INQUIRIES For a Sustainable Future

A Decision-Making Approach
to the Study of Selected Canadian Issues

AGRICULTURE AND AGRIBUSINESS

The Search for Sustainable Food Production

We must feed the world today, but we must feed the Earth — its soil, water, plants and animals — so that we can continue to feed the world tomorrow.

To Feed the Earth: Agro-Ecology for Sustainable Development,
by Michael J. Dover and Lee M. Talbot

Learning for a
Sustainable Future

AGRICULTURE AND AGRIBUSINESS

Agriculture involves the cultivation of crops and the raising of livestock for food, the most basic of human needs. Farmers, the first ecologists, understood the interaction of soil, water, grasses and trees; they understood the need to work with nature to produce sufficiency or abundance, and to try to avert scarcity in times of drought or pestilence. Agriculture dictated the survival and development of societies, and security in food allowed the growth of modern industrial states.

In today's interdependent and technological world of global markets and distribution systems, agriculture has become an essential element of national and international economies. Food is a commodity for trade, and food security is a matter of global concern. The future security of the world's food supply has focussed international discussion on one over-arching question: Can agricultural systems meet the demands of a rising world population and expanded expectations on the one hand, and deal with the deterioratation of land and soil resources on the other?

Many scientists today believe that modern agricultural practices, which have increased efficiency and production to an extent unknown in history, now appear to be exhausting the agricultural ecosystem. A movement towards more sustainable agricultural practices has begun. On the other hand, agribusinesses point to new science and technology based on genetic engineering and other methods that may revolutionize the food industry.

Canada, rich in resources, has always been a major exporter of food. Canadians, like other societies, have seen farmlands and farm communities as part of their environmental heritage, national identity and culture. But in today's world of supermarkets, fast foods and freezer containers, where food is available to all who can afford it, many urbanized Canadians have lost the connection between the food they eat and the land that produces it, not recognizing the profound changes that agribusiness has brought to farming communities, the farming way of life and the environment.

In recent years, concerns about pesticide use, biotechnology and other issues have focussed public attention on the quality and safety of food and industrial farming techniques, and spurred interest in alternatives. Resolving issues regarding the sustainability of Canadian agriculture will involve a new recognition of the integrity of nature and agro-ecosystems and the wisdom of farming methods in harmony with the local environment, while at the same time utilizing the best national and international science and technology to maintain food security levels and meet the challenge of rising populations and deteriorating land and soil resources.

Canada's strategy for sustainable agriculture demands the thoughtful consideration and decision-making of the Canadian public.

QUESTIONS

1. What is meant by “food security”? Why is it an issue of global concern?

2. What are the main causes of hunger in developing countries? To what extent is this a problem in Canada?

3. Why is agriculture part of Canada’s national identity? Describe your perception of the differences in farm life today and a century ago, and give reasons for changes.

4. Outline the stages involved from the farm to the supermarket shelf of any two of the following:

   - processed cheese or meat;
   - canned tomato soup;
   - milk;
   - frozen TV dinners.

   List some of the jobs involved and summarize the economic importance of agribusiness. What, if any, social or environmental concerns might be considered?

5. What is an ecosystem-organic approach to agriculture? How does it differ from conventional agricultural practices? Is organic farming a reversion to pre-industrial agriculture, impractical in today’s agricultural economy, or a necessary component of agricultural sustainability? Explain your answer.

6. What changes would be needed in government policies, in agribusiness, and in public attitudes to foster the growth of organic farming?

7. Summarize the potential advantages of new agriculture technologies and the major concerns. Are new technologies the whole solution to the world’s food security in the 21st century? Explain your answer. What role should they be given in the search for sustainable agriculture?

8. Evaluate Canada’s agri-food strategy from your vision of the main objectives and components of a sustainable food system for Canada.

BACKGROUND FOR THIS INQUIRY

Readings:

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THE NEED FOR SUSTAINABLE AGRICULTURE (1)

The Global Challenge

It is now widely accepted that the need for seeking strategies for the sustainability of food production, and renewable and non-renewable natural resource use, is beyond question. Although the worse case predictions of human population explosion have not been realized, there seems little doubt that there is already a significant increase in numbers; at least 90 million people are added to the world population annually. Unless there is major international cooperation in addressing the problems associated with population control, it is predicted that the global human population will reach more than 14 billion by the year 2050. The provision of adequate food, fuel and space for such an increased population will be unachievable.

Until the 1980s, global increases in food production exceeded the growth of human populations; however, progressively, agriculture is becoming unable to meet the world-wide per capita needs for food. A significant proportion, particularly in developing countries, does not receive enough calories. These problems are accentuated by factors such as world-wide reductions in soil fertility, the accelerating degradation of land that is suitable for food production through soil erosion, the world-wide trend for migration of human populations from rural habitats to cities, the increasing rates of economic growth and the resultant increased demands for food in developing countries, extremely rapid rates of global deforestation, and industrial pollution.

