for the World: The Canadian Experience

Cover — NFB/Phototheque

Agriculture Canada, Saskatoon

Above: Rapeseeds. Clockwise from upper right: **B. campestris** ***— yellow, Torch, Candle;*** **B. napus** ***— Midas, yellow, Tower.***
Cover: Rapeseed in bloom, Beaverlodge, Alberta.

Food for the World: The Canadian Experience

INTRODUCTION

Canada has only three per cent of the globe's arable land, yet it is currently the largest per capita donor of food aid in the world, and its total agricultural exports are the second highest. Its 1976 agricultural trade surplus was over $1 billion.

Both agricultural and fishery resources have played a vital role in Canada's economic growth. It enjoys an efficient agricultural system and a research network that is the envy of most other agricultural nations. Because of its expertise in working with developing countries, it is in a position to play a key role in helping meet the critical world food situation.

Canadian research programs cover all aspects of agricultural practice — from plant breeding to disease and pest control, nutrition and marketing. The development of improved strains of rapeseed, giving Canada both a domestic source of seed oil and an alternative cash crop to wheat, is a conspicuous example of Canadian agricultural ingenuity.

Canada's extensive food aid program started with shipments of wheat to India under the Colombo Plan in the early 1950s. During the last ten years, it has totalled more than $1.2 billion. To foster long-term world food security, Canada is directing more and more of its talents and resources toward development programs aimed at expanding indigenous production in food-deficit countries.

SOME RESEARCH ACHIEVEMENTS

Agricultural research has led to Canada's gaining and maintaining a significant share of the world market in some agricultural products. Canadian wheat, with its consistently high protein level, is in heavy demand as are Canadian genetic animal stocks. Through the use of artificial insemination, the problems associated with exporting animals themselves for breeding purposes have been circumvented.

RAPESEED

One of the most dramatic successes in Canadian agricultural research has been the development of rapeseed, a crop modified by Canadian scientists to improve its chemical and nutritional characteristics. Rapeseed is the largest oilseed crop in Canada, ranking third in production after wheat and barley. Rapeseed oil is the most widely used edible vegetable oil in Canada, accounting for 39.1 per cent of the domestic market. Canada is the top exporter of rapeseed in the world.

The development of rapeseed began twenty years ago. Canada needed a domestic source of vegetable oil other than soybeans, which cannot be grown in large quantities in most agricultural regions of the country due to climatic conditions. During World War II, it was demonstrated that rapeseed could be grown in the Prairies, where it was first cultivated to provide a marine lubricant for ships of the Allied navies.

The first extraction plant for edible rapeseed oil was built in Saskatchewan in the mid-1950s. Since then the western-based industry has expanded from 138,000 acres in 1955 to 6,900,000 acres in 1978.

Scientists from industry, academe and government have reduced the erucic acid and glucosinolates in rapeseed, making its oil desirable for human consumption and its protein meal a valuable addition to livestock feed. The high content in rapeseed oil of erucic acid, a fatty acid less easily metabolized in the body than most others, made it undesirable in the human diet. Through research, the entire composition of the oil extracted from the seed was changed, and over a decade plant breeders from Agriculture Canada successfully developed a rapeseed variety yielding oil with a low erucic-acid content. The first breakthrough came in 1968 with the licensing of the Oro variety. It took Canadian farmers only two years thereafter to switch to growing the new rapeseed. The oil now produced in Canada is no more than 2 per cent erucic acid, and often less — well below international standards, which allow a maximum of 15 per cent erucic acid in rapeseed oil for human use.

Research also overcame problems associated with the presence of glucosinolates, a group of hot-flavoured, sulphur-containing sugars that remained in the meal once the oil had been extracted and adversely affected thyroid gland functioning in some animals. These sugars also affected the palatability and nutritional level of meal fed to livestock.

The seed developed to overcome this problem, Tower, was licensed in 1974. It was also known as "double low" because of its low glucosinolate plus low erucic-acid content. Both domestic and export markets are now open to low-erucic rapeseed oil for human consumption and low-glucosinolate rapeseed meal for livestock feed.

The Canadian conversion to rapeseed varieties with low erucic-acid oil has been completed, and the industry is rapidly moving toward a complete conversion to double-low varieties.

Two species of rapeseed are grown in Canada today: *Brassica napus* or Argentine rape, and *Brassica campestris* or turnip rape. Of the *B. napus* types, the most popular low-erucic variety was Midas, developed at Agriculture Canada's Saskatoon, Sas-

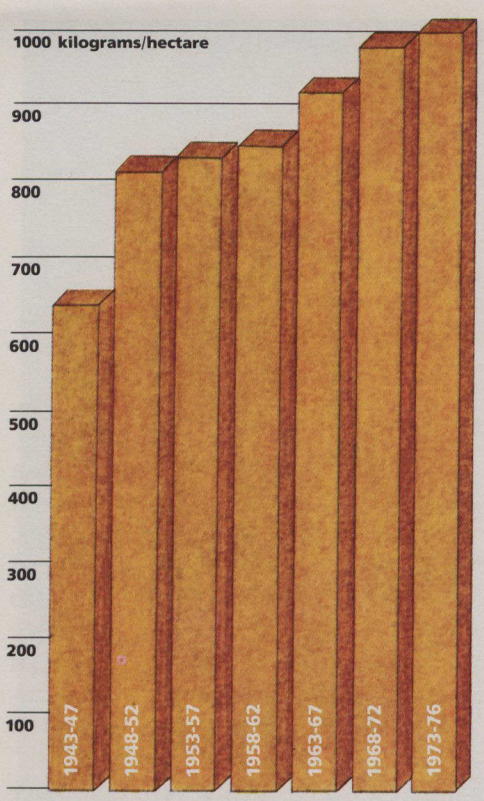


Figure 1: Average rapeseed yield.

