

The Carbon Sink Potential In Saskatchewan

Report of an Expert Workshop held at
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Introduction

Climate change is now accepted as a reality, and has the potential for severely affecting ecological and economic systems in Saskatchewan. Carbon dioxide (CO₂) concentrations in the atmosphere have increased from 280 parts per million before the industrial revolution to about 370 ppm today. This increase is thought to play an important role in the global warming that has been observed in the past few decades; this could have important consequences for Saskatchewan. Recent analyses (IPCC 2001) indicate that north-central North America could experience mean annual temperature increases of 3°C - 5°C, with greater than average warming in both winter and summer. Precipitation will likely increase in the winter, but changes in summer precipitation are not well understood. Under a warmer summer climate, evaporation will increase, so soil moisture deficits could become more common. Increased temperatures will allow plants to grow more quickly, but increase growth will be limited where soil moisture availability declines. There is an expectation of increases in plant insect and disease outbreaks, and of increase frequency and severity of forest fires. Many other impacts are likely in the Canadian prairies; for further details see Herrington et al. 1997; IPCC 2001; Johnston 2001a,b; Kulshreshtha 2001; Nyirfa and Harron 2001 and Wheaton 2001a,b,c.

Society's response to climate change falls into two broad categories: adaptation and mitigation. Adaptation refers to changing human activities in order to cope with and perhaps reduce the severity of climate change impacts; the implicit assumption is that climate change will occur and that prevention is not possible. In contrast, mitigation refers to activities designed to prevent climate change from occurring. This would be accomplished by reducing the atmospheric concentration of greenhouse gasses (GHGs), either through reducing emissions to the atmosphere or increasing removals from the atmosphere by biological or geological sequestration. Removal of GHGs through biological sequestration is referred to as a biological carbon sink, and is the subject of this report.

Background

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted by Canada following the Environmental Summit in Rio de Janeiro in 1992. According to the UNFCCC, countries agreed voluntarily to reduce their carbon dioxide emissions to 1990 levels. A review of progress toward this goal was held in 1995, and concluded that little if any movement was being made. In response, the Kyoto Protocol (KP) to the UNFCCC was developed in 1997, in which developed countries were given CO₂ emission targets that would become legally binding when the protocol was ratified. For Canada, the KP target requires CO₂ emissions to be reduced to 6% below 1990 levels. While CO₂ is the most important greenhouse gas produced by human activities, the KP includes five other GHGs that must also be controlled: methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride

(SF₆). Of these, carbon dioxide, methane and nitrous oxide are the most important in relation to Saskatchewan's economic activities and will be the only GHGs considered further in this report.

The KP requires that GHG sinks and sources from certain land use activities be included when countries report their overall emissions profile. Article 3.3 in the original KP (1997) recognized sources and sinks related to afforestation (establishing new forest where it had not previously occurred), reforestation (re-establishing forest on land that was forested but that has been converted to non-forested land), and deforestation (the conversion of forest land to non-forest land); these activities are collectively referred to as ARD. In July 2001, sources and sinks from additional land-use activities were included in the KP under article 3.4. These included forestland management, cropland management, grazing land management and revegetation. An important distinction among these activities is that accounting for sources and sinks due to ARD is mandatory, while countries have until 2006 to decide whether to include the additional activities under Article 3.4. In addition, countries will be required to define specifically what is included in these additional activities, e.g. including shelterbelt establishment and maintenance under cropland management. Attachment I is a recent summary of sinks accounting and reporting rules prepared by Natural Resources Canada that contains further detail.

Purpose

The purpose of this report is to summarize the current potential for carbon sink creation and maintenance in Saskatchewan by implementing the land use activities described above. This information arose from an expert workshop held at the offices of the Prairie Adaptation Research Collaborative (PARC) in Regina, March 25-26, 2002. Attendees included provincial and federal government scientists, government policy analysts and members of several non-governmental organizations. The objectives of the meeting were to assess the current state of knowledge of the GHG sink potential for Saskatchewan; to identify technical and policy gaps preventing the achievement of this potential; and to recommend to the provincial government priorities for action and an estimate of resources required to address these gaps. This report summarizes the presentations which provided the background for discussions, and the results of the breakout sessions in which priorities for action and resource requirements were identified. See Attachment II for the meeting agenda, questions for the breakout groups and a list of attendees. Copies of the presentations, along with a copy of this report, are available on the PARC web site: <http://www.parc.ca>

Presentations

Title: Saskatchewan's Expectations for Carbon Sinks Workshop

Author: Floyd Wist, Saskatchewan Industry and Resources, Regina, SK

Mr. Wist presented a brief review of some of the likely impacts of climate change for Saskatchewan, and indicated that the province considers climate change to be an important issue that requires action through a balanced approach. This includes the need to address climate change while maintaining economic growth, and recognizes that actions will be phased in as the degree and direction of climate change impacts become clear. Current activity is being jointly managed by Industry and Resources and Saskatchewan Environment, with input from Saskatchewan Agriculture and Food and the Saskatchewan Advisory Committee and Climate Change. Activities are underway in the areas of Public Education and Outreach, Agricultural and Forest Sinks, Climate Change Technology and Geological Sequestration, Adaptation and Impacts, and Efficiency, Conservation, and Alternate Energy. To date technical and policy activities have been undertaken in all areas except sinks, and hence the need for this workshop. Agricultural and forest sinks may be an important and cost-effective option for Saskatchewan because:

- Saskatchewan has 40% of Canada's agricultural land
- There is the potential to convert marginal agricultural land to pasture and woodlots
- There may be the opportunity for future revenue for agricultural and forest sectors from sink creation and maintenance

Saskatchewan needs to work closely with Saskatchewan Agriculture and Food and Agriculture and Agrifood Canada and others on soil sinks, e.g. through the Conservation Cover Program - \$26 M over 4 years. We also need to work closely with Saskatchewan Environment, Natural Resources Canada and others on forest sinks, to advance the science to identify and verify carbon sequestration sites and variables, and to develop policy and mechanisms to aggregate individual efforts into marketable, verifiable initiatives for purchase or lease by industry.

There are a number of uncertainties still remaining regarding sinks science and policy issues:

- What is the technical and economic potential of soil and forest sinks?
- What is the role of sinks if no emissions credits are included in the final KP or other agreements?
- What are the barriers to implementing soil and forest sinks?
- What are the activities planned or underway elsewhere?
- Who are potential partners in implementing sinks?
- What are the required specific research, policy and program initiatives for Saskatchewan?
- What is the optimum timing for implementing sinks activities - pre-Kyoto or post-Kyoto?
- What is the funding available vs. cost required?

- What is the federal role vs. the provincial role in implementing sinks activities?

Next steps for the provincial government include:

- Establish Climate Change Network involving Saskatchewan Research Council, University of Saskatchewan, University of Regina and others
- Screen broad range of possible activities to establish priorities
 - Shelterbelts, wetlands or pasture?
 - Basic research, policy development, or incentives?
- Initiate high priority activities
- Seek cost-sharing of activities with potential partners

Title: Agricultural Soil Sink Potential in Saskatchewan

Author: Marie Boehm and Brian McConkey, Agriculture and Agrifood Canada

Recent Kyoto negotiations, especially in Bonn, July 2001 and Marrakech, November 2001, resulted in the recognition of carbon sinks on agricultural land. Specifically, sinks related to cropland management and grazing land management are now included in the protocol. Recent work in AAFC has attempted to identify what the potential might be for carbon sinks under these land use practices in Saskatchewan.

Table 1 shows recent estimates of the sink potential for various agricultural management practices. Research indicates that values for Saskatchewan are generally at the upper end of the range of values given.

Table 1. Carbon sequestration opportunities on SK agricultural land

	RATE (Mg C ha ⁻¹ yr ⁻¹)	CONFIDENCE	FEASIBILITY
CROPPING PRACTICE			
Reduce Tillage	0.0 to 0.4	Med	High
Forages in rotation	0.0 to 0.5	Med	Med
Reduced Fallow	0.0 to 0.5	High	High
Revegetation with perennials	0.2 to 1.0	High	Low
Increasing residue additions	0.0 to 0.3	Med	Med
Addition of organic materials (manure, compost) to degraded land	0.0 to 0.5	High	Med
GRAZING PRACTICE			
Improve grazing practices	0.0 to 0.1	Low	Low
Improve productivity (fertilization, irrigation, legumes, etc.)	0.0 to 0.3	Med	Med

Several uncertainties remain that make it difficult to determine the absolute sink potential in Saskatchewan. These include:

- Rate of adoption of minimum tillage practices.
- Duration of sequestration; impacts of changing atmosphere and weather.

- Persistence of sequestered C; impacts of changing atmosphere and weather
- Rate of C sequestration
- Accounting and Monitoring Systems

Recent model-based analyses indicate that accumulation of soil organic carbon (SOC) is sensitive to both temperature and precipitation. Under a no-till continuous wheat cropping system, SOC continues to increase through 2100 when temperature remains similar to current values and precipitation increases. However, under a temperature increase of 4°C, SOC accumulation stabilizes by about 2080, with an increase in precipitation. With a 8°C temperature increase and increasing precipitation, SOC accumulation reached a maximum at about 2060 and then declines. Modeling also indicates that the effect of CO₂ fertilization on SOC accumulation is likely to be minimal.

In summary:

SK has a large sink potential on agricultural land. Most of this is on cropland, and would be realized through reduced tillage, reduced summer-fallow, the use of forages in rotation and better use of organic amendments (manure, compost). Carbon sequestration can be created and maintained by changing to more soil aggrading practices. However, the adoption rate of these practices is the largest uncertainty, and additional uncertainty comes from questions about the duration and persistence of sequestration. Additional information on the agricultural sink potential in Saskatchewan is available from the presentations posted on the PARC web site <http://www.parc.ca>

Title: Agricultural Sink Potential in Saskatchewan: the Landowner's Perspective

Author: Blair McClinton and John Bennett, Saskatchewan Soil Conservation Association,
Indian Head, SK

Best Agricultural Management Practices that sequester additional carbon in the soil include summer-fallow (SF) reduction, low disturbance seeding systems (No-till), minimum tillage systems, conversion of cropland to forages, introducing forages into annual crop rotations, and the establishment of shelterbelts. Summer-fallow area has declined in Saskatchewan since the 1970s and recent research indicates that it will decline further to about 2.7 million ha by 2010. In spite of the reduction in area, agricultural production has not declined. This raises the possibility as to whether the reduction on SF can be enhanced even further. No till area has increased dramatically in Saskatchewan, from 2.9 million ha in 1990 to about 10.8 million ha in 1998. Since 1995, the proportion of area in no-till practices went from 15% to over 40%. Based on these changes in agricultural practices, the amount of carbon sequestered (in tonnes of CO_{2e}) increased from 1.2 million tonnes in 1990 to an estimated 7.3 million tonnes in 2002. These changes are due to economic factors (increased productivity and efficiency) and environmental concerns (e.g. soil and wind erosion, water quality). In order to enhance these trends, producers need to reduce their risk (through better extension programs and safety nets) and incentives (carbon trading, government programs). Based on recent survey data, SSCA thinks that doubling the rate of adoption of these practices, i.e. 80% of producers practicing no-till and decreasing SF to 3.5 million acres/1.4 million ha, is feasible by 2010. However, policies that increase risk are disincentives to adoption and sink creation, and lack of a “Credit for Early Action” policy creates a perverse incentive to “burn-up” soil carbon before 2008.

