Collaboration for Self-Reliance

Canada's Scientific and Technological Contribution to the Food Supply of Developing Countries

March 1981

Science Council of Canada
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17th Floor
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March 1981

The Honourable John Roberts, PC, MP
Minister of State for Science and Technology
House of Commons
Ottawa, Ontario

Dear Mr. Roberts,
In accordance with Section 13 of the Science Council of Canada Act, I take pleasure in forwarding to you the Council's Report No. 32, *Collaboration for Self-Reliance: Canada's Scientific and Technological Contribution to the Food Supply of Developing Countries*.

Yours sincerely,

Claude Fortier
Chairman
Science Council of Canada

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Preface

Canada is in a unique position to help developing countries with their food problems. In the face of a hostile environment, Canadians have learned how to change a primitive form of labour-intensive agriculture into a highly sophisticated and efficient system. Admittedly, this system is based on a plentiful supply of petroleum-based energy, a high level of capital investment, and an abundance of highly productive land. Although Canadians must continue to adapt technology as these factors change, we have, nevertheless, faced and successfully solved many of the same problems now facing Third World countries. This Report offers recommendations for policy changes in Canada that will increase our capability to help developing countries solve their food-system problems.

Many of our recommendations are not new. Other studies have recognized that Canada's main contribution to the alleviation of hunger is not through food aid, but through the stimulation of food self-reliance in individual countries. Others have also concluded that worldwide food production is not the problem, but rather such things as distribution, storage, and the lack of purchasing power of the majority of the people in Third World countries. The Canadian International Development Agency (CIDA) has stated, and we strongly agree, that rural development is the key to self-reliance. Accordingly, Canada should work with individual countries to help them develop better rural infrastructures.

What is *new* in this Report is our conclusion that Canada's major role is to stimulate and facilitate greater self-reliance in these countries through their acquisition of scientific, management and technical capabilities. This can only be accomplished if Canada itself accords agriculture a high priority: we must expand our own scientific activities and increase our collaborative research in partnership with scientists in Third World countries. If Canada will adopt policies such as those recommended in the following pages, we can look forward both to a lessening of worldwide food insecurity and the prospect of a sustainable and more self-reliant agriculture and food system at home.

This Report is the result of four years' consideration and debate by the Science Council's Committee on Canada's Scientific and Technological Contribution to World Food Supply. The study was undertaken in response to Council's continuing concern about the future

of the agricultural and food system in Canada, and its interaction with the global food system. This work is one in a series of studies that began with Science Council Report 12, *Two Blades of Grass: The Challenge Facing Agriculture*, and continued through Report 16, *It Is Not Too Late – Yet* (dealing with pollution), Report 25, *Population, Technology and Resources*, and Report 27, *Canada as a Conserver Society: Resource Uncertainties and the Need for New Technologies*.

As Chairman of the Committee, I wish to acknowledge the contribution and effort of the members of the Committee, as well as members of Council who provided valuable assistance throughout the course of the study. I also acknowledge, with gratitude, the work of Council's staff. Without the dedication of Charles Beaubien, Suteera Thomson and Andrew McNaughton, this project would not have been possible.

Contributions to the study were also made by many people outside Council: people in Canadian government agencies, the universities, the non-governmental or voluntary agencies, and elsewhere across the country.

This publication is particularly indebted to the background study on universities prepared by Dr. William E. Tossell.[1] It also owes much to the editorial skill of Dr. Frank Kelly.

C.M. Switzer
Chairman
Committee on Canada's
Scientific and Technological
Contribution to World Food Supply

Summary of Principal Recommendations

General

Recommendation 1

Canada should re-assess its response to the global food problem. Direct food aid to developing countries is generally not in their long-term interest, and henceforth should be reserved primarily for emergency conditions. Consequently, Canada should preferentially encourage developing countries to formulate policies aimed at fostering greater self-reliance in food.

Recommendation 2

Canada can best further developing countries' policies for self-development, by helping them – more than at present – acquire indigenous scientific, technological, administrative, and management capabilities.

Canada can assist developing countries significantly by facilitating – on a country-by-country basis – the generation of science and technology and their practical application to food production. At the same time, Canada itself must not become overly involved in implementation: our primary objective should be to act as a catalyst and to provide support.

Recommendation 3

Canada should strengthen its support of the international food-system research network. (See Specific Recommendations.)

Recommendation 4

Federal and provincial governments in Canada, together with the universities, should give increased support to agriculture at the graduate studies level. A greater number of Canadian researchers are needed to further Canada's own research effort as well as for international development.

Recommendation 5

Canada should honour its 1979 pledge at UNCSTD to commit one per cent of its Official Development Assistance (ODA) to involve Canadian scientists in joint research ventures with organizations in developing countries.

Recommendation 6

Specific science-related tasks with which Canada should increasingly assist developing countries include:

a) training scientists and technologists;
b) building and supporting training and research institutions in developing countries; and
c) collaborative research.

Canadian universities and government departments with responsibilities in the food system should consider developing policies and mechanisms to encourage greater participation, both by the organizations themselves and by individuals.

Recommendation 7

Canada, while fully recognizing the sovereignty of other countries, should designate as a primary focus of its aid assistance in the development of rural infrastructure and, in general, the revitalization of rural life in poor countries.

Recommendation 8

The federal government should make a greater effort to foster understanding of, and support for, international development among Canadians.

Specific

Canadian International Development Agency (CIDA)

Recommendation 9

CIDA falls short of realizing its potential in three areas.

CIDA should:

a) *Strengthen its competence in project management.* Many more food system specialists are required both in Canada where projects are administered, and abroad where projects are identified and implemented. In addition, far greater continuity in project management should be assured. (pp. 78-79)
b) *Develop collaborative partnerships.* CIDA should seek an increased partnership with its main executing agents, such

as the universities and Agriculture Canada. A partnership approach should first be introduced in policy formulation. (p. 78)

c) *Strengthen its partners*. CIDA should fund specific positions within the organizations of its main Canadian partners (for example, 25 in university faculties of agriculture and veterinary medicine, and 25 in Agriculture Canada) for co-operative development activities. (p. 86) CIDA should also take other steps to enhance Canada's potential for service abroad, such as:
   (i) awarding more research associateships annually; (p. 86)
   (ii) sponsoring field work in international development projects for Canadian undergraduates; (p. 86)
   (iii) improving its roster of human resources, and providing more support for its Canadian partners to do likewise; (p. 86) and
   (iv) providing more comprehensive orientation programs before Canadians serve abroad. (p. 86)

International Development Research Centre (IDRC)

Recommendation 10

Canada must make better use of its national science system for development activities, and do so on a much larger scale by capitalizing on the experience of IDRC and its network. In fact, collaborative research programs using the skills of Canadian scientists could be doubled. IDRC should immediately explore how to involve Canadian university faculty in its food programs, to a much greater extent than at present. (pp. 75-77)

CIDA and IDRC

Recommendation 11

CIDA and IDRC should seek a closer working relationship. Specifically, CIDA should be alert to the research findings that IDRC helps generate, and seek opportunities to apply this technology, e.g., in pilot and extension projects. Also, IDRC should consider fostering research projects that utilize the skills of CIDA-trained developing country scientists (pp. 76-77).

Recommendation 12

Canada should continue its present level of support to the International Agricultural Research Centres (IARCs):

a) maintaining, in constant dollars, at least its present core funding, via CIDA multilateral aid; and
b) maintaining its present level of funding through IDRC projects. (p. 63)

Further, Canada should expand its financial and technical support for IARCs through new collaborative projects carried out with Canadian scientific institutions. (p. 63)

Recommendation 13

Substantially increased assistance should be provided by CIDA to National Research Institutes in developing countries, using Canadian universities, Agriculture Canada, and Fisheries and Oceans Canada as executing agents. IDRC, which already allocates approximately 40 per cent of its food research funds to these Institutes, should remain responsive to their requests. They should continue to be IDRC's first priority. (p. 66)

Agriculture Canada

Recommendation 14

Agriculture Canada should considerably expand its involvement in overseas development, especially in research, the management of research, and in training and institution building. (p. 80)

Universities

Recommendation 15

Canadian universities with faculties of agriculture and veterinary medicine should give serious and immediate consideration to declaring international cooperation a university objective. (p. 81)

Canadian universities should direct their efforts towards strengthening the universities in developing countries; and engaging in collaborative research. (p. 82)

The main emphasis in educational institution building in developing countries should continue to shift from the undergraduate to the graduate level. Similarly, the training in Canada of students from developing countries should continue to move to the graduate level. (pp. 75, 76 and 82)

At home, Canadian universities should provide food-system courses and seminars on the development process, in general, and on research and outreach strategies, in particular. Students from developing countries should be enabled and encouraged to carry out thesis research in their home countries. (p. 55)

Faculties and colleges of agriculture and veterinary medicine should explore means of establishing a consortium to coordinate and further their activities in development cooperation. Through such a consortium, universities should share in the task of de-

signing better project management systems; thereby improving their skills as executing agents. (p. 83)

Government Departments and Agencies

Recommendation 16

Canadian government departments and agencies (federal and provincial) with food-system capabilities should give serious consideration to making international cooperation an organizational objective. (p. 81)

Government Departments and Universities

Recommendation 17

Government departments and universities should develop:

a) policies concerning tenure and promotion that reward (rather than discourage) participation in development activities; (p. 87)
b) policies that ensure continuity of research during an overseas assignment; (p. 87) and
c) provisions for the upgrading of professional competence. (p. 87)

Technical and Trade Schools

Recommendation 18

Canada should help developing countries to meet their requirements for technicians and para-professionals by funding technical and trade schools in developing countries. This is essential to the effective adaptation and use of new agricultural technologies. (p. 57)

Non-Governmental Organizations (NGOs)

Recommendation 19

The high level of support NGOs receive from the federal and provincial governments should be continued (and increased wherever feasible), for the NGOs are important agents in transferring technology at the grassroots level. (p. 80)

NGOs should attempt to increase the agriculture and food component of their programming. (p. 80)

Canadian voluntary organizations should increase their efforts to keep pace with the growing body of research on subsistance agriculture; thereby enhancing their ability to help increase agricultural productivity in rural communities. (p. 80)

Abbreviations

AFNS	Agriculture, Food and Nutrition Sciences (IDRC)
AGDEVCO	Agriculture Development Corporation, Saskatchewan
AIC	Agricultural Institute of Canada
AIT	Asian Institute of Technology, Thailand
AUCC	Association of Universities and Colleges of Canada
CARC	Canadian Agricultural Research Council
CCIC	Canadian Council for International Cooperation
CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture, Colombia
CIDA	Canadian International Development Agency
CIMMYT	International Maize and Wheat Improvement Centre, Mexico
CIP	International Potato Centre, Peru
CUSO	Canadian University Service Overseas
FAO	Food and Agriculture Organization, United Nations
IARC	International Agricultural Research Centres
IBPGR	International Board for Plant Genetic Research
ICAR	Indian Council of Agricultural Research
ICARDA	International Centre for Agricultural Research in Dry Areas
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDO	International Development Office (AUCC)
IDRC	International Development Research Centre
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
ILCA	International Livestock Centre for Africa
ILRAD	International Laboratory for Research on Animal Diseases
IRRI	International Rice Research Institute
LCID	Liaison Committee for International Development
MOSST	Ministry of State for Science and Technology, Canada
NGO	Non-Governmental Organizations
NRC	National Research Council of Canada
SCITEC	The Association of the Scientific, Engineering and Technological Community of Canada
SEAFDEC	Southeast Asian Fisheries Development Centre
UNCSTD	United Nations Conference on Science and Technology for Development, 1979

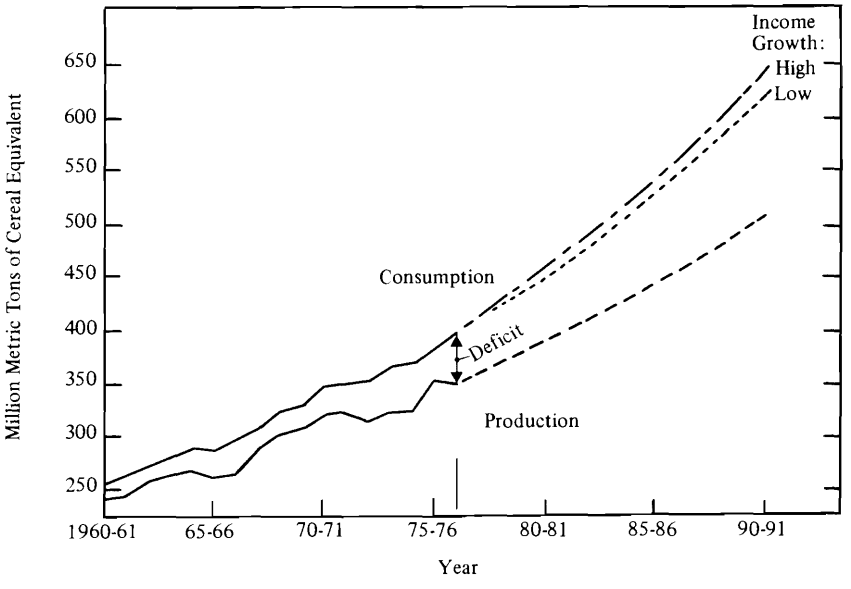
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization
VADA	Voluntary Agricultural Development Aid Program
WARDA	West African Rice Development Association
WFC	World Food Council

I. Introduction

Global food shortages for the 1980s and 1990s are projected at three to four times current annual shortfalls. The magnitude and intensity of hunger, poverty, sickness and related ills in many developing countries, in fact, are well known, and need not be detailed here. But the awesome truth confronts us: these problems are growing worse each year. As a responsible member of the world community, Canada must, therefore, take stock of its food-related resources, assess the nature and level of its future response to the food-population dilemma, and set its course in development assistance for the next decade or two.