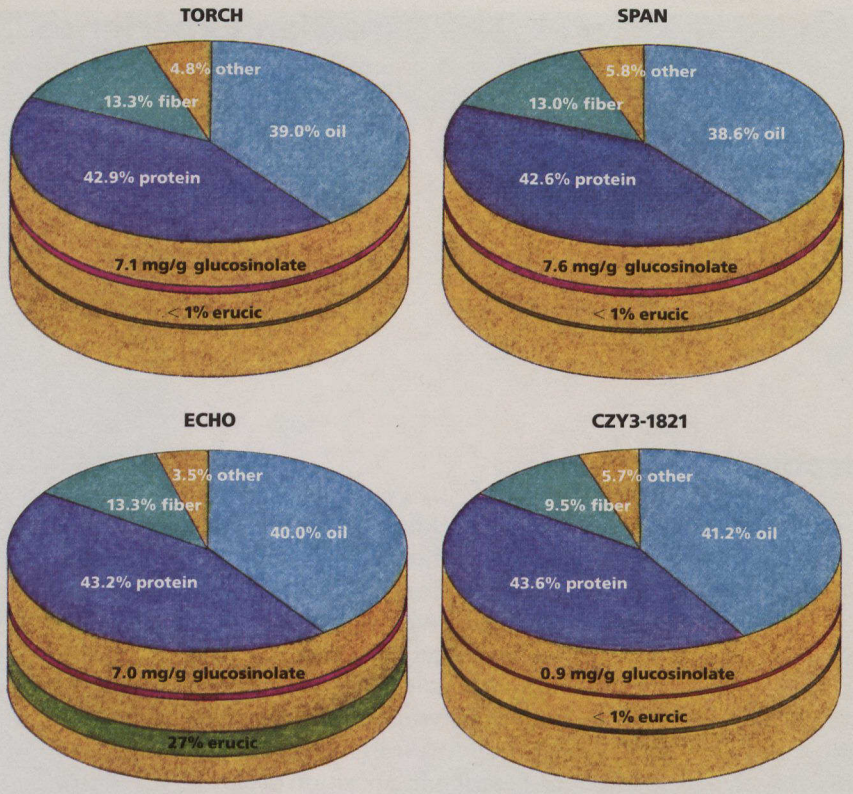


Figure 2: Composition of **B. campestris** *rapeseed varieties.*

katchewan, Research Station and licensed in 1973. Tower, the double-low rapeseed developed at the University of Manitoba in 1974, is now the major *B. napus* variety grown in Canada. The recent licensing of two new, higher-yielding double-low varieties, Regent and Altex, will ensure conversion to double-low rapeseed in the *B. napus* species by 1980. All are particularly suited for production in central Alberta, Saskatchewan and Manitoba.

Of the *B. campestris* varieties, Torch and Span were developed at the Saskatoon Research Station and licensed in 1973 and 1971 respectively. Span was the first turnip-rape variety virtually free of erucic acid in its seed oil.

The *B. campestris* varieties require a two to three week shorter growing season than the *B. napus* ones and are well suited to the Prairie climate, as well as to that of the Peace River area of British Columbia. However, the higher potential yield of the *B. napus* varieties is sufficiently attractive to offset their requirements for a longer growing season wherever achieving maturity is possible.

The yield factor is of great importance in any breeding program. The average farm's yield of rapeseed has increased by 56 per cent since the first five years the crop was grown (1943 to 1947); 40 per cent of this increase has occurred since 1961 (see table 1).

Further developments in the acreage being sown in the early maturing *B. campestris* will determine how quickly a complete Canadian conversion to double-low seed can take place. The first strain, Candle, was commercially tested in 1976 and licensed for contract production in 1977. It is the first with a seed coat that is partially yellow (rather than dark brown or black), a characteristic that accompanies decreased fibre and increased oil and protein content, both important advantages (see table 2). For 1978, experts forecast a tenfold expansion over 1977 in commercial planting and processing of the Candle seed to a total of 226,000 hectares or 560,000 acres. By 1980, production of Candle is expected to be sufficient for both domestic demand and launching an export program.

Canadian rapeseed breeders are now attempting to develop pure-yellow seed forms in both *B. napus* and *B. campestris* species in order to create a marketable product that contains all the desirable characteristics — low erucic-acid content, high oil content, high protein content, low fibre content and low glucosinolate content.

Harvest brand products are produced from rapeseed.

CSP Foods

BRUCELLOSIS

Brucellosis is an infectious disease that causes fetal abortions in pregnant cows. The brucellosis eradication program is the first priority of the Health of Animals Branch of the Department of Agriculture. Although the incidence of this disease has been brought to a low level, it is not eradicated. Until the last traces are completely wiped out, damaging outbreaks can still occur.

Researchers are currently increasing their understanding of the disease process in brucellosis, particularly the immune response in infected cattle. Studies are in progress on the kinds and amounts of antibodies in cattle blood serum at various early stages of experimental brucellosis, as well as in the naturally acquired infection.