The Global Need for Sustainability in Agriculture and Natural Resources,
by Clive A. Edwards, Mohan K. Wali,
in *Agriculture, Ecosystems and Environment*, Vol. 46 Nos. 1-4,
Elsevier © Amsterdam, 1993

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. . . there is mounting public concern and increasing scientific evidence that highly intensive production methods, such as the use of chemical fertilizers and pesticides, upon which the gains in output have been based, are resulting in environmental degradation, depletion of the Earth's resources, and threats to human health. . . Increasingly, concern is being raised about whether the resources available to future generations will be able to sustain the type of growth experienced during the last few decades.

Sustainable Agriculture: Economic Perspectives and Challenges,
Summary of a workshop held 6 and 7 May 1991 in Winnipeg, Manitoba
by Ron Thomas,
Science Council of Canada

THE NEED FOR SUSTAINABLE AGRICULTURE (2)

Hunger in the Midst of Sufficiency

It seems that at least once each decade, images of famine in Africa sear themselves onto our consciousness. These images determine and re-enforce our notion of the causes of both widespread hunger and over-population. Peasants with stone-age implements tend scrawny crops on dry, thin, windblown, semi-desert soil, and hordes of vacant-eyed children from overlarge families fill refugee camps. Yet another drought in a drought-plagued region seems to have pushed a population over the edge, from mere subsistence to starvation and environmental disaster.

When we first think about world population and hunger in such contexts, it seems obvious that the connection between the two is that hunger arises because populations are too large for their food supply. But simple observation indicates the need to go beyond such superficial analysis.

Throughout Africa's periods of drought and famine, that continent has been able to increase the rate at which it has produced export crops. While peasants die of starvation in Ethiopia, large international firms there produce alfalfa for export to Japan, where it is used to feed cattle.

Millions in India are still malnourished, yet the country is now an exporter of food. Indeed, the fact is that poor countries, even in the worst of famines, have always produced enough food to feed their people, if the food were evenly distributed. The simple idea — too many people, too little food — is simply not tenable.

Hunger and population are indeed linked, but not in the simple way suggested above. Widespread hunger, low food production, and rapid population growth do, however, have a common cause: the structural poverty of the majority of people in the Third World.

World Hunger and Population,
by William Murdoch,
in *Agroecology*,
C. Ronald Carroll, John H. Vandermeer, Peter Rosset, eds.,
McGraw-Hill, Inc., 1990

THE NEED FOR SUSTAINABLE AGRICULTURE (3)

Questions About the World's Food Security

Pesticides and fertilizer pollution continue to provoke serious concern. Poisoning of farm workers, contamination of food and water supplies, destruction of wildlife and fisheries, and pests' resistance to pesticides all contribute to a global awareness that agricultural chemicals can no longer be overused and misused. Coupled with chemical dependence is a growing reliance on fossil fuels to run the world's major agricultural production systems. Can world agriculture afford to depend on a diminishing resource that, despite current oversupply, is inherently limited? Can any nation's food security be assured if its soil fertility relies heavily on nitrogen fertilizer derived from fossil fuels? Can increasingly mechanized farms continue to function smoothly if fuel prices and supplies are unpredictable? These issues and others — such as deforestation, genetic erosion, and depletion of soil fertility — have prompted some in the international development community to address not only the productivity but the sustainability of agricultural systems. . .

Considering sustainability in agriculture is essential because, regardless of short-term gains, productivity without sustainability is mining. Today, at the same time that energy conservation and other economizing measures are being introduced to conserve and recover such non-renewable resources as fossil fuels and minerals, such so-called renewable resources as water, soil and forests are being depleted at alarming rates. Record crops produced at the expense of the next year's or the next decade's soil resource are nothing to be proud of, whether in the United States or anywhere else. If agricultural and development institutions fail to address the sustainability of current or future farming practices, they will be doing a disservice to the very people they are trying to help.

Clearly, the productivity of the land must be improved. Even if the most conservative estimates of population growth prove true, fertile land is so limited that productivity of existing agricultural areas will have to increase to meet ever-growing needs. Both crop yields and cropping intensity must rise. But where? Certainly, current crop surpluses in the industrialized world can be used for emergency food aid if funds are available. However, because poor nations cannot pay for continuing food imports in the long run, production increases in North America or Europe can do little to prevent chronic malnutrition in Africa, Asia and Latin America. Instead, productivity must be improved where the food is needed. Small holders and tenant farmers must be able to feed their own families and generate modest surpluses, and commercial farms should be able to employ the landless, sell produce at affordable prices to those who need it, and turn reasonable profits. However, these goals must be met without depleting soil, water and the other natural resources on which continued agricultural productivity depends.

To Feed the Earth: Agro-Ecology for Sustainable Development,
by Michael J. Dover and Lee M. Talbot,
World Resources Institute, 1987

THE NEED FOR SUSTAINABLE AGRICULTURE IN CANADA (1)

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. In Canada, perhaps one per cent of plant species are at serious risk, and up to ten per cent are at some risk. 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. Some 20 million hectares of food-producing land are abandoned each year because of water logging, salinisation, or alkalization of soils. In the Canadian Prairies, for example, salinisation 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;

- 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. 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.