Policies required to encourage farmers to sequester and maintain carbon stocks must include the clear recognition that farmers actions create soil sinks, and that any resulting value should accrue to farmers that take action. Recognition for early action is important: farmers have eliminated 30 million tones of emissions, they need credit for actions taken before the commitment period, and these credits should be bankable. Removal of disincentives is also important: extension and education is required because no-till practices are complex and create risk; current policies are sometimes a barrier (e.g. crop insurance); and equipment needs are different for these practices. Policies must also address farmers' exposure to financial risk when they undertake sequestration, e.g. variable input costs for no-till practices are higher than those for conventional till practices. Policies should recognize the emission reductions that have occurred in agriculture resulting from lower fuel and fertilizer use; this can be recognized by issuing Emission Reduction Units (ERUs) that could be traded as a commodity. Emission Removal Units (RMUs) should be issued based on sequestration in forestry and agricultural soil sinks but this should be seen as a service, not a commodity.

Policy-makers must realize that sequestration is reversible, and that farmers undertaking sequestration activities will incur a sink maintenance liability once the sink has been created. If credits are sold as a commodity, these credits would have to be repurchased by

the producer if the sink became a source e.g. because of drought or weeds. An alternative would be to rent or lease the carbon sink for a fixed time period, so that the need for the producer to maintain the sink is limited. When the period is over, there would be the option to lease the sink again or opt out of the trading system. An additional issue is the carbon accumulated by producers prior to the commitment period. This could also be counted as a credit with appropriate verification, and would remove the incentive to "burn up" the accumulated carbon before the commitment period.

Research is required to clarify the scientific and policy questions that remain, and needs to be directed to the needs of farmers. It should integrate both emission reductions and removals, and reflect commercial agricultural practices that are economically viable. Finally, research needs to be carried out with strong farmer-scientist interaction, in which farmers communicate research needs and scientists communicate research results.

Title: Sources And “Sinks” of Nitrous Oxide in Saskatchewan

Author: Reynald Lemke, Agriculture and Agrifood Canada, Swift Current, SK

Nitrous oxide (N_2O) emissions in agriculture arise from a number of sources: crop residues, biological N fixation, fertilizer application, organic soils and livestock (both grazing and feedlot operations). Nitrous oxide may be transferred to other (non-target) ecosystems through leaching or volatilization, or released to the atmosphere through volatilization. Nitrous oxide makes up about 10% of Canadian GHG emissions, but 19% of Saskatchewan's total GHG emissions and 83% of Saskatchewan's agricultural GHG emissions. Of the agricultural N_2O emissions, 24% comes from livestock (mostly from manure) and 76% comes from crop production, mostly from N fertilizer application and crop residues. Current IPCC Guidelines for determining N_2O emissions assume a loss of 1.25% of N fertilizer as N_2O , and there is a proposal to increase this to 3%. However, recent data indicate that actual loss rates are 0.1-0.2% for Saskatchewan. Application of manure is also a large potential source of N_2O .

N_2O is released during nitrification under aerobic conditions and during denitrification under anaerobic conditions. Anaerobic conditions occur frequently in saturated soils following storm events or in low-lying topographic positions, and these areas are often sources of N_2O .

Potential mitigation strategies include split N applications, site-specific management, nitrification inhibitors, coated or timed release fertilizers, fall applications of N and residue management (fall tillage, legume termination). For Saskatchewan, fertilizer placement, timing and formulation did not appear to significantly affect N_2O emissions. In addition, plants fertilized with N tend to be more efficient in sequestering CO_2 , so there may be some trade-offs associated with adding N, accepting some N_2O emissions but sequestering more CO_2 . Combining reduced tillage and reduced summer-fallow with a pulse crop in rotation also tends to reduce N_2O emissions.

In summary, nitrous oxide is a major component of GHG budget for Saskatchewan agriculture; estimated losses of N_2O may be overstated for Saskatchewan; we need to consider “risk” management (e.g. livestock manure) regarding N_2O emissions; several promising management strategies are available – but complete assessment is needed; we need to assess full GHG budget of any mitigation strategy; most of the promising C sequestration strategies appear to have a neutral to positive influence on N_2O emissions (i.e. a reduction).

Title: Shelterbelt Sink Potential in Saskatchewan

Author: John Kort, Prairie Farm Rehabilitation Administration, Shelterbelt Centre, Indian Head, SK

PFRA has been distributing trees to prairie landowners for over 100 years. In 1995-1997 a series of projects were established to estimate the carbon content and accumulation rate of the major shelterbelt species distributed by PFRA. The results were provided to the Sinks, Agriculture and Forestry Tables and reported in their respective Options Papers. In 2001, PFRA announced their Shelterbelt Enhancement Program, a \$4.8 million program designed to establish an additional 7,300 km of shelterbelts across the prairie provinces. PFRA has also established a position dedicated to educating landowners about the value of trees for climate change mitigation.

To determine the amount of carbon sequestered by agroforestry plantations, biomass equations were developed for a number of deciduous and coniferous tree species and for several shrub species. Equations were found to be fairly accurate for trees and less so for shrubs, and there was high variability within and among shelterbelts. Trees and shrubs were sampled across a range of ages so that carbon accumulation curves could also be developed. Shrubs were found to accumulate 0.25 to 0.50 tonnes carbon per km of shelterbelt per year. Corresponding values for conifer and hardwood tree species were 1-2 t C/km/yr and 1-4 t C/km/yr, respectively.

PFRA also carried out a study of land suitability for poplar growth, based on samples of hybrid poplar growth in 15 year-old plantings across the province. Suitability ratings were based on a combination of climatic, soil and site factors. Suitability was found to be highest in the eastern and northern portions of the agricultural zone, corresponding roughly with the black soil zone.

Conclusions:

- 1) For carbon in trees on the prairies, there are good empirical data for trees of different species, ages and in different locations.
- 2) PFRA has developed equations relating aboveground biomass to tree and shrub dimensions.
- 3) PFRA has developed equations relating aboveground biomass to tree or shrub age and soil zone.
- 4) These data and relationships can be used to estimate carbon stored in shelterbelts at the farm level and at the provincial level.

Title: Forest Management Sink Potential

Author: Werner Kurz, Canadian Forest Service, Victoria, BC

The basic steps involved in estimating forest carbon stocks include: determine total area under consideration; stratify area by ecosystem type; determine age-class structure of each ecosystem type; determine ecosystem-level C dynamics of biomass and dead organic matter; recognize “population dynamics” of ecosystems; summarize C dynamics over space & time. Landscape-level C stocks are then the carbon stocks in each age class times the area of each age-class, summed among all ecosystem types in the area of interest. In Canada, disturbances, especially fires and insects, redistribute area in the landscape-level age-class structure, the result is that the landscape-level age-class distribution reflects past disturbances, and that changes in disturbance regimes will also be reflected in the age-class structure. If the rate of disturbance increases, the age-class distribution shifts to the left, representing a younger forest with lower C stocks; the result is a C source. On the other hand, if the rate of disturbance decreases, the age-class distribution shifts to the right, representing an older forest with higher C stocks; the result is a C sink. In summary, *future* C stock changes will be affected by the *current* age-class structure of the managed forest, which is the result of *past* changes in disturbance regimes.

The Canadian Forest Service is using the Carbon Budget Model of the Canadian Forest Sector (CBM-CFS2) to estimate carbon stocks and their dynamics at a national scale. The model combines data on forest inventory, growth and yield, and change statistics with an ecosystem model. There are 42 spatial units for all of Canada, four of which represent the forests of Saskatchewan. The model is being used to estimate C stocks and stock changes as required under two articles of the Kyoto Protocol. In Article 3.3, C stock changes must be determined during the commitment period on areas affected by land-use change (Afforestation, Reforestation and Deforestation) since 1990. This reporting is mandatory if the KP is ratified. Article 3.4 requires that C stock changes be determined during the commitment period on areas affected by forest management since 1990. This reporting is optional but countries must choose whether to do so by 2006.

Afforestation sink potential is addressed by Silvia Lac's presentation (see below). Estimates of deforestation were completed for provinces by the Sinks Table in 2000. For Saskatchewan, emissions from deforestation due to transportation, mining and petroleum are about $0.06 \text{ Mt C yr}^{-1}$, with a similar amount due to forestry activities (mostly creation of roads and landings). This results in a total emission of $0.12 \text{ Mt C yr}^{-1}$ due to deforestation in Saskatchewan.

The sink potential for forest management will be determined by the definition of "The Managed Forest", i.e. what area is included. In addition, all carbon pools must be accounted for, including above- and below-ground biomass, dead organic matter and soil organic C. The CFS has analyzed 32 forest management scenarios comprising a variety of assumptions about the area of managed forest, harvest rates, natural disturbances, growth rates, decomposition rates and planting strategies. The area of forest management

was assumed to be the accessible and inaccessible timber productive area in the province which totals about 12 million ha. On this area, there are current biomass carbon stocks of about 0.5 Gigatonnes (Gt) C and 2.0 Gt C in dead organic matter for a total of 2.5 Gt C in the forest ecosystem. A constant average loss due to fires and insects was also assumed, and an increasing level of harvesting was assumed based on current trends. Due to constant disturbance by fires, insects and harvesting, the age-class distribution shifts to the left over time, resulting in a younger forest with lower carbon stocks, i.e. is a source as described above. The analysis was carried out through 2032, and during this time period the forest ecosystem in Saskatchewan was a constant net source of carbon. Changing assumptions about disturbance (lower) and growth rates (higher) still resulted in a net source for Saskatchewan's forests. Of the 32 scenarios considered, only four resulted in a sink for SK forests, and these were felt to be highly unrealistic. It appears that SK forests will be a C source under nearly all scenarios of future forest disturbance and management. However, the results are sensitive to assumptions about disturbance and harvesting rates, and the inventory data on which these analyses are based have high levels of uncertainty. In addition, the age-class legacy from past disturbances predisposes the forests in SK to being a C source in the next few decades. Forest management options to reduce the magnitude of the source include fire suppression, increased levels of planting and activities to increase growth. There may also be the opportunity to adjust the baseline used in C accounting to reflect the pre-1990 effects of disturbance on age-class structure. In addition, further detailed analyses need to be carried out with more recent inventory and growth and yield data.

Title: Carbon Sequestration Increase in the SK Gray Soils Through the Conversion From Agriculture to Agroforestry

Author: Silvia Lac, Department of Environmental Engineering, University of Saskatchewan, Saskatoon, SK.

This presentation describes an MSc project underway at the University of Saskatchewan. The goal of the project is to determine the potential for carbon sequestration under afforestation in the grey soils zones of Saskatchewan. Data used in the study were all from secondary sources. The steps involved were:

- Estimate the land area available for afforestation within the economic haul distance around the three major wood processing centres in the province: Meadow Lake, Prince Albert and Hudson Bay. Data from Statistics Canada indicated that approximately 7,000 farms in the study area had the potential to support tree plantations. The study's assumption was that 10 ha per farm would be converted to plantations.
- Determine the above-ground carbon sequestration potential for tree species using growth curves for three tree species: hybrid poplar, aspen and white spruce. Soil carbon sequestration potential was estimated from literature sources. Below-ground biomass was determined from literature sources for hybrid poplar, and from published equations for aspen and white spruce. Carbon sequestration in forest products will also be considered in the study but has not yet been completed.

