, Brown's Ranch, Bismarck, North Dakota, USA
3:45 pm	**Wrap-up**
4:00 pm	**SSCA AGM**

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KEYNOTE SPEAKER—GABE BROWN

The SSCA is pleased to announce that Gabe Brown, one of the pioneers of the current soil health movement which focuses on the regeneration of our resources, will be the KeyNote speaker at the 2017 Conference—and in fact, his appearance here will be one of his last speaking engagements.

Gabe, along with his wife Shelly, and son Paul, own and operate a diversified 5,000-acre farm and ranch near Bismarck, North Dakota. Their ranch focuses on farming and ranching in nature's image.

The Browns holistically integrate their grazing and no-till cropping systems, which include a wide variety of cash crops, multi-species cover crops along with all natural grass finished beef and lamb. They also raise pastured laying hens, broilers and swine. This diversity and integration has regenerated the natural resources on the ranch without the use of synthetic fertilizers, pesticides and fungicides.

The Browns are part owners of a state inspected abattoir which allows them to direct market their products. They believe that healthy soil leads to clean air, clean water, healthy plants, animals and people.

Over 2,000 people visit the Brown's Ranch annually to see this unique operation. They have had visitors from all 50 states and 18 foreign countries.

"Soil is a biological system. Its health provides the nutrients we need to sustain life thus it must be the focus of our operation."

SOIL HEALTH MANAGEMENT SESSION

Can You Tell if Your Soil is Healthy?
Dr. Reynald Lemke—Research Scientist, Agriculture & Agri-Food Canada, Saskatoon

It is virtually a truism that healthy soils are a vital aspect of sustainable crop production and, therefore, critical to human survival. There is rather less agreement on how exactly to define soil health, and less agreement yet on how it can be measured. In this presentation I will attempt to distill the current discussion about how soil health could be defined, and how we might develop standardized, meaningful measurement strategies that can be related to productivity and/or other ecosystem services. Examples from long-term crop production studies in Saskatchewan will be utilized to illustrate specific discussion points.

Creating Regenerative Agriculture with Holistic Management
Blain Hjertaas, Farmer, Redvers, SK

Blain has 40 plus years of farming experience, last 20 managed holistically. His presentation will give a brief description of Holistic Management:
- 4 ecosystem processes
- What puts carbon down and builds soil
- Importance of healthy soil to human health

Crop Rotations with Pulse Crops—
Optimizing Nitrogen Fixation Benefits
Dr. Diane Knight, Department of Soil Science, U of S, Saskatoon

This talk will address how nitrogen fixing crops best fit into Saskatchewan crop rotations. Traditionally, investigators have examined the nitrogen and non-nitrogen benefits of including pulse crops in rotation on the next crop gown in rotation, but not how the cropping sequence affects the pulse crop itself and specifically how cropping sequence affects biological N fixation. Also to be discussed are the underground inputs from roots and rhizodeposits and their contributions to nutrient cycling and overall soil quality and ultimately soil health.

DIVERSITY SESSION—PRODUCER PANEL

Multi-Species Cash-Cropping on My Farm
Colin Rosengren—Producer, Midale, SK

Colin will discuss the principles behind multi-species cash-cropping systems; talking about the theory, the goals, the benefits, and the challenges of such a system. He will tackle the issue from an agronomic, economic, and logistical perspective; sharing his diverse experience gained from intercropping for 12 years, over 25,000 acres and numerous crop combinations, row configurations, placements, and timings, right up to his current practice of multi-species site-specific planting.

Cow/Calf Operation on My Farm
Tim Nerbas, Producer, Waseca, SK

Tim Nerbas manages NRG Farms Ltd., a mixed farm operation, with his wife, Diane. Tim was on the SSCA board for many years and will have many entertaining stories to tell about his farming experiences.

Mixed Farming with Cows, Perennial Pastures and Crops on My Farm
Ryan Boyd, Producer, Forrest, MB

I will highlight our experiences with planned grazing of our perennial pastures and mixed species annual polycrops. I will discuss the changes we have seen regarding soil structure, water holding capacity, etc. I will discuss why we think soil health is a priority and what motivates us to do what we do. Also, I will talk about some of the challenges we have been faced with trying to implement a system of continuous year-round green growing roots within the annual cropping system and some experiences we have had switching to a low disturbance zero till system vs. "conventional" zero till. Furthermore, I can touch briefly on what we will be trying to implement on the farm next season regarding soil health.

Integrating Livestock, Grain, and Cover Crop Cocktails on a Mixed Farm
Garry Richards, Producer, Bangor, SK

Garry will give an introduction to cover crop cocktails—what they are and what they do—as well as why they grow cover crop cocktails on their farm. He will speak about how they have used cover crop cocktails and the results they have seen. Garry will also give practical examples of how cover crop cocktails can be used on your farm.

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