Findings from this research are being applied to the development of more-sensitive test procedures, which will detect, at an early stage of the disease, the small number of infected animals that can be missed by current herd-testing methods and remain to spread the disease further.

More than 99.5 per cent of Canada's 250,000 cattle herds are free from brucellosis. The new tests now under development may provide the solution for the other 0.5 per cent.

FOOD SCIENCE AND TECHNOLOGY

Agriculture Canada's research programs, in collaboration with universities and industry, affect food safety, nutrition, preservation, ingredients and processing. The objective of the food research program is to optimize the quality, nutritional value and use of Canadian agricultural products. Research ranges from fundamental studies in biochemistry to the development of better methods for processing food and the use of new nutrient sources for human foods.

The Food Research Institute (FRI) in Ottawa has developed a process to produce rapeseed protein concentrates and, in collaboration with the Canadian Department of National Health and Welfare, is currently studying their biological value. A process to produce rapeseed protein isolate is being researched at the University of Toronto. University of British Columbia researchers are working on methods to make industrial vegetable proteins soluble. An investigation of the potential toxicity of alkali processing of plant protein, carried out at the Université Laval à Québec, includes a study of the effect of proteolysis (the breaking down of proteins into simpler compounds) on the nutritional properties of plant proteins.

Research programs related to meat include (1) a process developed by FRI to evaluate amino-acid content (the basic constituent of proteins) in meat tissue; (2) a method devised by researchers at the Université Laval to measure protein quality in meat; and (3) the testing by Canada Packers of meat and non-meat proteins in mixtures.

Agriculture Canada's meat contract programs have focused on the microbiology of meat. For example, a study underway at the Université du Québec à Montréal is attempting to find ways to block the development of undesirable organisms in meat by injecting non-pathogenic organisms into the meat. A study to develop methods to evaluate the microbial quality of meats is being carried out at the Université Laval.

Dairy product research concentrates on the properties of whey proteins under different processing conditions.

Numerous programs pertaining to fruits and vegetables are devoted to devising improved methods for processing and canning. Others focus on developing new fruit and vegetable products and exploring new ways to use protein from Canadian vegetable products. A study underway at the Lethbridge, Alberta, Research Station is evaluating the protein quality of field beans. In a study of the suitability of fababean as a wheat-flour substitute in various baked goods, it has been demonstrated that in some cases the substitution results in a significant increase in protein level.

NITROGEN FIXATION

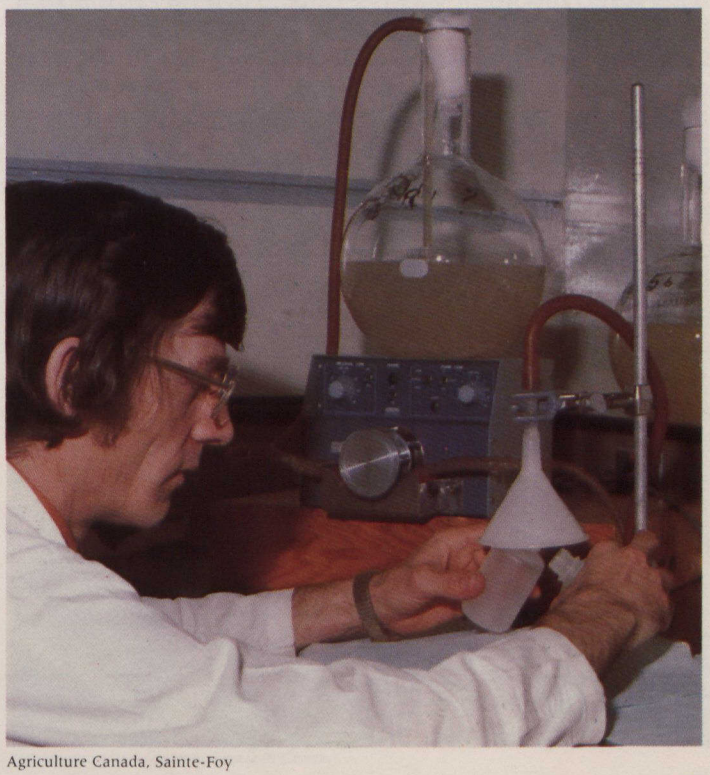
Other areas of research being pursued by Canadian scientists, though not at the applied stage, have a potential for practical results in the future. Research on nitrogen fixation, for instance, may eventually enhance world food supply.

Nitrogen fixation is a bacterial process by which nitrogen from the air is converted into a form the plant can use as a nutrient. Research projects are underway in Canada, as well as in many other countries, to study the possible applications in other crops of the self-fertilizing process that takes place in the roots of such legumes as beans and peas.

The development of cereal crops that can draw on nitrogen in the air to meet an essential part of their fertilizer diets has been a long-time dream of agricultural research. Toward that goal, a group of scientists at Agriculture Canada's Lethbridge, Alberta, Research Station has genetically altered a type of spring wheat so that it supports soil bacteria that can fix nitrogen taken from the air into a plant nutrient.

