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Agricultural Soil Carbon Sinks and the Kyoto Protocol:

A Practical Opportunity for the Environment

The adoption of good farming practices to develop a more productive and sustainable agriculture, also removes carbon dioxide (CO_2) from the atmosphere. That carbon is "sequestered" in soil as organic matter.

Encouraging agricultural sinks promotes farming practices that make agriculture more productive and environmentally sustainable.

Benefits from the Adoption of Carbon Sequestering Practices

Building up organic carbon in soil has a number of benefits. It improves soil quality and nutrient supply, making the soil more productive. This reduces the pressure to convert forests and native areas to agricultural lands. Better quality soil improves water filtration and increases moisture retention, aiding agricultural production in dry seasons. The risk of soil degradation and desertification is reduced. There is less risk of erosion and contamination of waterways. The runoff or leaching of substances attached to soil particles, such as phosphorus, pesticides and bacteria, decreases. The soil becomes less vulnerable to wind erosion, reducing the flow of particulate matter into the air. In short, good soil management that builds up the soil carbon pool improves air and water quality, and is consistent with soil and water conservation objectives. Moreover, carbon-sequestering agricultural practices enhance wildlife habitat, helping to protect biodiversity. These environmental benefits, along with greater productivity, translate into a more sustainable agriculture that yields economic and social advantages to rural areas.

Carbon-sequestering practices can be used to address a number of environmental issues, including climate change, wind, water and tillage erosion, soil salinity, desertification, pollution of air and water, as well as loss of wildlife habitat. These benefits are highly relevant for both developed and less developed countries.

Canada

What farmers can do to enhance the soil sink:

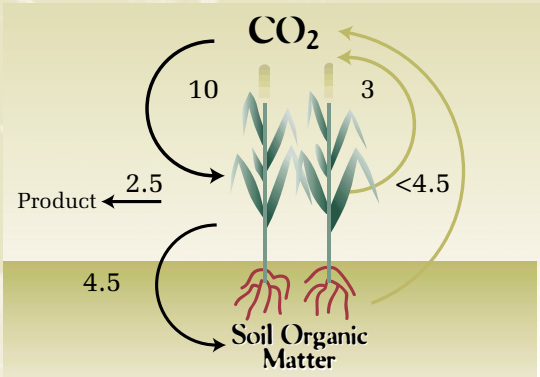
- reduce fallow
- restore degraded lands
- use forages
- return animal manures to the soil
- implement good fertilization practices
- implement good grazing management
- agroforestry, (e.g. plant shelterbelts)
- plant cover crops
- plant green manure crops
- reduce tillage

Improved grazing management can reduce greenhouse gas emissions and increase carbon sequestration.

The Agricultural Soil Carbon Sink

A sink is defined as any process that removes CO_2 from the atmosphere (United Nations Framework Convention on Climate Change). The soil carbon sink or carbon sequestration process begins with the transformation of atmospheric CO_2, via photosynthesis, into carbon-containing compounds within the plant including sugars, proteins, cellulose, and lignin. Some of these compounds are used by the plant for energy, thus releasing some of the CO_2 back into the atmosphere. Of the carbon remaining in the plant, a portion is removed during harvest (e.g. the grain) while the residue, including the roots, is transformed by soil micro-organisms into organic matter. During these transformations, the soil micro-organisms use some of the matter for energy and release some of the carbon back to the atmosphere as CO_2. A portion of the soil organic matter is stabilized with soil clay particles, therefore becoming quite resistant to further degradation into CO_2 by soil micro-organisms. Relative to a human lifetime, this soil organic matter is stable.

The carbon cycle in a corn field



Carbon moves from the atmosphere into plants then via plant residues into soil organic matter. Soil organic matter is slowly decomposed by micro-organisms and that C is released back to the atmosphere.

* Values shown (Mg/ha) are estimated annual C flows for a corn crop.