Sustainable Agriculture: The Research Challenge,
Science Council of Canada, Report 43, July 1992

THE NEED FOR SUSTAINABLE AGRICULTURE IN CANADA (2)

The Changes in Today's Agriculture 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. . .

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.
- Seven per cent of farms account for half of all farm sales; 26 per cent of farms generate three-quarters of all sales.

  . . .
- During the last 10 years, total farm debt has exceeded the annual value of cash receipts. In the same period, 4 258 farmers went bankrupt — more than one a day.
- 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.

  . . .
- 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.
- 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.

  . . .

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. 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.

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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.*

Sustainable Agriculture: The Research Challenge,
Science Council of Canada, Report 43, July 1992

TWO APPROACHES TO AGRICULTURAL DEVELOPMENT

Balancing Traditional and Modern Systems

Scientists and others concerned with agricultural development tend to see technology from one of two ends of a spectrum, at one extreme are those who maintain that the land's productivity can be increased only by introducing high-input and mechanized technologies based mainly on fossil-fuel energy, inorganic fertilizers, and chemical pesticides. At the opposite end from this "industrial" approach are advocates of an "ecological" approach — the development of more efficient low-input agricultural systems based on biological recycling of energy and chemical nutrients and reliance primarily on naturally occurring control mechanisms for crop protection.

. . . [The] industrial model is principally concerned with the flow of materials and money through the system. Its key measures are productivity . . . and economic efficiency . . . and it requires considerable capital investment, infrastructure development, and extensive training of farmers.

The ecological approach considers cycles as well as flows in the system, and maintenance as well as productive functions. Its performance criteria are cycling rates, stability measures, and energy efficiency. . .

There is a place and a need for both approaches in world agriculture today, and much middle ground between them. Both can benefit from improved plant varieties, though each may select different characteristics and deploy improved strains differently. Both can effectively use methods of soil, water and energy conservation, even though each approach will find different costs, risks and benefits affecting the choice of specific techniques.

Advocating the wholesale abandonment of industrial agriculture would be inviting catastrophe. However, that set of technologies has worked best under economic, social and ecological conditions unlike those in large areas of the developing countries . . . Often the productivity of the industrial approach has been achieved at the cost of an increasingly high energy subsidy and the depletion of soil, water and other essential resources.

Few agriculturalists still want all vestiges of traditional farming practices replaced with "modern" methods. Many scientists and others now recognize the inherent practicality in much indigenous agriculture and the need to preserve both the knowledge and the valuable genetic materials embodied in these farming systems. But — under the pressure of increasing populations, migration, and cultivation of inappropriate lands — traditional agriculture is now a major contributor to environmental degradation in developing countries. Because yields in many traditional systems are low, pressure to clear new land for farming continues to increase.

As industrial methods have been imported and adapted to developing countries, food production has increased dramatically where conditions have been right. However, attempts to transfer such

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technologies to farmers operating in less-than-ideal circumstances fail or even make things worse: yields drop after a short time, and soil erosion and other environmental degradation accelerates.

The growing need for a productive and sustainable agriculture calls for a new view of agricultural development that builds upon the risk-reducing, resource-conserving aspects of traditional farming, and draws on the advances of modern biology and technology. Key to this view — which is needed not only in the Third World but also to make farming in the industrialized countries more resource-efficient and environmentally sound — is a thorough understanding of agriculture's ecological underpinnings.

To Feed the Earth: Agro-Ecology for Sustainable Development,
by Michael J. Dover and Lee M. Talbot,
World Resources Institute, 1987

SUSTAINABLE AGRICULTURAL ECOSYSTEMS (1)

Sustainability means that the resources called upon, or used, are renewed by the very process that calls upon them. To be sustainable, the system must also be basically organic, that is, based on what occurs within the local ecosystem naturally, not dependent on externally produced inputs or support systems such as chemical fertilizer or “crop protection” materials (chemically or biologically fabricated agro-toxins), whether produced locally or brought into the bio-region from outside sources. It means relying on the natural systems that have evolved over very long periods of time, during which organisms and components have interacted and reproduced on a continuing basis without dependency on foreign or imported inputs, including engineered genes.

To describe a self-reliant food system as organic is simply to observe that what is non-organic (that is, introduced from outside the natural cycle) generally does not contribute to the health of the organism. The human body has to filter out and dispose of all the foreign matter that is introduced into its nutrient intake for purposes other than to feed the body. If crops are sprayed with an insecticide that leaves a residue, the human body has to cope with the result of an intervention made in order to make the production of the crop more profitable, but not more sustainable or more nutritious.

