Agriculture and Agri-Food Canada
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Research Branch
Direction générale de la recherche

THE HEALTH OF OUR AIR

Toward sustainable agriculture in Canada

Canada

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Foreword

It is only in the past four or five decades that scientists have increasingly understood many of the interactions between lands and oceans and the atmosphere—and how human actions may be modifying these exchanges. And it is only in the past two decades that the public and governments have been confronted with clear evidence of the changing composition of the global atmosphere and its likely effects. In the short space of a century, the burning of large quantities of fossil fuels stored in the ground over millions of years has had the largest impact. But the way in which we manage the land and produce food and fiber is by no means negligible. Pollution of the atmosphere affects directly all land creatures and plants, as well as the climate that governs productivity, human activities, and occurrence of extreme events such as drought, floods, and storms.

This book comprehensively addresses those interactions between land and atmosphere that arise because of agricultural practices in Canada. Some of the atmospheric changes may be benign or even beneficial to humans and plants. But there is much evidence to indicate that adverse effects are occurring. These negative effects will continue to increase unless changes occur in how we manage our energy, food, and fiber economies.

The authors wisely point out that the net release of greenhouse gases from agriculture "is usually a symptom of inefficient use of resources." This is also true of other economic sectors contributing to atmospheric changes. It is not just the case for greenhouse gases, but also for problems such as emissions of precursors to low-level ozone and acid rains.

Various means of increasing the efficiency with which we use our resources in agriculture are outlined. Also examined is the significant potential for restoring organic carbon in our soil through conservation tillage and other means, thus reducing atmospheric carbon dioxide. There are many "win–win" opportunities demonstrated, where increased soil and agricultural productivity go hand-in-hand with reducing pollution of the atmosphere. This book provides much of the scientific information needed to develop an effective strategy for Canada's agricultural sector.

Let us hope that this cooperative way of approaching the problems confronting agriculture and the global atmosphere becomes an inspiration for other sectors. As in agriculture, there are many cost-effective "win-win" opportunities for achieving energy efficiency to be found in transportation and forestry that can improve Canada's economic situation and simultaneously help protect the life-giving atmosphere of our small planet.

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Preface

This book has its roots in two international reports:

- the World Commission on Environment and Development, *Our Common Future*, better known as the "Brundtland" report
- the 1990 report of the Intergovernmental Panel on Climate Change, IPCC.

In 1987, *Our Common Future* brought world attention to problems such as global warming, ozone depletion, desertification, reduced biodiversity, burgeoning demands of a growing population, and the need for a global agenda for change that would make development sustainable. In short, the Commission sought ways to meet present needs without compromising the ability of future generations to meet theirs.

The IPCC, set up by the World Meteorological Organization and the United Nations Environment Program, produced its first scientific assessment in 1990. Several hundred scientists from 25 countries helped prepare and review the scientific data. The IPCC concluded that emissions from human activities are increasing the concentration of greenhouse gases. It warned that this could lead to a warming of the Earth's surface.

These two reports brought climate change to the forefront of the world environmental agenda. In 1992 nations met in Rio de Janeiro to sign the Climate Change Convention, an agreement to reduce greenhouse gas emissions. The IPCC released a second scientific assessment in 1995 stating that "the balance of evidence suggests a discernible human influence on global climate." A further international agreement, signed by 174 countries in Kyoto, Japan, in 1997, agreed to set specific targets for greenhouse gas emissions.

Scientists in Canada, as in other countries, now focused more attention on issues associated with atmospheric pollution, greenhouse gases, and climate. Within the Canadian federal government, the Atmospheric Environment Service (Environment Canada) and programs such as the Green Plan provided further support. Indeed, the four federal, science-based, natural resources departments of Environment, Fisheries and Oceans, Natural Resources, and Agriculture and Agri-Food joined forces and signed a Memorandum of Understanding for Science and Technology for Sustainable Development in 1995. The goal was to enhance cooperative research in areas of mutual concern such as climate change.

The Research Branch of Agriculture and Agri-Food Canada initiated a research program in greenhouse gases and ground-level ozone in 1992 in support of sustainable development. The program involved scientists working for the federal government, universities, provincial agencies, and the private sector. After 6 years, we now report our findings to the Canadian public.

The Health of Our Air joins *The Health of Our Soils* and the forthcoming *The Health of Our Water* as a series of scientific assessments evaluating the natural resources upon which Canadian agriculture depends.