The purpose in undertaking Council's study was to review the adequacy of Canada's past contribution to the food supply of developing countries, and to suggest through this Report how our contribution can be strengthened in future years. As the sub-title of the Report makes clear, the thrust of Canada's future involvement is seen to lie in the scientific and technological contributions of our institutions and people. Such a focus for development assistance should strengthen production systems in food-deficit countries and lead to a higher degree of food self-sufficiency than would result from stepped-up food aid programs alone.

Figure I.1 - All Food-Deficit Developing Market Economies: Production and Consumption of Major Staples, 1960-75, and projected to 1990

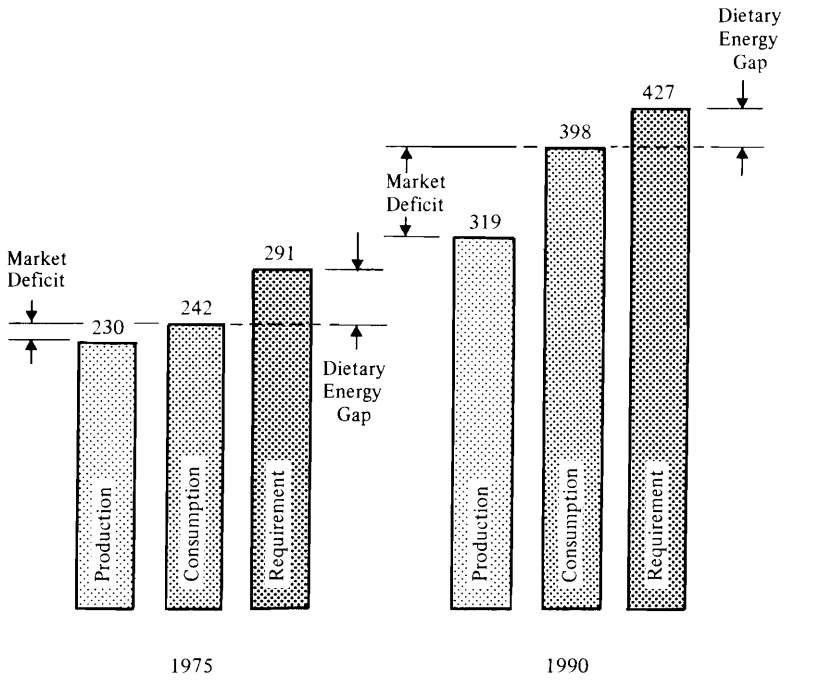


Source: International Food Policy Research Institute, *Food Needs of Developing Countries: Projections of Production and Consumption to 1990*, Research Report 3, Washington, DC, December 1977.

The widening gap between indigenous food production and consumption in Third World countries is shown in Figure I.1. The hard core of the problem exists in the low income, developing countries, wherein live the largest number of people. Indeed, the annual food deficit of these countries (strictly speaking the market economies) could rise to as much as 80 million metric tons of cereal equivalent by 1990 (as is shown in Figure I.2, this deficit relates to market demand, not dietary need), compared with about 12 million metric tons in 1975.[1] People living in Asia and Sub-Sahara Africa would suffer most. The great disparity in food-related parameters between developed and developing countries is illustrated most strikingly in Figure I.3.

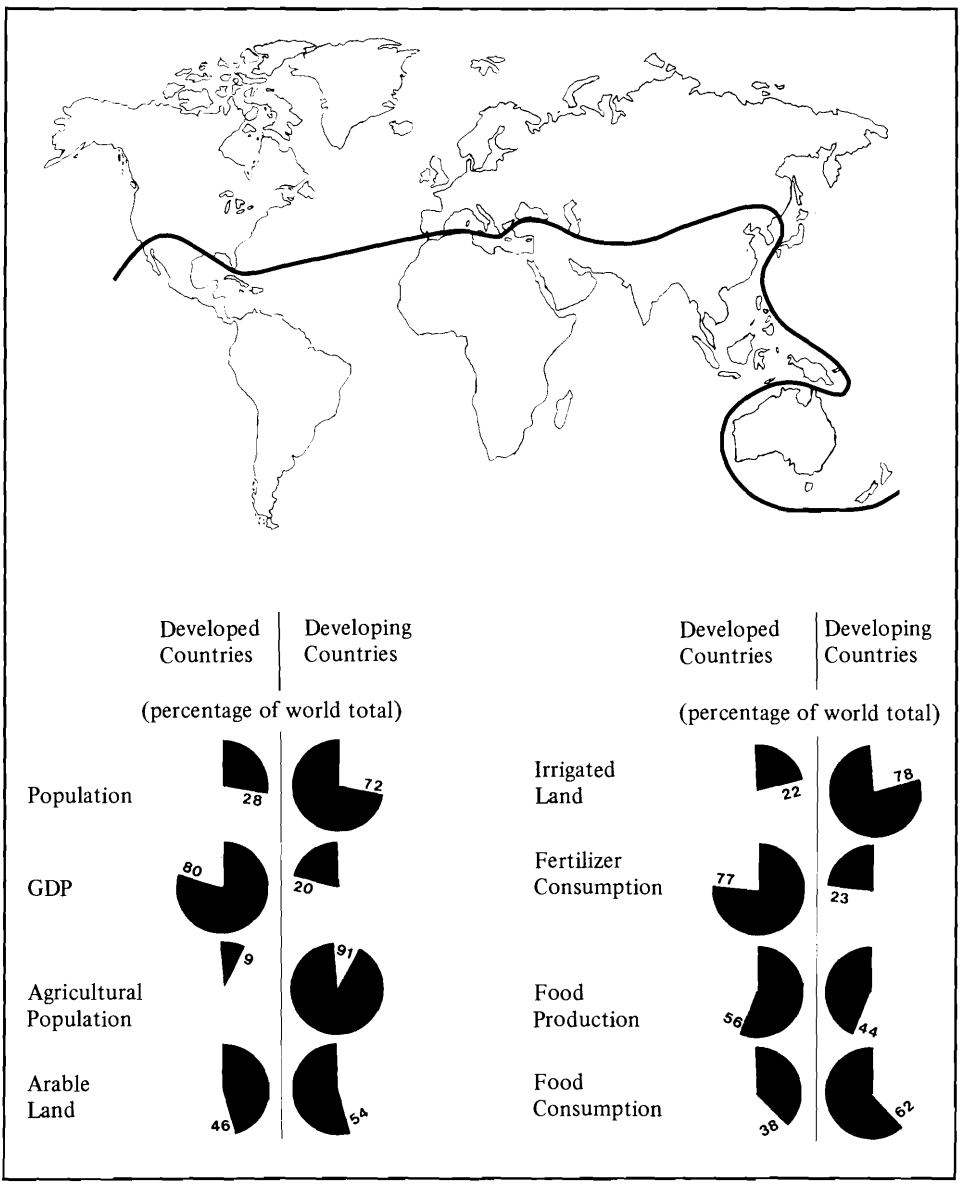
Although vast in scale, the problem must be viewed in human terms. "There are more hungry people in the world now than there have ever been: more than 1000 million may not get enough to eat to meet their energy requirements. Over 450 million of these. . . are estimated to suffer from serious under-nutrition. . . . Every year in

Figure I.2 - Market Deficit and Dietary Energy Gap (In Million Metric Tons, Cereal Equivalent)



Source: Based on data from IFPRI, Research Report 3, Washington, DC, December 1977.

Figure I.3 - A Comparison of Food-Related Parameters



Sources: Willy Brandt, *North-South: A Program for Survival*, MIT Press, Cambridge, Mass., 1980, Ceres, *12*, No. 1, 1979; based on FAO data; Report of the Independent Commission on International Development Issues.

developing countries, 15 million children die from malnutrition and disease, as compared to half a million in developed countries."[2]

Against this background, Canada is seen as an increasingly important contributor to future food needs. Canadians, therefore, have no option but to look upon these projected food shortages and the related miseries of millions of their fellow world citizens from the perspective of their own future contributions and involvement. Chief among the problems to be solved is how our efforts can bring the greatest benefit to the neediest people.

Why Food Aid is not the Answer

As studies and evaluations of past food aid programs accumulate, it becomes ever clearer that world hunger will *not* be solved by shipping overseas increasing quantities of cereal and other foodstuffs, surplus to Canadian needs. Nevertheless, public pressure to resort to such an expediency is bound to resurface whenever Canadian surpluses and critical food needs abroad coincide. In addition to the likelihood of massive food shortages abroad, economists at the Canadian Wheat Board and at universities in Western Canada are predicting increases in exportable grain (given suitable inducements) during the next five to ten years from current average levels of 20 million metric tons to about 28 to 30 million metric tons.[3*]

While limited amounts of food aid, wisely used, have a legitimate place in times of natural disasters, or in some food-for-work programs, such aid employed over long periods to make up for persistent shortages usually perform a costly disservice to the people and regions they were intended to help. In many instances, large quantities of "free" or "cheap" food from a donor country result in recipient governments diverting vital funds from long-term agricultural development projects into other sectors, and in establishing a domestic grain price below the local farmers' production costs. The result is lower than normal domestic production of similar foods.

The most serious problem with food aid, however, is that it creates an unreliable and potentially deadly dependence on foreign supplies. The tragic truth, experienced by several countries in 1974, is that food aid is usually available only so long as it is surplus in the donor country. When the donor country's cash grain markets are strong, or crops are small, food aid is quickly terminated. Hence, "free" or "cheap" food can turn out in the end to be extremely costly.

The direction to pursue, then, is not the short-term expedient of *relief* that leads to grief and disappointment, but rather the long-term strategy of *development* of the entire food-nutrition system, leading to a higher level of self-sufficiency.

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*For such an increase to occur, the world price must cover North American production costs – and this is by no means assured.

The Focus of Canada's Contribution

A Canadian commitment to encourage and assist those programs that lead to eventual self-reliance in food rather than continued dependency, suggests that Canada should support projects that help poor countries to acquire the scientific and technological (S&T) knowledge and materials required to increase their food production and to improve the nutrition of their people. This does not imply that science and technology are the only, or even the most important, factors in a major food development program. Indeed, the most important requirement is that the national government of the host country be strongly committed to such a program, and have the courage to establish and administer the policies and priorities necessary to achieve self-reliance.

Canada should, however, direct its major contributions to those sectors in which it has experience and expertise, and which do not infringe upon sensitive areas of national or local sovereignty in the host country. The sectors of most national or regional programs that best meet these criteria are likely related to the scientific and technological knowledge and materials needed to increase the production and distribution of food. Hence, it is to these limited but vital S&T components of regional programs that Canada can make its greatest contribution.

Canada can also be of assistance in the wise application of knowledge generated from: a) past research; b) ongoing research, conducted in host countries with Canadian assistance, or in Canada; or through c) training programs in developing country universities and other institutions, or in "third country" or Canadian institutions. All sectors of the food system would be included, i.e., crop, animal, and fish production, and the preservation, processing, storage, transportation and utilization of foods, and also nutrition.

Electing S&T as the focus of Canada's future contribution to the food supply of developing countries is to re-affirm the direction of the past. Much of our food-related assistance has been closely tied to our agricultural strengths, which are rooted in our science- and technology-related institutions of research, teaching and extension. However, our strengths could be applied much more imaginatively and effectively than in the past.

A brief inventory of these strengths confirms that, as a nation, we have: sophisticated S&T in all sectors of agriculture and food; a network of first class institutions for training overseas scientists at all levels and in all sectors of the food system; a wide range of qualified people who could train overseas personnel in their home countries; personnel and institutions skilled in stimulating new S&T in food-deficit countries and in adapting existing S&T to the needs of specific regions. Furthermore, Canada has the funds and equipment to provide full support for such programs. Finally, Canada has a

sound international reputation in development assistance, based on the work of the International Development Research Centre (IDRC), the Canadian International Development Agency (CIDA), and the activities of our non-governmental organizations (NGOs). These resources and strengths, successfully applied in many countries during the past few decades, provide a strong foundation upon which to build a still more effective contribution.

The Wider Context

The introduction of new technology into any society can have unpredictable social consequences of enormous magnitude. Who could have foreseen the full impact on life in the West brought about by the automobile, the farm tractor, or the television set? Introducing new S&T into a developing country is likewise a risky and a highly complex undertaking. If technology is viewed simply as a good thing and applied for its own sake, disaster is almost inevitable. To be useful S&T must be seen as simply one of many means towards a major social goal that has been clearly defined by the people whose life it is intended to improve. The technology must be selected and applied only with the greatest cultural sensitivity, and only in the context of a carefully considered national or rural development program and strategy.

This Report cannot deal adequately with the ecological, political, cultural and socio-economic dimensions of the development plans within which programs of S&T for food production must ultimately be considered, and still do justice to its chosen topic. Our intent is merely to indicate an awareness of the potential hazards of technology when mishandled in a delicately balanced culture or ecosystem, and to stress the need for wisdom when introducing it.