From Land to Mouth: Understanding the Food System,
by Brewster Kneen,
NC Press Ltd., 1989

SUSTAINABLE AGRICULTURAL ECOSYSTEMS (2)

An Ecologist's Perspective

By definition, sustainability refers to the long-term endurance of a system. The essential feature of ecological sustainability is the preservation of nature — that is, the plants and animals, as well as the soil, air, and water on which all organisms depend for sustenance. Any sustainable agriculture must endure indefinitely without depleting its ecological support base. This means that a sustainable agriculture must retain and build soil, and it must be maintained without a dependence on finite fossil fuel supplies and synthetic chemical inputs.

To incorporate the concept of ecological sustainability into agriculture, then, requires a fundamental shift from the economic perspective that has guided scientific agriculture for the past hundred years or more. The ecological perspective differs with respect to both the complexity of factors involved in the system and the long time-frame of consideration. Whereas the ecological perspective appreciates the complexity of natural ecosystems, the traditional economic/scientific approach attempts to simplify agroecosystems . . . A holistic, long-term perspective is simply more appropriate to biological systems and essential for gaining an understanding of sustainability in agriculture.

The kinds of questions ecologists ask about natural ecosystems reflect the differences between an ecological perspective and the modern agricultural perspective. Ecologists ask how ecosystems function, how they are sustained by sunlight, how species interact and coexist, and how energy and materials circulate within and between adjacent ecosystems. A move toward a sustainable agriculture implies that similar questions ought to be asked about agroecosystems. Researchers should be attempting to understand the functioning of agroecosystems rather than simply trying to manipulate that functioning. They should be asking how to make agroecosystems function more on sunlight and less on fossil fuels. They should investigate whether some crops might grow better together rather than alone in certain cases. And they should be trying to obtain efficient circulation of energy and materials within agroecosystems. . . A holistic approach involves examining agriculture at the whole farm or ecosystem level. For example, it may include looking at nutrient inputs and outflows, overall farm biological stability, and changes in the soil over time. By looking for overall patterns that work, this approach attempts to incorporate complex natural relationships into agriculture without first taking them apart and looking for cause-and-effect relationships. Rather than perfecting one crop at a time, the holistic ecological perspective suggests seeking out a collection of plants and animals that work well together.

Farming in Nature's Image, An Ecological Approach to Agriculture,
Judith D. Soule and Jon K. Piper,
ISLAND PRESS, 1992

RE-LEARNING FARMING IN NATURE’S WAY (1)

The Organic Farmers’ Perspective

All organic farmers begin with the idea that healthy crops are the result of a well-nourished and properly cultivated soil which is, in turn, our basic food-producing resource. The elimination of pesticides is only one part of their approach to farming. They concentrate most of their attention on soil improvement; often they will add organic matter to their soil, in the form of composted residues of plant material and animal excretions which break down to form the rich, dark soil known as humus. This material nourishes crops; it also feeds soil micro-organisms and earthworms which, in turn, add more organic material to the soil. A handful of this rich, porous soil will crumble easily in the fingers; it holds water well and allows new seedlings to emerge quickly. Some farmers put added nutrients into the soil by planting “green manures” — fields of nitrogen-rich crops such as clover or alfalfa which are then plowed back into the soil. This technique also prevents soil erosion: until they are plowed under, these plants hold soil in place and act as a buffer against wind and rain. Over time, such consistent feeding of the soil assures the farmer that well-tended fields will remain productive for the next generation to work the land. While soil nutrition has been basic to agriculture from the beginning, we may be the first generation to have to re-learn the simple rule-of-thumb that asks farmers to put back what they take out of the soil. . .

Bart Hall-Beyer and Monique Scholtz farm fifty-three hectares of land. . . He [Mr. Hall-Beyer] explains that every aspect of the operation is part of a closed system which recycles nutrients and waste products to create new crops and feed livestock. Like many organic farmers, he saves manure from livestock, which is composted with other organic waste products and fed back into the soil. By contrast, the operator of a conventional farm may run a one- or two-crop “factory” or a large livestock feedlot. In the case of field crops, chemical fertilizers have to be purchased off the farm since there is no livestock to provide manure. Hog operations or cattle feedlots have the opposite problem; the manure runoff can be so large that it can pollute nearby streams and lakes — along with the farm chemicals leaching out of the soil. . .

While the approach may seem old-fashioned to some, there is no longer much doubt that it works. The case for a more “sustainable” style of agriculture got strong public support in 1980 when the United States Department of Agriculture released a major study on organic farming. It viewed “sustainable” farming as the practice of long-term soil improvement techniques, used to produce healthy crops without the use of chemical fertilizers or pesticides. . . However, the report made it very clear that today’s organic farmer is not trying to return to the agriculture of the 1930s. It is a point that needs repeating, because these farmers still suffer from a “hippie” back-to-the-land image. They do not reject modern farm machinery, but organic farmers are more likely to think that the use of technology has limits. . .

