Contribution of Saskatchewan Agriculture to Greenhouse Gas Emissions

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Introduction

In many private and public circles, global climate change has been a frequent topic discussion. Canadian farm circles are equally, if not more, concerned about this phenomenon The Canadian public is also concerned about future climatic variability and change. In fact, initiation of a major "Country Canada Study" on this topic by Environment Canada, and a major effort on this phenomenon in the Canada's Green Plan stand as witness to the importance of this topic.

The agriculture industry has a special role to play in the context of global climate change. On one side, it is bound to be affected by the climatic variability, whereas on the other side it is also a part of the problem, since some of the emissions of greenhouse gases originate from various production and management related activities.

In order for Saskatchewan farmers to participate in any meaningful discussions on this subject, more information is needed which would enable them a fuller understanding of the issues. Armed with this knowledge, farmers have the ability to devise methods to either adapt to the changing climate, or participate in mitigating the global warming effect.

Objectives of the Study

The major objective of this paper is to provide estimates of emissions of greenhouse gases from Saskatchewan agriculture. These emissions are related to various activities for crop and livestock production in the province. In addition, effect of adopting selected mitigative measures on emission level under future agricultural situation are also shown

Place of Agriculture in Greenhouse Gas Emissions

Agriculture world-wide is a major contributor to emissions of greenhouse gases. Let us first identify the major greenhouse gases. Three gases are commonly referred to as the greenhouse gases. These are carbon dioxide, methane, and nitrous oxide. Agriculture contributes to emissions of each of these gases but in a different proportion. Details are shown in Table 1.

Inabsolute quantities, emissions of carbon dioxide are the largest, and nitrous oxide are the smallest. However, one should not draw the inference that nitrous oxide emissions, being very small are insignificant. Their significance is judged in terms of their potential to global warming. Methane and nitrous oxide are 21 and 3 10 times, respectively, more powerful than carbon dioxide in terms of global warming. One aspect of Canadian agriculture in this context is that it contributes, relative to the world, significantly less to the emissions of all greenhouse gases.

Table 1: Contributions of Agriculture to Total Anthropogenic Emissions of Greenhouse Gases, World and Canada

Particulars	Unit	Global	Canada
Total Anthropogenic Emissions Of	mt/yr		
Carbon Dioxide		24,933	467
Methane		340	3.7
Nitrous Oxide		3.8	0.11
Share of Agriculture for	% of		
Carbon Dioxide	Total	26	4
Methane		65	26
Nitrous Oxide		92	29

Method of Analysis

The estimation of emissions of greenhouse gases (GHG) from Saskatchewan was carried out using an integrated economic planning and GHG emissions model. The planning model, known as the Canadii Regional Agricultural Model, was already developed by Agriculture and Agri-Food Canada, Policy Branch The GHG Emissions model, that was developed for the project, was regional in nature, with the province being divided into nine crop production zones (almost consistent with the crop districts). Crop production in the model was permitted using various rotations (on stubble and on summerfallow) as well as three types of tillage practices – conventional tillage, moderate (or minimum till) and zero till. For the livestock production, the province as a whole was used.

The major greenhouse gases were considered in the model: carbon dioxide, methane, and nitrous oxide. Eleven production related activities were accounted for. Eight of these were for **crop production:** (1) Burning of biomass; (2) Burning of fossil fuels; (3) Crop residues; (4) Loss of soil organic matter; (5) Production of nitrogen fixing crops; (6) Use of fertilizer; (7) Use of manure either directly (through pasture animals) or through confined animals; and (8) Use of farm chemicals. The other three were for **livestock production,** and included: (9) Animal waste; (10) Raising of livestock; and (11) Livestock management related activities. Although conceptually each of these activities could contribute to the emissions of the three greenhouse gases, only those emissions that were significant, and/or for which level of scientific confidence was high, were included.

Saskatchewan Agriculture Production – Now and Future

Saskatchewan is primarily a cereal growing region, with some mixed farming in certain parts of the province. The Saskatchewan land use, along with dominant crop mix in 1990 are shown in Table 2. Of the total agricultural area of 25.6 million ha, 18.19 million ha, or 71% is under crops. In addition, about 4% of this area is under hay and forage crops, over and above the pasture

lands (both improved and unimproved) which constitutes almost a quarter of the total agricultural lands.

Major crop in the province include wheat, and durum, which are roughly 56% of the total area under crops. In many regions of the province, wheat is grown in rotation with summer-fallow, which constitutes almost 30% of the total area under crops. Speciality crops (such as lentils, and field peas) are only beginning to be a major crop in the province.