The Committee on Canada's Scientific and Technological Contribution to World Food Supply considered at great length and with a deep concern, however, the socio-ecological aspects of rural development. The Committee strongly affirmed general development goals of *sustainability* and *self-reliance*, as well as endorsing a *basic needs*, in contrast to a *trickle down*, approach. This philosophy of development is consistent with the aims and purposes enunciated by CIDA in its "Strategy for International Development Cooperation 1975-80." Indeed, the Committee recognized that a comprehensive report on this topic would address in some detail the *context* of S&T, as well as the S&T itself. In the case of food, the context is rural development for both the root and the scope of the problem reside in the rural areas.

II. A Two-Edged Sword

> "If developing countries acquire and develop technology, it should be the right technology. How do they decide on what is appropriate for them? How do they build the kind of technological infrastructure that will enable them to make the right decisions in determining their needs and the solutions of their problems? How do they know whether simple, traditional, labour-intensive technology is the best solution to the problem? Or, if sophisticated technology is what is called for, how do they choose from the many technologies available to them? We in the so-called developed world cannot simply tell those who struggle with the problems in developing countries what the best solutions are. But we have a major contribution to make to the building up of the human and institutional resources needed by the developing countries to choose the optimum technological path toward their goals. The creation of an infrastructure like this is a long-term process, and it will require new policies in Canada."[1]

These words were spoken by Canada's Deputy Under Secretary of State for External Affairs, Robert Johnstone at a science and technology seminar in Toronto, prior to UNCSTD in 1979. In this statement he captures the inherent complexity of the issues surrounding the use of science and technology, and the social, technical and political dilemmas faced by both the receiving and the donor countries. He stresses a) the crucial importance of applying only the appropriate or "right kind" of technology; b) the difficulty of deciding which technology is appropriate to a country or village; c) the importance of consciously selecting technology to solve the problems and meet the needs identified by the people concerned (namely, an S&T policy within a national development framework); d) the critical, yet sensitive, role of the donor country in not imposing solutions to its perception of the problems, but rather enabling developing countries to establish their own goals and their own paths towards them; e) the training of people and the building of institutions as the best contribution developed countries can make to such a process; f) the need for new policies in Canada before such a response can be realized; and g) the long-term nature of a development process based on new technology – hence the need for long-term commitment.

To those unfamiliar with rural development in developing countries, heavy emphasis on increasing food production through the latest agricultural science and technology might appear to be the easiest, most straightforward and obviously productive route to follow. In fact, it may be none of these. The unwise introduction of new technology into a village can have the following consequences: an increase in the already large number of under-employed; the pur-

chase of equipment and crop inputs that the farmers can ill afford; a threat to the values and other elements of the local culture; an increase in economic disparity among local people, leaving the very poor worse off; an upset in the ecosystem of the region; and disruption in social organization. A combination of these unwanted consequences can produce serious social and political unrest and might require central government intervention. Such an outcome is not inevitable, although it has occurred all too frequently in recent years.

Technology as Culture

Jorge Sabato, a leading Latin American authority on S & T, has written that:

> "technology is not just a machine, or a diagram or a recipe, or a computer program, or a formula or a patent, or a design, or the advice of an expert: it is all that and much more. Technology is a package of organized knowledge of various types (scientific, technical, empirical, etc.) coming from several sources (scientific discoveries, other technologies, patents, books manuals, etc.) through different methods (research, development, adaptation, copying, espionage, experts, etc.)."[1]

Indeed, technology is much more. Not only instruments and tools and knowledge: it also carries a powerful cultural impact. No longer is it assumed as it was at the first UN conference on technology in 1963 that technology is more or less culturally neutral and free of inherent "values". Technology is now refered to as a central element of culture: the transfer of technology is equated with the transfer of cultural forms. "Technology can be considered to resemble genetic material which carries the code of the society which conceived and nurtured it and which, given a favourable milieu, tries to duplicate that society."[3] Far from being neutral, technology carries with it the imprint and values of its society of origin. Accordingly, when a country imports technology or machinery, it also imports the values of the society in which the technology was produced. The result is a modification, for good or ill, of the importing countries' values.[4] Indeed, imported technology can be a two-edged sword.

Technology imports by poor countries are costly, but the nonmonetary costs of "technology transfers" are even more important. Such costs fall into three categories: a) the incompatibility of transfers with broad national development goals; b) their negative impact on the quest for social justice; and c) consequences of importing technology in domains of cultural diversity and ecological balance.[5] The heavy social price receiving societies often pay for foreign technology is not readily measurable or easily detected and certainly not inevitable, but it is nevertheless real. Such costs reinforce the view held by many in the Third World that their societies should not accept technology uncritically from the developed world, and that they

should eventually be able to create indigenous technologies congenial to their professed social values and their culture and ecology. For this reason the main thrust of Canadian S&T assistance should not be the export of existing Canadian technology (although this should not be excluded), but assisting Third World countries to develop their own technology. Such a focus would also contribute to the technological autonomy, and consequently the cultural integrity that developing countries are striving to acquire and maintain.

Rural Development and Poverty

One of the serious dilemmas facing developing and developed countries is the lack of useful analyses of the link between science and mass poverty: little understanding has been generated of how to relate investment in S&T to the problems of rural development.[6] This is serious indeed, because most developing countries have no alternatives to a heavy reliance on science and technology to meet the future food needs of growing populations. During at least the past decade, the annual food production growth rate in developing countries was between 2 and 3 per cent, but over 50 per cent of this increase can be attributed to the expansion of cultivated areas. Very soon additional land that is suitable for agriculture will cease to be available, especially in most Asian countries. Thus, the only way to increase food production will be through increasing the intensity of cropping per hectare. This means that new technology, derived from research and experimentation, will have to be employed.

This scenario sets in relief the realization that we are just scratching the surface of our understanding of how to use S&T to solve global food problems and, in particular, the problems of poverty and rural development. However, progress is being made. Slowly, but surely, the "appropriate technology" movement is gaining strength, credibility, and adherents.

"Appropriate" Technology

Appropriate technology means many things to many people. The same concept has been referred to as "intermediate", "alternative" or "rural" technology. Whatever the term, these technologies are developed as alternatives to the expensive, imported, labour saving and complex technologies from industrialized countries. By contrast, these technologies tend to be low cost, labour intensive, low in energy consumption and environmental impact, and suitable for small- and medium-scale production. "Appropriate" is usually taken to mean appropriate to conditions of high rural unemployment, low foreign exchange reserves, limited skilled maintenance facilities, and shortage of combustible fuels. Such technologies should never be construed as second best. As the Brandt Report observes,

> ". . .the call for appropriate technology does not prescribe any particular type; much less does it imply that the technology

should not be the latest or the most sophisticated. It means that the choice of technology should be a conscious one, taken in the knowledge that it can affect the character and direction of development. . . . Appropriate technologies also take account of the special nature of the problems in each area. . . . Some technologies can conserve scarce materials and save on imports; some are much better suited to the skills, management and industrial organization of developing countries. An appropriate 'consumption technology' can choose products which suit local incomes and objectives."[7]

The dangers of alien technology misapplied are particularly real in agricultural development programs. North American agricultural technology has brought about the current level of production "efficiency" primarily by substituting capital and energy dependent machinery for labour, and by a heavy use of ever more costly fertilizers and chemically-based pesticides produced from non-renewable resources. Clearly, this kind of technology is not appropriate to the long-term needs of village societies in developing countries, for many obvious reasons. There are few if any jobs in the towns and cities to employ farm workers displaced by machines, and, no less important, villagers are not likely to have the capital for mechanization nor, in general, the cash or credit for costly production inputs. Moreover, as implied earlier, such an application of technology likely would help only the better-off in the village and set the poorer farmers, the great majority, further behind than they were before.

This does not imply that improved soil fertility and pest (weeds, insects, diseases) control are unnecessary; indeed, they are basic to any future increases in food production in developing countries. Researchers must, however, intensify efforts to find ways of increasing soil fertility and controlling pests that do not depend entirely on high cost, imported, energy-intensive technology. Fortunately, progress is being made in improving fertility through inter- or multiple-cropping of grass and legume crops. Likewise, "integrated pest management" research is devising means of reducing traditional heavy dependency on chemicals for the control of certain insects.

Science and Technology Policy for Developing Countries

Along with growing global acceptance of the "basic needs" approach to development, concern has grown that appropriate technology also be understood to mean the kinds of technology that consciously and directly address the food, shelter, health and educational needs of rural as well as urban people. Altogether too small a proportion of international technological assistance to date has been allocated to these basic needs. Increasingly, developing countries are recognizing the need to formulate national policies that will guide or direct all

scientific and technological activities in directions compatible with national needs, goals, priorities, and development plans.

The task of formulating science and technology policy in developing countries is complicated by two factors. First, comparatively little technological activity exists in these countries: 90 per cent of the world's scientists and engineers, and 95 per cent of global scientific expenditures are concentrated in developed countries. As a consequence, access to technology is difficult and frequently costly for developing countries.

Second and just as significant a factor, it is a historical fact that in most of the Third World the powerful linkages between the generation of scientific knowledge and the evolution of production techniques that characterize developed countries have failed to develop. Divorced from the productive sphere, the pursuit of science in developing countries tends to be fragmented and imitative.

Most developing countries have an *exogenous* scientific and technological base: the evolution of scientific activities has not led directly to, or been clearly linked with, advances in production techniques. Developed countries, in which these linkages are well established, have an *endogenous* base.[8] If this viewpoint is accepted, the task of strengthening the autonomous S&T capability of a developing country is synonymous with a move towards endogenous science and technology, oriented to the country's development objectives. A Latin American policy analyst, Francisco Sagasti, suggests that this can be accomplished, and the need for imported technology can be substantially reduced, by a combination of actions:[9]

a) establishing priorities for science that relate in some manner to a country's development requirements;
b) recovering, and selectively upgrading, a country's traditional (and often dormant) technology base (traditional agriculture and rural industries are especially fertile areas for upgrading through linkages with modern science);
c) designing "combined" technologies that incorporate both "modern" and "traditional" elements; and
d) pooling resources with other developing countries to generate a collective endogenous S&T base.

Developing countries need specific strategies to deal with technology, considered as a special economic commodity. The following factors must be taken into account when formulating a technology strategy:[10]

- Determination of the appropriate balance between technological accumulation, distribution, and consumption;
- The amount or level of government intervention and degree of protectionism (Intervention is required to help establish the technological infrastructure, and protectionism is needed to use it effectively.);

- Regulation of the flow of imported technology to stimulate increased production and foster utilization of indigenous technology;
- Incorporation of indigenous technology in the process of technological accumulation is best obtained through a *gradual passage* from technological dependence to technological interdependence.

* * * * *

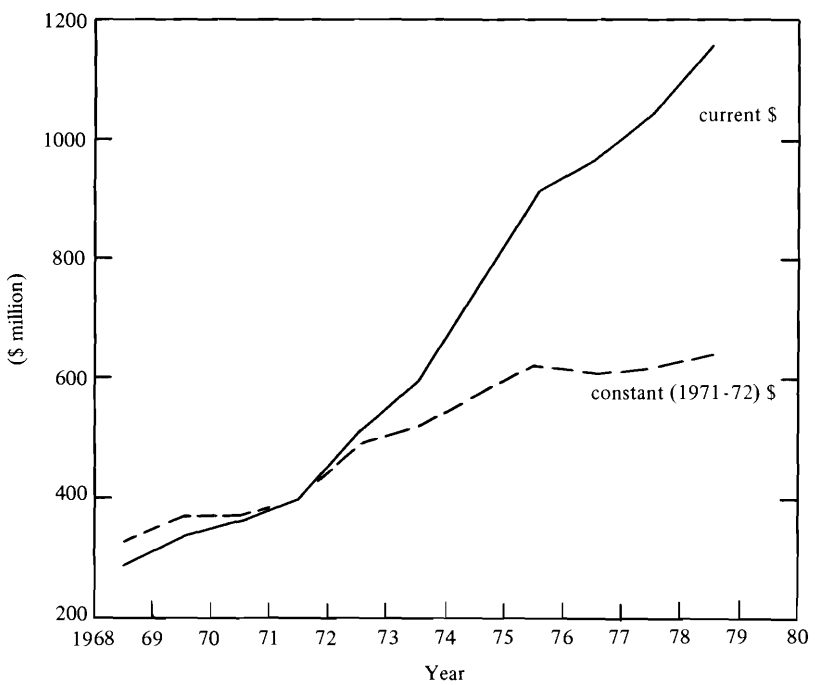
Whatever the risks, developing countries realize that science and technology provide opportunities and benefits. New S&T should not be seen as an autonomous force, however, to which populations must adapt themselves, but rather more as responsive, to be expressly designed for and used in the service of the world's communities.

III. Canadian Organizations Involved in International Cooperation

Canada has provided development assistance to Third World countries for thirty years. During the past ten years, this assistance has been channelled through the Canadian International Development Agency (CIDA), the International Development Research Centre (IDRC), and more than two hundred non-governmental organizations (NGOs). The increase in Canada's financial contribution to international development is shown in Figure III.1, and a comparison between Canada's aid and that of Sweden, the Netherlands, and the United States is provided in Figure III.2. Canadians involved in development assistance have come from various government departments, including Agriculture Canada; from universities and cooperative colleges; from NGOs; and from private consulting firms.