Organic farmers have a better chance of getting a fair price for their products because they do not usually deal with the giant corporate middlemen who normally get the largest share of the food

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profits. Organic farmers market their food individually or as part of a small group or co-op, and while this system has its limitations, it has allowed access to a specialty market which includes fine restaurants, health-food stores and local grocers. One grower remarked that her local grocer will pay premium prices for her vegetables because he sells them all and never takes a loss. It is also common for some smaller farms to do a custom business for rural neighbours and city people who place direct orders for eggs or livestock. Others make money selling at the farm gate. In British Columbia, organic food co-operatives buy from farmers who can also sell to markets in Washington State; the Canadian Organic Producers' Marketing Co-op in Saskatchewan is working to develop markets for their organically-grown grain. Similar farm co-ops operate in the Maritimes, and in Quebec's Eastern Townships, a small association of farmers sells to a U.S. wholesaler who has a good market for lettuce and spinach which cannot be grown in the hot summer climate of the southern states. Not all organic produce ends up with an "organic" label in a specialty store. In Ontario, some growers end up selling their produce through the Ontario Food Terminal, the province's major food wholesaler for shops, supermarkets and restaurants — a bonus for the buyer who may randomly select produce grown without chemicals. . .

Down to Earth: The Crisis in Canadian Farming,
by Carole Giangrande,
Anansi, 1985

RE-LEARNING FARMING IN NATURE'S WAY (2)

The Example for the Future?

Many family farmers have been sold a set of ideas and values which have damaged the enterprise of farming in this country. This includes the belief that today's farmer can only survive if he treats the farm as a capital-intensive industry which consumes resources without replacing them. A more sustainable form of agriculture is bound to help the family farmer who stands a better chance of making a good living by cutting costs. It is even possible that the hardships farmers are facing now may accelerate the process of change to organic techniques. Ken McMullen, the President of Canadian Organic Growers, is convinced that "in twenty to fifty years, you will see [organic farming] on every farm in North America". Whether or not this eventually occurs, a network of small-scale ecological farmers is now beginning to develop across Canada. Even if their numbers remain small, they are starting to create an alternate agricultural system which could have a considerable impact on food consumption. By increasing the demand for locally-grown food, organic farmers can help create regional markets. A demand for local products will help farmers develop distribution systems, allowing them to compete with imports. While proponents of large-scale agriculture argue that organic farming threatens the food supply, more lethal dangers to our food system may come from our growing dependency on imports to feed ourselves. Eventually, these options may include urban agriculture, which is already being practised in certain areas of the country.

Many of Canada's organic farmers believe that the future will prove the value of their work. It is for this reason that they do not vociferously oppose the techniques of their farm neighbours. They speak about farming as a way of life, a business, a stewardship of resources, a skilled craft, a practical science and an art. They do not see it as an industry, but they do not spend time arguing with those who do. "We are not here to protest," said one organic grower recently. "We are here to set an example. We are the future."

Down to Earth: The Crisis in Canadian Farming,
by Carole Giangrande,
Anansi, l985

THE VALUE OF INDIGENOUS KNOWLEDGE IN THE SEARCH FOR SUSTAINABLE AGRICULTURE

The study of traditional agriculture is not new. Anthropologists have been studying indigenous agricultural societies and systems for more than a century over a wide range of geographic regions.

The benefits derived from studying these systems are twofold. First, as change occurs in the Third World in the face of inevitable agricultural modernization, knowledge of the traditional cropping patterns and management practices and of the ecological rationale behind them is gradually being lost.

Second, ecological principles extractable from the study of traditional agroecosystems can be used to design new, improved, sustainable agroecosystems in industrial countries and thus correct the many deficiencies affecting modern agriculture. Traditional farming systems have emerged over centuries of cultural and biological evolution and represent accumulated experiences of interaction with the environment by farmers without access to external inputs, capital, or scientific knowledge. Such experience has guided farmers in many areas to develop sustainable agroecosystems, managed with locally available resources and with human and animal energy. Most traditional agroecosystems are based on the cultivation of a diversity of crops in time and space, allowing farmers to maximize harvest security under low levels of technology.

Indigenous knowledge about the physical environment is often very detailed. Many farmers throughout the world have developed traditional calendars to control the scheduling of agricultural activities.

A salient feature of traditional farming systems is their degree of plant diversity. In the Andes, farmers cultivate as many as 50 potato varieties in their fields and have a four-tiered taxonomic system for classifying potatoes, which is important in the selection of different potato varieties. Similarly, in Thailand and Indonesia, farmers maintain in their paddies a diversity of rice varieties that are adapted to a wide range of environmental conditions.

As more research is conducted, many of the farming practices of peasants, once regarded as primitive or misguided, are being recognized as sophisticated and appropriate. Confronted with specific problems of slope, flooding, droughts, pests and diseases, low soil fertility, etc., small farmers throughout the world have developed unique management systems aimed at overcoming these constraints.

The strength of rural people's knowledge is that it is based not only on acute observation but also on experimental learning. The experimental approach is very apparent in the selection of seed

varieties for specific environments, but it is also implicit in the testing of new cultivation methods to overcome particular biological or socioeconomic constraints. Farmers often achieve a richness

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of observation and a fineness of discrimination that would be accessible to Western scientists only through long and detailed measurement and computation.

