SUSTAINABLE AGRICULTURE: THE RESEARCH CHALLENGE

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The Honourable William C. Winegard, PC, MP
Minister for Science
House of Commons
Ottawa, Ontario

Dear Dr Winegard:

In accordance with Section 13 of the Science Council of Canada Act, I take pleasure in forwarding to you the Council's Report No. 43, *Sustainable Agriculture: The Research Challenge.*

Yours sincerely,

Janet E. Halliwell
Chairman
Science Council of Canada

C O N T E N T S

PREFACE

The Canadian agriculture-food industry, long a cornerstone of Canada's economy, is being challenged as never before. A $50 billion a year business that directly or indirectly employs 14 per cent of the country's workforce and accounts for as much as one-third of the nation's trade surplus, the industry is being buffeted by shifting world trade patterns, rising costs, and a growing number of bankruptcies. As well, it is facing mounting pressure over practices and technologies that lead to environmental degradation, resource depletion, and safety concerns.

Economic and environmental concerns are closely linked. The bond between economic viability and environmental integrity was brought forcefully to the world's attention in 1987 when the United Nations released the report of the Brundtland World Commission on Environment and Development, *Our Common Future*. This report introduced the concept of a sustainable development that was ecologically sound, productive, and enduring.

In its report, the commission highlighted many of the problems facing modern-day agriculture: surpluses in developed countries and starvation in the Third World; environmental stresses and resource depletion; and difficulties in further raising crop yields to feed a growing world population. The commission concluded that nothing short of a far-reaching revision of current agricultural practices and policies was needed to ensure the sustainability of the system for future generations.

There is a growing realization that for Canadian agriculture it can no longer be business as usual. If the industry is to compete in world markets and satisfy environmental concerns, modest accommodations will not be enough. New policies and programs must be developed. Appropriate scientific and technological advances must be applied. And academic, government, and industry institutions related to agriculture must be recast.

Revitalizing the agriculture-food system, however, entails more than policies, technologies, and institutional reform. It requires a new way of thinking that embodies a much wider perspective than one that equates farming solely with food production. Increasingly, agriculture must be integrated with the management of the environment. Current policies and subsidies that encourage over-production and the farming of lands better left in their natural state should be changed to recognize and reward farmers as stewards of the rural landscape. Processors, input suppliers, wholesalers, retailers, and consumers must also accept that their practices need to measure up against increasingly stringent environmental guidelines.

To follow sound environmental practices is not simply to bow to the environmental lobby; for the Canadian agriculture-food system, it is both good business and necessary for the system's long-term survival. The well-being of the farming community depends in large measure on the preservation of the land, water, and genetic resources that will sustain production levels into the future. And increasingly, sales of Canadian output on world markets will be driven by the perception abroad that our producers are following appropriate environmental practices.

For the agricultural community, the challenge is very real indeed. But restructuring the Canadian agriculture-food industry extends far beyond the farm gate. Successful transformation of the industry will require the involvement of all players in the agriculture-food system including agricultural suppliers, food processors, wholesalers, retailers, and consumers.

No one is suggesting the job will be easy, and hard choices will have to be made. In 1990, as a first step along the path to renewal, the Science Council of Canada undertook a comprehensive two-year study of the Canadian agriculture-food industry. This report presents the findings of that study and offers 27 recommendations to help set the stage for a revitalization of this key sector of the Canadian economy.

(1) CASCC should commission an independent review of its committee structure and membership with a view to meeting the needs of the agriculture-food system in the 21st century.

(2) The Minister of Agriculture should commit funding to CARC to allow it to fulfil its mandate as an independent advisory council with a full-time executive officer and an expanded secretariat. The chairman of CARC should report directly to the Minister.

(3) CARC should commission an independent review of its membership, with a view to including stronger representation from working farmers, ecologists, and economists. As an initial step it should appoint a representative of the Social Sciences and Humanities Research Council. The review should also consider how to shift the emphasis in modern agriculture from a narrow production orientation to a broader systems focus and ensure that this focus is reflected in the type of individuals each organization is requested to nominate for membership to CARC.

(4) Agriculture Canada should initiate an independent review of the Research Branch, with a view to redesigning the research system to make it more responsive to changing priorities.

(5) Agriculture Canada should review and clarify the mandates of its research stations and develop a strategy for rationalizing and strengthening them; particular consideration should be given to using some research stations as the focus for agro-ecosystems research.

(6) In developing a long-term strategy for research, Agriculture Canada should consider the promotion of sustainable agricultural practices through the reintroduction of demonstration farms.

(7) Agriculture Canada should strengthen cooperative research and training programs with university departments and colleges of agriculture, as well as with the corporate sector.

(8) The deans of agriculture and veterinary medicine should review existing departmental structures and undergraduate and graduate training programs with a view to strengthening multidisciplinary training and promoting greater understanding of agricultural systems.

(9) The deans of agriculture and veterinary medicine should review hiring and promotion criteria to encourage the appointment and promotion of staff whose teaching and research furthers the understanding of agricultural systems.

(10) The Natural Sciences and Engineering Research Council should review its funding programs, focusing on the structure and composition of granting committees and on the allocation of funds among different programs, with a view to promoting long-term, interdisciplinary research in food and agriculture.

(11) The Social Sciences and Humanities Research Council, in cooperation with Agriculture Canada, should develop a joint initiative to promote research in natural resources and the social sciences.

(12) Agriculture Canada, in cooperation with the provinces, should identify 30 to 80 sample farms in each province that are using alternative agricultural practices and integrate them into its Bench Mark Farms program. These farms should collectively represent the major agro-climatic and cropping regions of each province.

(13) Agriculture Canada, in cooperation with Environment Canada and Statistics Canada, should develop a set of variable, widely accepted measures of soil and water quality, including soil organic matter content, soil structure and tilth; and total coliform count, nitrite and nitrate levels, and total dissolved solids for a given region. As the measures are developed, they should be incorporated into the Bench Mark Farms program.

(14) Provincial departments of agriculture in concert with Agriculture Canada should provide scientific and analytical support to allow farmers to collect data that could assist in designing regional agricultural development policies.

(15) Agriculture Canada, together with provincial governments, the agriculture-food industry, the academic community, and farm organizations, should strike a coordinating committee to identify physical and biological indicators for sustainable agriculture.

(16) The deans of agriculture and veterinary medicine should explore ways to include performance of extension activities as a necessary criterion in the selection, promotion, and tenure of their academic staff.

(17) Provincial ministers of agriculture should include extension activities in the job descriptions of their agricultural research scientists.

(18) Agriculture Canada should review its policies with the objective of decoupling subsidies from specific production practices and creating clear and compelling incentives for the adoption of practices integral to sustainability.

(19) Agriculture Canada should redirect farm support from production subsidies to payments designed to maintain the rural landscape through the preservation of wetlands, woodlots, wildlife, and other environmentally and socially desirable resources.

(20) The Canadian International Development Agency, with Agriculture Canada and External Affairs and International Trade Canada, should review existing trade and foreign aid policies and develop criteria to ensure that sustainability becomes a key objective in the development and application of these policies.

(21) Farm organizations should work with school boards to develop "adopt a farm" schemes as part of a broadly based public information program on sustainable agriculture.

(22) Provincial departments of agriculture and departments of education should jointly establish curriculum development committees to design teaching materials on topics related to modern agriculture and food production.

(23) Provincial departments of agriculture, in concert with departments of environment and farm and environmental groups, should develop codes of agricultural practice to ensure that farms are operated in an environmentally sound manner, develop a realistic way to measure compliance, and implement effective penalties for non-compliance.

(24) The Food Institute of Canada should work with related associations and environmental groups to establish environmental strategies and codes of business practice.

(25) Agriculture Canada, with Health and Welfare Canada and consumer and environmental bodies, should establish a task force to develop improved criteria for the assessment of food safety and water quality that (a) satisfy public concerns and (b) are based on both the best available scientific methods and common sense.

(26) Agriculture Canada should review existing legislation for biocontrols with a view to simplifying and promoting their introduction into the market.

(27) Agriculture Canada should develop mechanisms to help farmers and food processors take advantage of rapidly emerging niche markets.

THE CHALLENGE FOR THE CANADIAN AGRICULTURE-FOOD SYSTEM

Canadian agriculture is at a crossroads. Today, shifts in global markets and transnational ecological issues are combining to shake the very foundations of our agriculture-food system. The challenge for the agricultural community — indeed for all Canadians — is to create new policies and institutional arrangements that can respond positively to these changing conditions. Canadians must chart a new path toward an agricultural system that is sustainable, safe, and responsive to market needs.

Modest accommodations will not be enough. The challenges are many and varied; they include the preservation of a viable rural community; the safeguarding of our land, water, and species diversity; and the maintenance of the competitive strength of Canadian agriculture on world markets. Having long provided an abundant supply of cheap, nutritious food for Canadians, the agriculture-food industry must now apply its ingenuity to meet a new agenda imposed on it by society at large. To succeed, it will have to adopt a much broader and more systematic approach to technological change and policy development.

Moreover, the industry and the country must chart this new path at a time when environmental concerns and fundamental changes in trading relationships are generating an unprecedented level of uncertainty. There are signs that we are facing a major discontinuity between the past and future, and there is widespread awareness that policies for the future cannot be based on a simple extrapolation of past trends. Indeed, many of the 20th century's assumptions about economic development and consumption practices are being challenged. Increasingly, the traditional belief in unrestricted progress driven by technological change is under fire, and a movement is growing to develop a new vision that is based on ecological principles and draws on elements of development economics, biological sciences, social theory, and political science.[1]

Sustainable development

Growing numbers of people around the world are realizing that it is not possible to separate economic development and environmental issues; unfettered development can wreak havoc on the environment, while environmental degradation can thwart development. In the past, environmental problems, such as air pollution and soil erosion, were viewed as imposing unavoidable costs on the general community. Today, however, there is increasing pressure on individual nations, businesses, and consumers to assume responsibility for the long-term environmental impact of their production and consumption practices.

The interlocking of the world's economy and ecology was the central theme of the World Commission on Environment and Development established by the United Nations in 1986. Its report, *Our Common Future* (also known as the Brundtland report), released in 1987, introduced the term sustainable development and defined it as "development that meets the needs of the present without compromising the ability of future generations to meet those of the future."[2]

Although the concept of sustainable development has been variously interpreted since then, it generally emphasizes the ability to endure indefinitely; equitable access to resources both for present-day global inhabitants and future generations; and continued growth in output to support an expanding world population.

The techniques and principles of sustainable agriculture come from many sources. Some of the ideas involved are quite recent; others have a much longer history.[3] In the past sustainable agriculture was viewed primarily as the provision of an adequate, dependable income for farmers and a relatively cheap, safe food supply for consumers. Recently, however, this definition of agricultural sustainability in almost exclusively economic terms has been overtaken. The concept of sustainable agriculture now meshes both economic and environmental concerns, reflecting mounting evidence that economic sustainability is jeopardized by the neglect of the physical and biological resources on which agriculture depends.[4] To

AGRICULTURAL FACTS
A NATIONAL PERSPECTIVE

As we near the end of this century, many national and international forces are bringing about major changes in Canada's agriculture and food system.