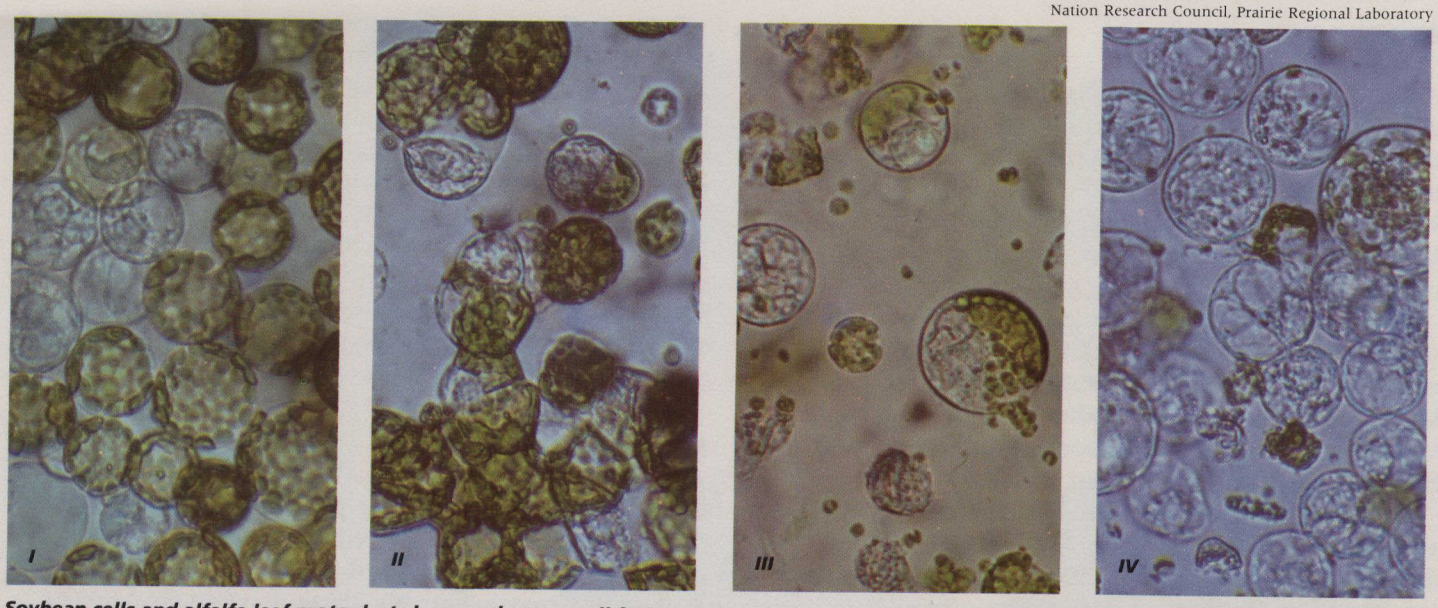
The solution is still a long way in the future. Nevertheless, if lines of wheat can be developed that encourage the growth

Rhizobium BALZAC inoculant, a bacteria used in nitrogen fixation, is prepared at the Agriculture Canada research station in Sainte-Foy, Quebec, where it was discovered.



Agriculture Canada, Sainte-Foy

Nation Research Council, Prairie Regional Laboratory



Soybean cells and alfalfa leaf protoplasts have undergone cell fusion on an experimental basis. Frame I shows the mixed cells; frames II and III, the fusion process; and frame IV, the day-old hybrid cells.

of such bacteria in the surrounding soil, the implications for nitrogen-hungry cereal crops that now depend on chemical fertilizers would be far-reaching.

PLANT CELL FUSION

Scientists are attempting to circumvent nature's constraints on sexual reproduction across species lines through cell fusion, a new technique for producing plant hybrids. Successful fusion could result in an increase in world food production through the introduction of new plant types capable of growing in presently hostile environments.

A group of scientists working at the Prairie Regional Laboratory of the National Research Council in Saskatoon, Saskatchewan, have assumed the leadership role in cell culture research in Canada. They have achieved fusion between widely differing plant species, such as brome grass and pine trees. However, few true hybrid cell formations have been produced, and the identification and isolation of the new cells present a continuing challenge.

Once a new hybrid has been formed, the next, and perhaps most critical task, will be morphogenetic research on the development of the plant to maturity. The group's expertise in morphogenesis already has been called upon by Canada's International Development Research Centre to deal with the mosaic disease afflicting cassava plants, whose food products are a basic commodity for more than 300 million people in the humid tropics of Asia, Africa and Latin America. The scientists cut off disease-free, growing shoot tips of a plant, cultured the cells and induced their growth into mature plants, thus developing a method for providing healthy stocks of the plants.

FOOD AID AND DEVELOPMENT PROGRAMS

As the world's largest grain exporter and as a major source of technical expertise, Canada plays a key role in helping meet the food needs of under-nourished populations, both through direct food aid and through programs to enhance production capacities within developing countries.

Two basic variables affect demand for food: population and income. During the 1960s the world food problem was perceived mainly in relation to population growth, with the focus on the developing nations, and world grain production succeeded in outpacing population growth. In the 1970s rapid global population growth has remained a primary element in expanding food demand. However, rising affluence, accompanied by rising expectations and purchasing power, has created a second claim on world food resources. A doubling of food production will be required by around the year 2000 in order to keep up with the projected demand.

Although future demands for food can be roughly estimated, food production is difficult to evaluate. Unpredictable factors, such as weather, advances in agricultural technology, prices and the market, come into play. Substantial increases in global food supplies will necessitate an accelerated expansion of indigenous food production. Increased food production will require responsible planning, innovative approaches and collaborative efforts among the governments of both developed and developing nations.