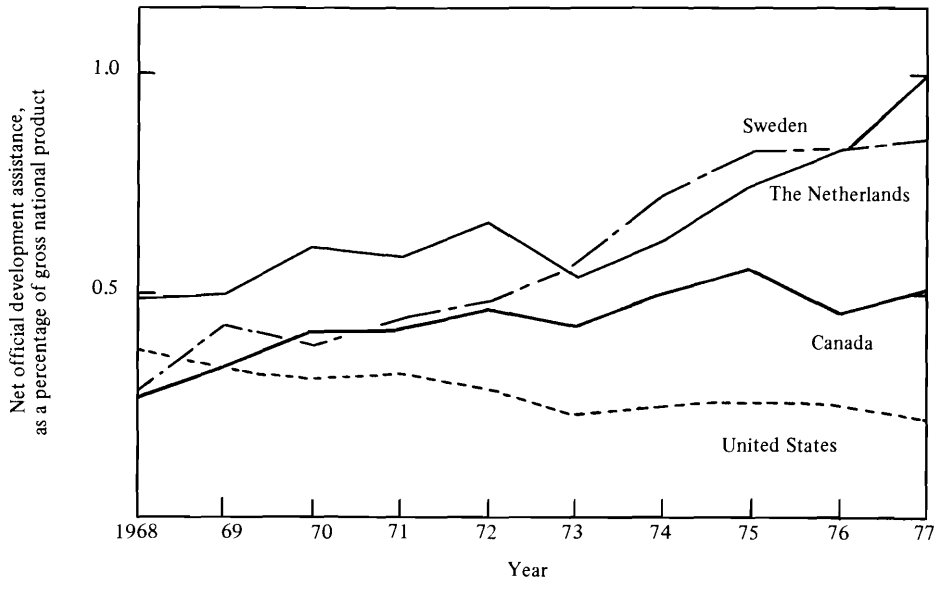
Canada has launched impressive initiatives in collaborating with developing countries. This chapter describes the evolution of institutions concerned with improving the food self-reliance of developing countries, and particularly the organizations that collabo-

Figure III.1 - Canada's Financial Contribution to International Development, via CIDA and IDRC



Source: Based on data in *CIDA Annual Review*, CIDA, various years.

Figure III.2 - Net Flow of Official Development Assistance to Developing Countries and Multilateral Agencies



Source: Development Cooperation Effort and Policies of the Members of the Development Assistance Committee, Organisation for Economic Co-operation and Development, 1979 Review, November 1979, pp. 286-287.

rate with those countries on scientific and technological aspects of the food system.

This chapter is purely descriptive. An evaluation of the organizations, and recommendations concerning their future orientation and areas of responsibility, will be found in the following chapters.

Development Agencies

International Development Research Centre

The International Development Research Centre was established by an Act of Parliament in May 1970.[1] A public corporation, the Centre was given the greatest possible flexibility and autonomy while still being responsible to Parliament. Its Board of Governors consists of 11 Canadians and 10 non-Canadians, 6 of whom come from developing countries. Many of the Centre's program officers are located in the field, attached to regional offices that are headed by nationals from the region. A considerable number of the staff are non-Canadians, with many coming from the developing countries themselves.

The Act of Establishment states that the Centre's principal objective shall be "to initiate, encourage, support and conduct research

into the problems of the developing regions of the world and into the means for applying and adapting scientific, technical and other knowledge to the economic and social development of these regions." The Centre pursues its objective through the funding of specific research projects and programs in response to requests from Third World institutions. Assistance is given on the basis of priorities established by the latter, the relevance of the research for *development* being a major concern. Beyond the immediate goal of supporting relevant research, IDRC is constantly aware of its central responsibility, "to assist the developing regions to build up the research capabilities, the innovative skills and the institutions required to solve their problems."

Leadership and experience set the course of any organization. IDRC was fortunate to have as its first president, David Hopper, an agricultural economist of international standing with many years experience in practical research in the Third World. In Hopper's view, the Centre's goal was to support the people in developing countries in their struggle to achieve a better life, and its focus the problems of rural societies, a field too often neglected in scientific and technological research.

The immediate clientele of the Centre is farm and non-farm people living in rural areas. These people constitute 80 per cent of the population of developing countries; yet they are the least able to gain immediate benefit from presently available technologies.[2]

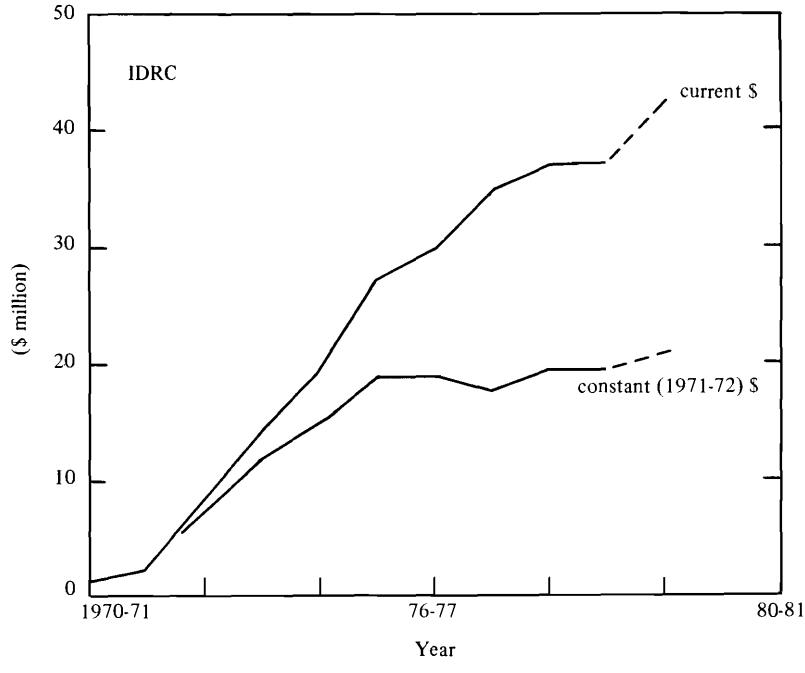
The Centre provides assistance in four areas: Agriculture, Food and Nutrition Sciences (AFNS), Health Sciences, Information Sciences, and Social Sciences. The AFNS Division accounts for 47 per cent of IDRC's program operations budget.

IDRC identifies capable Third World scientists within their own national research institutions. It supports their research, augments their knowledge through further training, helps them obtain essential materials and up-to-date research findings, and provides links with other workers by means of workshops and visits.[3] The goal is increased numbers of efficient applied scientists and research managers.

From its inception until March 1980, IDRC's Board has approved support for 906 projects, which required appropriations of $164.8 million. A few projects have involved expenditures of more than $1 million, some others less than $5000; the average amount allocated to each project has been about $182 000.[4] Research projects have been supported in more than 90 countries. Figure III.3 illustrates the increase in IDRC's revenues since its inception.

The AFNS Division supports applied research to improve the health and economic well-being of the rural poor. Priority has been assigned to food and tree crops in the arid and semi-arid tropics, to root crops that provide basic subsistence for more than 300 million

Figure III.3 - IDRC's Revenues, 1970-80



Source: IDRC, Annual Report, various years.

people, to artisanal fisheries and small-scale fish culture, to by-products and agricultural wastes as animal feed on small farms, and to combined farming systems that will benefit the poorer rural communities. About 50 per cent of the Division's budget has supported crops and cropping systems research; animal sciences research, 21 per cent; fisheries and forestry research, 11 per cent; and research on post production systems (processing, storage, food preservation, distribution, and use in the home), 7 per cent.[5]

In addition, IDRC has also brought together Third World scientists with similar interests. In this way, comprehensive and integrated programs of research have been mapped out that are more diverse and demanding of resources than could be provided by a single country; yet to which each country can make a significant contribution.

Nearly all of IDRC's work pertains to rural development. Through one Colombian project (Caqueza) though, it became involved in rural development proper.[6] Recognizing that a better knowledge of local production systems and the constraints of the farmer were necessary

before attempting change, the need for on-farm research was acknowledged. Further it was seen that a study of the total system, beginning with the farmer, was necessary.

Research Criteria

IDRC has been getting close to the heart of the world's rural development problems and enigmas. Criteria for the choice of projects have been excellent:

- the idea coming from within the participating countries, and not imposed from outside;
- the project aiming to close the gap between rich and poor;
- employing local people and using local resources;
- enabling local researchers to develop their own skills in solving their own problems;
- the findings being useful in other countries.[7]

IDRC acts as a facilitator through which regional bodies and networks are strengthened and the perspectives of local researchers are broadened. It often undertakes high risk projects carried out by younger researchers. It is also unusual in the degree of its promotion of South-South collaboration and inter-institutional research.[8]

Overall, IDRC has broken new ground in finding ways to assist indigenous scientists in developing countries strengthen their research capabilities and the innovative skills required to solve their own problems. Other countries, such as Sweden, are following in IDRC's pioneering footsteps.*

Canadian International Development Agency

CIDA's contribution to agricultural and fisheries development has been significant. The Agency has transferred millions of dollars in the form of grants, provided opportunities for thousands of trainees and students to receive training, gathered together a rich variety of consultants and made them available to more than 80 countries. Canadian NGOs, involved in overseas projects, have been supported and Canadians trained for service abroad.

Since 1968, CIDA has contributed over $5 billion in overseas development assistance, and of this more than $400 million has been spent on agricultural, fisheries and rural development.

In 1977-78, CIDA supported, bilaterally, agricultural and fisheries research in 17 centres, and in 11 agricultural and fisheries universities or technical schools.[9] Multilaterally, it has also been supporting the network of International Agricultural Research Centres (IARCs), and the United Nations Development Program (UNDP), which spends 25 per cent of its budget on agriculture.

*Conversely, Canada can learn from other developed countries. The International Agricultural College at Wageningen in the Netherlands trains people from developing countries at the technical level. Skills are upgraded in courses designed for farm management. Canada might consider the merits of establishing similar institutions, whether in agriculture or fisheries (which, at the technical level, is less site-specific than agriculture).

Most of CIDA's food sector work in research and in technology development has been carried out abroad by executing agents (other Canadian organizations under contract). The executing agents include IDRC, Agriculture Canada, the universities, private consultants, voluntary organizations, and Fisheries and Oceans Canada.

CIDA itself does not pretend to have the skills or technologies that it transfers to developing countries. It either purchases those skills and technologies in the Canadian marketplace or attempts to act as a catalyst in the development of new skills, at home or abroad.[10]

Since 1970, there has been a gradual decline in long-term general technical assistance as a result of increasing emphasis on the integration of technical assistance with capital projects. The result has been a reduction in the numbers of CIDA advisers and trainees. There has also been, over the past few years, an increasing reliance on the executing agents to implement projects, a trend that will probably continue. NGOs are also playing an important part in technological development through the upgrading of skills, especially specialized and practical skills.[11]

CIDA established support for the NGOs in 1968, and set a pattern of assistance that has been adopted by other donor countries.[12] Similar matching schemes were subsequently established by four Canadian provinces, encouraging widespread grassroots concern and involvement in development issues and projects.

In fact, a case can be made that some NGOs are themselves development agencies. CUSO, for example, has a development charter and a set of operating principles based on that charter. Because, however, NGOs are not government agencies and nearly all function with matching grants from government, this Report categorizes them as "partners" in international development. In no way should this be regarded as slighting their autonomy; indeed, NGOs are uniquely qualified to work on their own, which they effectively do – at the grassroots level.

Partners

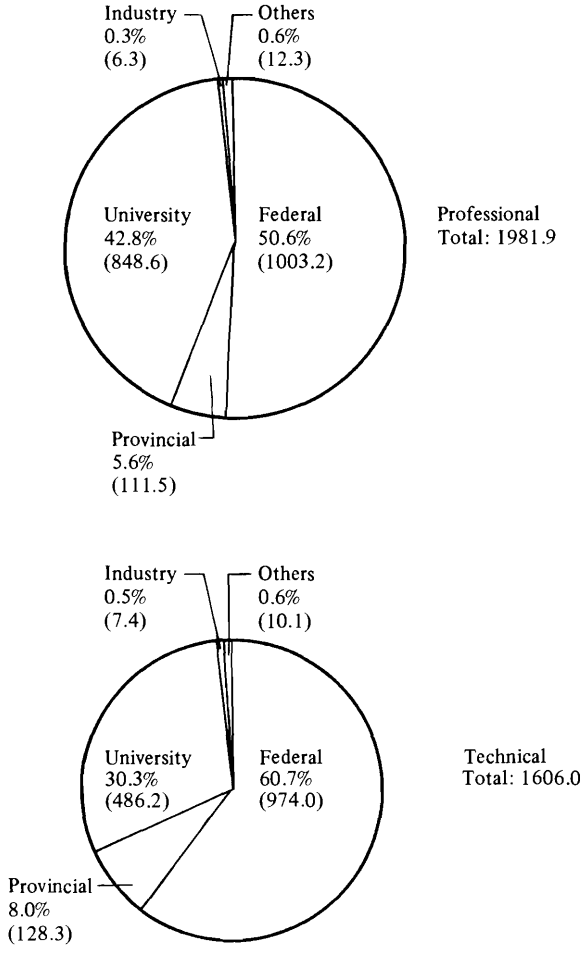
Agriculture Canada

Agriculture Canada has wideranging responsibilities throughout the Canadian food system, from production to consumption. At home, its research is carried out at 47 establishments across the country: its staff of nearly 1000 research scientists constitutes the largest single pool of highly qualified manpower in this field in Canada. (See Figure III.4). Its research expenditures are shown in Figure III.5; fisheries and marine research expenditures are also indicated for comparison.