Despite the onrush of modernization and economic change, a few traditional agricultural management and knowledge systems still survive. These systems exhibit important elements of sustainability — namely, they are well adapted to their particular environment, they rely on local resources, they are small-scale and decentralized, and they tend to conserve the natural resource base.

Industrial countries have much more to learn and will probably benefit more from the study of traditional agriculture than will the developing countries where this knowledge still exists. Indeed, it is expected that the challenge for sustainable-agriculture research will no longer be a one-way "technology transfer," but that innovations and insights will flow between the industrial and developing countries.

Why Study Traditional Agriculture?
by Miguel A. Altier,
in *Agroecology*,
C. Ronald Carroll, John H. Vandermeer, Peter Rosset., eds.,
McGraw-Hill, Inc., 1990

THE ROLE OF SCIENCE AND TECHNOLOGY IN THE SEARCH FOR SUSTAINABLE AGRICULTURE

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.

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. . .

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 — 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 food conversion efficiency could play major roles in boosting agricultural productivity in the 21st century. But these processes will undoubtedly face hurdles in gaining public and political acceptance.

Sustainable Agriculture: The Research Challenge,
Science Council of Canada, Report 43, July 1992

BIOTECHNOLOGY: THE "FOOD REVOLUTION"

Six giant agrochemical corporations are poised to dominate world food production with genetically engineered food. The result could be millions of farmers unemployed, poor countries losing whole export markets, a consumer revolt in Europe, and concentration of farming in fewer hands.

The scale and speed of the food revolution gathering pace in the United States is surprising governments, industry and analysts. The companies claim that more than 20 million acres [12 150 000 hectares] of genetically engineered crops have been planted this year, more than three times as many as in 1996 and ten times the acreage of 1995. "The market is expected to double again next year," said a spokesman for Monsanto, the chemical and biotechnology firm. In Britain, trial crops have been grown for several years and the first commercial releases of genetically engineered seeds are expected to be approved by the European Union early next year.

The eight billion dollar investment by American-based Monsanto, with international conglomerates Novartis, Agro-Evo, Dupont, Zeneca and Dow behind it, raises questions of corporate influence on governments. The drive to push genetic engineering has involved heavy lobbying of trade organizations, regulatory bodies, law-makers, the media and consumers. The companies claim that the new technologies are environmentally friendly and will lead to health benefits, an end to world hunger, and reduced use of pesticides. "There is no crop or person that cannot benefit. There is a tide of history turning. You can look back, or ask how you are going to feed the world," Monsanto said.

However, international consumer groups advise caution and say that scientific, ethical and social concerns are being swept aside. "Scientists and industry are making decisions on behalf of consumers with minimal public debate," said Julie Shepherd of the Consumers Association.

. . . The United Nations International Labour Organization [ILO] predicts that the food revolution will be established globally within ten years, with enormous consequences. Agriculture represents 65 per cent of the global economy. The United Nations Food and Agriculture Organization [FAO] expects great social and economic changes. "It is not possible to hope that there will be job creation with the new technologies," a spokesman said. "It will fundamentally affect farming everywhere and play a large part in the future of the poorest."

The McKinsey Business Quarterly report says, "the world is about to witness a revolution. The science is now in the hands of large, well-funded, agricultural, chemical and pharmaceutical giants which are poised to move from a handful of products on the market today to a full menu in five years' time. Biotechnology is revolutionizing the food chain." . . .

A $400bn Gamble with World's Food,
by John Vidal and Mark Milner,
The Guardian Weekly, December 21, 1997

BIOTECHNOLOGY: THE FOOD REVOLUTION

THE CASE "FOR"

We shall not be far into the next millennium before we realize that much of the current angst over genetically modified food was unnecessary. If research and development are allowed to continue, the products will be there for all to appreciate. New varieties of rice and other crops, resistant to insects and disease, will have replaced those cultivated today. Farmers will no longer lose substantial proportions of their harvests. The impact of these advances will be felt in less developed countries. Health benefits will also come from plants genetically engineered to be more balanced nutritionally than those that have evolved through natural selection or been bred by traditional methods. The potential medical spinoffs from plant biotechnology are considerable. A new generation of more potent vaccines, many against illnesses for which no vaccines have been available, will be grown in plants such as maize and bananas. Malnutrition could be banished. Biotechnology can improve efficiency of food production and generate more nourishing crops. Throughout the world, gardeners, vegetarians and consumers will benefit from plant varieties resistant to spoilage, foods which reduce our dependence on animals, and cheaper and/or tastier products.

We should not, however, overlook potential hazards in altering our diet by genetic engineering. As with all other applications of science to human welfare, biotechnology is likely to have risks. Mistakes will probably be made. Nevertheless, any analysis of the new techniques for ferrying genes between plants must surely conclude that they are being applied and controlled more stringently than any technology ever before. Nearly 25 years ago, when scientists first learned to combine DNA from different sources, commentators warned of the iniquity of "opening Pandora's box". Among their horrific forecasts were unstoppable epidemics and worldwide pestilence. None of these has come to pass, partly because genetic manipulation has not proved inherently dangerous. In addition, regulatory committees (many with public representation) have been set up to ensure that experiments are conducted in appropriately safe conditions. The regulators' task . . . is to consider risks that could come to light later. Will a gene, introduced into rape to protect it against virus attack, also make the pollen grains more likely to cause hay fever? All proposals have to survive positive vetting of this sort before they are sanctioned.