Results:

- Over a 20-year rotation, approximately 6.8 Mt C would be sequestered in hybrid poplar plantations on this land base. Over a 70-year rotation, aspen would sequester 4.8 Mt C and white spruce 4.1 Mt. This is the equivalent of between one third and one quarter of Saskatchewan's current annual CO₂ emissions. Hybrid poplar would produce approximately 15 million m³ of wood or about 3 times the current provincial annual allowable cut. Corresponding values for aspen and white spruce are 10.2 and 10.1 million m³ respectively.

The following research needs were identified:

- Growth curves specific to species and site conditions
- Soil organic carbon (SOC) measurements for each species, soil zone or ecological framework, agroforestry design and for the entire soil profile
- SOC measurements in similar cultivated sites/former cultivated sites
- Conversion factors relating biomass to carbon and volume to biomass for each species, soil zone or ecological framework, agroforestry design.
- Standardized measurement and lab procedures.
- More field data on long-term plots

Title: The Socioeconomic Impacts of Afforestation of Marginal Agricultural Land in Canada

Author: Dave Lee, Prairie Farm Rehabilitation Administration, Regina, SK

Canada has a large potential for carbon sequestration arising from land use activities in agricultural landscapes, including cropping practices, shelterbelt establishment and afforestation. However, current estimates of sequestration potential do not include the social and economic impacts on the farm community. The purpose of this study was to determine the potential for, and the social and economic impacts of, converting marginal farmland to forest production. Marginal land in this study was defined using biophysical criteria from the Canada Land Inventory (CLI) rather than defining it in economic terms. The analysis was done at the level of Ecodistrict in the Canadian Land Classification System. The general approach was:

1. Overlay maps of CLI Capability for Agriculture with current agricultural land use. This showed the extent and type of cropping that was occurring on marginal land.
2. If this comprised less than 5% of the area, the analysis was halted for that ecodistrict. If the area was greater than 5%, the CLI Forest Capability was determined for the area of marginal land.
3. If the Forestry CLI was low (<7), the analysis was halted. If it was greater than 7, the area and productivity class for indicator tree species was determined. In general, it was found that if land was marginal for agriculture, it was medium to poor for forestry.
4. Where forest capability was medium to high on marginal land, economic factors for that ecodistrict were analyzed. In the case where this was positive, the recommendation was to proceed with afforestation.

Further work needs to be done to determine the carbon sequestration potential using the same geospatial database and capability rankings. One outcome of this could be to determine the value of carbon credits required to encourage producers to convert agricultural land to forest production.

Title: Scaling-up Carbon (GHG) Estimates to the Landscape Level

Author: Tony Brierly, Agriculture and Agrifood Canada, Edmonton, AB

There is a need to verify the amount of carbon being fixed on agricultural landscapes and the variability due to both natural (e.g. slope position) and cultural practices (tillage, crop rotations, etc.). This presentation describes a database and modeling system currently under development in Alberta that will provide the basis for a national carbon accounting system for Canada's agricultural land. It will also provide information on N₂O emissions in different landscape elements. Elements of the program include models, information on land use and management practices, land resource information, and the integration of these.

Models appropriate for determining carbon and nitrogen cycling in soils include Century, DNDC, Expert N and others such as EPIC and USLE to estimate nutrient redistribution due to erosion. Inputs for these models include soil organic carbon, soil texture, climate, landscape position, slope % and length. Resolution of the model will be at the level of Soil Landscapes of Canada (SLC) polygons.

Management practice is a crucial input to the model, e.g., crop rotation, changes in tillage practice, fertilizer or manure additions.

Land resource information will be provided in the database system in the form of soils maps. Conceptual soil landscape models are the “building blocks” of soil maps. These models are based upon pedological paradigms, i.e. the distribution of soil types in terms of extent and location within the landscape. During the compilation of soil landscape databases, the soils and associated landscape attributes (specifically landscape position) have become “unlinked”. To utilize these databases in the scaling-up process the “links” between soils and landscapes have to be recreated. This will be done based largely on tacit knowledge of soil scientists.

To develop these databases and landscape models, research plots will be located on a certain type of soil, on a specific landscape. These will form the basis for model development, verification, etc. The critical attributes within the model are, e.g. inherent soil characteristics, climate and management. The link to soil map is Soil Name (series).

In summary, the SLC polygon will be the reporting unit. Components within a SLC polygon will be assigned to a landscape position with its associated landscape characteristics. Will also be able to describe each component in terms of its present C value, texture, etc. It will also be possible to link climate/weather scenarios or land use practices to each SLC polygon. The model(s) would then be run on each SLC component, and the SLC value would then be the sum of the value for each factor x extent (area) of the component.

Breakout Group Results

The participants were divided into three breakout groups and asked to answer a series of questions (see Appendix II). The groups were: Agricultural Sinks Measurement Issues, Agricultural Sinks Policy Issues and Forestry Sinks Measurement and Policy Issues

GROUP 1: AGRICULTURAL SINKS MEASUREMENT ISSUES

Brian McConkey (rapporteur), Reynald Lemke, Glenn Padbury, Tony Brierley, David Lee, Blair McClinton, Ken Panchuk

1. Sinks

Table 1

Practice	Size	Confidence of C amount	Opportunity	Cost to incent adoption
Reduced tillage and reduced summerfallow	H	H	H	L
Permanent forage onto marginal cropland	M	H	M	M
More forages in rotation	M	H	M	L (market issue)
Grazing land - range	L-M	L	L	M-H
Grazing land - improved	L	M	M	L-M
Restoring wetlands & permanent cover on riparian zones	L-H	M	M-H	H
Shelterbelts	L	H	L	H
Bio-products (e.g. strawboard)	L	L	L	L
Afforestation	L-M	M	L	H

Notes:

- H=high, M=medium, L=low
- Provide suite of sequestration options to farmers and landowners as part of overall environmental stewardship package
- Forage investment decisions should consider the entire GHG budget including the fed livestock and their manure
- Afforestation required better understanding of soil carbon changes, particularly in Dark Gray and Black soil zones
- Restoring wetlands need to consider the effects of adopting no-till and no fallow on reducing runoff, i.e. does the wetland have a high likelihood of staying wet?
- For shelterbelts, need to also include C source from shelterbelts lost from bulldozing of old farmsteads and removal of field shelterbelts
- For afforestation, need also to include C source from land deforested for agriculture at the forest fringe as well as small areas (>1 ha) of bush within agricultural land
- Strawboard requires lifecycle GHG budget and there is international policy uncertainty about whether strawboard could be considered sequestration

As part of a suite of practices, there is need to consider GHG reductions as well:

Table 2

Practice	Size	Confidence of C amount	Opportunity	Cost to incent adoption
Reduce methane emissions through better cattle diet	L-M	M	L-M	L-M
Improved N fertilizer use efficiency	M	M	M	L
Biofuels	L-M	L	L	L
Biogas from manure	L-M	H	M	H

Notes:

- reducing methane emissions through better diet will be most feasible in feedlots
- need more research on N₂O savings from practices that potentially increase N use efficiency
- Need complete GHG budgets for biofuels under Saskatchewan situations

2. Alternatives

Rated in Table 1. Believe any sink program should provide a variety of options. Incentives may be different for different practices but although an offered incentive may not be sufficient for widespread adoption, there will always be situations where adopting the practice makes sense for other reasons.

Afforestation is long term and it is important to evaluate different afforestation programs under future climate scenarios to determine how future climate change adds to their risk.

3. Required Activities

Much basic and applied research on effect of agricultural practices on C sequestration and associated GHG emissions is underway in other GHG research programs. Two new ones required for SK:

- Basic research required into soil C under afforestation of agricultural lands in SK
- Applied research required on whole system GHG budgets for SK conditions
- More research on C sequestration from wetland restoration and permanent cover on riparian areas under SK conditions
- Need research on C sequestration opportunities for SK native range
- Future climate scenarios for SK, better quantification on effects of increased CO₂ on crop, range, and tree growth

Data collection/gap filling centers around improving quantification of land use and management and changes in land use and management. Specific activities:

- Determining the accuracy of the Census of Agriculture in test areas
- Evaluation of using remote sensed data from satellites on trial areas
- PFRA crop residue survey
- Farm input surveys

- Targeted surveys in conjunction with other data sources (\$100-150/farmer/yr)
- Using Saskatchewan crop insurance data
- Evaluating use of Saskatchewan crop insurance a vehicle for collecting and managing wide range of management data

Policy Needs

- Policy on data regarding sharing and confidentiality (for large-area GHG inventories, confidentiality can be maintained; however, to reward individual producer for C sequestration total confidentiality cannot be maintained)
- Re-evaluate any disincentives such as crop insurance
- Taxation policy regarding land removed from agricultural land use
- Policy to prevent breaking of native range and better maintenance of range condition on crown leases

4. Timeframe, Cost-share Opportunities, Contribution to Sink

Practice	Timeframe	Cost-share		Contribution
		Gov't	Private sector	
Reduced tillage and reduced summerfallow	Now, peak 2020, end 2050	High	High	High
Permanent forage onto marginal cropland	Now, peak 2020	High	High (DU)	Med
More forages in rotation	Now, end 2050	Low	Low	Low-Med
Grazing land – range	Peak 2030	Med	Low	Low
Grazing land - improved	Now, peak 2020	Med	Med	Low
Restoring wetlands & permanent cover on riparian zones	Now, peak 2030	High	High	Low-High
Shelterbelts	Peak 2020-2040	High	Low	Low
Bio-products (e.g. strawboard)	?	Low	High (own)	Low
Afforestation	Peak 2030-2050	High	High	Low-Med

Notes:

- Reduced tillage, reduced summerfallow, and more forages in rotation will be largely done by 2050,
- permanent cover sinks will continue somewhat past 2050
- private sector mostly environmental (e.g. DU) and large emitters, but includes farm input suppliers (e.g. Monsanto) on cropped land
- Government mainly the federal government, provincial cooperation would be limited mainly to AB and MB (excluding through fed-prov programs) and those provincial collaboration would be through coordination of programs as opposed to joint funding of programs

5&8. Investment

For \$50-250/yr the additional required research outlined in 3. could be completed. At the high end of that range the evaluation and incorporation could be done.

Practice	What (who)
Reduced tillage and reduced summerfallow	Extension and tech transfer (SAF, SSCA, farm input suppliers, farm groups, PFRA, research community), PR program regarding myths and environmental benefits of practices targeted at general public (SAF, research community, farm groups), consideration in safety net (AAFC, SAF, crop insurance)
Permanent forage onto marginal cropland	Programming to incent adoption (SAF, PFRA, DU)
More forages in rotation	Economics (markets), Research and tech transfer of better methods to make transition from forages to crops and vice versa (SAF, research community)
Grazing land - range	Extension and tech transfer (SAF, PFRA, Lands Branch, producer groups)
Grazing land - improved	Extension and tech transfer (SAF, PFRA, producer groups)
Restoring wetlands & permanent cover on riparian zones	Programming to incent adoption (SAF, Environment Canada, Wetland Corporation, DFO, NRCan, PFRA, DU, other ENGOS)
Shelterbelts	Programming to incent adoption (PFRA)
Bio-products (e.g. strawboard)	Extension of tech transfer regarding erosion and soil quality concerns of widespread straw harvesting
Afforestation	Programming to incent adoption (SERM, PFRA, forestry products companies, NRCan)

Notes:

- research community is AAFC Research Branch, Universities, and research oriented producer groups (e.g. AGRIARM)
- new land going into reduced tillage and reduced summerfallow involves convincing farmers who are generally more averse to adopting new practices
- converting marginal cropland to perennial forages will cost \$15-50/ac
- restoring wetland and permanent vegetation on riparian areas will cost \$100+ per acre but provide many environmental benefits (water quality, biodiversity, soil quality, reduced N₂O emissions)

10. Priority

We considered priorities in terms of new funding assuming existing programs remain in place:

1. Promoting C sinks due to reduced tillage and reduced fallow (including practices that promote more efficient N use) provide the greatest opportunities so are highest priority.
2. Converting marginal cropland to perennial forages is sound policy for many reasons and would be second priority

3. Restoring wetlands and improving riparian areas provides a significant and attractive total ecological benefit and deserves more investigation would be third priority.