Canada is the largest per capita donor of food aid in the world. During the last ten years, Canada's food aid program totalled more than $1.2 billion, and it is expanding. At the World Food Conference in November 1974, Canada pledged an average of one million tons of cereal grains annually for the years 1975, 1976 and 1977. A substantial amount is being channelled through the United Nations World Food Program, which Canada helped develop and to which it has continually increased its contributions.

In addition to wheat, Canada's food aid has consisted increasingly of high protein items, such as dried milk, cheese, fish, rapeseed and rapeseed oil. A new product composed of wheat flour and milk powder has been supplied on an experimental basis to Ghana, Nigeria and Senegal.

Responding to new realities and priorities following the food crisis of 1972 to 1974 and the energy crisis of 1973, the Canadian government reoriented its aid policies in its *Strategy for International Development Cooperation 1975-1980.* The Canadian International Development Agency (CIDA) is responsible for implementing the new strategy, which is targeted

particularly at supporting the efforts of developing countries to evolve their own economic and social systems. CIDA is giving more attention to food production and distribution systems in developing countries, as well as enlarging food aid programs to the poorest among them.

The Canadian Food Aid Program has three parts: bilateral, multilateral and emergency food aid. The major part of the Canadian effort is through bilateral programs. Multilateral food aid has been channelled through United Nations programs, such as the World Food Program, the Relief and Works Agency and the Children's Fund. Foodstuffs provided for emergency relief are given under the International Emergency Relief Vote.

In the last five to ten years, about 50 developing countries have received Canadian help through emergency food aid or through development projects. Canada has provided assistance to improve agricultural production in many of these nations and has made related programs available at several international agricultural centres. The more than 200 projects undertaken in agriculture and food production include supplying fertilizers, researching dryland farming, evaluating water resources and developing wheat farming and storage facilities.

Although major time-limited projects have been undertaken in several countries, the emphasis has been on long-term implementation programs, such as those involving dryland farming in India, agronomic research in Tanzania, wheat breeding in Kenya, agricultural extension in Tunisia, oilseed production in Peru and work on sugarcane for livestock feed in Barbados. Canadian agricultural faculty members have assisted the University of Ghana at Legon, Khon Kaen University in Thailand, the Institut National Agronomique of Morocco and Makere University in Uganda.

Other important Canadian activities in developing countries are carried out through the programs of the International Development Research Centre (IDRC). Established in 1970 by an Act of Parliament, IDRC is a public corporation whose function is to stimulate and fund research in developing countries and to adapt science and technology to meet the needs of such countries. The problems of rural areas receive special emphasis. Five regional offices, located in Bogota, Cairo, Dakar, Nairobi and Singapore, are pivotal to IDRC's operations.

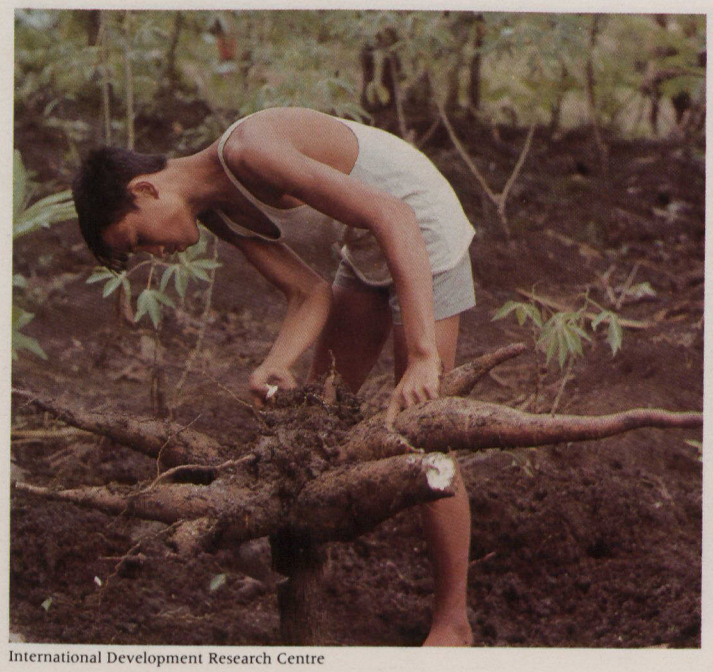
One of the basic goals of IDRC is to help developing regions build their research capabilities and the skills needed to solve their own problems. Researchers from developing countries take responsibility for the identification, design and execution of the research programs financed by IDRC funds.

IDRC's Agriculture, Food and Nutrition Sciences Division, one of five program divisions, had supported 235 projects in 50 countries by March 1977. Of the total appropriations of $47 million since 1971 for the division's work, 34 per cent had been devoted to projects in Asia, 26 per cent to those in Africa and the Near East, and 30 per cent to those in Latin America and the Caribbean. About 9 per cent went for general global and Canadian projects. During the past five years, roughly 50 per cent of the budget was devoted to crop and cropping systems research, 21 per cent to animal sciences, 11 per cent each to fisheries and forestry, and 7 per cent to postproduction systems, such as food preservation, processing, storage, distribution and utilization in the home.

One of the largest and most comprehensive projects that the division has been associated with is the Arid Land Agricultural Development Program (ALAD), financed jointly by IDRC and the Ford Foundation. The ALAD program offers sixteen countries research and training in such areas as breeding and selection of improved sorghums, millets and legumes, as well as in creating a greater awareness of their potential among governments of the region.