- The number of farms peaked at 733 000 in 1941. Although the number of farms has decreased by 60 per cent since then and totals fewer than 300 000 today, output has increased by 175 per cent over the same period.[1]
- Seven per cent of farms account for half of all farm sales; 26 per cent of farms generate three-quarters of all sales.[2]
- In the mid-1950s women accounted for 4 per cent of the agricultural labour force; by 1991 the figure had risen to 33 per cent. The number of women who are self-employed as farmers increased from just 9000 in 1976 to 46 000 in 1991.[3]
- The percentage of farmers reporting off-farm work is about the same today (39 per cent) as it was in 1941 (36 per cent). What has changed is the average number of days that farmers dedicate to off-farm work (75 in 1940; 173 in 1985) and the percentage of their income derived from off-farm sources (18 per cent in 1940; 68 per cent in 1985).[4]
- During the last 10 years, total farm debt has exceeded the annual value of cash receipts. In the same period, 4258 farmers went bankrupt — more than one a day.[5]
- Today only 15 per cent of Canada's rural population lives on farms; this is a decline from 53 per cent in 1951, and 67 per cent in 1931.[6]
- Most people think of wheat as Canada's "cash cow." However, as a source of farm cash receipts, wheat ranks third (at 14 per cent) after cattle and dairy products.[7]
- Agricultural support from the federal and provincial governments grew from $1.1 billion in 1981 to $3.8 billion in 1988.[8]
- Approximately 50 per cent of Canada's earnings from agriculture are derived from export sales. For example, 75-80 per cent of the earnings from wheat are from exports; for canola the equivalent is 60-70 per cent; for barley 40 per cent; and for hogs 25 per cent.[9]

Sources

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2. R.D. Bollman and P. Ehrensaft, "The microdynamics and farm family economics of structural change in agriculture," in United States Bureau of the Census, *1990 Annual Research Conference Proceedings* (Washington, D.C.: United States Department of Commerce and Bureau of the Census, 1990), p. 7.
3. Statistics Canada, Labour Force Survey, unpublished tabulations.
4. Royal Bank of Canada, *Royfarm Business Review*, December 1990, p. 1; Statistics Canada, *Socio-economic Characteristics of the Farm Population*, op. cit., pp. 21 and 31; and R.D. Bollman, *Off-Farm Work by Farmers* (Ottawa: Statistics Canada, 1979), p. 61.
5. H.G. Coffin, *Canada's Agri-Food Systems: A Descriptive Analysis*, contract report for the Science Council of Canada, 1991 (unpublished), p. 115; and Monique Leclair, Office of the Superintendent of Bankruptcy, Consumer and Corporate Affairs Canada, Ottawa, personal communication, 1991.
6. R.D. Bollman, Statistics Canada, Ottawa, personal communication, 16 January 1992, from data drawn from the *Census of Population* (various years).
7. Agriculture Canada, Policy Branch, *Handbook of Selected Agricultural Statistics 1990* (Ottawa: Ministry of Supply and Services, 1991), pp. 85-88.
8. M. Ingram, "The killing fields: farm subsidies are draining Canada's economy, but dropping them might destroy the sector," *The Western Report*, 23 April 1990, p. 22.
9. J.C. Gilson, *World Agricultural Changes: Implications for Canada*, C.D. Howe Institute, Policy Study 7 (Toronto, 1989), p. 183.

- The three Prairie provinces, which contain only 17 per cent of Canada's population, account for 50 per cent of the farms, 78 per cent of the improved farmland, and 67 per cent of total farm earnings.[10]
- The intensity of fertilizer use in Canada has increased from 6.4 kilograms of nitrogen per hectare in 1970 to 26.1 kilograms per hectare in 1990. In contrast, in the mid-1980s France used 80 kilograms per hectare, and the Netherlands, whose fertilizer usage is the most intensive in the world, used 250 kilograms per hectare.[11]

10. Ibid.

11. Agra Europe, *Agriculture and the Environment: How will the EC resolve the conflict?*, Agra Europe, Special Report No. 60 (London: Agra Europe (London) Ltd., 1991), p. 9; and Roger Larson, Canadian Fertilizer Institute, Ottawa, personal communication, 16 January 1992.

problems such as soil degradation, loss of prime agricultural land to other uses, and the degeneration of the genetic resource base have been added a range of other related "green" issues, such as wildlife protection, landscape preservation, animal welfare, and resource degradation. Confident of food security, many Canadians are now concerned more about the undesired side-effects of modern agricultural practices than the production of food.

Although the goal of sustainability is widely accepted, views differ on the severity of the threat to the sustainability of the Canadian agriculture-food system.[5] Views also differ on the relative importance of the factors that support a sustainable system. To some observers, environmental degradation is the key issue and rival concerns, including short-term economic viability, are overshadowed. Others see social factors as paramount and stress the importance of preserving farming as a way of life. Whatever the emphasis, the concept of sustainable agriculture embraces a broad range of interests and diverse set of goals. Its implementation will require policies that address the needs of the whole agriculture-food system.

A useful working guide in dealing with the concept of sustainable agriculture can be found in the definition adopted by the federal department of agriculture and its provincial counterparts:

> Sustainable agri-food systems are those that are economically viable, and meet society's need for safe and nutritious food, while conserving and enhancing Canada's natural resources and the quality of the environment for future generations.[6]

Simply deleting the word "Canada's" from this definition gives blunt recognition to the fact that the problems facing Canadian agriculture and the Canadian environment cannot be compartmentalized on a national basis. They are part of a global crisis. Policies to address Canada's domestic concerns will have direct bearing on the health of the global environment, just as the policies adopted in other countries will affect the sustainability of the Canadian agriculture-food system.

Building on this definition, we can identify the following principles of sustainable agriculture and food production:[7]

- thorough integration of the farming system with natural processes;
- reduction of those inputs most likely to harm the environment;

- greater use of the biological and genetic potential of plant and animal species;
- improvement in the match between cropping patterns and land resources to ensure the sustainability of present agricultural production levels;
- efficient production, with an emphasis on improved farm management and conservation of soil, water, energy, and biological resources;
- development of food processing, packaging, distribution, and consumption practices consistent with sound environmental management.

These principles provide guidelines for reducing environmental degradation, conserving resources, and providing an adequate and dependable farm income.

A major wealth creator

Canada's agriculture-food industry is a cornerstone of the nation's economy. Annual sales exceed $50 billion and the sector provides direct and indirect employment for 14 per cent of the country's labour force. In all, agriculture and food production account for as much as one-third of Canada's trade surplus.

Farming underpins a large, diversified, and economically important industrial sector. Few foods reach the domestic consumer without prior processing, packaging, transportation, and distribution through local retail outlets. On-farm production is supported in turn by a vital input industry, including pesticide, fertilizer, and equipment suppliers, as well as a network of research scientists, extension workers, regulatory agencies, and policy bodies.

This sophisticated system of food production and distribution has provided an abundant supply and variety of nutritious, cheap food for Canadians. Over time, the average per capita expenditure on food has declined,[8] and Canadians now spend a smaller proportion of their income on food than anyone else in the world except Americans.[9] Nevertheless, after shelter, food remains the largest item in consumer spending.[10]

The system has also enabled Canada to export a large share of its production, providing valuable foreign earnings and ensuring a positive trade balance. In fact, the relative importance of both exports and imports to agriculture and the food processing industry in Canada is about twice as great as it is in the United States.[11] Roughly half of the total value of Canada's agricultural production is exported.[12] Wheat is by far the leading item — almost 75 per cent of all wheat grown in Canada is exported.[13] Canada also enjoys a positive trade balance in such products as red meats, fish, coarse grains, oilseeds, and dairy products.[14]

Although overall demand for food remains relatively stable,[15] the nature of the demand has changed. In the face of new economic and social conditions, and in response to increasing information about nutrition and food safety, consumers have switched to more expensive types of food, favouring items of uniform size and shape, as well as fresh produce and certain processed goods. For example, red meat consumption is now lower than in the mid-1970s, while the amount of poultry and fish eaten has increased. Egg and butter consumption has fallen, while low-fat milk, cheese, and yogurt, as well as fresh vegetables and cereals have gained in popularity.[16]

Consumer pressures have unleashed a series of changes in the geography of the food supply system: agricultural land use and production patterns have changed; new trade relationships have developed; new corporate management strategies have emerged; and government has increasingly intervened in the marketplace. Today, farmers are responding to confusing demand signals while being thwarted by structural constraints that limit their contribution to the economy.

Canada's strong dependence on global markets leaves the industry vulnerable to sudden shifts in world trade conditions. Countries that were customers in the past are becoming self-sufficient in the crops that Canadian farmers used to provide. Trade liberalization, through such instruments as the U.S.-Canada Free Trade Agreement, will subject Canadian producers to new competitive pressures. GATT negotiations on the remaining barriers to agricultural trade will affect Canadian interests in grains and oilseeds. In addition, bilateral discussions under the auspices of the World Bank and International Monetary Fund will affect Canadian agriculture.

Faced with changing market conditions on the demand side, Canadian farmers are also encountering severe pressures on the supply side

as the cost of equipment, financing, and other inputs rises faster than the prices they receive for their output. Increases in labour costs have encouraged farmers to substitute other inputs, such as land, chemicals, and equipment, wherever possible. Consequently, labour inputs have declined to 88 per cent of 1971 levels.[17]

As an additional adjustment strategy, farmers have modified their patterns of production or, as a last resort, moved out of agriculture. Over the last 15 years, employment in agriculture has slumped from 5 per cent to 3.3 per cent of the employed population.[18] There are now fewer than 300 000 farmers in the country.[19] In turn, the area farmed has dwindled because of land abandonment, urbanization, land speculation, and competition from alternative uses. Rural depopulation, farm bankruptcies, and social problems are symptoms of a farm community in serious distress.

At a time when the economic outlook for the industry has never been more uncertain, farmers must also adapt to a staggering array of innovations in their operations. Buffeted by external forces over which they often feel they have little control, farmers are now being asked to take primary responsibility for problems that extend well beyond the farm gate.

Environmental degradation

Until recently farmers were seen by urban consumers as custodians of the environment; now they are often seen as a key factor in environmental degradation and pollution. Consumers, backed by a number of influential scientists, policy advisers, politicians, and environmentalists, are suggesting that many current agricultural and food production practices are unsustainable. Increasingly, modern intensive farming techniques are viewed as harmful to our water, land, plant, and wildlife resources. At the same time, environmental degradation and global change pose a threat to the agricultural resource base.

