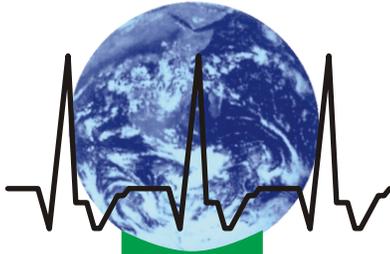


Spring 2000



National Environmental Indicator Series

# Environmental Sustainability of Canada's Agricultural Soils

Environmental indicators are selected key statistics that provide information on significant trends in the environment, natural resource sustainability, and related human activities. The indicators in this bulletin are part of a national set of environmental indicators designed to provide a profile of the state of Canada's environment and measure progress towards sustainable development.

## Issue context

### Why should we be concerned about agricultural soil?

Sustainable agriculture is the continuous production of food and fibre into the future while conserving the health of natural resources on and off the farm. Healthy soils serve as the foundation of sustainable agriculture by:

- ▶ providing a medium for plant growth,
- ▶ holding water, air, nutrients, and soil biota, and
- ▶ receiving organic wastes and recycling their nutrients back to plants.

Agricultural soils can also have an influence on overall environmental sustainability, by, for example:

- ▶ exchanging gases with the atmosphere and influencing global climate, and
- ▶ holding and breaking down contaminants.

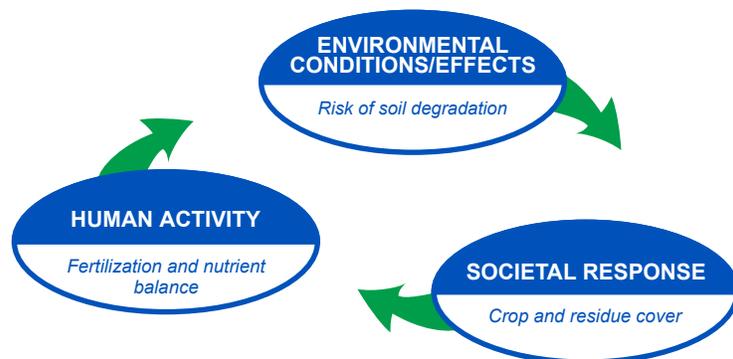
Virtually all available productive agricultural land in Canada is already under crop production. Some highly productive land has been (and is being) lost to urban and industrial uses. It is important to maintain the health of our remaining soil resources.

Water quality, biodiversity, and socioeconomic aspects of sustainable agriculture are not directly related to soils and will be covered under other issues.

### Indicators of agricultural soil sustainability

The cycle diagram below shows three broad components of the

## What are the links?



interactions between humans and the environment that are related to agricultural soils. Indicators are chosen to be representative of the cycle components (not necessarily an illustration of a particular cause-effect relationship). All the indicators presented in this bulletin are based on the detailed research underlying Agriculture and Agri-Food Canada's Agri-Environmental Indicator Project.

## **Human activity: Fertilization and nutrient balance**

Tillage, fertilization, and pest control are examples of human activities related to agriculture. Fertilization was chosen as the representative indicator since the focus of this bulletin is on soils. Pest control will be covered under other themes, and tillage is covered indirectly under the other two soil indicators.

Farmers must add nutrients to the soil to produce crop yields that satisfy human requirements and maintain soil fertility. The main sources of added soil nutrients are commercial fertilizers and animal manure. Sewage sludge and municipal compost are less commonly used. The major nutrients in these inputs are nitrogen, phosphorus, and potassium.

Nitrogen is a nutrient that is particularly mobile in soil. Overfertilization can result in surface water and groundwater pollution or the release of greenhouse gases such as nitrous oxide. Other factors, such as weather, the permeability of the soil, and management activities, influence whether excess nutrients in the soil will result in environmental problems. Underfertilization can result in serious depletion of soil fertility.

The fertilization and nutrient balance (residual nitrogen) indicator shows whether we are achieving a balance between nutrient availability and crop requirements.

## **Environmental condition: Soil degradation**

A small grouping of indicators of risk of soil degradation was chosen to represent environmental conditions and

effects. Soil organic matter content has good potential as an indicator representative of environmental condition, but existing data limitations need to be addressed to make it a better candidate for future bulletin updates. Soil may be degraded (e.g., through compaction and tillage erosion) by farming activities and by the natural processes of wind and water erosion. Some farming practices, such as summerfallow (soil left bare for one growing season), increase the risk of wind and water erosion. Other practices, such as conservation tillage and returning land to permanent cover, help to prevent erosion.