4. Everything else would fall somewhat lower priority than these three but still need to be included as part of a package of options.

GROUP 2: AGRICULTURAL SINKS POLICY ISSUES

Howard Loseth, (rapporteur), John Bennet, Oliver Bussler, Ed Dean, Wayne Gosselin, Jonathan Matthews, Greg Riemer, Chris Ruschkowski

Sink Potential, Q1 and 2:

The highest potential for agricultural soil sink creation and maintenance lies in annual cropping (adoption of no-till practices) and perennial (forage) crops. There is also a small potential in management of wetlands and range management. Some potential also exists in intensive livestock operations, largely on the emission reduction side rather than the sequestration side. Specifically, emission reductions could be achieved through management of effluent (reducing CH₄ emissions). However, there is a limited sink potential, so the benefits would be based on GHG reductions rather than removals.

Efforts in agriculture should focus on agricultural soils during first commitment period, since sink creation can occur relatively quickly. The emphasis should be on trees in later commitment periods. One approach that could assist landowners in adopting new practices is to help them through a transition period:

Transition in cropping practices: Annual cropping ⇒ forage rotation ⇒ perennial crop

The objective in all these activities should be the creation of as large a carbon sink as possible.

Annual Cropping (adopting minimum till practices): The policy adopted by the government to encourage no-till practices must clearly state the objective (i.e. the creation of as large a carbon sink as possible), and it also needs to result in a coordinated response among relevant departments.

Q4: Timing

	First Commitment Period	Subsequent CPs
Annual Crops (minimum till)	yes	yes
Perennial	yes	yes
Range Management	no	yes
Wetland management	yes	no
Livestock effluent	yes	yes
Shelterbelts	no	yes
Afforestation	no	yes

Q3 and Q8

	ACTION					
	Investment	Policy	Education	Research	Technology	Incentives
Annual (minimum till)	Low	Program alignment				Remove disincentives
Perennial	Low	Yes				Yes
Range Management	Low		Yes			
Wetland management	Med-high	Yes		Yes		
Livestock effluent	Med-high	Yes		Yes	Yes	
Shelterbelts	Med-high	Yes				Yes
Afforestation	Medium	Yes		Yes		

Summary:

Practice	Potential	Priority
Annual and perennial cropping	high volume of C at low cost	High Priority
Range Management	low volume of C at low cost	Low Priority
Wetland Management	small volume of C at medium cost	Low Priority
Intensive Livestock (sinks)	small volume of C at medium to high cost	Low Priority
Intensive Livestock (emission reductions)	high volume of C at med cost	High Priority
Shelterbelts	small volume of C at high cost	Medium Priority
Afforestation	large volume of C at medium cost	Medium Priority

GROUP 3: FORESTRY SINKS MEASUREMENT AND POLICY ISSUES

Mark Johnston (rapporteur), Doug Campbell, John Kort, Werner Kurz, Silvia Lac, Bruce LeBarre, Bob Wynes

What sinks or sinks-related activities have greatest potential for 1st Commitment Period?

Preventing deforestation that would occur under Article 3.3 - avoid the debit that would otherwise be assigned (Deforestation losses estimated at 60,000 t C/yr for SK)

Afforestation - but slow C stock increases initially and C releases in site preparation (17,000 ha of hybrid poplar plantations at 3.5 t C/ha/yr would be required to offset 60,000 t C/yr D losses).

Shelterbelts - net increases in shelterbelt lengths are sink (3.25 t C/km/yr * 4,000 km ~ 15,000 C/yr), assuming existing shelterbelts in net zero balance (this needs to be determined)

Forest Management - currently risk of net source in SK because of age-class structure; need better inventory data; explore management options for change and reduction in source.

Biofuels - evaluate alternate uses of biomass to substitute for fossil fuels

What are the data and research needs?

Afforestation: Need inventory of all areas afforested since 1990 (as well as their growth rates) - a definite sink but we must have data to quantify its size. Also need better growth data for afforestation species (both above- and belowground biomass).

Deforestation: Need inventory of all areas deforested since 1990 and the C stock changes during the Commitment Period - intense international scrutiny on this issue. (highly recommend remote sensing pilot projects).

Shelterbelts: Improved data on shelterbelt dynamics - if shelterbelts are considered part of cropland management under the KP, then net C stock changes need to be determined.

Forest Management: Improved forest inventory and age-class data (e.g. participate in National Forest Inventory NFI, remote sensing pilot projects).

Forest Management: Improved growth and yield data, especially managed stand yield curves - this needs to be based on existing plantations in order to determine past growth rates.

Forest Management: Determination of forest management options to enhance C stocks, but must use full carbon accounting, e.g. fertilization enhances growth but produces N₂O emissions; site preparation causes C losses. Also need to integrate natural succession into stand regeneration.

Issues related to the development of institutional and market mechanisms:

Tax breaks available to farmers may not apply to agroforestry systems.

Need to provide:

- “aggregator/coop” function for large number of small operators to reduce transaction costs (could be government, private sector or NGO)
- growth and yield information applicable to Afforestation projects (likely government responsibility)
- accounting tools/models in support of analyses (government)
- information management systems (joint government/private sector)

Clarification of C ownership in forests on crown and private land, e.g., who owns credits arising from industry's forest management practices that increase sequestration on crown land?

Implementation of Programs and Incentives: Afforestation

Given the difficult financial situations of farmers, assistance will be required for afforestation projects, in particular because up front costs are high and revenues delayed by years.

“Reverse mortgage” on future harvest (carbon) revenue provides income stream (requires initial funding for start-up).

Renting C storage space (provides continuous income stream for duration of project).

Income tax structure - allow cost of Afforestation to be deducted at time of planting not when revenue occurs.

Remove negative tax implications for Rural Municipality if agriculture land is converted to forest plantations.

Consider tax-deferred status for forest plantations.

Implementation of Programs and Incentives: Deforestation

Review options for reducing width of right-of-ways along roads and other corridors.

Review options for reducing size of wellhead clearings.

Reclamation practices of abandoned cleared area (e.g. do not seed grass but plant trees instead).

Reduce crown land liquidation cutting.

Are there opportunities to provide property tax incentives to keep land in forest cover?

Review options to remove areas from harvest or grazing, protecting ecological benchmarks as C sink projects and to obtain baselines.

Stakeholder Information and Education

Increase awareness among stakeholders of the impacts of their actions on C stock changes.

Assess impacts of various actions on C stocks and demonstrate available alternatives.

Ensure coordinated extension efforts among government agencies, e.g. web sites, brochures.

Benefits of co-planning of road infrastructure.

Time frame of sink types

Deforestation - immediate to short term

Afforestation - medium to long term

Forest management - short to long term

Shelterbelts - medium to long term

Government Investment

Afforestation - Develop inventory of areas afforested since 1990 (likely small area but instant gratification). Costs: medium \$50K for 1 year, then \$25K / year to maintain, cooperate with national efforts of CFS.

Afforestation of 17,000 ha at \$1,600/ha = \$27 million to offset current deforestation (opportunity to coordinate with Federal Green Cover program).

Enhanced Shelterbelt Program is already funded (anticipated cost \$4.8 million for 300,000 t C or \$16/t C).

Deforestation - primarily education and policy changes - low costs

- crown land - non-provincial forest forested crown land - do not let it go private
- private forested land - encourage not to clear but may require compensation
- grazing leases - grazing can lead to deforestation
- policies to encourage replanting of trees on industrial sites

Invest in better data on current deforestation rates and locations, mostly remote sensing (\$250K/yr)

Forest Management - fund research to better understand how various management options can affect C stocks (medium cost).

Review provincial policies that might act as disincentives to industry actions aimed at improving productivity (e.g. review early succession to aspen as a means for faster initial growth rates and lower fire risk) (low cost).

Improve forest inventory, growth and yield and information management systems (high).

Opportunity for Federal Cost Sharing

Afforestation - some opportunities with Federal Programs: Feasibility of Afforestation to Sequester Carbon (FACS), National Afforestation Initiative, Green Cover Program, Forest 2020.

Shelterbelts (high potential) - shelterbelt expansion program already in place.

Forest management (high potential)

- Forest inventory cooperation (National Forest Inventory)
- EOSD Change detection/deforestation program
- Carbon accounting - development and testing of models
- Information management (National Forest Information System)

Operationalization of these programs will require substantial provincial contributions.

Opportunity for Private Sector Cost Sharing

Afforestation - engage emitters in afforestation projects, engage forest industry to increase wood supply

Shelterbelts - farmers making in-kind contributions

Forest management

- Forest inventories - companies in SK now have responsibility
- PSP in the provincial forests (provincial and industry) - these need to be remeasured

Good forest management = good C management therefore some actions will be implemented for forest management reasons. Need to recognize these publicly.

Limited opportunities for direct carbon sequestration actions until there is a C market and therefore a business opportunity. In the meantime actions will be done for other reasons, e.g. forest management, wood supply, environmental, etc.

Conclusions and Recommendations

There is significant potential in Saskatchewan to create new and maintain existing carbon sinks, and to limit GHG emissions through land use activities. However, several important measurement and policy gaps need to be addressed before this potential can be realized. Following are the major conclusions from the workshop and recommended next steps.

Agriculture

The highest potential for sink creation, the lowest cost, and therefore the highest priority, is to increase the area of reduced tillage and reduce the amount of summer-fallow. The size of the sink is potentially large, there is high confidence in the amount of carbon that can be sequestered, and the costs to induce producers is relatively low. Other opportunities are (in decreasing order of priority):

- Establish permanent forage on marginal cropland;
- Restore and maintain wetlands and permanent cover in riparian zones;
- Include more forages in crop rotations;
- Establish new and maintain existing shelterbelts;
- Expand the area of improved grazing land;
- Implement better range management practices;
- Development of bio-products (e.g. strawboard).

In order to encourage the adoption of no-till cropping and reduced summer fallow, education and technology transfer programs for producers need to be expanded. In addition, the benefits of these practices need to be recognized by the various safety-net programs available to farmers. This will also be required to encourage the use of more perennial species in cropping rotations and to establish forages on marginal crop land. It is also important for the provincial government to align programs across departments so that producers receive a common message, to design incentives programs that all result in the right actions.

Research is required on the basic science of how land use practices affect the carbon cycle, including both sequestration or emissions. This needs to be done for cropping practices, wetlands, permanent cover in riparian areas and native range. Carbon accounting in all cases must be based on full-cycle accounting so that all sources and sinks are accounted for. We also need a better idea of how future climate change will affect the sink potential in the long term.

Data collection and gap filling requires improving quantification of land use and management activities and changes in land use and management, using both land owner survey techniques and remote sensing.

Policy needs include providing incentives, removing disincentives and examining tax policy to ensure it doesn't penalize removal of land from agriculture.

Forestry

Afforestation can provide a significant carbon sink in the longer term, but immediate benefits during the first Kyoto commitment period can be realized by preventing deforestation. We need better information on how much deforestation is occurring, its causes and what policies are required to prevent it. Shelterbelts can contribute somewhat to carbon sinks but will probably fall under cropland management.