Indeed, there are clear warning signs that our current production and consumption habits are stressing the environment, perhaps beyond repair in some cases. One need only consider the following:

- Biodiversity — Five to ten per cent of the world's species risk extinction over the next decade due to habitat destruction, in part because of agricultural expansion.[20] In Canada, perhaps 1 per cent of plant species are at serious risk, and up to 10 per cent are at some risk.[21] The threat of extinction also extends to beneficial insects and fungi, which contribute to the long-term health and productivity of agriculture through maintenance of soil quality, and as part of a tool chest of mechanisms used in plant breeding and disease control.
- Soil degradation — Currently, 35 per cent of the world's land area is threatened by desertification.[22] Some 20 million hectares of food-producing land are abandoned each year because of waterlogging, salinization, or alkalization of soils.[23] In the Canadian Prairies, for example, salinization has reduced crop yields by as much as 75 per cent, and wind and water erosion remove an estimated 275 million tonnes of soil each year.[24]
- Climate change — Greenhouse gases could increase global surface temperatures by between 1.5 and 4.5 degrees Celsius within the next 50 years, making the world warmer than it has been for two million years.[25] This warming would melt ice caps and flood coastal production areas. In addition, significant changes in precipitation would lead to more frequent and severe droughts in many areas, especially in southern Canada. Climate change would pose major adjustment problems for Canadian agriculture.

Recent disasters reveal the vulnerability of a system driven by agricultural policies that emphasize increased production at the expense of environmental considerations. On the Prairies, the 1980s were characterized by years of below-average precipitation[26] and above-average temperatures.[27] The extended drought was probably more severe than in the 1930s, but it did not cause the same degree of agricultural and social trauma. Billions of dollars in federal aid programs cushioned the worst effects.[28] Despite such intervention, however, the 1980s saw a collapse of yields, sagging export earnings, soaring bankruptcies, and serious rural depopulation. The impact was felt from coast to coast as jobs were lost not only in agricultural areas but also in port cities such as Thunder Bay, Vancouver, Montreal, and along the St. Lawrence Seaway.

Canadian agriculture exhibits wide regional variations that must be addressed in national policies for sustainable development of the sector.

British Columbia

- Less than 3 per cent (2.4 million hectares) of land in British Columbia is used for agriculture, yet the province produces the equivalent of 60 per cent of its food requirements and a greater variety of products over a wider range of geographical and climatic conditions than any other area in Canada.[1]
- Fruits, vegetables, and horticultural products combined provide 86 per cent of the province's total crop sales. More than one-quarter of Canada's fruit sales come from this province.[2]
- With sales worth $259 million, representing 22 per cent of total farm income, dairying is British Columbia's most important farm sector. Sales of beef rank second with a market value of $204 million.[3]

Quebec

- Quebec provides 48 per cent of Canada's butter, cheese, and yogurt. The dairy industry represents 35 per cent of farm sales.[4]
- More than 98 per cent of land in Quebec is incapable of supporting any agriculture.[5]
- Ninety-two per cent of Canada's maple syrup — almost 8 billion litres a year — is produced by about 7500 Quebec farmers. Eighty per cent of production is exported.[6]

Ontario

- Ontario generates 26 per cent of the country's income from farming. This is a larger proportion of national farm income than is generated in any other province.[7]
- The Ontario food and beverage industry generates sales in excess of $17 billion a year, provides direct employment for 84 000 people, and supports an export industry worth $1.6 billion.[8]
- Livestock and poultry production account for 39 per cent of farm income. Ontario has more commercial livestock farms than any other province and is second only to Quebec in its number of dairy farms.[9]

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1. Statistics Canada, *Canada Year Book 1990* (Ottawa: Ministry of Supply and Services, 1989), pp. 9-42; and Andrew Wharton, B.C. Ministry of Agriculture, Fisheries and Food, Victoria, personal communication, 14 January 1992.
2. Agriculture Canada, Policy Branch, *Handbook of Selected Agricultural Statistics 1990* (Ottawa: Ministry of Supply and Services, 1991), pp. 85-88.
3. Ibid.
4. Agriculture Canada, Agriculture Development Branch, *Dairy Market Review 1989* (Ottawa, 1989), pp.40, 41, 44, 46, and 47; and Agriculture Canada, Policy Branch, op. cit.
5. Statistics Canada, *Canada Year Book 1992* (Ottawa: Ministry of Supply and Services, 1991), p. 356.
6. Statistics Canada, *Canada Year Book 1990*, op. cit., pp. 9-35; and Marc Berard, "Maple die off," *Agriscience*, May 1989, p. 4.
7. Agriculture Canada, Policy Branch, op. cit.
8. P. Barkman, "Some measures of the size and significance of the agri-food sector, Canada and the provinces," *Food Market Commentary*, 12(3), 1990, pp. 23 and 25; Statistics Canada, *National Income and Expenditure Accounts, Quarterly Estimates*, 38(3), 1991, pp. 6 and 7; and *Report of the Food Advisory Committee* (Toronto: Ontario Ministry of Agriculture and Food and Ontario Ministry of Industry, Trade and Technology, 1990), p. 4.
9. Agriculture Canada, Policy Branch, op. cit., pp. 24 and 85-88.

The Prairies

- Manitoba, Saskatchewan, and Alberta contain over 80 per cent of Canada's farmland and have almost 50 per cent of Canada's farms.[10]
- Saskatchewan produced an average of 56 per cent of Canada's wheat over the past decade. In 1988, this figure dropped to 42 per cent, a direct reflection of the Prairie drought that year. In 1990, a good harvest boosted Saskatchewan's share to 54 per cent.[11]
- Farm bankruptcies in the Prairies increased 1000 per cent from 1979 to 1991. In 1991, 72 per cent of all Canadian farm bankruptcies were in the Prairies.[12]

The Atlantic Provinces

- In 1986, less than 0.1 per cent of Newfoundland was farmed — an area smaller than the city of St. John's. In contrast, Prince Edward Island has 48 per cent of its area in agriculture — the highest percentage of any province in Canada.[13]
- Fifty-nine per cent of Canada's potatoes are grown in the Atlantic region. Of this total, about 58 per cent comes from Prince Edward Island, with most of the remainder from New Brunswick.[14]
- Sixty-five per cent of Atlantic coastal marshes have been lost since early settlement — mainly through conversion to agriculture.[15]

10. Ibid., pp. 18-21.
11. Ibid., pp. 78-80.
12. Monique Leclair, Office of the Superintendent of Bankruptcy, Consumer and Corporate Affairs Canada, Ottawa, personal communication, 12 February 1992.
13. Statistics Canada, *Canada Year Book 1992*, op. cit., p. 356; and Rockwell Balsam, St. John's City Hall, Urban Planning Department, personal communication, 12 February 1992.
14. Agriculture Canada, Policy Branch, op. cit., pp. 78-80.
15. National Wetlands Working Group, *Wetlands of Canada*, Environment Canada, Ecological Land Classifi cation Series No. 24 (Ottawa, 1988), p. 406.

The drought of the 1980s cannot be dismissed as an isolated incident. Drought on the Prairies is a common and recurring phenomenon — over the last 748 years, 269 years or 36 per cent were dry enough to adversely affect the growth of vegetation.[29] Global warming will only worsen the situation.

Until now, it has been possible for Canadians to delay action on environmental issues by emphasizing the importance of international trade to Canadian agriculture and the need to remain competitive on world markets. It has also been possible to dispute the severity of environmental degradation in Canada relative, in particular, to parts of the United States and Western Europe where the intensity of agriculture and the reliance on massive inputs of fossil energy, pesticides, and fertilizers is much greater and the disposal of animal waste is a major public health issue.[30]

Although recent trade negotiations between Canada and other countries have totally neglected environmental problems, all indications are that future negotiations will put environmental issues high on the agenda. Increasingly, the cost of ensuring sustainability will be recognized as a fundamental part of the cost of doing business.

Far from imposing an unacceptable burden on Canadian agriculture, sound environmental management will offer a competitive advantage, while neglect of the environment will act as a barrier to trade. This is already evident in talk of potential trade boycotts of Canadian wood and paper products because of poor forest management practices, as well as in threats to bar exports of meat produced using synthetic hormones.

Failure to adopt sustainable practices and reorient the agriculture-food system to meet new market requirements will leave Canadian producers vulnerable as competitors move ahead to integrate their economic and environmental strategies. The 1991 Farm Bill in the United States specifically addresses the need to implement sustainable agriculture, reorder research priorities, and redesign policies accordingly. The European Community is increasingly integrating environmental objectives into its agricultural policies and anticipates a shift away from market support to environmental incentives. These changes in national policies are certain to surface in future trade negotiations.

It is not surprising that attempts to redirect Canada's total agriculture-food system are prompting lively debate and meeting active resistance. It is hard to argue with success. But continuing to dodge environmental issues is no longer wise from a technical perspective, nor is it tolerable politically.

Global needs

The massive increase in global food production in the last 20 to 40 years is the product of strategies developed to feed a hungry world. In the past, farmers have filled extra bellies by extending the land area under cultivation and by applying technologies to boost the output per hectare. New food technologies also played a vital role. Total world production from aquaculture, for example, is now 12 to 14 million tonnes a year, representing 14 to 16 per cent of world fish landings.[31]

Nevertheless, the problem of hunger remains. Globally, 770 million people lack sufficient food for an active working life. Each year 14 million children — about 10 per cent of the number of children born annually — die of hunger.[32] At the same time, another billion people are added to the world's population every decade.[33] Feeding this population poses an unprecedented challenge to the global community, a challenge compounded by the degradation of the natural resources on which continued agricultural production depends.

It is becoming increasingly apparent that the increases in food output required over the next 25 years will be much more difficult to secure than in the past. Already, farmers are encountering difficulty in raising the yield of cereal crops that previously experienced rapid yield gains. The marginal returns from progressive increases in fertilizer use have declined[34] and irrigation has become more costly. And there is evidence of increasing resistance to pesticides, with a concomitant need for more fertilizer to maintain crop yields.[35] To help combat the problem, the proportion of research funding devoted to maintaining crop yields has had to increase.[36]

Raising production levels to feed a growing world population poses a major technological and political challenge. New policies, programs, and funding will be required to reconcile broad environmental concerns with the need to maintain or increase agricultural output and at the same time ensure the profitability of farming.

A role for science and technology

A powerful political slogan, sustainable agriculture is often cloaked in nostalgia. But sentimental calls for a return to earlier agrarian practices threaten to erode the importance of the scientific underpinnings that are responsible for agriculture's successes. There is no turning back the clock. The adoption of new technologies and the wise use of those already available is critical if Canada is to develop an alternative to agriculture's current unsustainable course and maintain its ability to contribute to world food needs.

In the last 40 years, an extensive array of mechanical, biological, and chemical technologies has transformed agriculture and food production. That technological revolution continues with advances in genetic engineering, fifth-generation computers, artificial intelligence, robotics, and satellite imagery. How these advances will affect agriculture and food production remains to be seen. What is certain, however, is that new technologies will open a range of possibilities, some yet to be imagined.[37]

Some scientists believe the capacity of science and technology to reconcile environmental and economic objectives is virtually unlimited. For instance, some technological optimists contend that biotechnology will provide the means to meet world food needs and address global environmental concerns. But the record thus far has not been encouraging. Commercial biotechnology-based products and processes are slow to come on stream, and there are few on the horizon that promise fundamentally to enhance either the overall level or efficiency of food production.