Perhaps the largest research program undertaken by the division has been the development of triticale, a new cereal grain resulting from a cross between wheat (triticum) and rye (secale). Started in 1971, the project was a collaborative effort, which included IDRC, CIDA, the Centre for the Improvement of Maize and Wheat in Mexico and the universities of Manitoba and Guelph, Ontario. The purpose of the program has been to produce a highly nutritious cereal grain that would outperform the traditional cereal grains in terms

Harvesting Mukibat cassava in East Java.



International Development Research Centre

Triticale in Ethiopia.

International Development Research Centre

of yield and tolerance of adverse factors, such as sandy or arid soils, high altitudes and low temperatures.

The potential of triticale as a nutritious cereal crop that will thrive on marginal lands under conditions ill-suited to wheat and other major cereals is well on the way to being realized. Triticale yield and selection nurseries have been established in more than 65 developing countries. IDRC is financing cooperative breeding, selection and adaptability projects in India, Ethiopia, Algeria and Kenya.

CHARACTERISTICS OF CANADIAN AGRICULTURE

The Canada Land Inventory subdivides the 13 per cent of Canada designated as suitable for agricultural use on the basis of its production capabilities, given soil and climatic conditions. Fifty-five per cent is rated as useful only for forage or pasture. Although some of the other 45 per cent supports such crops as apples and tobacco, most is suited primarily for growing cereals, the least demanding of all agricultural crops in terms of soil quality and climate.

The climate of the principal agricultural regions of Canada — the prairie provinces of Manitoba, Saskatchewan and Alberta — is varied but generally unfavourable to optimum agricultural production due to the limited availability and poor distribution of moisture and to insufficient warmth. Annual frost-free periods amount to only 90 to 120 days in the Prairies, 160 days along the shores of Lake Ontario and Lake Erie, and 220 days in the coastal areas of southern British Columbia.

Canada's success in the face of these limiting conditions has been possible because of good levels of labour productivity and abundant agricultural capital — machinery, farm building, land improvement and livestock investments.

At the time of the 1976 census, there were 339,000 farm holdings in Canada. The gross income of Canadian farmers was $11.3 billion, and farmers had a capital value of $48.8 billion. Agriculture employed 474,000 persons.

For the 1971 to 1976 period, expenditures on machinery

Harvesting cranberries in British Columbia.

Bill Staley

Prairie wheat.

Canadian National

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Sorting tobacco leaves in Ontario.

Bryce Flynn

Quebec apple orchard.

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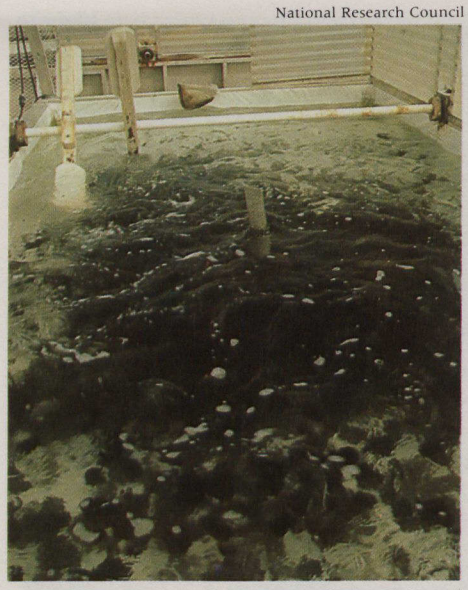
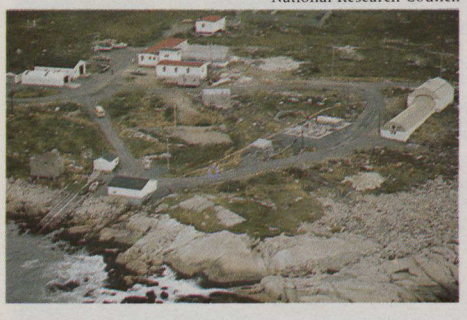


National Research Council



National Research Council

The Sandy Cove Seaweed Culture Station in Nova Scotia (left) is experimenting with the large-scale production of Irish moss seaweed in greenhouse tanks and on sites exposed to normal weather. Seawater is pumped through three sedimentation tanks and a filter before entering the growth tanks (upper left). Paddles keep the water in the tanks moving, a necessary condition if the seaweed is to grow. The cultured plant (above) is darker in colour than the wild one because of the use of fertilizer. Its spherical shape is probably caused by tumbling in the tank.

and equipment, livestock, seed and nursery stock, feed, and fertilizer increased steadily at rates of 15, 10, 23, 18, and 26 per cent per year respectively. In 1976, Canadian farmers spent $1.4 billion on machinery, $1.2 billion on feed and $485 million on fertilizer.

In recent decades, as primary agricultural production has been substantially mechanized, a concurrent increase has taken place in the average size of farms, with small farms being consolidated into larger units. A significant number of fairly large commercial operations have emerged, many of which are still family owned; and farms organized as either partnerships or family farm corporations are expanding in number, as well as in average size, and contribute a large portion of total production. There has also been a trend toward increased specialization, with the number of different products derived from the average farm declining.

A major decline in the number of farm operators has followed these developments. It has occurred largely because retiring farmers have not been replaced, rather than because existing manpower has been displaced.