Genetic engineering is far more precise — and thus predictable — than the gene movements which occur in nature. When plants fertilize and cross-fertilize in the wild, large numbers of genes are transferred in a haphazard fashion. Biotechnology allows individual genes to be moved with precision from one plant to another. It is much easier to know how one gene will work in its new setting. The likelihood of unexpected consequences, and the margin of error, are correspondingly reduced. . .

Genetic Seeds of Hope — or Despair,
by Dr. Bernard Dixon*,
The Guardian Weekly, January 4, 1998

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* Dr. Dixon is a member of the European Federation for Biotechnology's task group on public perception, and editor of the journal, *Medical Science Research*

BIOTECHNOLOGY: THE FOOD REVOLUTION

THE CASE "AGAINST"

. . . Today, long before the science of molecular biology has matured, global corporations have rushed to the market applying the tools of genetic engineering to whole systems of agriculture and food production. Genetically engineered crops and goods are already being launched by big companies bent on taking over agriculture. Profits are being privatized by patenting seeds, and safety concerns are not being addressed in the industry's drive for profits. The industry, which is speeding an immature technology onto the market, operates double standards. It declares an organism "novel" when it wants to claim it as property, and as "natural" when it wants to avoid the responsibility of risk.

Commercial applications of organic engineering are a large-scale experiment being carried out on nature and people. Risks associated with laboratory experiments do not provide proper lessons for safety of commercial use of genetically engineered organisms designed to survive in the environment. The risk of genetic engineering in agriculture has to be assessed in the context of its use on a huge commercial scale. The commercial growing of genetically engineered crops and micro-organisms has only just begun. We cannot justify taking the results of small-scale experiments in laboratories and extend those to complex ecosystems. Field tests for safety and risk assessment only look at the plants and are not designed to look at what happens to surrounding environments where commercial crops may be grown.

Genetic engineering is not a precise science. It is a highly uncertain technology. The ability to move individual genes is not equivalent to knowing how the transgenic organism will behave. Gene transfers lead to unpredictable outcomes because plants and organisms are continually changing. One micro-organism, *Klepsiella planticola*, which was recently genetically engineered to digest agricultural waste and convert it to ethanol, was found to destroy crops and soil, fauna and flora, thus threatening the very basis of agriculture instead of providing a solution to disposal of agriculture byproducts.

Genetic engineering threatens to destroy millions of peasant livelihoods in the Third World. Tropical crops such as sugar cane, coconut, vanilla and cocoa can be grown anywhere with genetic engineering. Whole industries in developing countries may disappear. The most popular argument used by the biotechnology industry is that without its genetic engineering the world will starve. The industry promises an increase in crop yields of 10 to 15 per cent but data shows that small farms which base their agriculture on many different sorts of farming can be five to ten times more productive per unit than large mono-cultural farms. Land reform is a safer and more equitable route to food security.

Genetic Seeds of Hope — or Despair,
by Dr. Vandana Shiva*,
The Guardian Weekly, January 4, 1998

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SCIENCE, TECHNOLOGY AND VALUES

It is important to acknowledge openly that values and beliefs do indeed influence technology and the science that supports and develops that technology. For a more specific example of how values influence science and technology, consider for a moment the values today's food crops reflect. Crops dependent on herbicides to deal with weeds speak of the value placed on economic efficiency rather than environmental safety. Perfect winter produce in the supermarkets of the Northern states is a tribute to the emphasis on cosmetics, aesthetics, and comfort over humane treatment of the poor in Latin America and fair distribution of resources. A change in crop characteristics to a set more compatible with sustainability requires a simultaneous change in the values held by society.

In an interconnected world, a little neglect goes a long way. One thing done wrong can have ramifications throughout the system. But one thing done right can solve several problems at once. An obvious example is the wide-ranging consequences of pesticide use. The costs associated with these are simply not included in the price tag of the products. Yet, eventually, someone pays. When overuse of a pesticide results in resistant pests or new pests, farmers pay down the line in the form of higher pesticide costs to pay for development of new chemicals, or for more chemicals, or in the form of reduced yields. When a farm pesticide escapes into the groundwater, neighbours for miles around pay (although unknowingly, oftentimes) in ill health or in costs for new wells, water filters, or purchase of expensive bottled water. When pesticides kill stream fauna, all other species that eat fish suffer in addition to the fishing business. The true costs are diffused across human and wild communities in forms that are not easily traceable or assessable. No one in particular is held accountable for the costs; yet everyone, in general, pays in some way.