Saskatchewan is at a large disadvantage with regard to the managed forest, as this area is likely a net source of carbon due to disturbance and the current age-class distribution. We need research to determine how forest management activities could be used to offset at least a portion of this source; this analysis needs to be based on full-cycle carbon accounting.

Data needs include a comprehensive capability and suitability assessment for afforestation, an inventory of areas deforested since 1990 and data on the cause of deforestation, data on shelterbelt dynamics, and better data on managed forest growth and yield.

Policy needs to be developed concerning ownership of credits based on forestry activities, especially those carried out on crown land. Tax policy may be preventing land owners from undertaking afforestation and needs to be examined. There also needs to be incentive arrangements that provide an early revenue stream to the land owner so they don't have to wait until the trees are harvested.

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ATTACHMENT I

ACCOUNTING AND REPORTING RULES FOR SINKS IN THE KYOTO PROTOCOL

1. Introduction

This note describes the rules that will apply to Canada's land use, land-use change and forestry, or "sinks", activities under the 1997 Kyoto Protocol to the UN Framework Convention on Climate Change (UNFCCC). Article 3.3 of the Protocol requires that Canada account for the carbon stock changes in the commitment period resulting from afforestation, reforestation and deforestation (ARD) that have occurred since 1990. In Article 3.4, the Protocol allows further negotiations on additional sinks activities to include in the accounting.

Under the Protocol Canada must reduce its greenhouse gas emissions to 6% below the 1990 level by the first commitment period of 2008-12. Our target in the 5-year commitment period is therefore 94% of our 1990 emissions, times five. Credits resulting from sinks activities will be added to Canada's target, meaning that fewer emission reductions will be needed. Debits from sinks activities will be subtracted from our target, meaning that it will be harder to reach.

Sinks negotiations since Kyoto have focussed on deciding which additional activities to include, and on developing agreement on definitions, accounting rules and reporting requirements. In July 2001, in Bonn, Germany, the sixth Conference of the Parties (CoP6) to the UNFCCC reached a political agreement on how to treat sinks in the Protocol (part of the Bonn Agreement covering all subjects under negotiation). It also agreed to a legal text on principles, definitions and accounting rules for sinks, based on the Bonn Agreement. The text was not adopted at CoP6 pending agreement on outstanding issues unrelated to sinks.

In November 2001, in Marrakech, Morocco, CoP7 adopted decisions to elaborate the rules for Kyoto Protocol implementation, paving the way for all Parties to consider ratification. In Marrakech, Parties adopted all the draft decisions agreed in Bonn, and also agreed to technical rules for accounting, reporting and review. Collectively these adopted decisions are known as the Marrakech Accords.

Canada's estimation, accounting and reporting of our domestic sinks activities will be governed by 3 sets of rules adopted as part of the Marrakech Accords. Other rules adopted in Marrakech will govern sinks projects in developing countries under the Clean Development Mechanism (CDM) or in industrialized countries under Joint Implementation (JI) – these rules are not discussed in this note.

1. ***Sinks accounting rules:*** these are the rules for treatment of sinks activities under Articles 3.3 and 3.4 of the Kyoto Protocol, as agreed in Bonn and adopted without change in Marrakech.

2. **General accounting rules:** these are the rules for including emissions and removals from sinks activities in the detailed accounting system needed for operationalizing the Protocol under Article 7.4 of the Protocol.
3. **General reporting rules:** these are the general rules for reporting on sinks activities and associated emissions and removals, under Articles 7.1 and 7.2 of the Protocol.

While the Marrakech Accords establish sufficient rules for sinks and other elements of the Protocol to allow Parties to consider ratification, further technical work is ongoing and will be highly relevant to accounting for sinks. This is described in Section 5 below.

2. Sinks Accounting Rules

The sinks agreement in the Marrakech Accords establishes the accounting rules for treatment of activities under Articles 3.3 and 3.4. Appendix 1 provides the full text of the sinks agreement, including definitions for ARD activities, forest management and agricultural land management activities. Many of these rules are implemented as part of the general reporting and accounting rules under Article 7 of the Kyoto Protocol (see the following sections, and Appendices 2, 3 and 4).

The agreement gives each country the choice of whether its wants to include forest management in its accounting in the first commitment period, with the decision to be made by 2006. A country that has a net ARD debit can use credits from its forest management to offset this debit, up to 9 Mt C/yr (33 Mt CO₂/yr), provided it has chosen to include forest management in its accounting. Use of this offset is subject to the proviso that its managed forest since 1990 is a net sink at least equal to the ARD debit.

The agreement allows further credit for forest management in the first commitment period up to a cap, which for Canada is 12 Mt C/yr (44 Mt CO₂/yr)¹. It also allows for the inclusion of cropland management, grazing land management and revegetation in the first commitment period using a net-net accounting approach². There is no cap on credits from these agricultural activities. A country has until 2006 to decide if it wants to include one or more of these agricultural land management activities in its accounting.

¹ The cap on forest management also includes credits from JI forest management projects. At Marrakech, informal discussions revealed divergent understanding of how these projects would be included in the cap. Canada has been of the view that credits from forest management projects undertaken by Canadians in other industrialized countries are part of Canada's cap. The European Union believes that Canada's cap covers credits from forest management projects undertaken in Canada by other industrialized countries. For Canada, this difference in interpretation is likely not important - it appears likely that such projects will be insignificant, both in Canada and by Canadians in other industrialized countries.

² There are ambiguities and inconsistencies in the agreement related to the accounting for agricultural land management activities due to the use of net-net accounting (net emissions or removals in the commitment period less 5 times net emissions or removals in 1990) for these activities. However, the agreement is clear that no double counting is allowed.

3. General Accounting Rules

The Marrakech Accords established the overall accounting rules for the Protocol. Four accounting units are used. Canada's target, or Assigned Amount, in the first commitment period is 94% of its 1990 level of emissions, times 5, and is made up of Assigned Amount Units (AAUs). Credits associated with CDM projects are termed Certified Emission Reduction units (CERs), while credits associated with JI projects are termed Emission Reduction Units (ERUs). The accounting unit for sinks credits is the Removal Unit (RMU), each representing removals for a specific activity and commitment period. All of the units are one metric ton of CO₂-equivalent.

At the end of the commitment period, the sum of available AAUs, CERs, ERUs, and RMUs will be compared with actual emissions in the commitment period to determine if Canada is in compliance with its target. If the sum is lower than actual emissions, then Canada will have a short period in which to come into compliance through buying credits from other countries in the international emissions trading system allowed in the Protocol. If the sum is higher, then excess units (except RMUs) can be 'banked' for use in the next commitment period.

The following accounting rules govern accounting for sinks activities:

1. **Timing of credits/debits:** Parties can decide whether, for each sinks activity, they want to account annually or only at the end of the commitment period. Reporting of estimates for an activity must be done annually even if accounting (adding credits and subtracting debits) for the activity is only done at the end of the period.
2. **Quality of sinks estimates:** information submitted for the purpose of accounting will be subject to in-depth review before approval. If an estimate is incomplete or not prepared using good practice guidance then a conservative adjustment will be made (i.e. sinks credits will be adjusted downward and debits will be adjusted upward). Severe problems, as determined by a variety of evaluation criteria, will mean that credits cannot be issued (adjustment procedures and the criteria for severe problems have yet to be developed - see Section 5 below).
3. **Sinks credits:** approved credit estimates will be accounted for by issuing an appropriate amount of RMUs.
4. **Sinks debits:** approved debits will be accounted for by subtracting the appropriate amount from existing AAUs, RMUs, CERs or ERUs.
5. **Separability:** Estimates for different sinks activities will be evaluated separately. This means that a poor quality estimate for one activity will not

prevent issuance of RMU credits for other activities for which high quality estimates have been provided.

6. **Trading:** RMUs can be traded in the international emissions trading system.
7. **Banking:** Excess RMUs cannot be ‘banked’ for use in a subsequent commitment period, although there is nothing to prevent RMUs from being exchanged or ‘recycled’ for the other accounting units, all of which can be banked.

4. General Reporting Rules

The Marrakech Accords establish three distinct reporting requirements for sinks that Canada’s measurement, accounting and reporting system will need to satisfy. The first is a pre-commitment period report by January 2007 (see Appendix 2). In this report Canada will have to specify whether it wants to include one or more of forest management, cropland management, grazing land management or revegetation in its accounting, and whether it wants to account for each sinks activity annually or at the end of the commitment period.

The second reporting requirement is the annual reporting that must occur for each year of the commitment period (see Appendix 3). This will include aggregate estimates of emissions and removals, as well as information on the areas encompassing land included in the accounting, and associated emission and removals.

The third requirement is reporting as part of Canada’s periodic national communication (see Appendix 4). This report will likely occur twice, once around 2006 and once during the commitment period. It will include a description of our national system for estimating emissions and removals, including from sinks activities.

5. Further Work

Three important and related areas of work relevant to measuring, accounting and reporting for sinks activities will be addressed over the next three years.

The first is the work the Intergovernmental Panel on Climate Change (IPCC) is undertaking now on Good Practice Guidance for LULUCF, which will elaborate the existing Revised 1996 IPCC Guidelines for Greenhouse Gas Inventories. Together these technical guidelines will provide the detailed approaches to be used for estimation and reporting for both the UNFCCC and its Kyoto Protocol. Good practice guidance is meant to promote the development of inventories which are transparent, documented, consistent over time, complete, comparable, assessed for uncertainties, subject to quality control and quality assurance, and efficient in the use of resources.

Work on good practice guidance is due to be approved and adopted by CoP9 in 2003. Once this is completed, CoP10 in 2004 is due to agree on and adopt methodologies for

adjustments to poor quality sinks emission and removal estimates. These adjustments will be applied in cases where estimates submitted by a country are judged to be poor quality because they are incomplete or prepared in a way that is not consistent with good practice guidance. Adjustments will be conservative, in the sense that emissions will be adjusted upward and removals will be adjusted downward.

Once work on good practice guidance for LULUCF is completed, CoP will also develop and adopt a decision on the criteria for judging whether a Party has severe problems in an estimate for a sinks activity (i.e. it has failed to meet the methodological and reporting requirements). The criteria are likely to include threshold tests relating to the size and frequency of adjustments needed for the estimates - i.e. large or repeated adjustments above a threshold will mean a Party will be judged to have a severe problem. The consequences of this will be inability to issue credits for the activity.