Since 1951 farm output has increased, in spite of the declining labour force. Productivity per unit of labour in the agricultural sector now exceeds the average of other sectors of the Canadian economy on both a per person and a per man-hour basis. A major contributing factor, in addition to the increased use of agricultural capital, has been a general upgrading of the technical and managerial skills of farm workers, especially owner-operators. The proportion of the Canadian farm-labour pool with some formal technical agricultural training is increasing steadily, and more farmers are gaining the expertise required for modern enterprises.

FISHERIES

Canada's ocean and freshwater fishery resources are an invaluable source of high protein food for Canadians and the rest of the world. The Atlantic, Pacific and Arctic coastlines extend more than 48,000 kilometres, and freshwater lakes and rivers cover more than 647,000 square kilometres. Some 150 species of fish and shellfish live in Canadian waters.

The Atlantic Ocean stretches around the provinces of Newfoundland, Nova Scotia, New Brunswick, Prince Edward Island and Québec. A chain of the world's richest fishing banks runs for nearly 3,220 kilometres from the Nantucket Shoals of New England to Flemish Cap at the eastern-most fringe of the Grand Banks off Newfoundland. Though the area is known for cod, it also has other species of ground fish, including haddock, hake, redfish, pollock and cusk. Flatfish, such as halibut, plaice, yellowtail and flounder, also populate the Atlantic waters, as do lobsters and other shellfish. Herring, mackerel, smelt and Atlantic salmon are numerous. In addition Irish moss and other marine algae have long been harvested by Maritimers.

Salmon predominate off the coast of British Columbia, although sole and other flatfish, albacore, clams, crabs and oysters can be found too.

The inland waters of Canada constitute more than one half of the world's fresh water. Important commercial fisheries in Ontario, the Prairie Provinces, Québec, New Brunswick, the Yukon and the Northwest Territories offer a great variety of fish. Whitefish can be found in all the provinces, and pickerel and trout, in scattered locations.

Fishing is Canada's oldest industry. Though initially abun-

dant, wild fish resources have diminished, and in the past quarter-century the intensive multi-nation exploitation of ocean resources has brought about the establishment of international commissions to regulate the utilization of fish stocks. These efforts did not succeed in curtailing overfishing, and the depletion of stocks led to Canada's extending its fisheries management jurisdiction to 200 miles in 1977.

Planned management of fisheries, through control of fishing intensity, water quality and manpower resources, is important to Canada's effort to assure optimum future fish harvests. Production, protection and utilization of fish and aquatic animals and plants also receive high priority. The target for Canada's fisheries is to show noticeable improvements within five years and be restored to at least 85 per cent of their peak level within ten to fifteen years.

Increased attention has been given to developing alternative fish production and to expanding natural resources. For example, in 1975 the Department of Fisheries and Marine Service, in cooperation with British Columbia, began a major program to restore Canada's Pacific salmon to their historic abundance, double their current level. Proven enhancement techniques, such as artificial spawning channels, hatcheries and fishways, are aimed toward reaching that goal by 1990.

Another program is designed to increase fish production in small Prairie ponds, which can be stocked with trout. A six-month season is sufficient for fish to grow from fry to at least 200 grams with an estimated 86 per cent recovery.

Other programs to determine the scientific principles of fish culturing, particularly in relation to lobsters, salmon and trout, have been developed at the Biological Station, Fisheries and Marine Service, St. Andrews, New Brunswick. In one pilot project scientists use a special cantilevered stacked tank to introduce an automatic feeding system into the larva-rearing phase of lobsters. They hope to eventually produce 1,000 pounds of marketable lobster annually.

Marine plants may one day become an important source of nutrition. At present, algae found in the Maritimes are being studied at the National Research Council's Atlantic Regional Laboratory in Halifax, Nova Scotia. Techniques for the culture of Irish moss have been developed, following successful studies of the chemical nature of carrageenans and their relationship to the plant's life cycle. Carrageenan, a polysaccharide obtained from Irish moss, is used as an emulsifier and sizing ingredient in cosmetics, paint and drugs, as well as in certain foodstuffs. The possibility of growing Irish moss vegetatively on a large scale is currently being tested by two companies at pilot plants.

FOOD PRODUCTION AND INTERNATIONAL TRADE

Canada is the second largest country in the world, with a total land expanse of 998 million hectares, or nearly 2.5 billion acres. Although only 13 per cent of the land is suited to agricultural production, a high level of agricultural productivity and a relatively small population have made Canada one of the few net exporters of food in the world. Canada's agricultural products are shipped to almost every nation in the world. Its primary food exports are grain and oilseed. The value of Canadian agricultural exports increased 140 per cent between 1965 and 1974; exports to developed countries increased 85 per cent, and those to developing nations soared by 370 per cent. Today, between 30 and 35 per cent of Canada's total agricultural output, including 75 per cent of its wheat crop, is sent abroad. It imports fresh fruits

Unloading wheat at Quebec City.

Paul Lambert

and vegetables in the winter and raw sugar, tea, coffee and other foods that are not suited to its climate, year-round.

Wheat is Canada's most important agricultural export. Offshore sales average $2 billion annually, and between 1974/75 and 1977/78, Canada held an average of 13 per cent of world wheat reserves. (The United States held about one third of them during the same period.) Fluctuating Canadian barley exports have averaged 3.3 million tonnes in recent years and accounted for from less than 20 to more than 40 per cent of world trade. Oat exports are small—89,000 tonnes in 1977/78.