This book contains our most recent research findings. As the research continues, better estimates of greenhouse gas emissions will emerge. New, more efficient technologies will be developed, and we will learn more about the relationship between agriculture and the health of air. The Research Branch of Agriculture and Agri-Food Canada is committed to research in support of sustainable development of the Canadian agriculture sector.

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1. Introduction

Agriculture is tied tightly to the environment. Future food production depends on preserving soil, air, and water quality; in turn, the way we farm influences these resources. As a result, we need to assess, from time to time, the changes taking place in the environment, both to ensure that farming can be sustained and to measure its effect on other ecosystems. An earlier report considered *The Health of Our Soils*; in this companion, we focus on *The Health of Our Air*.

Unlike soil, which is fixed in place, air moves and mixes freely around the globe. Air at the earth's surface can exchange with air many kilometres up within hours, and air currents can move around the world in a matter of days. Some of the carbon dioxide released by fires in Asia may be absorbed by orchards in Ontario, and some of that released from decomposing straw in Saskatchewan is taken up by the jungles of South America. As a result, we have to view the health of our air from a global perspective.

Importance of atmospheric health

Our atmosphere has many essential functions. It is a reservoir of gases upon which life depends: carbon dioxide and nitrogen for plant growth, oxygen for us to breathe, water vapor for rain that refreshes the land. It insulates the planet against temperature extremes and filters out harmful radiation from the sun. It even helps detoxify harmful substances released into it, either hastening their breakdown or diluting and dispersing them. Because living things depend so completely and in so many ways on the atmosphere, any change in its makeup should concern us.

Our changing atmosphere

The air is always being recycled by exchange of gases and particles with land, water, and living things. The rates of gases entering the atmosphere are usually balanced by rates of gases lost, so that the composition of the atmosphere has remained nearly constant for many centuries. This balance has been disrupted, however, by increasing emissions from human activity, so that some gases are now accumulating, altering the composition of the air.

One of the most noticeable changes, in recent years, has been an increase in concentrations of some "greenhouse gases": carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and chlorofluorocarbons (CFCs). These gases absorb some of the energy radiating from the earth, thereby warming the atmosphere. A build-up of greenhouse gases, therefore, is expected to increase global temperature over time.

Greenhouse gases are not the only constituents of air whose concentration is changing. The levels of other constituents such as nitrogen and sulfur gases, ozone (O_3), gaseous organic compounds, and suspended particles are also increasing as a result of human activity, including agriculture. These changes, like those in greenhouse gases, may affect climate and the health of the environment.

Growing concern over the changing atmosphere has prompted global efforts to reduce emissions. These include recent international agreements to limit emissions of O_3-depleting chemicals (Montreal Protocol) and a Canada–US agreement on air-pollution. Perhaps most noteworthy is a treaty signed in Kyoto, Japan in December 1997 where 174 countries, including Canada, agreed to curb emissions of greenhouse gases.

Objectives of this report

Agriculture occupies a larger portion of global land area (about 35%) than any other human activity. Because of its scale and intensity, agriculture emits a lot of gases into the atmosphere. For example, agriculture is a main source of greenhouse gases, accounting for about 25% of the CO_2, 50% of the CH_4, and 70% of the N_2O released via human activity globally. As well, agriculture accounts for more than 50% of ammonia released into the air.

But because farmlands are managed so intensively, farmers can control, at least partly, the amounts of gases released. Various ways of farming produce different emissions; and by choosing new practices, it may be possible to reduce emissions. For some gases, farmlands may, in fact, even be made to absorb more than they emit, thereby helping to restore air quality.

In this report, we focus on the effect of Canadian agriculture on the atmosphere. Specifically, we try to answer three questions:

- How do farming practices affect the composition of the atmosphere?
- What is the amount of agriculture's emissions to the air?
- How can we reduce these emissions?

Scope of this report

The most pronounced change in the atmosphere, and the one with greatest potential consequence, is the build-up of greenhouse gases. Hence, this report addresses in detail the amounts of greenhouse gas emission and possible ways of reducing them. We limit our discussions mainly to agricultural production itself and, except for ethanol, do not consider the fate of agricultural products once they leave the farm. Many of the findings presented were obtained from a national research program initiated by Agriculture and Agri-Food Canada in 1992.

Besides focusing on greenhouse gases, we also consider several other current atmospheric issues, though in less detail: ground-level O_3, ammonia, ultraviolet (UV) radiation from the sun, aerosols, nitrogen oxides, pesticides, and farm-related odors. Wherever possible, our discussion is based on findings from Canadian studies but, where Canadian results are only just emerging, we have drawn on results from elsewhere.