Soil salinization, another form of soil degradation, limits the ability of crops to take up water and nutrients. Some Prairie soils have naturally high levels of water-soluble salt, given the regional climate and geology, but inappropriate irrigation and cropping practices can worsen salinity problems. The risk of soil degradation indicator shows the proportion of cultivated land where the levels of risk for water erosion, wind erosion, and soil salinization are low enough for agricultural soils to be sustainable. With future updates, the trends will be more apparent and helpful in deciding on appropriate responses.

## **Societal response: What are we doing to protect soil?**

Soil conservation has been promoted for decades in agricultural regions of Canada. Research is ongoing on the timing of fertilization, improved manure storage methods, methods of fertilizer application, and other techniques to improve nutrient management and maintain soil health. The crop and residue cover indicator reflects the degree to which farmers are adapting management strategies to enhance the sustainability of agricultural soils. Greater plant cover with fewer bare-soil days promotes higher organic matter content and contributes to reducing runoff and to holding nutrients in upper soil layers.

Collectively, these indicators show an improvement in the management of

Canada's agricultural soils. However, large areas of agricultural land in Canada, particularly where cropping is intensive or where marginal land is cultivated, remain susceptible to soil degradation.

### **Acknowledgements:**

These indicators were developed principally by a team at Agriculture and Agri-Food Canada (AAFC), with input from the Indicators and Assessment Office, Environment Canada and advice from AAFC's Public Advisory Committee. The input and collaboration of the Research Branch and the Policy Branch, AAFC, Ottawa, are gratefully acknowledged.

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This bulletin is accessible on Environment Canada's Green Lane Internet site ([www.ec.gc.ca/soer-ree](http://www.ec.gc.ca/soer-ree)).

A TECHNICAL SUPPLEMENT TO THIS BULLETIN IS ALSO AVAILABLE.

THIS BULLETIN WILL BE UPDATED PERIODICALLY.

Published with the Authority of the Minister of the Environment.

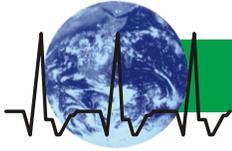
Minister of Public Works and Government Services Canada, 2000.

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ISSN 1192-4454



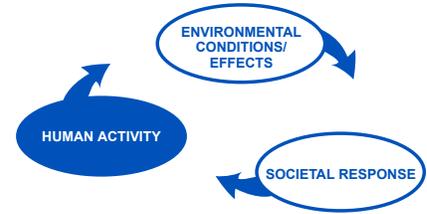


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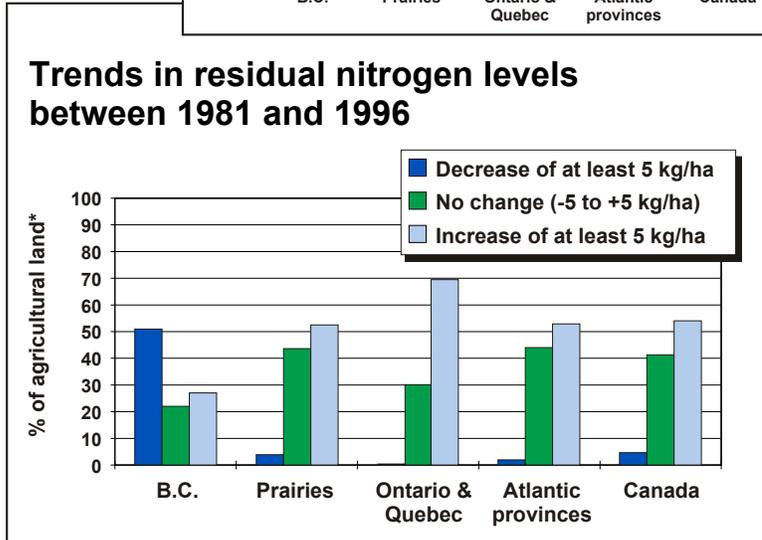
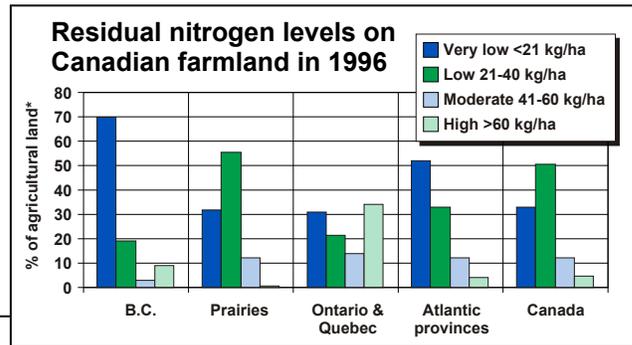
## Environmental Sustainability of Canada's Agricultural Soils



*Agriculture will be more sustainable if the application of nutrients is in balance with crop requirements—maintaining soil fertility while preventing excess nutrients from contaminating water supplies or contributing to the release of greenhouse gases. Placing more emphasis on the recycling of nutrients from manure and other renewable sources will also contribute to sustainability.*