Formal agreements have been made between Agriculture Canada and CIDA by which Agriculture Canada undertakes to manage particular programs for CIDA. In 1979-80, Agriculture Canada had,

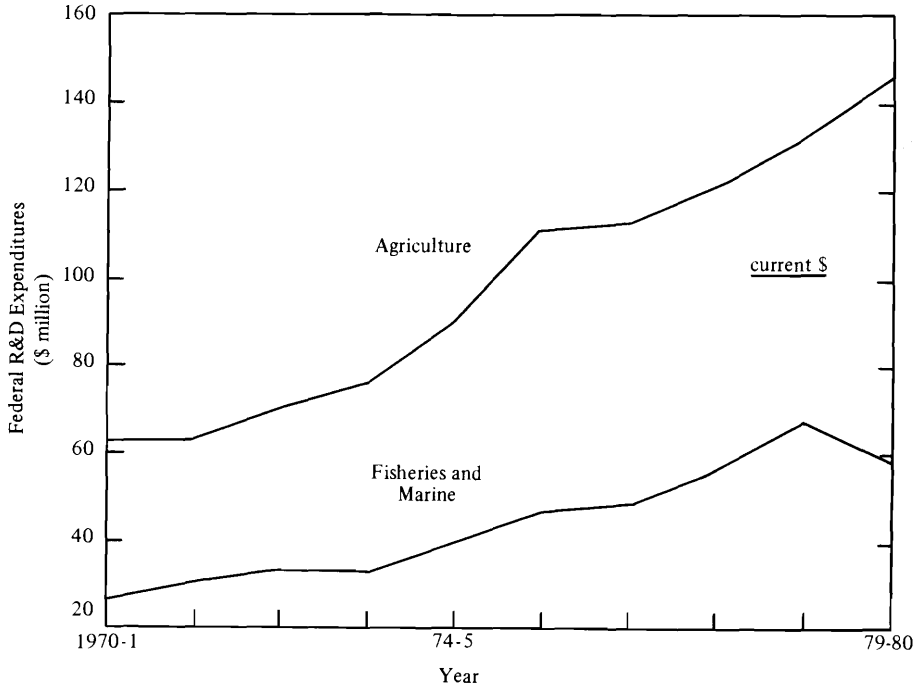
under its management, eight such programs in seven countries, for which nine person-years were provided in the fiscal year 1979-80. (See Table III.1.) It is assisting recipient countries to plan, develop and execute research programs aimed at solving an array of agricultural problems, and to develop their capacity for agricultural planning.

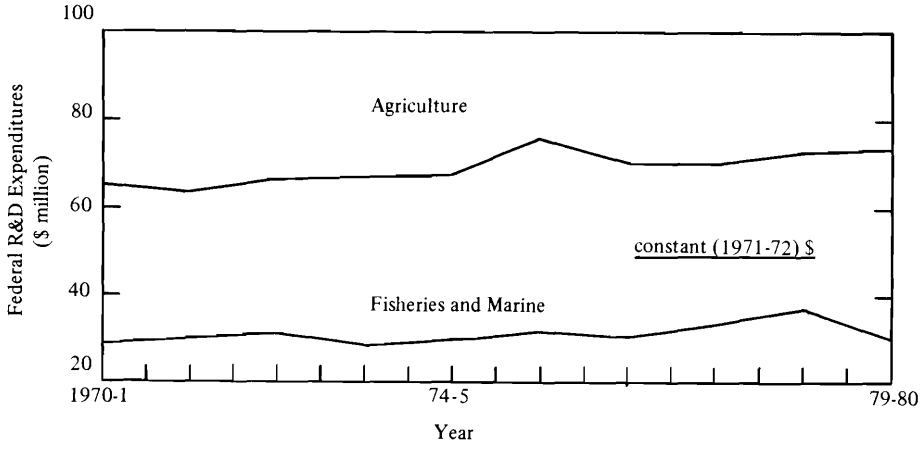
Figure III.4 - Canadians in Agricultural Research (Person-Years), by Research Establishment, 1978-79



Source: Canadian Agricultural Services Coordinating Committee, "Inventory of Canadian Agricultural Research," *A Canadian Agricultural Research Council Report* (CARC), 1978-1979.

Figure III.5 - Federal Intramural Expenditures on Food-Related Research and Development





Source: Statistics Canada, Science Statistics Centre, unpublished data, 1980.

Table III.1 - Agriculture Canada Foreign Aid Projects*

	Number Seconded from Agriculture Canada (Person-Years)	Number Contracted from Outside (Person-Years)	Value of Project ($ Million)
Dryland Research *India*	1.0	3.0	2.3
Dryland Research *Sri Lanka*	2.0	1.3	1.5
Wheat Improvement *Brazil*	0.5	-	0.3
Adaptive Wheat Research *Tanzania*	3.0	5.5	2.2
Large Scale Wheat Production *Tanzania*	0.0	5.5	1.8
Soil Survey *Sarawak*	1.0	-	0.4
Food Processing *Colombia*	1.5	0.5	0.2
Technical Support in Economic Planning *Zambia*	1.5	0.5	2.0
Total	9.25	15.8	10.7

*Fiscal Year 1979-80

Source: Agriculture Canada, unpublished data.

Each program has a Canadian leader who, in the case of research projects, is usually a director of one of Agriculture Canada's research stations. In the case of larger programs, Canadians live in the recipient country, and are either seconded from the department's staff or hired on contract for a particular job.

The department also loans its experts to CIDA on a short-term basis for project identification and planning duties, and to act as supervising consultants for projects executed by CIDA. Probably Agriculture Canada's key contribution has been assistance in research management: identifying problems, assigning priorities, and designing effective research programs. The need for such assistance is great for frequently research managers in developing countries have neither experience nor training in management, and often have little research experience.[13]

Fisheries and Oceans Canada

For many years, staff of the federal department of Fisheries and Oceans have been active in international development, although the department has not been specifically organized for the task as has Agriculture Canada. Fisheries and Oceans has, nevertheless, provided most of the people for CIDA's fisheries development projects overseas.

As of November 1979, CIDA had 19 fisheries projects underway and 10 more in the planning stage. Active projects included help to research and training institutions, and to government units as well as work related to physical infrastructure; however, most projects relate to the development of fisheries (including small-scale or artisanal fisheries). Projects in the planning stage included three involved with post-harvest technologies.[14]

Universities[15]

Canadian universities have contributed to the development of Third World countries in a number of ways: undergraduate and graduate education; special non-degree courses and workshops in Canada and abroad; participation in institution-building in developing countries; and research. Over the period 1968-78, Canadian university faculty members participated in 382 food-system development assistance projects. They provided professional advice for 195 projects, and were involved in the implementation phase of 187. Faculty involvement averaged 28 person-years annually for 11 years, and amounted to 32 person-years in 1978, when 125 faculty members were involved.

Most faculty activity abroad has been associated with the food needs of low- and middle-income people in food-deficit countries. Institution building, mainly of universities, along with some national research units, accounted for 43 per cent of the person-years; production and rural development projects accounted for another 35 per cent; other projects (including some in human nutrition) such as workshops and short courses accounted for the remaining 22 per cent.

Thirty-three Canadian universities have been active in food-system projects over the past decade. Eight universities with faculties or colleges of agriculture and/or veterinary medicine accounted for 78 per cent of the person-years.

CIDA and IDRC projects utilized 67 per cent of the person-years: 53 and 14 per cent, respectively. Support for the remaining projects came from various agencies, including the Food and Agriculture Organization, the World Bank, the Ford Foundation, and the World Health Organization.

Of the agriculture and fisheries projects undertaken in conjunction with CIDA, the most successful were those managed by Canadian universities; the least successful have been those projects for which CIDA recruited individuals from different universities and government units in Canada and exercised direct management itself.

Historically, Canadian faculties of agriculture, especially in the West, have maintained liaison with their surrounding rural communities. As a consequence, they can play a major role in assisting Third World universities to meet the needs of their own farmers and rural people.

Provincial Governments

At least five provinces are directly involved in agricultural development cooperation abroad (British Columbia, Alberta, Saskatchewan, Manitoba and Quebec), as part of their broader contribution to international development. Most provide support by matching funds for Canadian NGO projects in developing countries. On average, provincial government support for agriculture and food approaches $1 million, annually.

Saskatchewan has set up a non-profit corporation – the Agricultural Development Corporation (AGDEVCO) – whose purpose is the provision of service both in Canada and to developing countries, through the management, planning and coordination of development projects. The Corporation's International Projects division actually implements projects selected from developing country aid requests, generally acting as executing agent for CIDA. It also coordinates the Saskatchewan Department of Agriculture's activity under VADA (Voluntary Agricultural Development Aid Program), which was set up by the federal and provincial governments in 1975.

Non-Governmental Organizations

The term non-governmental organizations (NGOs), in the language of international development, refers to voluntary organizations and professional organizations. Because very few professional organizations are *substantially* involved in international development, NGO is frequently used as a synonym for "voluntary organization"; such usage is followed in this Report. More than 200 Canadian NGOs (of which about 100 are voluntary organizations) are contributing to overseas development assistance.[16] They are involved in various types of projects in developing countries; in particular, education, community development, health and population, and food production. About 10 per cent of their efforts are expended in food production.

During the period 1973-78, Canadian NGOs dispatched about $100 million for rural development projects (broadly defined), and about $40 million for agricultural projects.[17] About half of these resources came from CIDA's NGO Division, using matching formulas.[18] Four voluntary organizations: Canadian Catholic Organization for Development and Peace, CARE Canada, Foster Parents Plan, and World Vision have accounted for 58 per cent of all rural development spending by Canadian NGOs.[19] The work of the Mennonite Central Committee should also be mentioned.

Voluntary organizations tend to espouse a common philosophy of community development and self-reliance. Historically they have acted as precursors of official government assistance: the social services first carried out by them now being carried out by the state. Hence it is significant that the priority they give to agricultural pro-

gramming, which was low, has been growing in recent years.

Criteria for the design of projects are largely defined by CIDA. However, these criteria seem valid for organizations with a philosophy of community development, or of integrated rural development.

Canadian voluntary organizations have a reputation in Third World countries for supporting small, flexible, low-cost projects. Assistance is virtually untied, and this permits local cost funding and greater flexibility in program execution. Opportunities can be seized, such as undertaking pilot projects that assist the planning and implementation of larger schemes. Greater risks can be taken with smaller projects. The NGOs are better able than government agencies to work directly with local implementing agents.

High local participation in projects and the use of appropriate technologies are favoured by NGOs. Their tendency is to adapt technology at the low end of the scale because of the perceived desirability of local self-reliance. It is important to them that service, spare parts, and expertise be available locally.

Sometimes, projects are experimental, employing technologies unavailable locally. However, as few agencies wish to continue projects for more than two to three years, innovative technology requiring lengthy introductory periods is generally not employed. Technologies brought in cover a wide range, from solar cookers and rice dryers to the "technologies" of credit unions.

In general, however, the technological component of NGO projects has not been considered of prime importance. Projects with a substantial technological component have even been avoided. This tendency may be explained by the fact that many NGO volunteers have had less technical training than some other development workers. Voluntary organizations also realize that if local people are to handle projects, simple labour-intensive techniques must be used and only low recurrent costs incurred.

Indirect evidence points to a success rate for NGO projects at least as high as for the large agencies.

Private Consulting Firms

Consultants in Canada who have been active in agricultural management and rural development projects abroad include management consultants and engineering firms, consulting agrologists, members of the cooperative movement, and others.

Canadian management consulting and engineering firms are capable and flexible, and their experience abroad has been both extensive and varied. These firms tend to be relatively large, numbering often hundreds of employees. In contrast, agricultural consultanting firms are generally very small in Canada with a complement of two or three professionals being common. Their survival depends on their initiative and adaptability.

Canadian consultants have gained much of their experience in poor countries, either directly with clients, with CIDA or through American or international organizations. Some consulting firms have never succeeded in getting contracts from CIDA; the full range of factors important in obtaining contracts is unknown to them. Nevertheless, CIDA contracts awarded to consulting firms are more numerous in the food sector than those let to all other groups (e.g., universities, NGOs, and governmental agencies) combined.

Consultants concede that Canada's knowledge of tropical agriculture is limited, although they still claim competence, especially in marketing and distribution, and in general management ability. Their competence would be far greater if the market for their services were large enough for them to engage significant numbers of experts from tropical countries. CIDA projects, however, require the use of Canadian expertise only.

The Private Sector

No mention has yet been made of the vital contribution of private industry. In agriculture nothing is more important than the productive system; and within that system the private sector is of paramount importance. The parts of the system range from grain growing to the manufacture of inputs, such as fertilizer and pesticides, to the production of machinery. Throughout, no function is more critical than management.

The intensification of agriculture in developing countries will require the assistance of people previously uninvolved with the needs of the subsistence farmer. If at first, public sector scientists must develop new crop or animal varieties, fertilization practices, means of disease and pest control and crop and animal management practices, then private industry must subsequently supply essential inputs at a reasonable price and often also participate in the processing, storage, marketing and transport of the harvested product.[20]

With sufficient safeguards, transfers of production-oriented technology from industrialized to industrializing countries could be encouraged. Much in the pattern of development of the industrialized countries will inevitably follow in developing countries, but it would be extremely beneficial for government and industry to cooperate to defining a suitable role for the private sector.