Moreover, these new products and processes are encountering enormous public resistance, and they are likely to face major legislative controls. Their greatest promise appears to be in replacing existing pesticides and veterinary products currently under regulatory pressure because of food safety, reliability, or cost concerns. Consequently, the main impact of biotechnology on agriculture is not likely to be felt until well into the 21st century, and for many years the products of biotechnology are likely to coexist with traditional chemical technologies.

The scientific and technological challenge in achieving sustainability in agriculture is enormous. But the real challenge may prove to be the acceptance and adoption of new technologies by farmers, processors, retailers, and consumers. Blanket opposition to new technologies may even discourage the adoption of techniques and practices that are more environmentally friendly than those now in use. For example, food irradiation[38] — which could radically reduce the need for preservatives and packaging — is a technology that has generated so much emotion that objective assessment of its potential to promote a sustainable agriculture-food system is next to impossible.

Only informed public debate can ensure that important scientific advances, particularly in fields such as animal biotechnology and veterinary products, are exploited in such a way as to ensure the safety and quality of food without unnecessary risk to the environment. Genetic controls on animal diseases, higher reproduction rates, and increased feed conversion efficiency could play major roles in boosting agricultural productivity in the 21st century.[39] But these processes will undoubtedly face hurdles in gaining public and political acceptance.

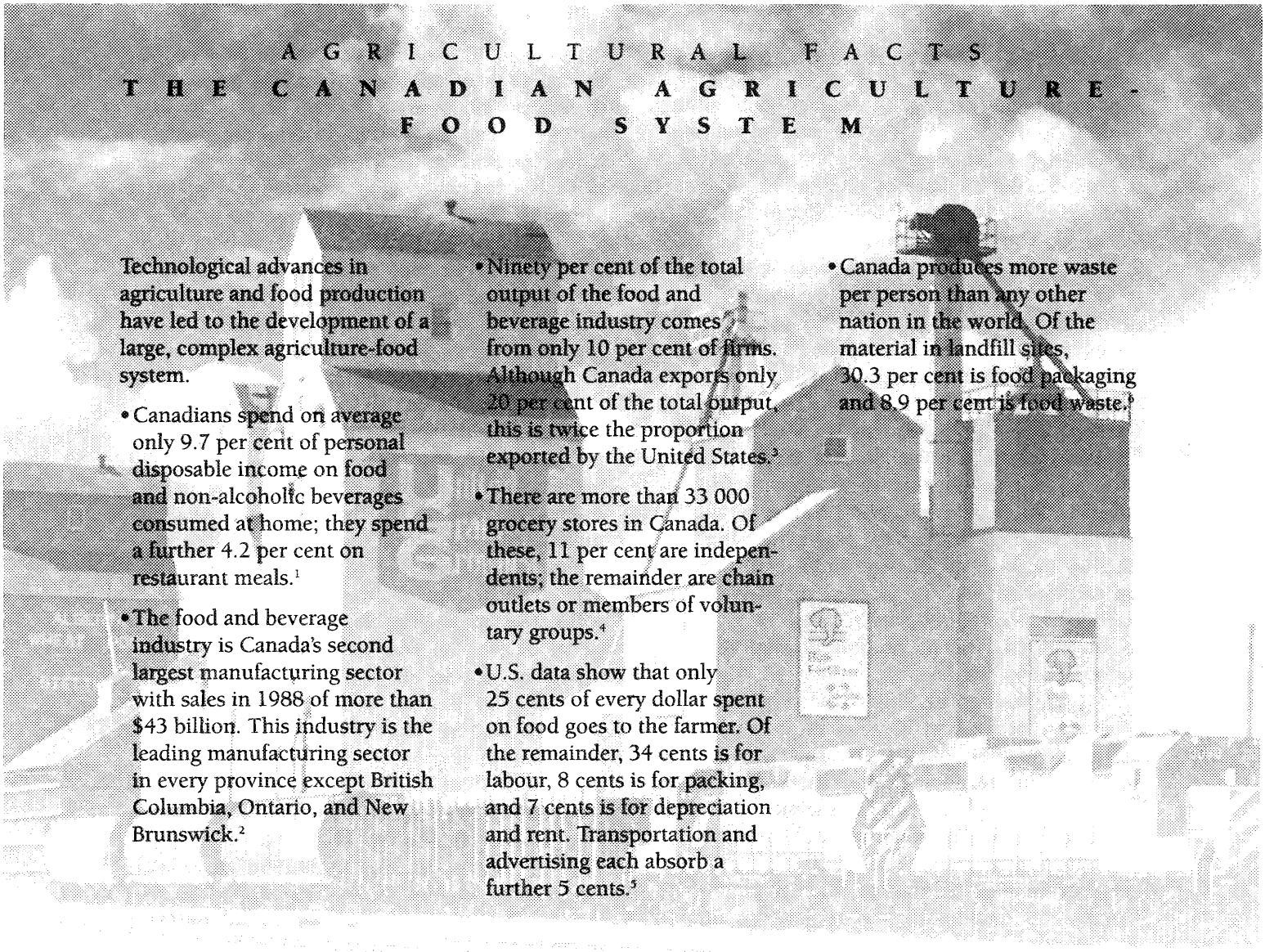
Science and technology in themselves will not secure sustainable agriculture. But the judicious use of existing technologies and the redirection of scientific and research priorities can help address specific concerns and reconcile economic and environmental needs. The benefits of both existing and new technologies must be assessed. Such an assessment requires an informed population, knowledgeable farmers, and a realignment of the agriculture-food system, as well as a strong research base. Securing sustainable agriculture will also require policies for science and technology that address their role in the context of environmental needs and social objectives.

Implementing sustainable agriculture

In the wake of the Brundtland report and a series of subsequent investigations and reports,[40] few informed people believe that the global economy can continue under the slogan of "business as usual."

Economic development based on ever-increasing inputs of fossil energy and other natural resources cannot be sustained and must be recast into development geared to less intensive resource use. As a major land user and a vital contributor to human well-being, agriculture has come under particular scrutiny in the debate over sustainable development.

THE CANADIAN AGRICULTURE-FOOD SYSTEM



Technological advances in agriculture and food production have led to the development of a large, complex agriculture-food system.

- Canadians spend on average only 9.7 per cent of personal disposable income on food and non-alcoholic beverages consumed at home; they spend a further 4.2 per cent on restaurant meals.[1]
- The food and beverage industry is Canada's second largest manufacturing sector with sales in 1988 of more than $43 billion. This industry is the leading manufacturing sector in every province except British Columbia, Ontario, and New Brunswick.[2]
- Ninety per cent of the total output of the food and beverage industry comes from only 10 per cent of firms. Although Canada exports only 20 per cent of the total output, this is twice the proportion exported by the United States.[3]
- There are more than 33 000 grocery stores in Canada. Of these, 11 per cent are independents; the remainder are chain outlets or members of voluntary groups.[4]
- U.S. data show that only 25 cents of every dollar spent on food goes to the farmer. Of the remainder, 34 cents is for labour, 8 cents is for packing, and 7 cents is for depreciation and rent. Transportation and advertising each absorb a further 5 cents.[5]
- Canada produces more waste per person than any other nation in the world. Of the material in landfill sites, 30.3 per cent is food packaging and 8.9 per cent is food waste.[6]

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Advances in the physical and biological sciences are providing a more profound understanding of the ecosystem that nurtures and maintains us all, and people are becoming more aware of the connections between human activities and the natural environment. This explosion of knowledge about global processes, however, is not easily translated into the effective public policies needed to address global issues.

To date, agricultural policy has been far more concerned with offering public support for farmers and meeting short-term economic needs than with redirecting agriculture to satisfy other interests. Some recognition of the needs of a broader constituency is emerging, although most policy activity in sustainable agriculture remains focused on the registration of chemicals and fragmentary initiatives on various environmental issues. However, these moves are unlikely to satisfy public concerns about the way we produce food and the quality of the food we eat; nor do they come near to restructuring agricultural policies for a changing world.

Consensus is emerging on the need to promote more sustainable agricultural practices. But there remains a profound ignorance concerning the practices required for a given cropping or livestock operation in each particular locale; a confusion over our capacity to reconcile economic and environmental requirements; and a widening belief that the issues involved transcend the time and space dimensions that our existing institutional and social structures were designed to address.

Redirecting the Canadian agriculture-food system toward sustainability requires a new way of thinking: a move from established economic thought, which gives a value to things, to evolutionary thinking, which gives value to the diversity that fosters higher production and greater stability in ecological systems.

Clearly, much can be achieved by integrating environmental services — such as water quality, species diversity, and air quality — more fully into the existing pricing system. Means of valuing non-market environmental services exist and provide a basis for a better accounting of the costs and benefits of alternative actions, thereby helping promote the behaviour most consistent with good environmental management.

However, placing a price on pollution, through tradable pollution credits for example, does not prevent pollution. Nor does viewing the current global environmental crisis as a simple matter of market failure address either the need to build cultural and biological information into models of economic development or the central issue of the kind of world future generations should inherit and how best to provide it.[41]

Securing a sustainable agriculture will require public participation in decision making and hard political choices that will involve costs. The wise application of existing scientific knowledge and technological skills, the revision of existing policies, and the careful use of market signals will all play a key role. Beyond that, we must shift to a new way of thinking that makes environmental integrity a priority; we must change the structure of our existing institutions, including government departments and research institutions, colleges and universities, granting councils, priority-setting mechanisms, and decision-making bodies; and we must forge a new partnership between all the players in the agriculture-food system, including farmers, suppliers, processors, retailers, consumers, and government.

A new vision

A fresh vision of the Canadian agriculture-food system is required if we are to reconcile environmental concerns with issues of economic viability and if we are to achieve harmony between the needs of current and future generations. On an encouraging note, various federal and provincial government reports, as well as the speeches and writings of politicians, academics, leaders of farm organizations, and business leaders, reveal acceptance of the need for a new sense of direction and new policies.

The Science Council believes that Canada can secure a strong, revitalized agriculture-food system that will provide an abundant supply of high-quality, safe food; maintain a vibrant rural community; and generate valuable foreign earnings. But this renewal will be possible only if we shift the emphasis away from measures of efficiency based solely on crop yields, the amount of cropland harvested per machine, or the size of farms. More complex performance indicators are needed, grounded in ecological principles and responsive to the needs of both the individual and society.

The world produces more food per head of population than ever before, yet as many as 730 million people remain hungry or malnourished. Moreover, throughout much of the world, degradation of the resource base is undermining the capacity to meet future needs.

