Brief for Senate Standing Committee on Agriculture and Forestry
Ottawa, Ontario, Canada - April 29, 2003

Siân Mooney, Assistant Professor, University of Wyoming

Mr. Chairman and Members of the Committee. Thank you for the opportunity to appear today to discuss agricultural adaptation to climate change. My professional background and training is in agricultural economics. I have conducted two studies that consider the impacts of climate change on agriculture in the Canadian Prairie Provinces and more recently I have directed my research toward greenhouse gas mitigation using agricultural practices. I am appointed to the Wyoming Governor's Carbon Sequestration Advisory Committee, served the Montana Governor's Carbon Sequestration Group, provided technical assistance to the National Carbon Offset Coalition and am a member of the Consortium for Agricultural Soils Mitigation of Greenhouse Gases (CASMGS).

Climate change is likely to have several effects on Canadian agriculture. These can be classified into two categories, biophysical effects and economic effects. The overall outcome for Canadian agriculture i.e. whether climate change is beneficial or detrimental, will be determined by a combination of both factors.

a) Biophysical Effects

The Intergovernmental Panel on Global Climate Change and numerous individual researchers agree that changes in temperature and precipitation will change crop yields and thus crop varieties and crop types that are suitable in any given region. The direction of yield changes and the types of new crops that could become suitable for Canada will depend on the realized climate change scenario. The IPCC and many other studies show that crops receive a CO_2 fertilization effect that can increase yields and improve crop water use efficiency. Overall yield changes are dependent on many factors. A recent report by Henry Hengeveld of the Meterological Service of Canada showed that four climate models predicted a mean summer temperature change of between 2^{o}C to 3^{o}C in Southern Alberta by 2050, winter temperatures were predicted to increase slightly more (between 2.5^{o}C to 4.5^{o}C), while winter precipitation was predicted to change very little or increase. Unfortunately these models did not agree on the direction of change for summer precipitation, some predicted increases while others predicted decreases. Crop model predictions of yield changes will differ depending on the climate scenario chosen for their analysis. Another important factor for crop production will be future climate variability, the frequency of extreme weather events and the timing of critical weather events such as the occurrence of rainfall for seed germination at an appropriate time. Climate models are in general agreement on global mean temperature and precipitation changes however local and regional changes are much harder to predict and it is these changes that will drive production within any region.

Land suitable for agricultural production could increase in Southern Canada and some land could be brought into production in the far north if soils are suitable. An increase in mean temperatures as a result of climate change will increase the number of growing degree-days and lengthen the growing season in many areas. Two studies published in 1980 discuss soil and agro-climatic limitations north of the 55th parallel. They suggest that under a warmer climate there might be as much as 1.44 million hectares of land in northern Alberta, Saskatchewan and Manitoba that could be brought into production. This area is currently class 4 soils – the lowest class able to sustain agricultural production.

Yield changes, varietal changes and crop type changes combined with an increase in land area suitable for agricultural production will together determine the biophysical potential for crop production. i.e. what can be produced and how much can be produced.

b) Economic Effects

Market prices are also an important factor in determining the economic effects of climate change. The prices received for many agricultural commodities are determined in a global market place. Thus production changes in Canada and the rest of the world will determine how global commodity prices will change. Few studies have estimated global prices under climate change.

Many other economic factors could be modified as a result of climate change, for example, fuel and energy costs. These will alter input costs for agricultural activities. Adjustments in yields, suitable crop types, output prices and input costs will change the potential agricultural profitability of many areas. Land prices are in part driven by the potential of each hectare to generate economic profit. It is likely that climate change could adjust relative land values across Canada. In areas where agriculture becomes more profitable we expect that agricultural land prices will increase.

c) Overall Outcome

The overall outcome for Canadian agriculture will be determined by a combination of biophysical changes and economic effects. For example, if the yield of a particular crop declines in Canada, but the global market price goes up the overall effect could be beneficial to those crop producers. Conversely, if a particular crop yield increases in response to climate change and that increase is matched in several countries, global market prices might fall and the overall effect could be detrimental for those crop producers. Many other potential variations are possible. It is important to note that information on yield change is not sufficient on its own to provide any insight into the economic effects of climate change on Canadian agriculture. Biophysical effects must be combined with economic data to provide the full picture.

In an early study of the impacts of climate change on agriculture in Manitoba, I estimated crop yield changes under a $2*CO_2$ scenario that was warmer and drier that at present using a crop growth model run by Agriculture Canada. This model predicted yield reductions for several major prairie crops, but indicated that some high valued crops could be grown over a more extensive region ultimately resulting in a positive economic outcome. A second model matched the predicted temperature under a $2*CO_2$ scenario with existing temperatures in the US. Results suggested that climate would move approximately 650 km northward to Canada, and thus crop yields from the Dakota's, Minnesota and Montana were used as proxies for Canadian yields under a changed climate. These yields represented a climate that was slightly warmer and wetter than historical climate averages. Both scenarios indicated that net revenue for the area could increase (as a result of growing higher valued crops and using a larger land base for agricultural production) although net revenue per hectare declined in some cases. This study did not attempt to estimate how global market prices might respond to climate change.

d) Adaptation response

It is unlikely that a single "best" response to climate change will emerge. Adaptation to climate change will vary spatially in response to heterogeneous biophysical and economic conditions. Maintaining an agricultural sector that is flexible could be an important adaptation strategy, that is avoid adopting policies that encourage producers to lock in current practices and prevent change. Early economic incentives to encourage the adoption of best management practices given our current knowledge could be misplaced and reduce the incentive for producers to make

necessary incremental changes over time. Activities that could smooth adaptation are efforts to educate producers about possible future scenarios, improvements in medium to long term forecasting and risk management tools.

e) Possible Opportunity – Agricultural Soil Carbon Sequestration

One opportunity for agricultural producers as a consequence of increasing atmospheric concentrations of greenhouse gases is agricultural soil carbon sequestration. Several studies in the US and Canada have indicated that agricultural soils could store more carbon than they do at present. Estimates from my own studies for the dryland crop system in Montana suggest that between 0.1 and 0.6 metric tonnes/ha/yr can be stored in agricultural soils in that region. Other areas can have higher or lower potential to sequester soil carbon. Although each hectare does not store a large quantity of carbon per year in comparison to other carbon sources for example, forestry; Canada and the US are relatively land rich with millions of hectares. Overall these could sequester a large quantity of carbon. Estimates for the US suggest that cropland agriculture could sequester between 75 to 208 million metric tonnes of carbon per year (up to eight percent of US emissions). Several studies have examined the costs of soil carbon sequestration in Montana and Iowa and concluded that it is possible to sequester soil carbon in these areas at prices that are competitive with forestry and other carbon sources. Markets for greenhouse gas credits are beginning to emerge globally, even in countries that have not ratified the Kyoto protocol. This new market activity could provide benefits for some Canadian agricultural producers and increase their enterprise diversification as well as possibly reduce atmospheric concentrations of greenhouse gases.