Table 2. Saskatchewan Land Use, 1990

Particulars	Area in Thos. Ha	% of Total Area	% of Total Cropland
Cropland	18,190	71.0	
wheat&Durum			47.2
Canola & Flax			8.6
Spec. Crops			1.4
others			13.2
summerfallow			29.6
Haylands	940	3.7	
Improved Pastures	1,080	4.2	
Unimproved Pasture	5,400	21.1	
Total	25,610	100.0	100.0

Source: CRAM Output

The livestock base of the province included in the model consisted of 955 thousand beef cows (not including replacement cattle, stocker calves, and feeders), and 88 thousand hogs. In addition, the province has 43 thousand dairy cows (excluding dairy heifers and dairy calves), and 15.1 million poultry birds (broilers, layers, and turkeys).

Current and Future Levels of Emissions

In 1990, it is estimated that Saskatchewan agriculture generated an annual level of emissions of the three greenhouse gases of 12.2 Mt (or 12.2 million tonnes). Please bear in mind that this is the amount in terms of Global Warming Equivalent (GWE), where all gases are converted into carbon dioxide equivalent using their long-term potential for climate change. About a quarter of this was from crop production related activities, and the rest from livestock production. Major GHG emitted from livestock production is methane, whereas carbon dioxide is the major GHG from crop production Relative to Canada

Table 3. Current (1990) Levels of Emissions, in kt/yr, of Greenhouse Gases, in Global Warming Equivalents', Saskatchewan

Particulars	Crops	Livestock	Total
Carbon Dioxide	5,385	139	5,524
Methane	0	2,545	2,545
Nitrous Oxide	3,949	192	4,141
Total	9,334	2,876	12,210
% of Total Sask. Emissions	76.4	23.6	100.0
% of Canadian Agric. Emissions	00	00	19.5

Global Warming Equivalence of methane in terms of carbon dioxide is 21, and that ofnitrous oxide is 310.

Source: Estimation

as a whole, Saskatchewan emissions are roughly one-fifth of the total emissions, although for crop production, share of Saskatchewan is slightly higher at 35% of the total Canadian emissions from crop production related activities.

Distribution of the total Saskatchewan emissions from agriculture by various GHG emitting activities is shown in Figure 1. Use of fossil fuels, loss of soil organic matter from present tillage practices, and emissions from crop residues are the three significant sources of emissions from agriculture.

How would these emissions levels change in the future? To estimate these, we first had to project the crop mix and livestock herd for the province for the year 2010. Second, change in the emissions coefficients for various crop and livestock activities were also estimated. Inmost cases, we assumed that these levels will remain unchanged, except for the release of carbon dioxide from soil carbon. Studies on the future levels of these emissions suggest that by the year 2010, Saskatchewan soils would be in balance – net emissions from the loss of soil carbon would be zero. Under these assumptions, forecasted level of GHG emissions from agriculture are shown in Table 4.

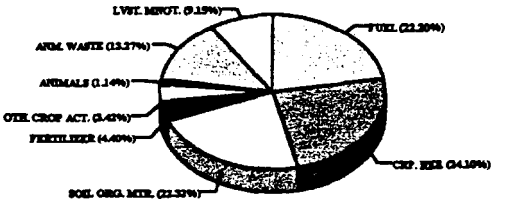

Figure 1: Distribution of Saskatchewan 1990 GHG Emissions, by

Results suggest that GHG emission levels from Saskatchewan **agriculture** will increase in20 10 to 13.6 MT per year – an increase of about 12% of the base level.

Table 4. Estimated Level (2010) of Emissions, in Thousand Tonnes per year, of Greenhouse Gases from Saskatchewan Agricultural Production

Particulars	Crop	Livestock	Total
Carbon Dioxide	5,259	159	5,418
Methane	0	3,000	3,000
Nitrous Oxide	5,032	208	5,240
Total	10,291	3,367	13,658
% of 20 10 Total Emissions	75.3	24.7	100.0
% Change from 1990 Emission Level	10.2	17.0	11.9

Source: Estimation

A slightly larger increase in these emissions would be through increases in livestock production related emissions. Here a 17% increase from the base level is estimated. In terms of

individual gases, by 2010, emissions for carbon dioxide are expected to decline by almost 2% of the base, whereas those for methane and nitrous oxide are to increase by 17.8% and 26.5% of the base level, respectively. The decrease in the emissions of carbon dioxide are to be realized through the Jack of loss of soil carbon through conventional tillage practices. In 20 10, crop residues and use of fossil fuels remain as the dominant sources of greenhouse gases.