- Every second the world's population increases by 3 people — 260 000 a day or 93 million a year. And every year, more than 25 billion tonnes of topsoil are lost, roughly double the amount that covers Australia's wheatlands.[1]
- An estimated 6 to 7 million hectares of agricultural land are lost annually to erosion and about 1.5 million more — mostly irrigated land — are lost to waterlogging, salinization, and alkalization.[2]
- In the quarter century 1975-2000, expanding cities are expected to consume 25 million hectares of cropland. Even assuming average levels of productivity, this represents the food supply for as many as 84 million people.[3]
- Water use has doubled at least twice this century and could double again during the next two decades. Yet, in 80 developing countries with 40 per cent of the world's population, lack of water is already a severe constraint on development.[4]
- Without a major expansion of arable land and if current population projections are correct, the world average of 0.28 hectares of cropland per capita is expected to decline to 0.17 hectares by 2025.[5]
- Thirty-five per cent of existing cropland suffers from some desertification. The amount of land permanently degraded to desert conditions continues to grow at an annual rate of 6 million hectares.[6]
- Runoff of agricultural chemicals from fertilizers and pesticides is one of the most widespread and serious of all water quality problems. The problem is most acute in industrial countries where fertilizer use is high. In the developing world, fertilizer use is still relatively low but there are important exceptions. Brazil is one of the top five countries in the world in terms of tonnes of fertilizer used, and extremely high levels of PCBs and pesticides have been found in various Asian water bodies, especially in Indonesia and Malaysia.[7]
- In 1989, there were an estimated 10 million environmental refugees worldwide. At least 8 million were refugees from land degradation throughout Africa, Asia, and Latin America. About 2 million were displaced over the long term by natural disasters whose effects were exacerbated by human activity.[8]

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As an overall principle or objective, the Science Council considers it essential to move toward:

> **An agriculture that works with nature to maintain essential ecological processes, guards the wholesomeness and security of the food supply, and maintains economically and socially viable farms and farm communities.**

Realizing this vision of sustainable agriculture requires a policy framework based on the following elements:

- redirection of R&D efforts toward scientific and technological advances that promote innovative farming systems and reduce the disparity between economic and ecological goals;
- elimination of policies that thwart sustainable agricultural practices;
- new policies that promote and reward good environmental management;
- policy decisions that are based on objective data;
- education of farmers, consumers, and other players in the agriculture-food system about the environmental implications of farming practices and food preferences;
- integration of environmental considerations into policies on international trade;
- promotion of policies and practices that protect the natural resource base, including air, soil, water, and the genetic diversity of plants and animals;
- development of more flexible institutional arrangements to meet emerging environmental needs and market demands;
- comprehensive development policies for rural Canada that integrate agriculture with alternative economic opportunities.

This framework provides the basis for the recommendations presented on the following pages.

Canada is the second largest country in the world and holds 20 per cent of the world's fresh water. The very abundance of resources has encouraged over-exploitation, and evidence of environmental stress is all too clear.

- Fifty-eight per cent of the area lost to urban expansion between 1966 and 1986 was prime agricultural land. Ontario accounted for about 35 per cent of the land lost. Replacing the productive value of this land would require developing and farming more than twice as much land in climatically marginal areas.[1]
- More than 1.2 million hectares of improved farmland in the Prairies is affected by natural salinity or by secondary salinity resulting from inappropriate management practices. In Saskatchewan, a quarter of a million hectares of previously productive land has no crop production because of salinity.[2]
- Phosphorus promotes the growth of algae and can kill fish and other animal life by reducing the oxygen available. About 70 per cent of the 3000 tonnes of phosphorus that enters the Great Lakes from Canada comes from agriculture.[3]
- Estimates of the annual on-farm cost of the losses attributed to soil degradation range from $713 million to $1064 million. Another estimate places the annual off-farm cost of soil erosion at $125 million.[4]
- Summer fallowing is known to promote salinization. Between 1971 and 1986, the amount of farmland used for summer fallow decreased by almost 22 per cent from 10.8 to 8.5 million hectares.[5]
- Households contribute pesticides to the contaminant load in local wildlife and water. Forty-three per cent of Canadian households with yards or gardens apply pesticides. Averages range from 50 per cent in Ontario and the Prairie provinces to 27 per cent in the Atlantic provinces.[6]
- Over 90 per cent of Canada's land area cannot support agriculture of any kind. Of the remaining 10 per cent, only half is free of severe physical limitations to crop production.[7]
- In 1986, 75 per cent of Canada's crops were grown using methods that promote soil erosion. The area of tilled land at risk amounts to 32.5 million hectares.[8]
- Of the 3269 known plant species in Canada, 1009 are considered rare.[9]
- Canada has one-quarter of the world's wetlands — 127 million hectares or one-seventh of Canada's land area is covered by bog, fen, marsh, or swamp. It is estimated that one-seventh of the country's pre-settlement wetlands have been converted to other uses.[10]

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In 1990 the Science Council of Canada launched a major study to investigate how science and technology can best be managed to achieve an agriculture-food system that is economically and environmentally viable. As part of the study, the Science Council gathered input from a wide variety of sources, including:

- 29 written submissions from persons and organizations concerned with the agriculture-food system;
- 10 commissioned reports on topics ranging from the state of the R&D system for agriculture to case studies of Canadian farmers using alternative production techniques (these documents are listed on page 42);
- a two-day workshop co-hosted with the Canadian Agricultural Economics and Farm Management Society that brought together more than 100 economists, farmers, and government officials and received some 40 papers;
- a one-day workshop involving 15 representatives of key environmental and farm groups to debate their mutual interests in sustainable agriculture;
- a one-day workshop co-hosted with the Canadian Agricultural Research Council that brought together more than 35 agricultural experts to review and debate an interim report;
- extensive consultations with producer and consumer groups, as well as the scientific, business, academic, and government communities.

By the end of the study, the Science Council had developed 27 recommendations aimed at the renewal of the Canadian agriculture-food system. The recommendations address the research challenge through a range of issues, including institutional change, training, education, data collection, technology transfer, and codes of agricultural and business practice.

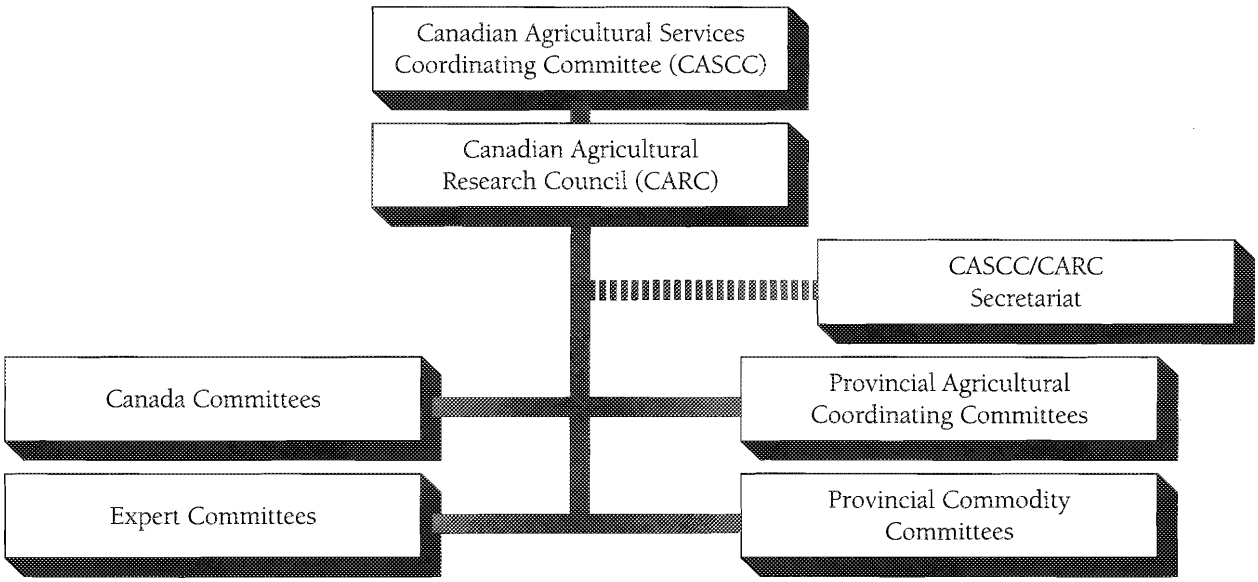
Providing effective research leadership

Canada has a large, integrated system of committees to coordinate all agricultural activities, set national research priorities, and foster the application of research findings to the agriculture-food system (Figure 1). The entire committee system is managed by the Canadian Agricultural Services Coordinating Committee (CASCC). This agency provides useful information to firms, universities, and the federal and provincial governments, making these parties aware of concerns emanating from the grassroots committees, which are in constant touch with producers. However, CASCC has not served well as a decision-making body. By the time that resolutions work their way from a commodity committee through provincial coordinating committees and eventually to CASCC, the ideas behind them have either been accepted and are being implemented, or they have been dropped.

Recommendations brought to CASCC may generate a federal-provincial task force. This can prompt quick and effective action. But where recommendations from CASCC go directly to granting agencies, such as the Natural Sciences and Engineering Research Council, they are not necessarily given priority by the peer-review committees that decide on strategic funding. Moreover, large segments of the agricultural community believe that the federal government, through Agriculture Canada, simply uses the CASCC system as a sounding board for its own agenda.

The committees established by CASCC are organized primarily by discipline. Membership of these committees is determined largely by official position, with most members drawn from research, research management, industry, or producer and commodity groups. These stakeholders must continue to be represented. But to meet emerging needs, the committees must also include more individuals who have a broad understanding of agriculture, such as representatives of consumer groups, working farmers, environmentalists, social scientists, and others involved in the agriculture-food system.

Figure 1. Canadian Agricultural Services Coordinating Committee (CASCC) System



(1) **CASCC should commission an independent review of its committee structure and membership with a view to meeting the needs of the agriculture-food system in the 21st century.**

One CASCC committee, the Canadian Agricultural Research Council (CARC), has a crucial role in determining the future of Canadian agriculture. CARC was established following a recommendation from the Science Council of Canada in 1976 that Canada set up a body to coordinate the national agricultural research program and provide informed scrutiny — a regular "technical audit" — of government research.[42] This scrutiny was deemed vital to enable the large agricultural research system to adjust to changing needs and goals.

In its recommendation, the Science Council noted the need for a national (not federal) body and identified among the conditions for its success the existence of a full-time executive officer, reporting directly to the Minister of Agriculture, and the funding of a secretariat. It also proposed that CARC manage federal government expenditures on agricultural research.

Under its current mandate CARC sets priorities for research and other policy and regulatory issues. In addition, it indicates which organizations and institutions might most effectively carry out needed activities. It is funded by Agriculture Canada, but it may also receive funding from other sources for special projects.

In the fiscal year 1991-92, its budget from Agriculture Canada was $65 000. A secretariat of four Agriculture Canada employees serves not only CARC but all the other committees in the CASCC system, which consists of more than 1000 people.

CARC has made a significant contribution to the agricultural research community. However, it is unlikely that CARC as presently constituted can provide the dynamic leadership needed to promote and secure sustainable agriculture without a thorough restructuring and improved resources. It is an organization that is perceived by many scientists as being too closely allied to Agriculture Canada to provide other than a federal perspective, and as lacking the financial or staffing resources to fulfil its mandate. What is most needed is a research advisory body that is completely separate from Agriculture Canada.