In two important oilseed crops, rapeseed and flaxseed, Canada has led the export field in the last ten years, supplying up to 60 per cent of the total world demand.

Canada also leads as a source of fertilizers, which are vital to high-yield agriculture. It is first in world potash production and supplies 7 per cent of all manufactured fertilizers worldwide. Canada exports 80 per cent of its fertilizer output. It must, however, import phosphorus.

Other significant Canadian agricultural export commodities are skim-milk powder, meat and live animals. The leading buyers of Canada's agricultural exports are Japan, the European Economic Community (EEC), the United States, the Soviet Union and China.

Canada is also among the leading fish exporters, sending about two thirds of its total fish production abroad. About 60 per cent of all Canadian fish exports (nearly 40 per cent of total production) go to the United States market, primarily as fresh or frozen products. The remaining 40 per cent, mostly in the form of canned, salted, dried and smoked fish products, go to the EEC, Japan and the Caribbean.

Atlantic fisheries account for more than one half the market value of all Canadian fish. Altogether, 30 different kinds of fish, shellfish and marine mammals are used commercially, the most valuable being lobster and cod. Salmon dominates the Pacific Coast fisheries, representing over one half of the total value, while the most important catches of commercial inland fishing are whitefish, pickerel and lake trout.

RESEARCH PROGRAMS IN CANADA

Canada's research programs seek solutions for current and anticipated agricultural problems in the many soil and climatic zones of Canada. Emphasis is placed on both production and utilization of crops and animals.

There are 1,610 agricultural research scientists in Canada. The total investment in supporting agricultural research is an estimated $175 million annually (equivalent to about 1.8 per cent of Canada's gross farm income). Federal and provincial departments of agriculture, universities and industries share in this research effort.

The Canadian Department of Agriculture conducts more than half of the research and assumes two thirds of the annual cost. It employs 900 professionals from all scientific disciplines and operates a network of 47 research establishments. Seven of these are on university lands. The Research Branch of the Canadian Department of Agriculture cooperates closely with provincial governments, other federal departments (in particular the departments of Environment and of Regional Economic Expansion and the National Research Council), international agencies, farm organizations, agricultural industries and universities.

Specific research programs are designed (1) to determine optimum conditions of soil and climate for specific crop and animal production; (2) to create improved varieties of crops and breeds of animals; (3) to improve crop management techniques and animal husbandry through biological and engineering studies; and (4) to develop new and improved methods for the preparation and preservation of food. A new Crop Development Fund provides up to $1 million annually to help bring new crops, new plant varieties and new management techniques into practical use.

Of particular concern are soil survey and evaluation, biosystematics and protection of the environment. Intensive research programs have been designed to reduce losses caused by disease, weeds and insects. Such protection re-

IDRC-assisted seine netting in Malacca, Malaysia.

International Development Research Centre

Canadian National

Cattle in British Columbia.

search includes controlling crop disease through the use of chemical treatments, resistant germ plasm and cultural practices. Modern research on epidemiology utilizes such tools as electronic data collection equipment and remote sensing. Pest oriented programs have integrated the use of pesticides with other, non-chemical control methods, such as using sex phermones to attract insects. Studies of weed control focus on their ecological characteristics, biological control and the use of herbicides.

Provincial departments of agriculture assume responsibility for reseach concerning their particular interests. The eleven faculties of agriculture in Canadian universities conduct about 30 per cent of all research. Approximately 520 professional man-years are devoted to university-based research. While industry's involvement in agricultural research to date has been limited, it is gradually increasing through efforts by some governmental agencies to contract out needed research.

The National Research Council (NRC) pursues long-term research of special interest to agriculture, such as food research, nitrogen-fixation studies and research on environmental quality. The NRC also helps promote agricultural research in industry and supports such research in universities. The NRC's relationships with provincial research councils and foundations are important parts of Canada's total range of agricultural research services.

Advice and guidance in coordinating this diversity of agricultural research is provided by the Canadian Agricultural Services Coordinating Committee. Under the chairmanship of the federal deputy minister, this committee is composed of provincial deputy ministers of agriculture, deans of agriculture and veterinary medicine faculties at the universities, several senior federal officials and representatives of various national agricultural organizations.

SERVICING FARMERS

Canadian farmers are most interested in income stabilization, which requires stable markets. Legislation and the creation of marketing boards by both the federal and provincial governments have responded to this need. For example, the Canadian Wheat Board, established in the 1930s, handles payments to Prairie farmers and allocates quotas and the export of grains. The Canadian Dairy Commission (a Crown corporation founded in the late 1960s) controls milk production and prices.

Government programs to protect producers against market instability have established floor prices for many products under the Agricultural Stabilization Act. The Agricultural Stabilization Board, which administers the act, seeks an equitable balance between the prices farmers receive and the cost of the goods and services they buy. The board supports prices by buying products at prescribed prices, granting deficiency payments and making direct payments to producers at a fixed rate. The board also provides funds for the dairy industry through the Canadian Dairy Commission. Such funds, along with other Agricultural Stabilization Act payments, amount to about $300 million annually.

FOOD STRATEGY

The federal government's "Food Strategy for Canada" focuses on basic principles by which all Canadians will be ensured adequate supplies of safe and nutritious food at prices that are reasonable to both producers and consumers. The strategy states that the government will actively pursue means to maintain or expand trade in agricultural food products while it continues to recognize the responsibility of Canada to provide food aid to the developing nations.

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