### Indicator: Fertilization and nutrient balance (residual nitrogen)<sup>1</sup>

- ▶ The amount of nitrogen applied to cultivated land routinely exceeds the amount removed in the harvested crop. The difference between the amount of nitrogen available to the growing crop and the amount removed in the harvested crop is called “residual nitrogen”. Inputs of nitrogen greater than what is recommended can contribute to water quality problems and greenhouse gas emissions.
- ▶ In the drier Prairies, nitrogen applied to the soil will often remain available for subsequent crops. “High” levels of residual nitrogen in the Prairies can be of concern during storms and periods of heavy runoff. In humid areas of the country, such as central and eastern Canada, the environmental risks associated with “moderate” to “high” levels of residual nitrogen in the soil are much greater than in the Prairies.
- ▶ There was a strong trend between 1981 and 1996 towards increasing levels of residual nitrogen in all provinces except British Columbia. The share of farmland showing an increase of at least 5 kg/ha during this period ranged from 27% in British Columbia to 80% in Manitoba.



**Note**

\* The agricultural area considered for the baseline varies between indicators; see the technical supplement for details.

**Source**

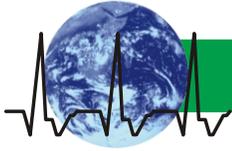
MacDonald, K.B. 2000. Residual nitrogen. In:McRae, T., C.A.S. Smith, and L.J. Gregorich (eds.). *Environmental Sustainability of Canadian Agriculture: Report of the Agri-Environmental Indicator Project*. Agriculture and Agri-Food Canada, Ottawa, Ontario.

<sup>1</sup> Data and calculations for phosphorus will be available for the next update of this indicator.



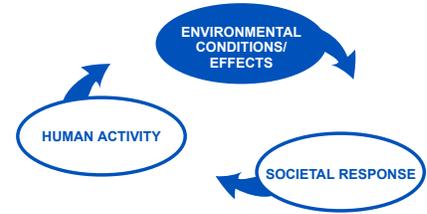


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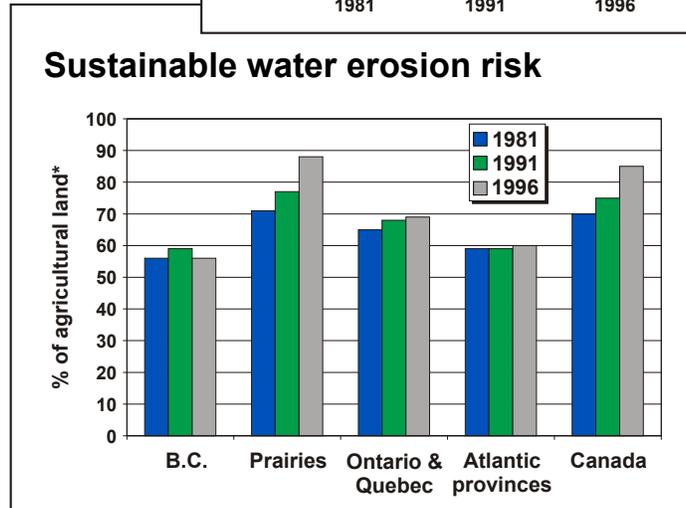
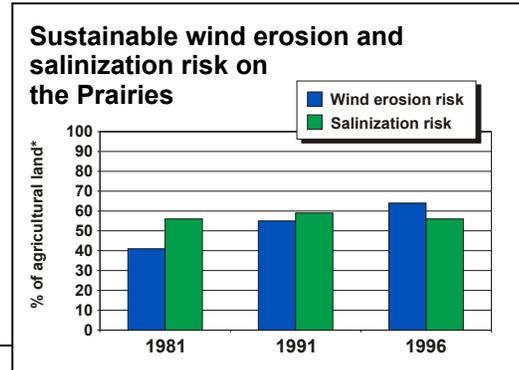
## Environmental Sustainability of Canada's Agricultural Soils



*Agriculture will become more sustainable when the risks of soil erosion and other forms of soil degradation are reduced to tolerable levels through improved agricultural practices.*

### Indicator: Risk of soil degradation

- ▶ In 1996, almost 85% of cultivated lands in Canada were within a sustainable level of water erosion risk<sup>1</sup> (56% in British Columbia, 88% in the Prairies, 69% in Ontario and Quebec, and 60% in the Atlantic provinces). Over 20% more cultivated land was within a sustainable level of risk of water erosion in 1996 than in 1981.
- ▶ Prairie soils are more susceptible to wind erosion and salinization than are soils from other agricultural regions in Canada. Between 1981 and 1996, the proportion of cultivated land in the Prairies within a sustainable level of risk of wind erosion rose by 23 percentage points to 64%, and the proportion under high risk of wind erosion declined by 9 percentage points. The proportion of cultivated land within a sustainable level of risk of salinization did not change over this period.
- ▶ Trends towards lower risk of soil degradation are mainly due to increased conservation tillage and changes in cropping systems (such as bringing summerfallow area into continuous crop production and converting cultivated land to permanent cover).