(2) **The Minister of Agriculture should commit funding to CARC to allow it to fulfil its mandate as an independent advisory council with a full-time executive officer and an expanded secretariat. The chairman of CARC should report directly to the Minister.**

(3) **CARC should commission an independent review of its membership, with a view to including stronger representation from working farmers, ecologists, and economists. As an initial step it should appoint a**

representative of the Social Sciences and Humanities Research Council. The review should also consider how to shift the emphasis in modern agriculture from a narrow production orientation to a broader systems focus and ensure that this focus is reflected in the type of individuals each organization is requested to nominate for membership to CARC.

CARC, with its role in monitoring the adequacy of agricultural research in Canada, must send a clear message to CASCC that sustainability is the context within which all priorities must be set — and it must ensure that the message is heeded.

Recasting federal research

Research and development for the agriculture-food system in Canada receives about $582.3 million a year, including $371.8 million from the federal government. Almost $250 million of federal monies are spent by Agriculture Canada on in-house research.[43] In addition to its Central Experimental Farm in Ottawa, Agriculture Canada operates 27 regional research stations and 11 experimental farms.

As the largest single performer of agricultural research in the country, Agriculture Canada has a special role in shaping a more sustainable agriculture-food system. The size of the research effort pursued by Agriculture Canada, and the burden of its distinguished history in making Canada a world leader in agriculture, make restructuring Agriculture Canada to meet new needs both an essential and a difficult task.

Agriculture Canada's research activities, like those of all federal research divisions, are constrained by lack of clear or suitable mandates, micro-management, weak peer-review processes, and lack of flexibility. These shared problems are fully documented in a report of the National Advisory Board on Science and Technology, *Revitalizing Science and Technology in the Government of Canada.*[44] The problems are compounded in this instance by the maintenance of regional stations that are often underfunded, poorly located, and lacking the facilities to meet even current needs.

Implementation of the recommendations in the report of the National Advisory Board on Science and Technology, particularly the establishment of the Research Branch as an independent research institute, would help revamp the agricultural research program. It is difficult to envisage any radical restructuring of the federal research system without such a change — the closure of a small regional facility currently being perceived as politically akin to the closure of a large military base.

Whether or not the institute model is adopted or a rationalization of regional stations occurs, Agriculture Canada should de-emphasize research focused on single commodities and disciplines and increase research that takes an integrated, interdisciplinary approach to agricultural problems.

To maintain the existing structure of agricultural research is contrary to the long-term needs of Canadian agriculture and ignores the changes occurring in Europe, the United States,[45] and elsewhere. It also ignores the advice of Canada's scientific community.

(4) **Agriculture Canada should initiate an independent review of the Research Branch, with a view to redesigning the research system to make it more responsive to changing priorities.**

(5) **Agriculture Canada should review and clarify the mandates of its research stations and develop a strategy for rationalizing and strengthening them; particular consideration should be given to using some research stations as the focus for agro-ecosystems research.**

(6) **In developing a long-term strategy for research, Agriculture Canada should consider the promotion of sustainable agricultural practices through the reintroduction of demonstration farms.**

(7) **Agriculture Canada should strengthen cooperative research and training programs with university departments and colleges of agriculture, as well as with the corporate sector.**

Collaborative research and training

Canadian universities that do agricultural research and colleges of agriculture have undergone some useful structural modifications in recent years, most obviously in the establishment of new institutes and the grouping of loose clusters of academic staff from different disciplines around common themes. For the most part, however, disciplinary and departmental structures remain intact.

Some universities and colleges have recognized the new pressures on agriculture and the need to involve a wider range of stakeholders by renaming their agricultural faculties. For example, McGill University established a faculty of agricultural and environmental sciences in 1990, and the University of Manitoba created a faculty of agriculture and food sciences in 1991. However, the need to redesign structures and modify teaching and research programs cannot be obviated by a simple relabelling, and most deans of agriculture and veterinary medicine are still struggling to promote greater flexibility in their institutions.

Despite an often enviable reputation based on past achievements, it is doubtful that our faculties and colleges of agriculture can meet either current or emerging needs. Already, an increasing proportion of the basic research that impinges on agriculture, and much of the research and teaching on broader issues central to sustainable agriculture — such as natural resource management, health, and the vitality of rural communities — are being performed in departments other than those of agriculture and veterinary medicine.

Sustainable agriculture requires research and training that is more collaborative than that encouraged by existing arrangements. If the universities and agricultural colleges are to provide the intellectual leadership and trained personnel for a sustainable agriculture-food system, they must radically restructure the existing discipline-based programs. They should retain high levels of expertise in key areas of science and technology, but set such expertise in a broader context, shifting the research emphasis from specific production problems to the exploration of agricultural systems. These institutions need to ensure greater flexibility in teaching programs and research and develop the tools to promote a sustainable agriculture.

(8) **The deans of agriculture and veterinary medicine should review existing departmental structures and undergraduate and graduate training programs with a view to strengthening multidisciplinary training and promoting greater understanding of agricultural systems.**

The long-term success of these moves will depend on the availability of chairpersons who view the agriculture-food system in its broadest perspective, as well as staff who are willing to do team research that does not necessarily generate the individually authored publications that normally determine academic promotion.

(9) **The deans of agriculture and veterinary medicine should review hiring and promotion criteria to encourage the appointment and promotion of staff whose teaching and research furthers the understanding of agricultural systems.**

Funding interdisciplinary research

The federal granting councils, in particular the Natural Sciences and Engineering Research Council (NSERC), are a primary source of external funding for research in agriculture and food.[46] NSERC has a number of programs that support agricultural research and research training. In 1989-90, its research grants program provided $14.5 million for 559 projects related to the agriculture-food system. Awards are normally made on a three-year basis for long-term basic or applied research programs directed by individual faculty. The selection process involves peer review by committees composed mainly of leading scientists in the various disciplines. Consequently, it promotes and copes most easily with discipline-based research.

In addition, NSERC funds research projects targeted at designated areas through three programs: strategic grants; cooperative R&D grants; and industrial research chairs. In 1989-90, 107 projects related to agriculture received almost $8 million under these programs.

Inevitably, the funding policies of the granting councils have a major influence on what research is done and the environment in which researchers are trained. Therefore, implicitly or explicitly, these policies help set national research priorities.

A shift in funding in favour of ecologically based research is already evident. In October 1991, the three granting councils — NSERC, the Social Sciences and Humanities Research Council (SSHRC), and the Medical Research Council — were awarded $50 million over six years to create the Funding Program for Research and Training in Environmental Studies. Under this new program, research funds are available to interdisciplinary teams for ecosystems research in Canada. The program — coordinated by SSHRC on behalf of the three granting councils — is a concrete demonstration of the councils' commitment to

foster cross-disciplinary and inter-council cooperation.

The initiative by the granting councils to promote ecological research is a step in the right direction. But securing sustainable agriculture requires a more substantial adjustment in favour of long-term, interdisciplinary systems research.

(10) **The Natural Sciences and Engineering Research Council should review its funding programs, focusing on the structure and composition of granting committees and on the allocation of funds among different programs, with a view to promoting long-term, interdisciplinary research in food and agriculture.**

Strengthening the social sciences

Achieving sustainable agriculture will require a fundamental attitudinal shift by all players in the agriculture-food system. It will also require a stronger partnership between the physical and social sciences and the policy community. An integrated approach to agricultural research is needed that recognizes the interplay of human activities and natural processes.

Even Canadian agricultural economists, who among the social scientists are perhaps most fully accepted in the agricultural community, have little expertise in natural resource economics or in institutional and environmental economics. Consequently, they are not positioned to contribute as effectively as they might to the debate on sustainable development. Some agricultural economists have recognized and gone some way to address this weakness. The Canadian Network of Resource Economists was created in 1989 to share information and help focus the debate, but it has no base funding and operates with support from Macdonald College and Agriculture Canada.

The need to strengthen support for research that pushes back traditional disciplinary limits and encourages work on an interdisciplinary basis has also been recognized by the granting councils. They have worked to ensure broader participation in review committees, while maintaining quality control through interdisciplinary committees targeted at issues of national concern. However, there remains a need to further strengthen social science research in sustainable resource use and development so that economic and behavioural issues can be integrated into teaching, research, and policy development for sustainable agriculture.

The joint initiative program of SSHRC is one mechanism that could be used to bolster the role of the social sciences in sustainable resource use. The program — which promotes interdisciplinary research through funding partnerships with other public agencies and industry — makes funding available through a variety of mechanisms, including research chairs; targeted research grants; and support for centres, networks, research groups, or individual students. This type of program encourages interdisciplinary research; the communication of research results to a wide audience, including policy-makers or "users" of the results; and partnerships between academic researchers and agencies in the public and private sectors. Partnerships, which need not include a financial contribution, involve sponsors in the design, execution, and dissemination of results.

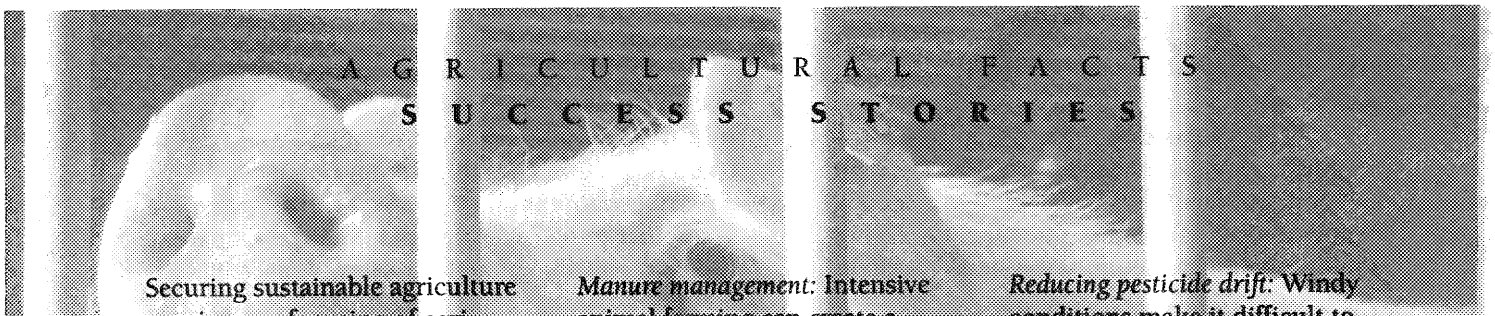
(11) **The Social Sciences and Humanities Research Council, in cooperation with Agriculture Canada, should develop a joint initiative to promote research in natural resources and the social sciences.**

Improving the knowledge base

All across the country, farmers are reducing the use of pesticides, adopting soil conservation practices, and better managing the disposal of animal manure and chemical containers. In August 1990, more than 50 per cent of Canadian farmers reported that during the previous 12 months they had implemented changes in their farming practices because of environmental concerns.[47] Many farmers have switched to totally different production systems. Some of these changes are market driven. Farmers want to increase profitability by lowering input costs and securing premium prices for "green" products.[48]

Information to back these changes is often shared through farmers' self-help groups and various "alternative" farmers' associations. Information is traded internationally but is rarely integrated into formal government-supported information schemes. Only Quebec uses provincial funds directly to promote alternative production techniques.[49]

Much of the debate over the extent, cost, and implications of environmental degradation related to agriculture can be explained by the absence of a sound database. Statistics Canada recently published *The Impact of Human Activities on the Environment*,[50] which contains a section



Securing sustainable agriculture requires a refocusing of agricultural research: the current preoccupation with reducing food production costs must give way to a new emphasis on understanding the interrelationships between different components of the production system.