This discussion leads to a final point — that of humility, one last essential ingredient in the development of sustainable agriculture. This is the humility that realizes that humans are part of nature, not above it. This humility is expressed by a willingness to listen — by scientists listening to farmers, and to one another, across disciplinary bounds; by farmers listening to new ideas from scientists, as well as remaining attentive to nature and their own experience; by all of us listening humbly and carefully to history as well. This humility requires a willingness to admit to many defeats in the historical struggle with nature — defeats by insects, wind, water, and gravity. It also requires attention to the few success stories — those histories wherein farming has endured as long as human habitation, with no apparent harm done. Studying traditional agroecosystems may be the key to speeding the discovery of agroecological principles that will permit the development of sustainable agriculture throughout the world.

But most importantly, people must learn to listen to nature. After all, nature works. The most essential challenge for humanity is to learn to eat from nature's bounty without destroying it in the process, to find our appropriate niche within nature.

Farming in Nature's Image, An Ecological Approach to Agriculture,
Judith D. Soule and Jon K. Piper,
ISLAND PRESS, 1992

AGRICULTURE IN CANADA

An Overview

The agriculture and agri-food sector accounts for 9 per cent of the GDP. Directly or indirectly, it provides jobs for about two million people — nearly 15 per cent of the nation's employment. The sector generates more than $17 billion in exports and contributes almost $5 billion to Canada's positive trade balance.

Farm production is affected by physical, technological, economic, and social factors. The nature of these factors varies tremendously across Canada, and many diverse agricultural production systems have evolved. The environmental risks of agricultural production also vary significantly as a function of the type of production, the environment in which production takes place, and management practices. Environmental issues related to agriculture and agri-food production include water quality and use; use and management of agricultural inputs (nutrient, pesticides and energy); land use, land management, and soil quality; agroecosystem biodiversity; climate; and air quality.

As the farm sector continues to broaden its environmental approach from farm resource conservation to the effects of its operations on the larger ecosystem, new issues are emerging, largely driven by concern for human health and off-farm environmental effects. Water quality, now the public's greatest concern related to natural resources, is affected by management of soils, manure, fertilizers, pesticides, and other chemicals. Other emerging issues are environmental liability, compliance with provincial requirements for agricultural practices, and international scrutiny of the potential risks associated with agricultural inputs, such as pesticides.

The environmental future of Canadian agriculture and agri-food will continue to be shaped by social and economic forces, including the world's demand for food; commodity prices; federal, provincial and municipal government policies; international trade agreements; technology; and agricultural research. The food- and beverage-processing industry is working to enhance its competitiveness, productivity and export performance. It will be important to ensure that economic progress is accompanied by environmental gains. Also needed is better information on environmental opportunities and risks in the industry. Primary production agriculture will need to increase production on existing crop land to meet the growing world demand for food and non-food products. This will likely mean continued intensification and concentration of production in both crop and livestock commodity sectors, and potentially increased environmental risks. To minimize these risks, agri-food decision makers at all levels will require access to appropriate tools and information.

Agriculture in harmony with nature,
Agriculture and Agri-Food Canada, 1997

A CANADIAN STRATEGY FOR SUSTAINABLE AGRICULTURE

. . . Canada's *Strategy for Environmentally Sustainable Agriculture and Agri-Food Development in Canada*, [was] developed in consultation with many sectoral and interest groups. The strategy focuses on environmental sustainability, aiming to bring understanding of this component of sustainable agriculture and agri-food production up to the level of our understanding of social and economic components. . . The following six principles guided [its] design.

1. Partnerships: We will actively cooperate with our sectoral, government and other partners in our work to promote sustainable agriculture and agri-food production.
2. Integration: We will encourage building environmental thinking into the way decisions are made and business is conducted in Canada — on the farm, in the food processing plant or food distribution centre, and in the government office.
3. Ecosystem approach: We will promote an ecosystem approach to better place agriculture and agri-food activities in the context of the broader environment.
4. Environmental and resource stewardship: We will promote "anticipate-and-prevent" rather the "react-and-cure" approaches to the stewardship and protection of the resource base and the environment.
5. Intergenerational equity: We will strive for a fair distribution of the costs and benefits between generations and encourage environmentally responsible practices today to minimize the environmental liabilities our children might some day have to assume.
6. Competitiveness: We will build on and support a market system that promotes the best environmental practices, clarifying the linkages between environmental sustainability and economic productivity and competitiveness.

Strategic Directions

1. Increasing Understanding: Improve the capacity of departmental and sectoral decision makers to integrate environmental factors into day-to-day decision-making.
2. Promoting Environmental and Resource Stewardship: Promote the stewardship and sustainable use of the environment and agricultural resource base by the agriculture and agri-food sector.
3. Developing Innovations and Solutions: Focus research, development, and technology transfer to address environmental challenges and foster sustainability in the agriculture and agri-food sector.
4. Seizing Market Opportunities: Encourage agriculture and agri-food marketing and trade that promote environmental quality and sustainable growth.

Agriculture in harmony with nature,
Agriculture and Agri-Food Canada, 1997