Economic Importance of Carbon Sinks

The farmed soil resource provides the world with food and fibre that has been, and continues to be, essential for human survival and economic growth. Thus, the protection and enhancement of the soil resource base through carbon sequestration encourages sustainable economic development and global food security.

Carbon-sequestering agricultural practices can substantially reduce economic costs to farmers and governments. Fuel and fertilizer use per unit of food grown is reduced, leading to lower production costs over the long term. Fewer resources will need to be allocated toward addressing environmental problems such as land degradation and the contamination of lakes and rivers with sediment.

The formal recognition of agricultural soil sinks in the Kyoto Protocol will boost investment to encourage farmers to adopt carbon-sequestering practices. Since the adoption of these practices already has economic advantages for farmers, a marginal increase in education and awareness, technical support, and/or funds to offset some risks or capital investments could substantially increase the rates of adoption.

Engaging Farmers on Climate Change

Agriculture is responsible for one fifth of the annual increase in greenhouse gas emissions from human activities. However, farming produces little carbon dioxide relative to its emissions (in CO_2-equivalents) of nitrous oxide and methane. Reducing methane and nitrous oxide emissions is a great challenge for agriculture if it is to produce the same quantity and quality of food as it does at present, let alone additional food to meet the nutritional needs of an increasing world population. A soil richer in organic matter resulting from adoption of carbon sequestration typically reduces the total greenhouse gas emissions per unit of food produced. The immediate recognition of agricultural carbon sinks in the Kyoto Protocol would allow farmers to contribute positively to reducing greenhouse gas emissions through carbon sequestration while improved agricultural practices are developed to reduce the agricultural emission of nitrous oxide and methane.

The adoption of carbon-sequestering agricultural practices has the potential to restore degraded landscapes.

Technical Issues Related to the Recognition of Soil Sinks in the Kyoto Protocol

The substantial social, economic and environmental benefits of fostering the agricultural soil sink provide a strong rationale for the international community to include soil sinks in the Kyoto Protocol. The details for inclusion of agricultural soil sinks need to be resolved by the international community. Important considerations include:

- carbon accounting and verification;
- measurement uncertainty;
- permanence of carbon sequestered in soil; and
- carbon sinks in the Kyoto Protocol mechanisms.

Carbon Accounting and Verification

At present, agricultural emissions of carbon dioxide, nitrous oxide and methane are recognized in the Kyoto Protocol, yet carbon sequestration is not. Canada is dedicated to developing a practical and yet comprehensive land-based accounting system for all greenhouse gases. This minimizes the possibility of inadvertently creating incentives that negatively affect the environment. The *Special Report of the Intergovernmental Panel on Climate Change* (IPCC) *on Land Use, Land-Use Change, and Forestry* (LULUCF) confirms that Annex 1 Parties to the Kyoto Protocol have the technical capability to measure carbon stock changes and net greenhouse

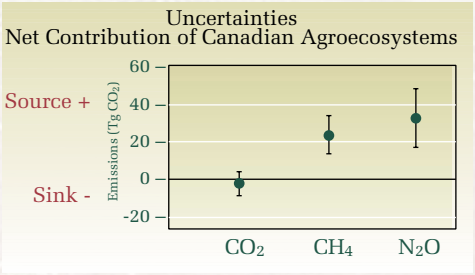
Shelterbelts can sequester atmospheric carbon in addition to reducing soil erosion, improving water quality and increasing biodiversity and wildlife habitat.

gas emissions in terrestrial ecosystems. Countries can use scientifically credible, cost-effective methods to ensure that soil carbon stocks are measured accurately, whether they are sequestering carbon, or emitting CO_2. Certification of carbon stock changes could be accomplished by a system from an international team of experts.

Uncertainty

Technical methods exist to deal with uncertainties. Sources of uncertainty include measurement, the identification of lands and additional sink activities under Articles 3.3 and 3.4 of the Kyoto Agreement as well as the definition and application of baselines. These uncertainties can be addressed by using experimental data, simulation models, soil and land use databases, validated scaling-up protocols and good-practice guidelines.