Biological control of weeds: Weeds from Europe have found their way into Canada. Without natural predators to control their propagation some weeds, such as knapweed, have become a significant threat to rangelands in many parts of British Columbia. Chemical control of knapweed is costly and associated with water pollution. However, a biological control program has been developed that reduces the incidence of knapweed by 60 per cent. The program, which entails the release of flies that feed on the seed heads and weevils that feed on the roots, is cheaper than chemical control and poses no threat to the environment.

Manure management: Intensive animal farming can create a serious water pollution problem. A new computer-assisted manure management program allows users to assess the nutrient content of manure from several animal species and identify the amount of manure needed on specific farm fields. The program allows manure to be managed in a way that eliminates water pollution problems and at the same time reduces farmers' expenditures on chemical fertilizers.

Disease-resistant crops: Disease-resistant crops provide one way to decrease the pesticide load on the environment. A new disease-resistant variety of oats — AC-Stewart — was registered in 1991. This variety is resistant to smut (no chemical treatment of seeds is required), rust (no foliar fungicide is required), and barley yellow dwarf virus (no insecticide is required). The new variety is also short and strong strawed, which means it requires no growth regulator to combat potential wind damage.

Reducing pesticide drift: Windy conditions make it difficult to apply pesticides and can result in the use of increased amounts. Once wind-borne, pesticides contribute to air pollution and can damage plants. Canadian researchers have developed a windproof sprayer that greatly reduces pesticide drift and cuts the amount of chemicals used by up to 50 per cent.

Source

Dr Laure Benzing-Purdie, Agriculture Canada, Ottawa, personal communication, 13 December 1991.

Kenneth Ginn

on agriculture but reveals the inadequacies of our statistical resources in addressing the new questions posed under the paradigm of sustainability. Data on soil erosion in Canada, for example, are perhaps the best available on any agricultural environmental issue, but are still controversial. Data on agriculture and water pollution, in particular groundwater pollution, are especially weak.

Under its Bench Mark Farms program, Agriculture Canada collects data on the economic performance of individual farms. This program could be extended to incorporate farmers practising alternative management schemes. Such an extension, by enabling alternative systems to be compared with conventional systems, would contribute to the formulation of science-based policies for sustainable agriculture. An extended Bench Mark Farms program would also increase the amount of financial data available to banks and other financial institutions; this would help reduce the bias that alternative producers face in securing loans and other financial services.

Agriculture Canada needs to build on the expertise of farmers who are trying unconventional approaches by having scientists support these farmers in collecting data, analyzing the results, and identifying research needs. This would also encourage the recognition of farmers as legitimate sources of information.

(12) **Agriculture Canada, in cooperation with the provinces, should identify 30 to 80 sample farms in each province that are using alternative agricultural practices and integrate them into its Bench Mark Farms program. These farms should collectively represent the major agro-climatic and cropping regions of each province.**

(13) **Agriculture Canada, in cooperation with Environment Canada and Statistics Canada, should develop a set of variable, widely accepted measures of soil and water quality, including soil organic matter content, soil structure and tilth; and total coliform count, nitrite and nitrate levels, and total dissolved solids for a given region. As the measures are developed, they should be incorporated into the Bench Mark Farms program.**

(14) **Provincial departments of agriculture in concert with Agriculture Canada should provide scientific and analytical support to allow farmers to collect data that could assist in designing regional agricultural development policies.**

Developing physical and biological indicators

Canadian farmers, scientists, consumers, business leaders, and policy-makers have all expressed enthusiasm for sustainable development as applied to agriculture and food production. Several initiatives are in place. For example, the announcement of a Pest Management Alternatives Office and a Canadian Pest Advisory Council is indicative of an emerging consensus on the need to redirect research towards more ecologically sound agricultural practices.[51] However, progress will remain limited until sets of physical and biological indicators are established against which alternative agricultural practices can be assessed. Without suitable indicators, questions will remain unanswered as to the impact of agricultural pesticides on natural predators and controls, the impact of different cultivation practices on soil and water quality, and the reversibility of changes wrought by different agricultural systems. The development and application of empirical indicators would allow progress towards sustainable agriculture to be assessed and provide evidence of any slippage.

It remains unclear what data are available to develop appropriate indicators and how quickly any additional data can be generated. Certainly, no one set of national indicators will meet the wide variations in ecological conditions in Canada. The Federal-Provincial Agriculture Committee on Environmental Sustainability identified the need to address issues of sustainable agriculture within the context of agro-ecosystems and recognized that 90 per cent of Canadian agriculture takes place within just five ecozones. Developing suitable indicators for each agro-ecosystem poses a challenge to the scientific community. It is an exercise in applied ecology that will require a cooperative effort by the university and business communities, government scientists, and farmers.

(15) **Agriculture Canada, together with provincial governments, the agriculture-food industry, the academic community, and farm organizations, should strike a coordinating committee to identify physical and biological indicators for sustainable agriculture.**

Reaching the farmer

Ultimately, the successful implementation of policies to promote sustainable agriculture will depend on the willingness and capacity of farmers to adopt new management practices.

It is commonly argued that sustainable agriculture will require greater management skills than conventional agriculture. Certainly, sustainable agriculture will require farmers to make decisions based on a full understanding of the total farm system; and this understanding will replace the more compartmentalized approach possible in conventional agriculture. Sustainable agriculture will also require producers to tailor general practices to the specific ecological conditions of their farm. But it is not certain that this shift in approach requires more managerial ability. It is easy to downplay the extent to which farmers already exercise skill and judgement under existing management practices or modify farm operations to meet individual circumstances. What is clear, however, is that a change to more sustainable practices will, at least in its initial phases, require increased managerial flexibility and the development of new knowledge and skills.

Canada has a large, provincially based system of extension workers to encourage the transfer of technologies and new management practices to farmers. The role and effectiveness of these extension workers vary widely across the country. In some provinces, farmers report that extension staff are reluctant to adopt new approaches and look down on alternative methods; in other provinces, the extension staff have had to accept a bureaucratic role that is at odds with their primary educational role. In still other provinces, however, extension workers are highly regarded and play a vital role in maintaining a viable farm economy.

New technologies and market conditions have reduced farmers' dependence on provincial extension services and increased their reliance on alternative sources of information. Industrial representatives, in particular, now play a key role. In addition, some farmers who recognize the need to move toward more sustainable practices have formed self-help groups to share experiences, tap into alternative information sources, and develop farm management plans.

Researchers, extension workers, and farmers each have a role to play in the design of production systems for sustainable agriculture. For the most part, however, researchers take little responsibility for the transfer of new information to farmers. This constrains the rapid transfer and adoption of new technologies and limits scientists' understanding of their clients' needs. If Canadian agriculture is to be recast and sustainable practices developed and promoted, this problem must be addressed. Agricultural scientists must become more aware of the problems farmers face in shifting to more sustainable practices and more directly involved in the application of research results.

This involvement would help improve the design of research projects to meet farmers' needs and increase the flow and speed of transfer of new knowledge to its users. Success for the scientist would be judged not only by the number and quality of articles published or increased yields generated, but by some service-oriented measure of responsiveness to user needs. Provincial government agricultural scientists in Alberta provide a model — their work contracts require them to be responsible for the application of their research results. In the United States, scientists at the land-grant colleges have three responsibilities — teaching, research, and extension work. Most faculty members have split appointments involving at least two, and often all three, basic missions.

Changes are needed to meet the needs of Canadian farmers for more and better information, to bolster the role of extension workers, and to strengthen the contribution of science to sustainable agriculture.

(16) **The deans of agriculture and veterinary medicine should explore ways to include performance of extension activities as a necessary criterion in the selection, promotion, and tenure of their academic staff.**

(17) **Provincial ministers of agriculture should include extension activities in the job descriptions of their agricultural research scientists.**

Meshing economy and ecology

Canada has long recognized the need to address environmental problems associated with agricultural production. The National Soil Conservation Program, for example, had its origins in the 1920s. A large number of programs have been established since then, including the national Soil Quality Evaluation Program and the

Pesticide Registration Review; the Soil and Water Enhancement Program in southern Ontario, the 1984-89 federal-provincial Agri-Food Development Subsidiary Agreement in Manitoba and Saskatchewan (which focused on residue management practices to control wind and water erosion), and erosion control and soil conservation programs in the Maritimes.

Praiseworthy as it is, a catalogue of environmental legislation and agreements does not amount to a program for sustainable agriculture. Indeed, the continued tendency to "tag on" an environmental component to existing farm programs under the guise of sustainable development reveals a fundamental misunderstanding of the concept. Sustainability requires the integration of environmental concerns into all agricultural policies; it requires policies that address the causes of environmental problems, and not just the adverse consequences of certain systems or practices.

Commentators have repeatedly claimed that many existing policies work against sustainable agriculture because they discourage sustainable practices on the farm. By distorting market processes, for example, aid packages may increase the gap between sustainability and current practice. The 1991 Gross Revenue Insurance Plan — which encourages farmers to plough up fragile soils — is one income support program cited by many farmers and officials as working at cross-purposes to the goals of a sustainable system. This program needs to be reassessed, as do other programs that encourage and subsidize the destruction of wetlands and woodlots and promote intensive production techniques that are not justifiable even in conventional economic terms.

On the international front, most trade negotiations take place with little or no concern for environmental sustainability. The recent GATT negotiations are a case in point. Nor is the environment fully integrated as a context in foreign aid policy.

Abrupt policy shifts would be unnecessarily disruptive to the farm economy, and in hard economic times apparent threats to subsidy payments could make farmers think that they alone have to bear the cost of promoting sustainability. One solution would be to *decouple* subsidies from production, which would reduce the "welfare" stigma felt by farmers, and to *recouple* assistance with sustainable practices — including payment for wildlife reserves, woodlots, and wetlands — which would both rally public support and strengthen the agricultural economy.

(18) Agriculture Canada should review its policies with the objective of decoupling subsidies from specific production practices and creating clear and compelling incentives for the adoption of practices integral to sustainability.

(19) Agriculture Canada should redirect farm support from production subsidies to payments designed to maintain the rural landscape through the preservation of wetlands, woodlots, wildlife, and other environmentally and socially desirable resources.

(20) The Canadian International Development Agency, with Agriculture Canada and External Affairs and International Trade Canada, should review existing trade and foreign aid policies and develop criteria to ensure that sustainability becomes a key objective in the development and application of these policies.