Developed country help with the management and development of technologies can be expensive, but can also be an excellent means of avoiding far greater expenses of a welfare nature. The technical and administrative capabilities of developing countries must be strengthened; and even established in some cases, with a view to enabling them to negotiate or renegotiate on an equal basis with trans-

national corporations* and foreign investors generally. Policy guidelines are also required to ensure that the activities of these groups conform with national objectives of rural development.[21]

* * * * *

As should be evident, the various Canadian institutions concerned with food system projects in developing countries have established an interlocking organizational network that is functional and adaptable. Particularly over the last decade, this network has grown in size and complexity. There have been commendable initiatives and striking successes. Nevertheless, because the magnitude of the task is such that much greater efforts are needed, the remainder of this Report addresses three questions. What strategies should Canada pursue for effective international food-system development during the eighties? How can these strategies be implemented effectively and economically? And, to what extent are Canadian aid agencies well-equipped to carry them out?

*Because of their size, sophistication, and number, multinational corporations are extremely important to Third World countries. Unfortunately, the role of multinationals (and of Canada's private corporate enterprise generally) could not be adequately examined in this study. Resources did not permit it. However, we wish to include a note of caution. Although the potential of multinationals is great, equally great is the need for care, for multinationals do not lack detractors.

IV. Putting S&T to Work

This Report has given some indication of the dimensions of the "food problem", and has shown that it is inextricably linked with the broader issue of development, particularly with the task of fostering rural development around the world. Although – as we have noted – science and technology in all cases needs careful adaptation and humanization, it is always an integral and necessary part of the development process. The challenge is, of course, to promote self-reliance in the developing world. Self-reliance is a matter of knowledge and will. The will each developing country must acquire for itself; but knowledge – especially in the form of science and technology – is a resource that can be shared.

Several questions arise. Are Canada, and other developed countries, adequately sharing this knowledge? Are we generating usable forms of knowledge? Are we encouraging developing countries to generate their own knowledge, and to adapt our technology to their own particular needs and circumstances? Finally, how well are we organized to carry out these tasks? A fair assessment can be made of Canada's performance in the realm of science and technology: first, of our proficiency in actually putting S&T to work for development (as will be done in this chapter); and second, of our readiness and ability to respond to future events (the topic addressed in Chapter V).

During the two decades prior to 1970, the Canadian S&T effort, relating specifically to development, was concentrated in three areas: training and strengthening educational institutions; strengthening institutions for research and for technology development; and applying known technology through technical assistance projects. After 1970, increased emphasis was placed on the development of an indigenous problem-solving capability through research with the establishment of IDRC and the attention it gave to the food sector.

Training

Training the Scientists and Technicians

An adequate number of scientists, technologists, and technicians is the first priority in building an indigenous capability for S&T in developing countries. These countries, with few exceptions, have not, and still cannot meet their own needs.

During the 1950s and 1960s, Canada responded by emphasizing training for developing country personnel, most of which was carried out in Canadian universities, technical institutions, and government laboratories, with a moderate amount of on-the-job training for technicians. Significantly, many of the students and trainees subsequently held positions of influence in universities, technical institutions, research centres, government planning and application units, and in industry in their own countries.

On the other hand, training during this era had two serious weaknesses: it was not closely aligned with the real needs of the student's country, and a high proportion of the trainees emigrated to developed countries. (Despite attempts at correction, these weaknesses still linger.)

In the late 1960s, CIDA became increasingly selective in its training assistance. Greater attention was paid to the choice of students in relation to manpower needs of the developing country, and care was taken to place students where they would receive training most relevant to their needs. Low priority is now given to undergraduate training, especially in Canada. The number of undergraduate visa students enrolled in agriculture, fisheries and food programs in Canadian universities is relatively small (189 in 1978). There is no valid reason to increase this, provided students have access to undergraduate programs in their home countries or in other countries in the same region, especially when the institutions have programs relevant to local needs. Not only will the learning environment be similar to the subsequent work environment, but also, the readjustment problems after graduation will be minimized.

At the same time, CIDA began to provide assistance for "third country" training; students from one developing country to be trained in a neighbouring developing country with specialized capability. For example, CIDA recently has assisted students from East African countries to study food science and nutrition at the University of Ghana, a university that had previously participated with the University of Guelph in a CIDA-supported cooperative program to strengthen food sector programs. IDRC has followed the same pattern: 35 of the 59 fellowship holders in 1978 pursued their studies in "third" countries.

During the past decade, training activities also became increasingly related to the program activities of both CIDA and IDRC in an attempt to focus training support on areas of greatest need. Counterpart training was built into projects in order to train nationals to continue the project activity after the Canadian "advisers", or more appropriately "collaborators", left at the end of the assistance period. The principle is sound, but there have been problems in operation. Normally, as CIDA projects are relatively short (three to four years), there have frequently been difficulties in identifying enough nationals, and early enough in the project,to have the counterparts fully trained and working before the departure of their Canadian collaborators. Another problem has been that many nationals trained for specific projects moved to other positions within the country or in another developing country, and all too often they emigrated to industrialized countries. These problems are illustrated in the CIDA project to assist in strengthening the Njoro Research Station in Kenya. The University of Manitoba, as the executing agent, had Ca-

nadian scientists on site from 1965 to 1975, and arranged for the training of counterparts. However, by 1978 the national staff had been reduced – although working elsewhere in Kenya – to the point where CIDA was requested by the Kenyan government to re-establish the project.

Local adaptation of foreign expertise and the effective use of technical assistance require a high degree of collaboration among people of different cultures, experience and needs. Canadian experts can help their counterparts to strengthen their skills in the process of transferring and adapting technologies. To be able to do this effectively, Canadians should improve their intercultural competence: social interaction with nationals; ability to speak local languages; concern with the transfer of technology and factual knowledge; and tolerance and openness. A recent study for CIDA, *Canadians in Development*, concluded that Canadians employed by CIDA are not very effective in transferring their skills.[1] According to the study, part of the reason is that CIDA experts have poor social interaction with the host nationals. Canadians who learn local languages once in the field (such as the majority of CUSO volunteers) generally interact more effectively with their counterparts. This does not mean, of course, that transfers of technology occur automatically. To ensure that technology actually does get transferred, such an objective should be given a top priority in any mission of Canadians in development projects in the Third World.

The importance of Canadians becoming involved in on-the-job training must be stressed. Theoretical knowledge is not enough; it must be transformed into useful expertise. Knowledge acquired through education must be implemented, and translated into actual operations at a worksite. Furthermore, in order for expertise to be useful, it must bear the stamp of an individual culture. For although science tends to be universal, technologies are not. Each culture has its own way of doing things, and this is why more and more developing countries are seeking to acquire expertise in their own milieu or environment. In fact, because of its site-specific nature, collaborative efforts in on-the-job training in developing countries call for greater sensitivity and adaptability than does science education.

Scientists trained at the graduate level are the key element in the S&T system. Hitherto, most CIDA-supported graduate students have been trained in Canadian universities. As graduate training capability increases in the developing countries, the proportion of training taking place in Canada will decline. However, in spite of substantial advances in university growth, developing countries do not yet have the capacity to handle graduate training in all subjects. They will need to continue to draw upon the resources of developed countries during the next decade. Canada should continue its collaboration.

The number of visa students from developing countries in food sector programs at the graduate level in Canadian universities rose from approximately 100 in 1973 to 277 in 1978. This accounts for one-quarter of all graduate students in faculties of agriculture and veterinary medicine in Canada. Eighty per cent are from low- and medium-income developing countries, which have food deficits.

Canadian universities should provide study programs designed to equip the scientist for work in the developing countries. Scientists dealing with food-system problems in developing countries must have scientific knowledge and training of the highest order. A focus on development must, however, be maintained, rather than simply on science for its own sake. Therefore, a course or seminar series on the development process and on research and outreach strategies for development should be included in university programs, and made a requirement for all visa students from developing countries.

Careful attention should be paid to the selection of the thesis research topic: in addition to providing a vehicle for research training it can maintain the student's orientation to development-related science. Allowing developing country students to undertake their thesis research in their home country or region is one way of accomplishing this objective. In 1973, such an arrangement was initiated between IDRC, Laval University and the National Agricultural Research Station in Bambey, Senegal. Laval University agreed to provide master's program training for 11 students from six Sahel countries, with the course work at Laval and thesis research at Bambey. According to Laval, Bambey, and IDRC participants, the arrangement was very successful. Since then, IDRC has awarded 15 scholarships for students to do their PhD thesis research in their own countries.

The advantages are that students keep in close touch with, and establish a scientific presence in their home country, and contribute at the same time to their country's development. There are drawbacks. The training period is extended, costs are higher, the student's efforts can be disrupted by such relocations, and more demands are made on faculty time for student supervision. On balance though, it is a valuable system for improving the quality of training, and it should be used more widely whenever the specific research topics permit and whenever it will provide the best quality research experience for the student.

Non-thesis graduate degree programs ("professional programs") should be offered more generally by Canadian universities for those students interested in careers in outreach and extension rather than in research. (These flexible graduate programs should be directed towards Canadian students as well as those from developing countries.)

Canada has provided some training at the non-degree level, but it has been carried out by only a few institutions. The diploma and

short-course programs in cooperative formation and in social development at the Coady International Institute of St. Francis Xavier University have had a significant impact on rural development. More than 2000 graduates over the past 30 years are now working in 100 countries, where they have played a major role in cooperative formation and management. The Centre for Cooperative Studies, University of Sherbrooke, is developing a similar program for francophone students. Also, the College of Fisheries of Newfoundland provides technical and skills training in fisheries.

As the S&T system grows in developing countries there will be a growing need for specialized courses, workshops, and study periods to deal with specific topics. Topics include teaching methodology; research techniques; research planning and management in a development setting; specialized discipline subjects; laboratory methods; and extension, outreach and communication systems. New topics will arise continually.

Specialized training for individuals has been built into CIDA and IDRC projects, with some training located in appropriate centres in the developing regions and some (although a relatively small amount) in Canada. Agriculture Canada provides training for research scientists and support staff for twinning projects between Agriculture Canada and research institutions in developing countries. Brazilian scientists involved in the project between the wheat breeding station at Passo Fundo and Agriculture Canada spend half their time in Winnipeg each year, learning new techniques. In some cases, Agriculture Canada brings support staff to Canada at crucial times to learn particular techniques: for example, pilot plant processing of fruits and vegetables, and meat inspection.

Canada should increase its activities in special training. However, an increasing number of programs should be offered in developing countries under collaborative arrangements with local institutions. A trend-setting model is a program developed by UNESCO to provide specialized training in specific aspects of veterinary medicine. The plan calls for the identification of a base institution in a developing country and one in an advanced country to collaborate in the program and, on an alternating basis, to provide the site for a short course. Broad aspects of the topic are covered in the developing country and the more specialized aspects, requiring the input of many specialists and access to special equipment, at the university in the developed country. The first course under this plan (held at Guelph) was successful.

Although scientists and technologists are the first requirement, the S&T system will not operate effectively, especially at the development and application end of the system, unless large numbers of indigenous skilled technicians are available. Most of the training must be located in the developing countries because of the site-spe-

cific nature of food-sector training and because of the numbers involved. Strong technician training institutions are essential in developing countries. Canada, which has done little in their support, should give high priority to such requests from developing countries.

Strengthening the Educational Institutions

The single most important activity in promoting greater self-reliance in S&T for developing countries is building and strengthening their institutions for training, research, outreach and application. Most of Canada's efforts to date have been aimed at strengthening universities, and national and regional research centres.

One of the first comprehensive Canadian university-building projects, which included staffing, staff training, assistance in providing equipment and facilities and assistance in program development, involved Thailand's Khon Kaen University and the University of Manitoba. It began in 1965. As executing agent for CIDA, the University of Manitoba helped develop Khon Kaen's faculties of agriculture and engineering, and seven Manitoba faculty members were located at Khon Kaen between 1965 and 1972. The number of agricultural graduates has grown from 35 in the first graduating class of 1967-68 to 120 in 1977-78. The number of faculty with graduate degrees in agriculture grew from zero in 1965 to 55 (11 from Canada) out of 94 faculty members in 1978. These professors are currently involved in a number of research projects, and there is some modest involvement in outreach activities. The success of the project is due partly to the fact that the university was built on an established foundation of successful university operation in Thailand and enjoyed a satisfactory level of local funding.

The most comprehensive university-building project concerned with the food-system took place between the University of Ghana and the University of Guelph (1970-78). The project was initiated upon the request of the University of Ghana with the University of Guelph as the executing agent for CIDA. Twenty-three staff members from three Canadian universities and from the Extension Branch of the Ontario Ministry of Agriculture and Food participated in Ghana, and 48 Ghanaian students and faculty members were trained in Canada to develop staff for the university and for government ministries.

The university has grown in strength to the point that it is increasingly selected by CIDA scholars from developing countries for "third country" training. Canadian faculty in Ghana, along with Ghanaian faculty colleagues and with the Ghanaian and Canadian graduate students who were doing their thesis research on Ghanaian topics, were able to produce significant applied research results. They went further, and trained extension officers to ensure effective application.

Of special interest in this project was an inservice training program for technical officers of the Ministry of Agriculture. Guelph project staff, in cooperation with Ghanaian faculty and Ministry staff, assisted in training more than 1400 technical officers in extension methods in 58 short courses. The Ministry requested, and CIDA approved, continuation of Canadian assistance for this outreach phase through 1979. The Ghanaian request is one measure of the success of the outreach phase, an activity that should be an important component of the program of all developing country universities that have faculties dealing with the food system.