APPENDIX 1

MARRAKECH ACCORDS: SINKS ACCOUNTING RULES

MATTERS RELATED TO LAND-USE, LAND USE CHANGE AND FORESTRY

Decision -/CP.7

Land use, land-use change and forestry

The Conference of the Parties,

Recalling its decisions 1/CP.4, 8/CP.4, 9/CP.4 and 16/CP.5,

Recalling also its decision 5/CP.6, containing the Bonn agreements on the Implementation of the Buenos Aires Plan of Action,

Acknowledging with appreciation the scientific advice provided in the *Special Report on Land use, Land-use Change and Forestry* prepared by the Intergovernmental Panel on Climate Change,

1. *Recommends* that the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol at its first session adopt decision -/CMP.1 (*Land use, land-use change and forestry*);
2. *Requests* the Subsidiary Body for Scientific and Technological Advice (SBSTA):
 - (a) To consider, following the completion of the methodological work by the Intergovernmental Panel on Climate Change (IPCC) as outlined in paragraph 3 (c) below, and adopt methodologies to account for anthropogenic greenhouse gas emissions resulting from direct human-induced degradation and devegetation activities, with a view to the Conference of the Parties at its tenth session recommending a decision for adoption by the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol at its first session regarding whether such activities should be included in the first commitment period;
 - (b) To investigate the possible application of biome-specific forest definitions for the second and subsequent commitment periods with a view to the Conference of the Parties at its tenth session recommending a decision for adoption on the use of such biome-specific forest definitions for future commitment periods to the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol at its first session;
 - (c) To incorporate the work of the IPCC as outlined in paragraph 3 (d) below into any revisions of modalities, rules and guidelines prior to the second commitment period, for the accounting of activities under Article 3.4 of the Kyoto Protocol;

- (d) To develop at its fifteenth session terms of reference for the work to be conducted under paragraph 2 (e) below;
- (e) To develop definitions and modalities for including afforestation and reforestation project activities under Article 12 in the first commitment period, taking into account the issues of non-permanence, additionality, leakage, uncertainties and socioeconomic and environmental impacts, including impacts on biodiversity and natural ecosystems, and being guided by the principles in the preamble to decision -/CMP.1 (*Land use, land-use change and forestry*) and the terms of reference referred to in paragraph 2 (d) above, with the aim of adopting a decision on these definitions and modalities at the ninth session of the Conference of the Parties, to be forwarded to the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol at its first session;

3. *Invites* the Intergovernmental Panel on Climate Change (IPCC):

- (a) To elaborate methods to estimate, measure, monitor, and report changes in carbon stocks and anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from land use, land-use change and forestry activities under Article 3.3 and 3.4, and Articles 6 and 12 of the Kyoto Protocol on the basis of the *Revised 1996 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories*, taking into account decisions -/CMP.1 and -/CP.7, to be submitted for consideration and possible adoption to the Conference of the Parties at its ninth session;
- (b) To prepare a report on good practice guidance and uncertainty management relating to the measurement, estimation, assessment of uncertainties, monitoring and reporting of net carbon stock changes and anthropogenic greenhouse gas emissions by sources and removals by sinks in the land use, land-use change and forestry sector, taking into consideration decisions -/CMP.1 and -/CP.7, to be submitted for consideration and possible adoption to the Conference of the Parties at its ninth session;
- (c) To develop definitions for direct human-induced ‘degradation’ of forests and ‘devegetation’ of other vegetation types and methodological options to inventory and report on emissions resulting from these activities, to be submitted for consideration and possible adoption to the Conference of the Parties at its ninth session; and,
- (d) To develop practicable methodologies to factor out direct human-induced changes in carbon stocks and greenhouse gas emissions by sources and removals by sinks from changes in carbon stocks and greenhouse gas emissions by sources and removals by sinks due to indirect human-induced and natural effects (such as those from carbon dioxide fertilization and nitrogen deposition), and effects due to past practices in forests (pre-reference year), to be submitted to the Conference of the Parties at its tenth session;

4. *Decides* that any changes to the treatment of harvested wood products shall be in accordance with future decisions of the Conference of the Parties.

Draft decision -/CMP.1
Land use, land-use change and forestry

The Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol,

Affirming that the implementation of land use, land-use change and forestry activities included under the provisions of the Kyoto Protocol shall be consistent with the objectives and principles of, and any decisions taken under, the United Nations Framework Convention on Climate Change and its Kyoto Protocol,

Having considered decision -/CP.7 adopted by the Conference of the Parties at the second part of its sixth session,

1. *Affirms* that the following principles govern the treatment of land use, land-use change and forestry activities:
 - (a) That the treatment of these activities be based on sound science;
 - (b) That consistent methodologies be used over time for the estimation and reporting of these activities;
 - (c) That the aim stated in Article 3.1 of the Kyoto Protocol not be changed by accounting for land use, land-use change and forestry activities;
 - (d) That the mere presence of carbon stocks be excluded from accounting;
 - (e) That the implementation of land use, land-use change and forestry activities contributes to the conservation of biodiversity and sustainable use of natural resources;
 - (f) That accounting for land use, land-use change and forestry does not imply a transfer of commitments to a future commitment period;
 - (g) That reversal of any removal due to land use, land-use change and forestry activities be accounted for at the appropriate point in time;
 - (h) That accounting excludes removals resulting from: (i) elevated carbon dioxide concentrations above their pre-industrial level; (ii) indirect nitrogen deposition; and (iii) the dynamic effects of age structure resulting from activities and practices before the reference year;

2. *Decides* that good practice guidance, and methods to estimate, measure, monitor and report changes in carbon stocks and anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from land use, land-use change and forestry activities, as developed by the Intergovernmental Panel on Climate Change, shall be applied by Parties, if decided in accordance with relevant decisions of the Conference of the Parties and the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol;
3. *Decides* that anthropogenic greenhouse gas emissions by sources and removals by sinks shall be accounted for in accordance with the annex to this decision and reported in annual inventories and reviewed in accordance with relevant decisions relating to Articles 5, 7 and 8 of the Kyoto Protocol, and in accordance with the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, any future elaboration of these guidelines, or parts of them, and any good practice guidance on land-use change and forestry in accordance with relevant decisions of the Conference of the Parties and the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol;
4. *Adopts* the definitions, modalities, rules and guidelines relating to land use, land-use change and forestry activities under Articles 3, 6 and 12 of the Kyoto Protocol contained in the annex for application in the first commitment period.

ANNEX

Definitions, modalities, rules and guidelines relating to land use, land-use change and forestry activities under the Kyoto Protocol

Definitions

1. For land use, land-use change and forestry activities under Articles(1) 3.3 and 3.4, the following definitions shall apply:
 - (a) “Forest” is a minimum area of land of 0.05-1.0 hectares with tree crown cover (or equivalent stocking level) of more than 10-30 per cent with trees with the potential to reach a minimum height of 2-5 metres at maturity *in situ*. A forest may consist either of closed forest formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest. Young natural stands and all plantations which have yet to reach a crown density of 10-30 per cent or tree height of 2-5 metres are included under forest, as are areas normally forming part of the forest area which are temporarily unstocked as a result of human intervention such as harvesting or natural causes but which are expected to revert to forest;
 - (b) “Afforestation” is the direct human-induced conversion of land that has not been forested for a period of at least 50 years to forested land through planting, seeding and/or the human-induced promotion of natural seed sources;

- (c) “Reforestation” is the direct human-induced conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was forested but that has been converted to non-forested land. For the first commitment period, reforestation activities will be limited to reforestation occurring on those lands that did not contain forest on 31 December 1989;
- (d) “Deforestation” is the direct human-induced conversion of forested land to non-forested land;
- (e) “Revegetation” is a direct human-induced activity to increase carbon stocks on sites through the establishment of vegetation that covers a minimum area of 0.05 hectares and does not meet the definitions of afforestation and reforestation contained here;
- (f) “Forest management” is a system of practices for stewardship and use of forest land aimed at fulfilling relevant ecological (including biological diversity), economic and social functions of the forest in a sustainable manner;
- (g) “Cropland management” is the system of practices on land on which agricultural crops are grown and on land that is set aside or temporarily not being used for crop production;
- (h) “Grazing land management” is the system of practices on land used for livestock production aimed at manipulating the amount and type of vegetation and livestock produced.

Article 3.3

2. For the purposes of Article 3.3, eligible activities are those direct human-induced afforestation, reforestation and/or deforestation activities that meet the requirements set forth in this annex and that started on or after 1 January 1990 and before 31 December of the last year of the commitment period.
3. For the purposes of determining the area of deforestation to come into the accounting system under Article 3.3, each Party shall determine the forest area using the same spatial assessment unit as is used for the determination of afforestation and reforestation, but not larger than 1 hectare.
4. For the first commitment period, debits(2) resulting from harvesting during the first commitment period following afforestation and reforestation since 1990 shall not be greater than credits(3) accounted for on that unit of land.
5. Each Party included in Annex I shall report, in accordance with Article 7, on how harvesting or forest disturbance that is followed by the re-establishment of a forest is distinguished from deforestation. This information will be subject to review in accordance with Article 8.

Article 3.4

6. A Party included in Annex I may choose to account for anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from any or all of the following human induced activities, other than afforestation, reforestation and deforestation, under Article 3.4 in the first commitment period: revegetation, forest management, cropland management, and grazing land management.
7. A Party included in Annex I wishing to account for activities under Article 3.4 shall identify, in its report to enable the establishment of its assigned amount pursuant to Article 3.7 and Article 3.8, the activities under Article 3.4 which it elects to include in its accounting for the first commitment period. Upon election, a decision by a Party will be fixed for the first commitment period.
8. During the first commitment period, a Party included in Annex I that selects any or all of the activities mentioned in paragraph 6 above shall demonstrate that such activities have occurred since 1990 and are human-induced. A Party included in Annex I shall not account for emissions by sources and removals by sinks resulting from activities under Article 3.4, if these are already accounted for under Article 3.3.
9. For the first commitment period, accountable anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from cropland management, grazing land management and revegetation under Article 3.4, shall be equal to anthropogenic greenhouse gas emissions by sources and removals by sinks in the commitment period, less five times the anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from these eligible activities in the base year of that Party, while avoiding double accounting.
10. For the first commitment period, a Party included in Annex I that incurs a net source of emissions under the provisions of Article 3.3 may account for anthropogenic greenhouse gas emissions by sources and removals by sinks in areas under forest management under Article 3.4, up to a level that is equal to the net source of emissions under the provisions of Article 3.3, but not greater than [9.0] megatons of carbon times five, if the total anthropogenic greenhouse gas emissions by sources and removals by sinks in the managed forest since 1990 is equal to, or larger than, the net source of emissions incurred under Article 3.3.
11. For the first commitment period only, additions to and subtractions from the assigned amount of a Party(4) resulting from forest management under Article 3.4, after the application of paragraph 10 above and resulting from forest management project activities undertaken under Article 6, shall not exceed the value inscribed in the appendix(5) to this decision, times five.
12. A Party may request the Conference of the Parties to reconsider its numerical values as contained in paragraph 10 and in the appendix to paragraph 11, with a view to the Conference of the Parties recommending a decision for adoption to the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol, no later than 2

years prior to the beginning of the first commitment period.(6) Such a reconsideration shall be based upon country-specific data and the elements of guidance and consideration in footnote 6 to paragraph 11. These shall be submitted and reviewed in accordance with relevant decisions related to Articles 5, 7 and 8 of the Kyoto Protocol, and in accordance with the *Revised 1996 Intergovernmental Panel on Climate Change Guidelines for National Greenhouse Gas Inventories*, any future elaboration of these guidelines, or parts of them, and any good practice guidance on land use, land-use change and forestry in accordance with the relevant decisions of the Conference of the Parties.

D. Article 12

13. The eligibility of land-use, land-use change and forestry project activities under Article 12 is limited to afforestation and reforestation.
14. For the first commitment period, the total of additions to a Party's assigned amount resulting from eligible land-use, land-use change and forestry project activities under Article 12 shall not exceed one per cent of base year emissions of that Party, times five.
15. The treatment of land-use, land-use change and forestry project activities under Article 12 in future commitment periods shall be decided as part of the negotiations on the second commitment period.