**Note**

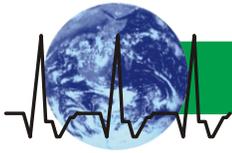
\* The agricultural area considered for the baseline varies between indicators, see the technical supplement for details.

**Source**

McRae, T., C.A.S. Smith, and L.J. Gregorich (eds.). *Environmental Sustainability of Canadian Agriculture: Report of the Agri-Environmental Indicator Project*. Agriculture and Agri-Food Canada, Ottawa, Ontario.

<sup>1</sup> "Sustainable level of risk" means that the risk of soil degradation does not exceed soil building processes or that crop health will not be significantly affected. See the technical supplement for definitions of various levels of erosion and salinity risk.

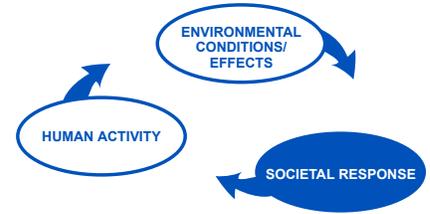




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# National Environmental Indicator Series

## Environmental Sustainability of Canada's Agricultural Soils

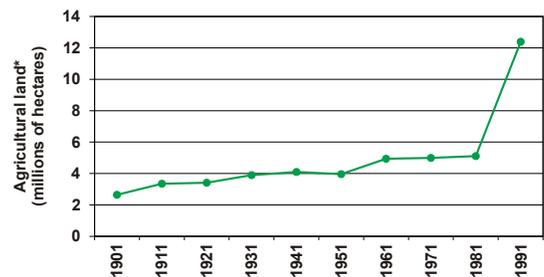


Soil left exposed by various cropping practices is vulnerable to erosion. The crop canopy and crop residues protect the soil from wind and water erosion. The less soil that is left exposed, the smaller the risk of erosion.

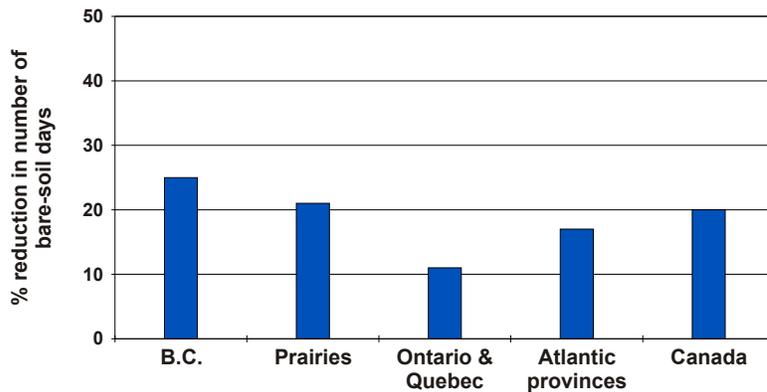
### Indicator: Crop and residue cover

- ▶ Between 1981 and 1996, the average number of bare-soil days in Canada's agricultural regions dropped by almost 20%, from 98 to 78. This reflects a decline in every province and agricultural region except central Canada's St. Lawrence Lowlands, indicating an overall improvement in soil cover during this period.
- ▶ The decrease in the number of bare-soil days in Canada since 1981 and the considerable increase in dense plant cover are due to the adoption of conservation management practices. These practices include using no-till or minimum-till methods to maintain plant residues on the surface, reducing summerfallow, increasing the use of continuous cropping, and growing cover crops over the winter period.
- ▶ Most regions with improvements in soil cover of greater than 20% have less land under agriculture and less intensive agriculture. Regions showing less than 10% improvement in soil cover have large areas in row crops, such as silage corn, soybeans, potatoes, and vegetables, which provide only low levels of soil cover.

Changes in dense plant cover in Canada



Change in bare-soil days from 1981 to 1996



**Note**

\* The agricultural area considered for the baseline varies between indicators, see the technical supplement for details.

**Source**

Huffman, E. 2000. Soil cover by crops and residue. In:McRae, T., C.A.S. Smith, and L.J. Gregorich (eds.). *Environmental Sustainability of Canadian Agriculture: Report of the Agricultural Environmental Indicator Project*. Agriculture and Agri-Food Canada, Ottawa, Ontario.