Requests for collaboration in this comprehensive type of project have declined as developing countries have strengthened their universities at the basic undergraduate level. Most recent requests have been for collaboration in strengthening a specific subject area. Examples are: agriculture at the University of Zambia (University of Manitoba), agricultural engineering at the University of The West Indies, Trinidad (University of Guelph), graduate program and research in soil science at two universities in Brazil (University of Saskatchewan), and graduate program in food science at the University of Campinas, Brazil (University of Guelph).

The university-building projects in the food sector, for which Canadian universities have been executing agents for CIDA, have generally been successful. Unfortunately this does not seem to be the case for similar projects managed by CIDA itself.* It is recommended that CIDA implement future university-building projects through a collaborative arrangement between a Canadian university and the developing country university, with the Canadian university as the executing agent.

Despite their success, universities have encountered many difficulties in their involvement in CIDA Bilateral Branch projects. The main causes seem to be project staff who are not familiar with the complexity of the food system; the rapid turnover of project officers; and the overall organization of CIDA's field supervision. Recommendations to overcome these problems appear later in this Report.

On the other hand, university management of some CIDA projects has been weak – although this has seldom been the case in food-system projects. Before participating in a project as executing agent, universities should design a general project management system to ensure efficient administration in Canada, and efficient and sensitive management in the field.

Overall, Canadian assistance in developing the capacity to train skilled para-professionals (large numbers of technicians, people skilled in handling the hardware of the new technology, and tech-

*As, for example, in the case of CIDA's help to the fisheries component of the University of the South Pacific at Fiji.

nology transfer agents) has been very limited. The institutions and systems for such training must be built in the developing countries, but Canadians certainly can play a role. One example of a successful CIDA-supported project is Proshika in Bangladesh. The project provides opportunities for tens of thousands of poor workers and landless labourers to solve their own problems through developing indigenous leadership and practical skill training. Fish and animal raising projects are involved as well as bee-keeping and honey production. CIDA's principal financial contribution has been to cover the recurrent costs for the 16 development centres. This in turn allows young Proshika workers to be trained as animators, and enables the rural poor to be trained in food production and income-generating activities. Training is based on experience appropriate to the villagers' own lives. The Proshika project encourages women to become involved in the training process.

The food problem is of such urgency that technology now ready to apply, or simply requiring adaptation, should be utilized immediately. There is, therefore, a pressing need to educate the technicians and skilled personnel essential to this task. Consequently, Canada, through CIDA and NGO projects, should consider new initiatives and expanded activities in this area.

* * * * *

So far we have discussed only one component in the task of putting S&T to work in the food system: generating (and maintaining) a supply of trained people who are skilled in research activities, in transforming these results into technology, or in applying the technology for practical results. Training is an essential activity, but institutions that generate research and technology, and apply this knowledge must also exist. Their special needs – and Canada's role – are discussed below.

Research

Strengthening The International Agricultural Research System[2]

To comprehend the structure of the world's agricultural research system, it is necessary to have some knowledge of the different levels at which this research is conducted.

Agricultural research can be categorized as *operational* (at farm level), *tactical* (supportive of operational, as at local experimental stations), *strategic* (direct support of tactical, intended to solve major problems in wide geographic areas), *supporting* (where usefulness is only partially foreseen), and *basic*.

These categories of research do not exist in isolation; any research centre may carry out work in several categories. For any cat-

egory to be effective it must be linked with other levels. Strategic, tactical, and operational research must draw upon the findings of basic and supporting research. Conversely, basic, supporting, and strategic research have little value unless tactical and operational research make their findings usable.

Over the past three decades, an interlocking "three-tiered" system of agricultural research has begun to emerge. One tier consists of the national programs, large or small, in each country. A second consists of the international or regional research installations in the tropics or sub-tropics, which back up national efforts (with strategic research) and provide linkages to centres of specialization elsewhere. The third tier consists of the centres of specialization, located mainly in the developed countries, where advances through basic and supporting categories of research (and in some cases strategic) are generated.

Each and every country, if its rural areas are to progress, must have capabilities at the operational and tactical levels, even if it can afford no other work. The establishment or strengthening of tactical research will allow any country, even though small, to draw technologies from elsewhere and to adapt them to regional and local needs.

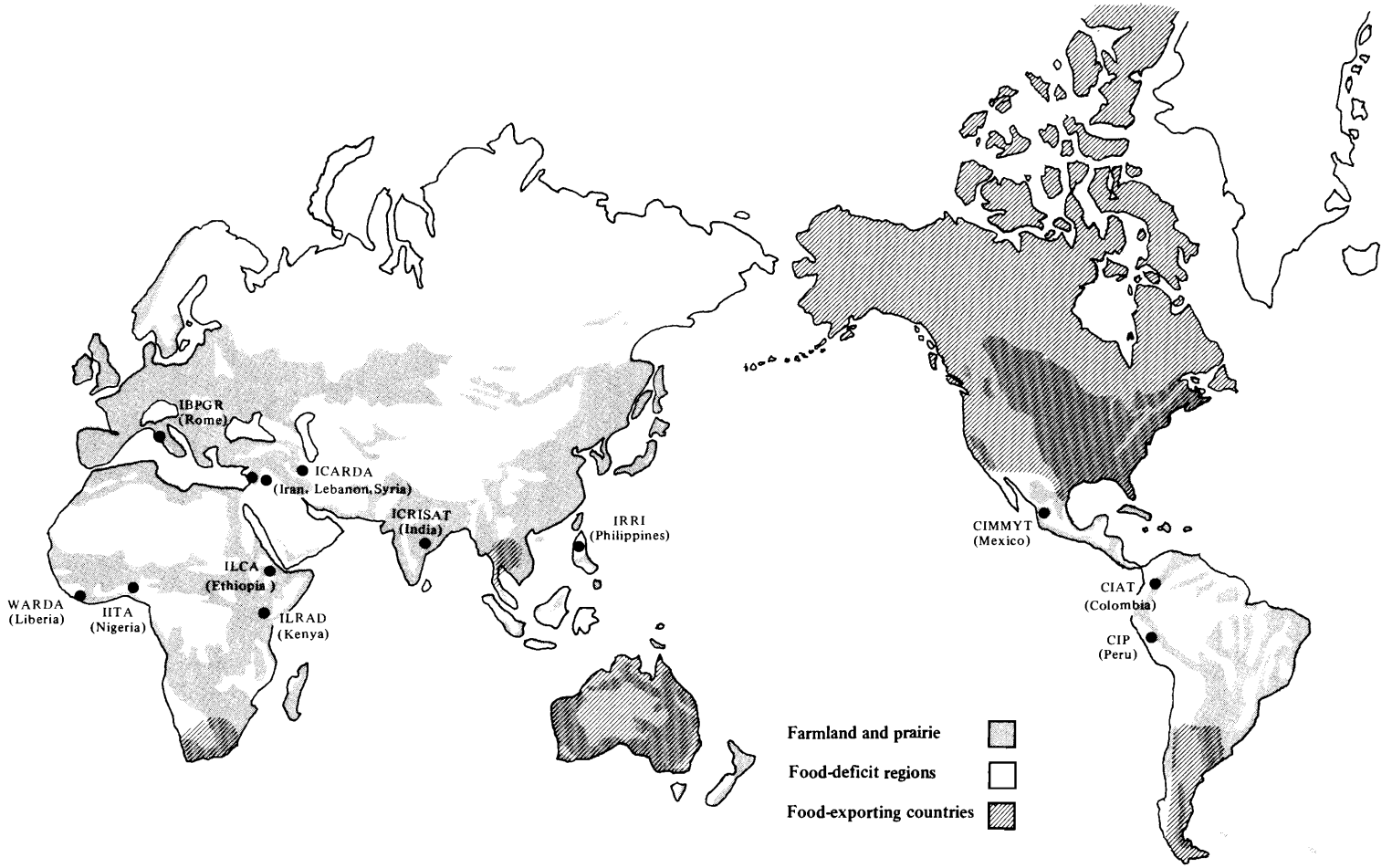
Some larger countries also will be able to support and, in fact, will need, strategic research efforts. Because so many small countries cannot afford strategic research in all fields related to their national development, local efforts at adaptation and testing must be augmented by centres of strategic research elsewhere in the region. For this reason, the Ford and the Rockefeller Foundations in the early 1960s, and more recently the Consultative Group on International Agricultural Research (CGIAR), established in cooperation with host governments a network of International Agricultural Research Centres (IARCs). The Centres support national research efforts, and train personnel for national programs. Thirteen activities are presently supported by the CGIAR system, including ten research centres.* Figure IV.1 shows their locations.

The IARC system coordinated by the CGIAR is the largest and most visible innovation in the S&T system for agricultural development over the past two decades. The system was initiated with the establishment of the International Rice Research Institute (IRRI) in the Philippines in 1960 and the International Maize and Wheat Improvement Centre (CIMMYT) in Mexico in 1966. The new rice and wheat cultivars that created the "green revolution" in the late 1960s came from these centres.

(Nineteen countries and 16 international agencies and foundations fund the system. Canada, through CIDA's Multilateral Division,

*See Appendix, The IARCs: The CGIAR Network.

Figure IV.1 - The International Agricultural Research Centres



Source: Consultative Group on International Agricultural Research, CGIAR, New York, 1976.

joined the early funding group, providing unrestricted core support to the Centres. Canada's 1979 contribution ($7 million) made it the third largest national donor next to the United States and West Germany.)

Other institutes outside the CGIAR system are also engaged in strategic research; among them are the International Fertilizer Development Centre, the International Centre for Insect Physiology and Ecology in Nairobi, and the Asian Vegetable Research and Development Centre in Taiwan.

Research of the supporting type will be found to some extent in the major research centres of the larger developing countries and in the IARCs, but most is conducted at universities or in industrial laboratories in the more affluent countries; only a relatively small number of countries can afford vigorous support for work covering the entire spectrum.

The three-tiered interlocking system of agricultural research is an international achievement of considerable magnitude. The challenge is to put to use the flood of useful knowledge emerging from the system. However, Third World countries have not had, and still do not have, adequate institutional capability in research and related outreach and technology transfer activities. Canadian contributions to the various levels of the system are now examined.

International Agricultural Research Centres

The goal of the IARCs is to focus research on carefully selected commodities and topics where major breakthroughs could result in significant increases in food supply. Such research can be carried out on a larger scale than is possible for a single country to fund by itself. Furthermore, research programs are designed to be compatible with, and to stimulate, national programs. For example, the new germ plasm of crop plants created at the Centres is used by national research centres to produce new food crop cultivars. The Centres also provide worldwide information services on the major commodities and topics, and operate a training program to assist national outreach and technology application activities.

IDRC has worked closely with several Centres, contributing directly to the IARC network through financial and technical support for a number of specific activities. IDRC played a leading role in assisting the Ford Foundation in creating the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Subsequently, IDRC was appointed by the CGIAR as the executing agency for the creation of the International Livestock Centre for Africa (ILCA) in Ethiopia, and for the establishment of the International Centre for Agricultural Research in Dry Areas (ICARDA), which will carry out research in crops and farming systems of importance to the Mediterranean, the Near East and North Africa.

The growth of the IARC network in recent years is one of the most heartening developments in the world food system. They occupy a unique niche between national research institutions on one hand, and centres for specialized and basic research (mainly in developed countries) on the other.

Also, the IARCs provide an outstanding example of the widespread benefits (and economies) attainable through international collaboration on strategic research. The work they perform is indispensible.

Canada should continue its present high level of support to the IARCs: at least maintaining *core* funding levels in constant dollars; and maintaining present funding levels, through IDRC projects.

Furthermore, Canada should expand its financial and technical support through new collaborative research projects carried out with Canadian scientific institutions (for which IDRC's cassava project could serve as a model). However, substantial increases in our overall level of support for these Centres does not seem called for at present.

There is, nevertheless, danger on the horizon. These institutions, situated midway between basic research and tactical research functions, will encounter a constant temptation to become involved in both fundamental investigations and in practical applications. The temptation must be resisted; separate institutions already exist for these purposes. The role of IARCs is to "focus directly and intentionally on the creation of the technology required to support development efforts."[3]

As Omond Solandt has noted: "The Centres shouldn't try substituting themselves for national programs of agricultural extension and training; they must ensure that the inputs of knowledge to these programs are good, relevant and up-to-date, but they must not begin to do the national job themselves."[4]

In short, astute selectivity is the key to their continuing excellence. The growth of IARC activities should not be limited by the availability of money as much as by the availability of projects and people that meet the high standards of the group.

Regional Institutes in Developing Countries

In a rather different category from the IARCs is a small number of institutes that exist to serve the development needs of a specific *region*, Southeast Asia, for instance. The following example is representative.

Canada, through CIDA and IDRC and in cooperation with 17 other governments and a number of international organizations and foundations, has provided support to the Asian Institute of Technology (AIT) in Thailand. More than half the world's population live in the countries served by this regional graduate school.[5] Early in its history it engaged in contract research on behalf of government and pri-

vate agencies. Now 20 years old, the Institute has expanded through the years to address the social, economic and technical needs of Southeast Asia: agricultural and food engineering is now offered as well as energy, environmental and water resource engineering. The academic staff is of high calibre, roughly 50 per cent Asian and 50 per cent seconded from the West. In both education and research, AIT can use the very latest technologies in both education and research. Almost 1800 students had graduated by August 1979; of these, 92 per cent are working in Asia, 85 per cent in their own countries.[6]

Such regional institutes are as much training schools as producers of technology; furthermore, unlike the IARCs, they are not concerned solely with food-related disciplines. Also, their output tends to be more immediately applicable; in fact, they provide a bridge from the end of the research spectrum to the beginning of application.