General

16. Each Party included in Annex I shall, for the purposes of applying the definition of "forest" as contained in paragraph 1 (a) above, select a single minimum tree crown cover value between 10 and 30 per cent, a single minimum land area value between 0.05 and 1 hectare and a single minimum tree height value between 2 and 5 metres. The selection of a Party shall be fixed for the duration of the first commitment period. The selection shall be included as an integral part of its report to enable the establishment of its assigned amount pursuant to Article 3.7 and 3.8 in accordance with decision -/CP.7, and shall include the values for tree crown cover, tree height and the minimum land area. Each Party shall justify in its reporting that such values are consistent with the information that has historically been reported to the Food and Agriculture Organization of the United Nations or other international bodies, and if they differ, explain why and how such values were chosen.
17. For the first commitment period, and subject to other provisions in this annex, the additions to and subtractions from the assigned amount of a Party pursuant to Article 3.7 and 3.8 shall be equal to anthropogenic greenhouse gas emissions by sources and removals by sinks measured as verifiable changes in carbon stocks, and non-carbon dioxide greenhouse gas emissions during the period 1 January 2008 to 31 December 2012 resulting from afforestation, reforestation and deforestation under Article 3.3

and forest management under Article 3.4, that have taken place since 1 January 1990. Where the result of this calculation is a net sink of greenhouse gases, this value shall be added to the assigned amount of that Party. Where the result of this calculation is a net source of greenhouse gas emissions, this value shall be subtracted from the assigned amount of that Party.

18. Accounting of anthropogenic greenhouse gas emissions by sources and removals by sinks resulting from land use, land-use change and forestry activities under Article 3.3 and 3.4, shall begin with the onset of the activity or the beginning of the commitment period, whichever comes later.
19. Once land is accounted for under Article 3.3 and 3.4, all anthropogenic greenhouse gas emissions by sources from and removals by sinks on this land must be accounted for throughout subsequent and contiguous commitment periods.
20. National inventory systems under Article 5.1 shall ensure that areas of land subject to land use, land-use change and forestry activities under Article 3.3 and 3.4 are identifiable, and information about these areas should be provided by each Party included in Annex I in their national inventories in accordance with Article 7. Such information will be reviewed in accordance with Article 8.
21. Each Party included in Annex I shall account for all changes in the following carbon pools: above-ground biomass, below-ground biomass, litter, dead wood, and soil organic carbon. A Party may choose not to account for a given pool in a commitment period, if transparent and verifiable information is provided that the pool is not a source.

1 “Article” in this annex refers to an Article of the Kyoto Protocol, unless otherwise specified.

2 ‘Debits’: where emissions are larger than removals on a unit of land.

3 ‘Credits’: where removals are larger than emissions on a unit of land.

4 As will be elaborated in the relevant decision dealing with modalities for the accounting of assigned amounts.

5 In arriving at the values in the appendix below, the Conference of the Parties was guided by the application of an 85 per cent discount factor to account for the removals identified in paragraph 1(h) in the preamble of decision - /CMP.1 (Land use, land-use change and forestry) and a 3 per cent cap on forest management, using a combination of data provided by Parties and by the Food and Agriculture Organization (FAO). Consideration was also given to national circumstances (including the degree of effort needed to meet Kyoto commitments and the forest management measures implemented). The accounting framework established in this paragraph shall not be construed as establishing any precedent for the second and subsequent commitment periods.

6 The Russian Federation does not recognize the numerical value in paragraph 10 and the value for the Russian Federation in the appendix to paragraph 11 as final values for it. (See FCCC/CP/2001/CRP.10.)

APPENDIX

Party	Mt C/yr
Australia	0.00
Austria	0.63
Belarus	
Belgium	0.03
Bulgaria	0.37
Canada	12.00
Croatia	
Czech Republic	0.32
Denmark	0.05
Estonia	0.10
Finland	0.16
France	0.88
Germany	1.24
Greece	0.09
Hungary	0.29
Iceland	0.00
Ireland	0.05
Italy	0.18
Japan	13.00
Latvia	0.34
Liechtenstein	0.01
Lithuania	0.28
Luxembourg	0.01
Monaco	0.00
Netherlands	0.01
New Zealand	0.20
Norway	0.40
Poland	0.82
Portugal	0.22
Romania	1.10
Russian Federation	17.63
Slovakia	0.50
Slovenia	0.36
Spain	0.67
Sweden	0.58
Switzerland	0.50
Ukraine	1.11
United Kingdom of Great Britain and Northern Ireland	0.37

7 The list of countries in this table differs from that found in decision 5/CP.6 as a result of consultations undertaken during the session.

APPENDIX 2

MARRAKECH ACCORDS: **PRE-COMMITMENT PERIOD REPORTING REQUIREMENTS FOR SINKS**

Decision -/CMP.1

**Modalities for the accounting of assigned amounts under Article 7,
paragraph 4, of the Kyoto Protocol**

ANNEX

**Modalities for the accounting of assigned amounts under
Article 7, paragraph 4, of the Kyoto Protocol**

I. MODALITIES

...

6. Each Party included in Annex I shall facilitate the calculation of its assigned amount pursuant to Article 3, paragraphs 7 and 8, for the commitment period and demonstrate its capacity to account for its emissions and assigned amount. To this end, each Party shall submit a report, in two parts, containing the information specified in paragraphs 7 and 8 below.
7. Part one of the report shall contain the following information, or references to such information where it has been previously submitted to the secretariat:
 - (a) Complete inventories of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol for all years from 1990, or another approved base year or period under Article 3, paragraph 5, to the most recent year available, prepared in accordance with Article 5, paragraph 2, and relevant decisions of the Conference of the Parties serving as the meeting of the Parties to the Kyoto Protocol (COP/MOP), taking into account any relevant decisions of the Conference of the Parties (COP);
 - (b) Identification of its selected base year for hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride in accordance with Article 3, paragraph 8;
 - (c) The agreement under Article 4, where the Party has reached such an agreement to fulfil its commitments under Article 3 jointly with other Parties;
 - (d) Calculation of its assigned amount pursuant to Article 3, paragraphs 7 and 8, on the basis of its inventory of anthropogenic emissions by sources and removals by sinks of greenhouse gases not controlled by the Montreal Protocol.
8. Part two of the report shall contain the following information, or references to such information where it has been previously submitted to the secretariat:
 - (a) Calculation of its commitment period reserve in accordance with decision -/CP.7 (Article 17);
 - (b) Identification of its selection of single minimum values for tree crown cover, land area and tree height for use in accounting for its activities under Article 3,

- paragraphs 3 and 4, together with a justification of the consistency of those values with the information that has been historically reported to the Food and Agriculture Organization of the United Nations or other international bodies, and in the case of difference, an explanation of why and how such values were chosen, in accordance with decision -/CP.7 (Land use, land-use change and forestry);
- (c) Identification of its election of activities under Article 3, paragraph 4, for inclusion in its accounting for the first commitment period, together with information on how its national system under Article 5, paragraph 1, will identify land areas associated with the activities, in accordance with decision -/CP.7 (Land use, land-use change and forestry);
 - (d) Identification of whether, for each activity under Article 3, paragraphs 3 and 4, it intends to account annually or for the entire commitment period.
 - (e) A description of its national system in accordance with Article 5, paragraph 1, reported in accordance with paragraphs __ and __ of the guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol;
 - (f) A description of its national registry, reported in accordance with paragraph __ of the guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol.

APPENDIX 3

MARRAKECH ACCORDS: **ANNUAL COMMITMENT PERIOD** **REPORTING REQUIREMENTS FOR SINKS**

Decision -/CMP.1

Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol

ANNEX

Draft guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol

I. REPORTING OF SUPPLEMENTARY INFORMATION UNDER ARTICLE 7, PARAGRAPH 1

...

5. Each Party included in Annex I shall include in its annual(5) greenhouse gas inventory information on anthropogenic greenhouse gas emissions by sources and removals by sinks from land use, land-use change and forestry activities under Article 3, paragraph 3 and, if any, elected activities under Article 3, paragraph 4, in accordance with Article 5, paragraph 2, as elaborated by any good practice guidance in accordance with relevant decisions of the COP/MOP on land use, land-use change and forestry. Estimates for Article 3, paragraphs 3 and 4, shall be clearly distinguished from anthropogenic emissions from the sources listed in Annex A to the Kyoto Protocol. In reporting the information requested above, each Party included in Annex I shall include the reporting requirements specified in paragraphs 6 to 8 below, taking into consideration the selected values in accordance with paragraph 16 of the annex to decision -/CMP.1 on land use, land-use change and forestry.
6. General information to be reported for activities under Article 3, paragraphs 3, and any elected activities(6) under Article 3, paragraph 4, shall include:
 - (a) Information on how inventory methodologies have been applied taking into account any IPCC Good Practice Guidance on land use, land-use change and forestry agreed by the COP and recognising the principles as laid out in decision -/CP.7 on land use, land-use change and forestry;
 - (b) The geographical location of the boundaries of the areas that encompass:
 - (i) Units of land subject to activities under Article 3, paragraph 3;
 - (ii) Units of land subject to activities under Article 3, paragraph 3, which would otherwise be included in land subject to elected activities under Article 3, paragraph 4, under the provisions of

- paragraph 8 of the annex to decision -/CMP.1 on land use, land-use change and forestry; and
- (iii) Land subject to elected activities under Article 3, paragraph 4.

The information aims to ensure that units of land and areas of land are identifiable. Parties are encouraged to elaborate on this information on the basis of any relevant decisions of the COP/MOP on good practice guidance associated with land use, land-use change and forestry under Article 8;

- (c) The spatial assessment unit used for determining the area of accounting for afforestation, reforestation and deforestation;
 - (d) Information on anthropogenic greenhouse gas emissions by sources and removals by sinks(7) resulting from activities under Article 3, paragraphs 3 and 4, for all geographical locations reported in the current and previous years, under paragraph 6 (b), above, since the beginning of the commitment period or the onset of the activity, whichever comes later. In the latter case the year of the onset of the activity shall also be included. Once land is accounted for under Article 3, paragraph 3 or Article 3, paragraph 4, reporting shall continue throughout subsequent and contiguous commitment periods;
 - (e) Information on which, if any, of the following pools: above-ground biomass, below-ground biomass, litter, dead wood and/or soil organic carbon were not accounted for, together with verifiable information that demonstrates that these unaccounted pools were not a net source of anthropogenic greenhouse gas emissions;
7. Information(8) should also be provided which indicates whether or not anthropogenic greenhouse gas emissions by sources and removals by sinks from land use, land-use change and forestry activities under Article 3 paragraph 3 and elected activities under Article 3 paragraph 4 factor out removals from:
- (a) Elevated carbon dioxide concentrations above pre-industrial levels;
 - (b) Indirect nitrogen deposition; and
 - (c) The dynamic effects of age structure resulting from activities prior to 1 January 1990;
8. Specific information to be reported for activities under Article 3, paragraph 3, shall include:
- (a) Information that demonstrates that activities under Article 3, paragraph 3, began on or after 1 January 1990 and before 31 December of the last year of the commitment period, and are directly human-induced;
 - (b) Information on how harvesting or forest disturbance that is followed by the reestablishment of a forest is distinguished from deforestation;

(c) Information on emissions and removals of greenhouse gases from lands harvested during the first commitment period following afforestation and reforestation on these units of land since 1990 consistent with the requirements under paragraph 4 of the annex to draft decision –/CMP.1 on land use, land-use change and forestry.