Creating a learning partnership

It is not always clear what the public wants from the modern agriculture-food system. Indeed, there is little to suggest that the public is interested in agriculture until it is linked to environmental concerns, the issue of animal welfare, or doubts about the safety and quality of food. Defensive reactions by those involved in agricultural production are unproductive and most certainly will not make current practices more acceptable to the public. Where public concerns are unfounded they should be shown to be so. Where they are legitimate they should be properly addressed. The agricultural community as a whole must recognize the shift in consumer preferences towards more "natural" produce, and view these shifts as market opportunities rather than threats.

Despite the emergence of the "green" consumer, the majority of Canadians still get their milk from cartons and their beef from the freezer. Fewer and fewer Canadians have any direct contact with a farm. There is considerable ignorance about modern agriculture and misconception about its place in the environment. A massive public education program is needed to alert consumers and farmers to the concept of sustainable agriculture and its benefits to both parties. Only in this way can consumers and farmers learn to see each other as partners rather than antagonists in securing sustainable agriculture.

AGRICULTURAL FACTS
NON-FOOD USE OF AGRICULTURAL PRODUCTION

Plants and animals have from the earliest times provided not only food but shelter and clothing. Even in a modern, highly industrialized society, new ways to use these resources are continually being sought.

Pharmaceuticals: One in four prescription drugs contains ingredients derived from plants. Medically important biochemicals also come from animal by-products. Insulin, kallikrein, and heparin are packing-house by-products used respectively to treat diabetes, control high blood pressure, and promote blood clotting. Each of these drugs enjoys annual sales of as much as $120 million.[1]

Industrial processing: Enzymes play a vital role in the food processing industry. Yeast, a single-cell fungus considered until recently to be a plant, is an essential component of most brewing and many baking procedures. Chymosin (rennet), an enzyme from the fourth stomach of calves, is used to clot milk in cheese production. Catalase, commonly obtained from beef liver, is used to "sterilize" milk by killing harmful bacteria while leaving advantageous microorganisms unharmed.[2]

Clothing and footwear: Globally, cotton, flax, tree bark, and even potatoes play a role in providing clothing. In Canada, wool from sheep generates sales worth more than $2 million a year; fur sales total more than $41 million; and hides for shoes and other leather goods generate annual export earnings of nearly $250 million.[3]

Hearth and home: Plants provide many of the products necessary to the comfort and attractiveness of our homes. For example, flax provides significant ingredients for house paints, stains and enamels, caulking, insulation, fine paper, erasers, linoleum, and soap. Linseed oil, the principal item produced from flax, is now facing renewed demand as an environmentally friendly product. This bodes well for Canada, the world's largest producer and exporter of flax seed.[4]

IDRC photo

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Other countries face a similar challenge. Some have found it useful to start with programs for young people. In New Zealand, for example, farmers have established an "adopt a farm" scheme. Under the scheme, pupils visit a farm once or twice a year to gain direct hands-on experience of food production. Such an approach might be useful here, even if it is not easy to put in place in major urban areas.

(21) **Farm organizations should work with school boards to develop "adopt a farm" schemes as part of a broadly based public information program on sustainable agriculture.**

These schemes should be part of a comprehensive curriculum package designed to promote informed debate about sustainable agriculture in the school room. In some provinces, for example, Ontario and British Columbia, such packages are already being developed. This approach should be extended across the country.

(22) **Provincial departments of agriculture and departments of education should jointly establish curriculum development committees to design teaching materials on topics related to modern agriculture and food production.**

Setting codes of agricultural practice

Progress toward sustainable agriculture depends on the maintenance of a viable farm population and a secure land base. However, farmland and farmers themselves are increasingly subject to competition from a variety of urban-related processes.

Agricultural land is being lost to urbanization around almost all of Canada's towns and cities. Laws and regulations to protect farmland are in place in every province but are enforced with varying degrees of enthusiasm and political will. The land on which agriculture depends is also in demand for recreational uses, wildlife reserves, and conservation areas. When farms are close to residential areas they are vulnerable to runoff from urban land, vandalism, and trespass; they are also subject to controls on farm practices that have been developed in response to complaints about smells and noise.

An increasing number of people from towns and cities are moving into rural areas to live. Many of these new residents view the countryside not in agricultural but in aesthetic or recreational terms. This perception clashes with the farmer's struggle to achieve profitability and increase efficiency. Conflict has intensified under the twin pressures of rising standards of living and rapid technological change, which reduce concerns about food security and encourage increased intensification of farm production.

Most provinces have responded to this situation by passing some form of right-to-farm legislation, often under pressure from farmers themselves. Such legislation assumes an inherent incompatibility between farm and non-farm interests. Yet, there is often considerable common ground between the different players. Farmers have at least as much interest as other rural residents in good management practices and a healthy environment,[52] and newcomers to the countryside have frequently been attracted by, and wish to maintain, a farming landscape.

The need for codes of agricultural practice is implicit in several major works on sustainable development.[53] These approach sustainability as a philosophical concept that requires partnerships to reconcile economic, social, and environmental objectives. British Columbia has led the way in encouraging farm and environmental groups and other interested parties to jointly develop codes of agricultural practice and to institute peer-group inspection by farmers when complaints are recorded.[54] These codes address concerns such as the use and storage of agricultural products and waste materials, and the pollution of water by animal manure.

The process of developing codes of agricultural practice, unlike legislation generated in response to individual complaints, lessens the likelihood of confrontation between farmers and other rural residents. At the same time, codes reduce the need for bylaws that penalize the whole farm community because of complaints against one farmer. By recognizing farmers as professionals and granting them the same self-regulatory powers accorded to other professional groups such as teachers and lawyers, the codes acknowledge the commitment of farmers themselves to good environmental practices. The codes recognize the legitimate rights and needs of farmers in going about their business. They also encourage non-farmers to accept the trade-offs inherent in sustainable development and to better understand the technical developments and economic pressures that dominate farmers' lives.

(23) **Provincial departments of agriculture, in concert with departments of environment and farm and environmental groups, should develop codes of agricultural practice to ensure that farms are operated in an environmentally sound manner, develop a realistic way to measure compliance, and implement effective penalties for non-compliance.**

Setting codes of business practice

The global market for the products of Canadian agriculture is hard to predict. Dramatic political changes in Eastern Europe over the last few years have heightened the uncertainty. Recent increases in demand for imports there will probably be wiped out in the longer term as self-sufficiency builds. Long-term population growth, particularly in the Third World, could boost the demand for Canadian produce but, again, self-sufficiency could limit the need for Canadian exports. This uncertainty and variability in market conditions gives new urgency to strategies designed to capture any market advantage available to Canadian producers.

Whatever the future level of demand, environmental considerations will clearly affect trade, whether through trade regulations and agreements or through consumer pressure. Failure to address environmental concerns could place Canada's trade prospects at a grave disadvantage.

Canadian business has responded to changing markets and consumer demands by developing alternative products and, in some sectors, by setting codes of business practice. These codes encompass self-regulation, environmental audits, and stewardship of potentially environmentally damaging products over their full life cycle. Codes of business practice are also a wise defensive strategy against the imposition of government controls and regulations. Like other Canadian industries, the agriculture-food industry must recognize environmental protection as good business and as part of any development strategy for the 21st century.

(24) **The Food Institute of Canada should work with related associations and environmental groups to establish environmental strategies and codes of business practice.**

Improving risk assessment and regulatory flexibility

The response of consumers to new technologies will have a major influence on the competitiveness and sustainability of Canadian agriculture, and those involved in the production and supply of food have an obligation to provide the information necessary to permit informed decision-making. Such information, however, is not always available.

Problems are evident on two fronts: product and process standards, and controls on the use of new technologies. Arguably, too much of the debate on sustainable agriculture has centred on concern over pesticide residues in food. In particular, consumers, believing the only safe level of residue is no residue at all, have been unnecessarily alarmed when improvements in detection have revealed minute traces of toxic chemicals in food. Continued reliance on the concept of zero tolerance will result in more currently "safe" products being perceived as unsafe. Some new criteria acceptable to both scientists and consumers are urgently required.

(25) **Agriculture Canada, with Health and Welfare Canada and consumer and environmental bodies, should establish a task force to develop improved criteria for the assessment of food safety and water quality that (a) satisfy public concerns and (b) are based on both the best available scientific methods and common sense.**

The registration of new pesticides is a complex balancing act between product and environmental concerns. Many scientists believe that efforts to block registration of any new pesticide may actively discourage or delay the introduction of new environmentally friendly products.

Biocontrols offer a powerful means to better manage farm pests and address environmental concerns. However, the registration of new biocontrols is subject to turf warfare as different departments and agencies attempt to assert legislative control. Registration under current legislation involves two different federal acts: the Pest Control Products Act and the Plant Protection Act. Four federal departments are involved in the application of the legislation. As a result, the cost of developing and registering a product that is effective and environmentally friendly may

far exceed its commercial value. Moreover, the Plant Protection Act, which governs the registration of insects to control weeds, was designed to keep out plants and animals through quarantine regulations, not to encourage their introduction and use.

(26) Agriculture Canada should review existing legislation for biocontrols with a view to simplifying and promoting their introduction into the market.

The Canadian agriculture-food system takes justifiable pride in the high-quality, safe, standardized nature of its output. But the complex mesh of legislation and regulations that has evolved to ensure this standardization promotes a rigidity that works against modern market needs. In particular, lack of regulatory flexibility thwarts attempts to exploit niche markets for products ranging from organic foods to fruit spreads and free-range eggs, without necessarily promoting more food safety.

Farmers are missing out on potential profits. Consumer interest in nutrition, animal welfare, and the environment provides the opportunity to make money from environmentally friendly products tailored to specific market needs. For example, in January 1989 Loblaws introduced a line of 100 "environmentally friendly" products, including several food items. In Ontario alone, $5 million of these G•R•E•E•N products were sold within four weeks of the launch — double the projected sales volume.[55] Increased regulatory flexibility would allow more extensive exploitation of other, similar opportunities abroad as well as in Canada.

(27) Agriculture Canada should develop mechanisms to help farmers and food processors take advantage of rapidly emerging niche markets.

The Orphan Animal Drug Program in the United States offers a useful model, provided the necessary consumer safeguards can be ensured. This program is designed to encourage the development of products that would fill a small market niche by giving the producer monopoly rights for a set period.

The challenge to Canadians

The recommendations in this report provide a framework for reshaping agricultural research to meet the needs of a more sustainable agriculture-food system — one that accommodates environmental concerns and is better geared to meet long-term changes in the global environment and shifting economic conditions.

Science and technology offer powerful tools for achieving a more sustainable agriculture-food sytem. But their contribution will not be fully realized until a number of fundamental issues have been resolved.

It is not enough simply to accept sustainable agriculture as a broad policy goal. Canadians as a whole must decide what kind of agriculture they really want and what kind of countryside they want to maintain: should agriculture be designed primarily to meet domestic food needs and export requirements? Should it be run as a business, irrespective of the social cost? Or should it be the basis for preserving a distinctive way of life and natural habitats? What price is society prepared to pay to support a rural population, and of what size?

The agricultural community must join in debate with the environmental movement and consumers and lead the move to a sustainable future. The alternative is to have changed imposed from without.

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