Mitigative Measures

At the Earth Summit, held in Rio de Janiero in 1992, Canada signed a document called " Framework Convention on Climate Change". Under this convention, various signatories were expected to develop measures to reduce the level of anthropogenic emissions in the future. The question is, how can Saskatchewan farmers reduce these emissions? What likely measures are available to them to undertake such mitigation? What about other likely future changes in the provincial agriculture -what likely impacts could such paths have on emission levels. Answers to some of these questions were analyzed using the GHG Emissions model.

Although many different types of mitigative strategies can be visualized, for many the scientific data is still in somewhat preliminary stages. However, there are number of things that are more popularly talked about in various circles. Some of these became the basis for the development of scenarios for this study. A total of seven scenarios were selected for the study. These included:

1. Doubling of conservation tillage practices by 2010
2. Decrease in the summerfallow area by 25% of the base period
3. Reduce fertilizer use by 10% of the base level
4. Improve Fuel Use Efficiency of Farm Machines by 10%
5. Improve Efficiency of Manure Handling Systems
6. Improve the Rumen Efficiency of Farm Animals
7. Increase in the Red Meats Production (50% increase in beef cattle and doubling of hogs) in 2010

Changes in the emission levels under these scenarios are presented in Table 5. The changes are also reported in terms of the base scenario for the year 2010. Under this base scenario, it was assumed that farmers would undertake no additional mitigative measure to reduce GHG emissions. However, one should keep in mind that Saskatchewan soils were assumed to be in equilibrium, relative to the rate of change in soil carbon.

Results suggest that any additional measures such as the reducing summer-fallow area, or increasing the area of conservation tillage systems would not lead to significantly lower emission levels. The reason for this negligible change in the total emissions is, as noted above, is the predicted state of soil carbon dynamics in the future. Another proposed method of mitigation to reduce fuel use through improving efficiency of farm machinery and / or to reduce fertilizer use. Both of these measures do lead to reduced emissions levels. Total emissions in GWE are estimated to decrease to 13.4 million tonnes per year, but this is only a decrease of 2% of the forecasted level. Similar results

in the reduction of total emission levels are 'expected if farmers were to reduce fertilizer use by 10%.

In Saskatchewan there are already some trends to increase red meat production, particularly hogs. Thus, in this study, in addition to examining inputs and technology, an alternate path of agricultural development was examined. This involved increasing red meat production, such that beef cow numbers will increase by 50%, and hog numbers would double. What implications does this enhanced level of livestock for greenhouse gases emissions, and finally for the global climate change. Answer for this scenarios is shown in Scenario 7 in Table 5. Emissions of various GHG are estimated at 16.3 million tonnes per annum, which is 19.3% higher than the emissions from the base livestock herd.

Table 5. Change in the Total Emissions of Greenhouse Gases (in GWE), from Saskatchewan Agriculture

Particulars	Emissions in Thousand Tonnes	% Change from Base Level
Base 20 10 – No Mitigation	13,658	·
Scenario l- Conservation Tillage	13,452	-1.5%
Scenario 2 - Reduce Summer fallow	13,649	0
Scenario 3 - Reduce Fertilizer	13,404	-1.9%
Scenario 4 - Reduce Fuel Use	13,359	-2.2%
Scenario 5 - Improve Manure Handling	13,154	-3.7
Scenario 6 - Improve Rumen Efficiency	13,543	-0.8
Scenario 7- Increase Livestock	16,299	+19.3

Source: Estimation

Conclusion

Agriculture is part of the puzzle of global climate change, a phenomenon commonly called global warming. Saskatchewan agriculture's contributions of about 12.2 million tonnes (GHE) per year in 1990, is predicted to increase to 13.6 million tonnes by the year 2010. This increase would occur under the assumption that no mitigation measures are undertaken to reduce the emissions, and that the enterprise mix, particularly the size of the livestock numbers on farms, remains constant. Increased livestock production could increase our emissions levels by almost one-fifth by the year 2010. Conventional measures, such as improving fuel efficiency, manure handling systems, and rumen efficiency may help but only marginally. Herein lies the challenge facing the agriculture industry. If it has to participate in lowering its emissions of greenhouse gases, more innovative solutions are to be devised. Furthermore, adoption of some of these measure may also affect the farmers adversely. If such is the case, what incentives are there for farmers to adopt such measures. The global community must address these issues prior to embarking on imposing sanctions for reducing agricultural emissions.

References

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