9. Specific information to be reported for any elected activities(9) under Article 3, paragraph 4, shall include:

(a) A demonstration that activities under Article 3, paragraph 4, have occurred since 1 January 1990 and are human induced;

(b) For Parties included in Annex I that elect cropland management and/or grazing land management and/or revegetation, anthropogenic greenhouse gas emissions by sources and removals by sinks for each year of the commitment period and for the base year for each of the elected activities on the geographical locations reported under paragraph 6(b), above;

(c) Information that demonstrates that emissions by sources and removals by sinks resulting from elected Article 3, paragraph 4, activities are not accounted for under activities under Article 3, paragraph 3;

(d) For Parties included in Annex I that elect to account for forest management, under Article 3, paragraph 4, information that indicates to what extent the anthropogenic greenhouse gas removal by sinks offsets the debit incurred under Article 3, paragraph 3, if any, consistent with the requirements under paragraph 10 of the annex to draft decision –/CMP.1 on land use, land-use change and forestry.

5 It is recognised in the IPCC 1996 Revised Guidelines that the current practice on land use, land-use change and forestry does not in every situation request annual data collection for the purpose of preparing annual inventories based on a sound scientific basis.

6 The elected activities shall be the same as those identified in the Party's report referred to in paragraph 8 of annex to decision -/CP.7 (*modalities for the accounting of assigned amounts*).

7 Such information shall be within levels of confidence as elaborated by any IPCC good practice guidance adopted by the COP/MOP and in accordance with relevant decisions of the COP/MOP on land use, land-use change and forestry.

8 This recognises that the intent of the Appendix to the Annex of the decision -/CMP.1 (land use, land-use change and forestry) is to factor out the effects described in (a) - (c) for the first commitment period.

9 See footnote 6.

APPENDIX 4

MARRAKECH ACCORDS: **PERIODIC REPORTING REQUIREMENTS FOR SINKS**

Decision -/CMP.1

Guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol

ANNEX

Draft guidelines for the preparation of the information required under Article 7 of the Kyoto Protocol

II. REPORTING OF SUPPLEMENTARY INFORMATION UNDER ARTICLE 7, PARAGRAPH 2

...

19. Each Party included in Annex I shall provide a description of how it is performing the general and specific functions defined in the guidelines for national systems under Article 5, paragraph 1. The description shall contain the following elements:

- (a) The name and contact information for the national entity and its designated representative with overall responsibility for the national inventory of the Party;
- (b) The roles and responsibilities of various agencies and entities in relation to the inventory development process, as well as the institutional, legal and procedural arrangements made to prepare the inventory;
- (c) A description of the process for collecting activity data, for selecting emission factors and methods, and for the development of emission estimates;
- (d) A description of the process and the results of key source identification and, where relevant, archiving of test data;
- (e) A description of the process for the recalculation of previously submitted inventory data;
- (f) A description of the quality assurance and quality control plan, its implementation and the quality objectives established, and information on internal and external valuation and review processes and their results in accordance with the guidelines for national systems;
- (g) A description of the procedures for the official consideration and approval of the inventory.

...

25. Each Party included in Annex I shall report any relevant information on its domestic and regional legislative arrangements and enforcement and administrative procedures, established pursuant to the implementation of the Kyoto Protocol, according to its national circumstances. This information shall include:
- (a) A description of any domestic and regional legislative arrangements and enforcement and administrative procedures the Party has in place to meet its commitments under the Kyoto Protocol, including the legal authority for such programmes, how they are implemented and procedures for addressing cases of non-compliance under domestic law;
 - (b) A description of any provisions to make information on these legislative arrangements and enforcement and administrative procedures (e.g. rules on enforcement and administrative procedures, action taken) publicly accessible;
 - (c) A description of any institutional arrangements and decision-making procedures that it has in place to coordinate activities related to participation in the mechanisms under Articles 6, 12 and 17, including the participation of legal entities.
26. Each Party included in Annex I shall provide a description of any national legislative arrangements and administrative procedures that seek to ensure that the implementation of activities under Article 3, paragraph 3, and any elected activities under Article 3, paragraph 4, also contributes to the conservation of biodiversity and sustainable use of natural resources.

ATTACHMENT II

Saskatchewan Carbon Sinks Assessment Workshop

March 25-26, 2002

Prairie Adaptation Research Collaborative

#150, 10 Research Drive, University of Regina, Regina SK

Time	Topic	Speaker	Affiliation
Day 1			
1000-1030	Introduction, Purpose, Objectives	M. Johnston	SRC
1030-1100	Desired Outcomes of the Workshop from the SK Government's Perspective	F. Wist	SEM
1100-1200	Agricultural Soil Sink Potential In SK	M. Boehm	AAFC
1200-1300	Lunch		
1300-1345	Agricultural Soil Sink Potential From The Landowner's Perspective	B. McClinton	SSCA
1345-1430	N ₂ O Sources And Sinks In Saskatchewan	R. Lemke	AAFC
1430-1515	Shelterbelt Sink Potential In SK	J. Kort	PFRA
1515-1530	Break		
1530-1615	Forest Management Sink Potential	W. Kurz	CFS
1615-1700	Afforestation Sink Potential In SK	Silvia Lac	U of S
Day 2			
0830-0915	Assessing Afforestation Potential In The Prairie Provinces	D. Lee	PFRA
0915-1000	Scaling Up Carbon Estimates To The Landscape Level	T. Brierley	AAFC
1000-1030	break		
1030-1045	Charge to working groups		
1045-1200	WG Session 1		
1200-1300	Lunch		
1300-1500	WG Session 2		
1500-1530	break		
1530-1630	Plenary		

Questions for break-out group: Agricultural Sinks Measurement Issues

1. What sink types seem to have the greatest potential for Saskatchewan – agricultural soils, shelterbelts, etc. Rank each sink type according to Large, Medium, and Small opportunity
2. For each sink type, are there some aspects/alternatives that seem more important than others for– e.g. if agricultural soil sinks seem attractive, should Saskatchewan promote zero-till or permanent cover or both? Identify the alternatives and rank each of them as Large, Medium and Small opportunities
3. For each sink type, what type of activity is required in Saskatchewan over the next three years to work towards achievement of the sink opportunity, e.g.
 - basic research
 - applied research
 - data collection/gap filling
 - policy development
 - other
4. For each prospective sink type, what is the timeframe for achieving the opportunity in Saskatchewan – short term (pre-2008), medium term (2008-2012), or long term (post-2012)
5. For each prospective sink-related activity identified above, what is the magnitude of the total government investment required for the next three years in Saskatchewan - Low (less than \$50,000 per year); Medium (\$50,000 - \$250,000 per year); High (more than \$250,000 per year)
6. For each prospective sink type, what is the likely opportunity for Saskatchewan to obtain cost-sharing of proposed activities from the federal government or other provincial governments – High, Medium or Low
7. For each prospective sink type, what is the likely opportunity for Saskatchewan to obtain private sector cost-sharing of proposed activities – High, Medium or Low
8. For each prospective sink type, what specific initiative/action should be taken first; who should be involved; what is the timeline for the action; and what is the required budget?
9. For each prospective sink type, what is your estimate of the contribution the sink type can make toward reducing Saskatchewan's emissions – Low (less than 5% of required emissions reductions; Medium (5% - 20% of required emissions reductions); High (greater than 20% of required emissions reductions).
10. For each prospective sink type, what is your overall assessment of the priority Saskatchewan should assign to the sink type – High, Medium or Low

Questions for break-out group: Agricultural Sinks Policy Issues

1. What sink types seem to have the greatest potential for Saskatchewan – agricultural soils, afforestation, shelterbelts, etc. Rank each sink type according to Large, Medium, and Small opportunity
2. For each sink type, are there some aspects/alternatives that seem more important than others for– e.g. if agricultural soil sinks seem attractive, should Saskatchewan promote zero-till or permanent cover or both? Identify the alternatives and rank each of them as Large, Medium and Small opportunities
3. For each sink type, what type of activity is required in Saskatchewan over the next three years to work towards achievement of the sink opportunity, e.g.
 - policy research
 - data collection/gap filling
 - policy development
 - development of institutional and market mechanisms
 - implementation of programs/incentives
 - stakeholder information/education
4. For each prospective sink type, what is the timeframe for achieving the opportunity in Saskatchewan – short term (pre-2008), medium term (2008-2012), or long term (post-2012)
5. For each prospective sink-related activity identified above, what is the magnitude of the total government investment required for the next three years in Saskatchewan - Low (less than \$50,000 per year); Medium (\$50,000 - \$250,000 per year); High (more than \$250,000 per year)
6. For each prospective sink type, what is the likely opportunity for Saskatchewan to obtain cost-sharing of proposed activities from the federal government or other provincial governments – High, Medium or Low
7. For each prospective sink type, what is the likely opportunity for Saskatchewan to obtain private sector cost-sharing of proposed activities – High, Medium or Low
8. For each prospective sink type, what specific initiative/action should be taken first; who should be involved; what is the timeline for the action; and what is the required budget?
9. For each prospective sink type, what is your estimate of the contribution the sink type can make toward reducing Saskatchewan's emissions – Low (less than 5% of required emissions reductions; Medium (5% - 20% of required emissions reductions); High (greater than 20% of required emissions reductions).
10. For each prospective sink type, what is your estimate of the market cost for carbon dioxide required to stimulate the development of sinks – Low (less than \$10 per tonne of carbon dioxide equivalent per year); Medium (between \$10 and \$50 per tonne of carbon dioxide equivalent per year); and High (more than \$50 per tonne of carbon dioxide equivalent per year).
11. For each prospective sink type, what is your overall assessment of the priority Saskatchewan should assign to the sink type – High, Medium or Low

Questions for break-out group: Forestry Sinks Measurement and Policy Issues

1. What sink types seem to have the greatest potential for Saskatchewan –afforestation, preventing deforestation, shelterbelts, forest management, etc. Rank each sink type according to Large, Medium, and Small opportunity
2. What is the relative priority we should place on measurement and policy for preventing deforestation versus promoting afforestation and forest management?
3. For each sink type, what type of activity is required in Saskatchewan over the next three years to work towards achievement of the sink opportunity, e.g.
 - basic research
 - applied research
 - data collection/gap filling
 - policy development
 - development of institutional and market mechanisms
 - implementation of programs/incentives
 - stakeholder information/education
4. For each prospective sink type, what is the timeframe for achieving the opportunity in Saskatchewan – short term (pre-2008), medium term (2008-2012), or long term (post-2012)
5. For each prospective sink-related activity identified above, what is the magnitude of the total government investment required for the next three years in Saskatchewan - Low (less than \$50,000 per year); Medium (\$50,000 - \$250,000 per year); High (more than \$250,000 per year)
6. For each prospective sink type, what is the likely opportunity for Saskatchewan to obtain cost-sharing of proposed activities from the federal government or other provincial governments – High, Medium or Low
7. For each prospective sink type, what is the likely opportunity for Saskatchewan to obtain private sector cost-sharing of proposed activities – High, Medium or Low
8. For each prospective sink type, what specific initiative/action should be taken first; who should be involved; what is the timeline for the action; and what is the required budget?
9. For each prospective sink type, what is your estimate of the contribution the sink type can make toward reducing Saskatchewan's emissions – Low (less than 5% of required emissions reductions; Medium (5% - 20% of required emissions reductions); High (greater than 20% of required emissions reductions).
10. For each prospective sink type, what is your estimate of the market cost for carbon dioxide required to stimulate the development of sinks – Low (less than \$10 per tonne of carbon dioxide equivalent per year); Medium (between \$10 and \$50 per tonne of carbon dioxide equivalent per year); and High (more than \$50 per tonne of carbon dioxide equivalent per year).
11. For each prospective sink type, what is your overall assessment of the priority Saskatchewan should assign to the sink type – High, Medium or Low

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*AM - agricultural sinks measurement; AP - agricultural sinks policy; FO - forestry sinks measurement and policy