Measurement uncertainties associated with carbon sequestration are lower than for some greenhouse gases already recognized in the Kyoto Protocol, including methane and nitrous oxide.



The relative size and uncertainty of measuring agricultural CO_2 emissions/sinks is much less than for methane (CH_4) and nitrous oxide (N_2O) emissions already included under the Kyoto Protocol.

Permanence of Carbon Sequestered in Soil

The world's farmers manage a soil carbon reservoir on land used for crops and grazing. The size of this reservoir is about equal to the total carbon that would be released after 100 years of fossil fuel burning at the current world rate. In recent years, farmers have managed this immense carbon pool so that its size has changed very little. Despite the apparent stability of this carbon reservoir, there is nothing permanent about any of the carbon which it contains, nor of the agricultural practices that promote this apparent stability. Neglecting this issue in the Kyoto Protocol has serious consequences. Farmers could react to future economic forces by shifting farming practices to those that generate large carbon emissions from soil. Unintended and unmonitored carbon dioxide emissions from soil could easily cancel out, and possibly overwhelm the current emission reductions called for in the Kyoto Protocol. In the short term, further use of carbon-sequestering practices will enlarge the world agricultural soil carbon sink only slightly. Nevertheless, global climate change policy must continue to encourage good soil management so that the soil sink remains healthy, and less vulnerable to carbon decreases. Moreover, it is in everyone's interest to ensure that the agricultural soil sink is comprehensively monitored. The substantial benefits provided by carbon-sequestering agricultural practices will be reinforced by including the soil sink in the Kyoto Protocol, diminishing the reasons to revert to farming practices that emit CO_2.

Conservation tillage and crop residue management improve soil quality and sequester carbon as organic matter.

The Canadian Context

In Canada, one-quarter of a million farmers manage 61 million hectares of land. Overall, these farmers have considerably improved the sustainability of their soil management practices on land used for crops and grazing. In the year 2000, for the first time in Canada's history, its agricultural soils sequestered more carbon than was emitted. This achievement was the result of a strong commitment to address soil degradation, in response to desertification risk and devastating erosion during much of the 20th century. At current adoption rates of carbon sequestering agricultural practices in Canada, soil carbon accumulation can continue for at least another 20-25 years. After this period, the continuance of sound farming practices that conserve the soil will maintain this sink rather than increase it.

It is clear that agriculture's commitment and contribution to reducing greenhouse gas emissions prior to the first commitment period (2008-2012) is considerable. Present estimates show that Canada's carbon sinks can provide the country with a potential credit of approximately 10 Mt of CO_2/yr during the first commitment period. This represents a very small share of Canada's greenhouse gas emissions. However, it represents an important contribution toward Canada's environmental goals. These data were obtained by a team of experts using experimental data, simulation models, and national soils and land use databases.

Conclusion

Canada is committed to protecting and enhancing its soil resources and sees a role for the international community to encourage the world-wide preservation of agricultural soils. The provision of additional incentives to adopt carbon sequestering agricultural practices needs to be addressed for reasons of ecosystem health no matter if the fixed carbon is credited or not. However, the international community now possesses a historic and practical opportunity to promote these practices on a world scale through its climate change agenda. Thesooner agricultural soils are recognized and included in the Kyoto Protocol, the greater will be the incentive and opportunity for farmers to reduce CO_2 in the atmosphere.

Project-based Activities and the Clean Development Mechanism

Project-based carbon-sequestering activities may assist Annex 1 Parties to the Kyoto Protocol in meeting their emissions targets through certified emissions reductions, based on Clean Development Mechanism and Joint Implementation projects in countries with and without emissions commitments. These activities would stimulate the global implementation of sustainable land management practices which provide enormous environmental benefits, especially to those areas most at risk of soil degradation. All potential project sites could submit to the same comprehensive greenhouse gas accounting system used in the Annex 1 countries, thereby ensuring the scientific credibility of the projects.

For more information on Canadian agricultural sinks, estimates and data, please contact:

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