Another excellent example of the work of regional institutes – also from Southeast Asia – concerns fish production. In June 1975, IDRC gave a substantial boost to a program of the Southeast Asian Fisheries Development Centre (SEAFDEC), located in the Philippines, in approving a $826 000 three-year grant for its aquaculture department. The research program was on a scale never before attempted,[7] and concerned the breeding and rearing of milkfish in captivity. The work was very successful and greatly advanced the culturing of the fish in a sustainable, labour-intensive manner.

Despite these successes, regional institutes have in our opinion failed to achieve significant regional impact. To this extent, they constitute a weak link in the food-system network; however, they are important and deserve increased support from Canada.

National Research Institutes in Developing Countries

Most developing countries, no matter how poor, have at least the outline of a national research system, devoted to operational and tactical agricultural research. Indeed, some large developing countries have a network of national research institutes, from which technology is transferred to technological institutes, and thence to demonstration stations and experimental farms. (One objective of national research institutes is to act as intermediaries between IARCs and extension services to villages.)

One criticism is that these institutes are often insufficiently aware of the practical problems encountered by their clients, the farmers. In some cases one may question the appropriateness, to local and regional development needs, of their output of technology. To some extent this is attributable to the scientific reward system, for in developed countries, peer pressure favours publication over practical application.

The major problem is funding. Most of these institutes are inadequately staffed; generating and adapting technology for regional

(or local) conditions requires many researchers. The institutes warrant greatly increased support, both from their own governments and from developed countries.

It is especially unfortunate that the poorest developing countries spend proportionately the least amount on agricultural research. (See Table IV.1) These countries are precisely the ones that most need innovations in agriculture. However, their national research institutes are too poorly funded to function adequately or even to make effective use of either the international research network or research from developed countries.

However, many heartening examples of productive collaboration between national research institutes and Canadian organizations do exist. One instance is the involvement of Agriculture Canada in the programs of Indian national research stations.

The All-India Coordinated Research Project on Dryland Agriculture was initiated by the Indian Council of Agricultural Research (ICAR) in June 1970, in collaboration with the government of Canada (through CIDA). Twenty-three research centres were selected to represent eight zones with differing soils and agroclimatic conditions. The objectives of the project were to conserve soil and water, to increase individual yields, and to stabilize dryland agriculture to meet weather aberrations.

Another example (mentioned earlier in this Report) concerns interaction between a Canadian university faculty and a Kenyan research station. As executing agent for CIDA, the University of Manitoba was charged with building up the Njoro Crop Research Station from 1965 to 1975. Wheat production was improved through breeding and agronomic research. Emphasis was placed on developing an effective combination of facilities, staff, and methodology for ongoing progress after the end of the project. Canadians were active in day-to-day research, working side by side with Kenyans.

Table IV.1 - Expenditures on Agricultural Research as a Percentage of Value of Agricultural Product, 1974

Country Per Capita Income, 1971	Percentage on Research
Over $1750	2.55
$1001 to 1750	2.34
$401 to 1000	1.16
$150 to 400	1.01
Below $150	0.67

Source: Consultative Group on International Agricultural Research, *Report of the Task Force on International Assistance for Strengthening National Agricultural Research*, (based on *Research and Extension Programs*, James K. Boyce and Robert E. Evenson, Agricultural Development Council, 1975.) New York, August 1978.

The upgrading of the station through successful research led the Kenyan Ministry of Agriculture to establish it as the National Plant Breeding Station in 1975, and to extend its scope to include barley and oilseed crop improvement.[8]

By far the most significant interaction between Canada and national research institutes occurs through IDRC projects, however. Indeed, of its total budget for food research IDRC spends around 40 per cent in these institutes.[9] The following examples illustrate the variety of national institutes and their range of research interests:

(1) *Crops*. A three-year project is being funded by IDRC at the Colombian Agricultural Institute in Bogota, to develop efficient multiple cropping methods, and to recommend ways of increasing small farm production and income in Colombia.

(2) *Fisheries*. With IDRC sponsorship, the Foundation for the Scientific Study of Man and Nature in Quito, Ecuador, is studying how to improve cultivation and to increase the practical uses of the native fish, the chame, as a food for rural communities along the tropical Pacific Coast of Latin America.

(3) *Agro-forestry*. The Ministry of Rural Development of Senegal is, with continuing IDRC funding, performing research to improve the production of gum arabic from the acacia tree, and to develop new techniques for reforestation in the Sahel.

(4) *Animals*. In Peru, the Veterinary Institute of Tropical and High Altitude Research is attempting to introduce pasture grasses and legumes so that cattle can be maintained in the largely uncultivated Amazon river basin. This is a three-year (IDRC) project.

(5) *Post-Production Handling*. In Malaysia, rice harvested during the wet season is often lost through spoilage. With IDRC funding, the Malaysian Agricultural Research and Development Institute is developing alternative methods of cleaning and drying rice at the farm level.

These examples have been cited to demonstrate the immediacy and relevance of the work these institutes perform. National research institutes are essential to each country's development. Generally, however, their impact still falls short of its inherent potential. Measures to strengthen them are needed immediately. They need far more financial support; in some instances, even a tenfold increase would not be excessive.

Canada should remain responsive to requests from developing countries for assistance in this regard. However, IDRC is already using most of its food research funds for this purpose, and can do no more without an increase in its budget.

In addition, increased technical assistance should be provided to these institutes by CIDA, using Canadian universities, Agriculture Canada, and Fisheries and Oceans as executing agents.

Involving Canadian Scientists

As we have seen, it is of the utmost importance that research (especially the operational, tactical, and strategic varieties) continue to increase in developing countries and in the laboratories of the IARCs. Canada has a significant role to play in supporting and encouraging this research.

Recently, developing countries, recognising the usefulness of scientific knowledge, have asked the developed world for direct contributions of basic and supporting research – in many instances, research yet to be performed. In response to this and to the supportive need just mentioned, in 1979 Canada pledged to perform a significant amount of research – primarily through collaborative ventures aimed at solving problems of the developing world. (See p. 82)

In this section, the direct involvement of Canadian scientists in development-oriented research is discussed, deferring for later consideration the organizational framework most suited to selecting, overseeing, and transferring this research.

Involvement to Date

Until around 1975, Canadian scientists were moderately involved in research connected with Third World problems. However, this involvement was never extensive, and in the last five years it has declined. This decline is disheartening, for when Canadian scientists have been involved they have demonstrated considerable ingenuity and expertise.

A small but important component of IDRC's program involves basic research supporting the more applied work. Some of this basic research has been carried out in Canadian institutions. As an excellent example of this, funds – managed by IDRC – were provided by CIDA for research by Canadian universities on aspects of the cassava program that an international research centre (CIAT in Colombia) did not have the expertise nor special equipment needed to carry out the research itself. From 1970 until 1975 when the program ended, 12 academic departments within two Canadian universities were involved. The National Research Council Prairie Laboratory was also involved. IDRC subsequently capitalized on the new Canadian strength generated by the program to develop a world cassava research network.

Canadian scientists have also been successfully employed by IDRC in consulting work. They have participated in project feasibility and design studies, and in progress reviews. One such model of Canadian scientific involvement came about through a partnership between IDRC and the Alberta faculty of agriculture. In Nigeria, the University of Alberta provided backup support in engineering, home economics, and management organization for the very successful IDRC Maiduguri Mill project. Alberta, together with some other Ca-

nadian universities, used special facilities and expertise available in Canada but not in Nigeria, to contribute in a unique way to the development of milling equipment, baking methods and new food products. Furthermore, Alberta faculty working with IDRC staff made key contributions to the evolution of a network for post harvest research in West Africa. Involved on a long-term basis, they currently have an input to all of the 60 active IDRC projects in this field. Canada now has, in Alberta, a centre of strength on post-harvest research related to development.

As mentioned, however, the involvement of Canadian scientists in development has not been extensive. The trend concerning university faculty involvement in particular has been dipping since 1976. (See Figure IV.2.) And yet, IDRC could have been expected to seek the cooperation of Canadian scientists, especially of those in the universities. IDRC has the mandate to enlist the talents of Canadians in its work, and university people are very well represented at the organizations's policy level (11 board members out of the 1979 total of 21 are academics, including four Canadians). Significant participation by Canadian scientists was indicated when the organization was first set up; program officers of the AFNS division were placed at 4 Canadian universities, and major programs were initiated (including cassava with University of Guelph and triticale with the University of Manitoba). Presently, however, program officers are located at only two Canadian universities and large projects have either been terminated or are terminating. (Although managed by IDRC these large projects were for the greater part funded by CIDA.) Universities in Britain, the Netherlands, and Sweden have become more deeply involved in international development since 1970; whereas in Canada the opposite is the case.

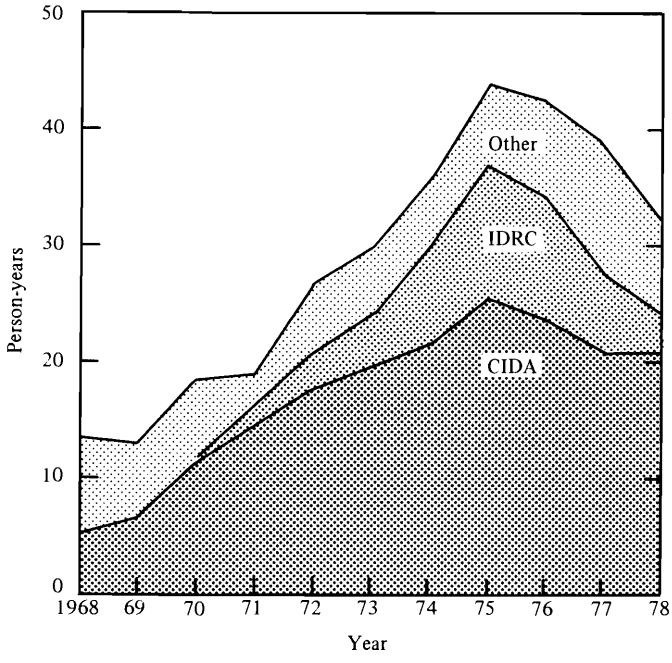
After leaving IDRC, its former president David Hopper recalled that only 7 per cent of its research resources had gone into research in Canada, another 1 per cent to research in other developed countries, and 92 per cent of its research budget had gone to the developing world. Perhaps, he said, we should have moved towards a 20:80 or 25:75 ratio, although it was important in the beginning for the bulk of our resources to go to scientists in developing countries.[10]

The Challenge of UNCSTD

Impelled partly by arguments such as those listed above, and partly by requests from developing countries themselves, Canada at the 1979 UNCSTD meeting pledged 1 per cent of its Official Development Assistance (approximately $12 million) to encourage the Canadian research community to pursue collaborative research with and for the benefit of these regions.

Treasury Board has budgeted $1 million (1981-82) for this endeavour, and IDRC (which was invited to become the lead agency for

Figure IV.2 - Trends in University Faculty Involvement in International Development (Food System)



Source: Based on data in William E. Tossell, *Partnership in Development*, Background Study No. 45, Science Council of Canada, 1980, Table III.3.

this new program) allocated $300 000 of its own money in 1980-81 to lay the groundwork for this research in Canadian institutions. IDRC is expected to build up its capacity to use the full funding fairly rapidly over the next few years. (IDRC has responsibility for devising the mechanism for allocating this money; accordingly, this matter will be discussed more fully under New Directions for IDRC.) We recommend most strongly that the federal government live up to its full UNCSTD commitment.

One encouraging development is the creation in 1978 of the International Development Office (IDO) within the Association of Universities and Colleges of Canada. Although this office deals solely with university involvement in international development, it will be instrumental in communicating the challenge of development to a wider range of university faculties. (So far, interest in development cooperation has been shown mainly in the areas of agriculture and medicine.)

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Thus far, this Report has addressed two aspects of the process of putting S&T to work for development: training people in S&T (and

building appropriate training institutions), and performing research (whether in developing country institutes, in IARCs, or in Canada). We now come to the third, and final step: *applying* research and technology. This step can be more expensive, more uncertain, and potentially more disruptive than either of the preceeding steps. It is, nevertheless, the *raison d'être* of the whole process.

Application

The most effective technology is that which is developed locally, and uses the skills of those for whom it is intended.

No technology, however appropriate, can take root unless there already exists, or is prepared in advance, a favourable and receptive environment. This factor is so important and so often overlooked that the remainder of this section is devoted to it.

Preconditions for Success

It is now well recognized that the existence of research does not, by itself, lead automatically to usable technology. An incentive to transform basic scientific knowledge into technological expertise must first exist; and a favourable environment (including, for example, specialized institutions) must then be created if the task is to be successfully carried out.

Less generally recognized is the fact that a similar gap exists between technology and its productive application. Indeed, it is often assumed that the "technological imperative" is irresistible: the very existence of practical agricultural technology is presumed to lead inevitably to its implementation, with benefits for all. Given this viewpoint, failure to act is attributed – especially by those who develop the technology – to "irrationality" or "lack of vision".

In fact, the farmers' world is quite rational. Almost always, reluctance to use *new* technology is based on an accurate perception of two crippling liabilities: lack of incentive and lack of a favourable environment. In short, without an underlying support system conducive to success in new methods, continuing along traditional paths is rational, even clear-sighted.

In our view, this absence is the most important obstacle to the immediate application in developing countries of a wide range of proven agricultural technologies. In many countries, not only is the infrastructure seriously flawed in at least one essential element, but there is also – at planning levels – failure to appreciate the crucial nature of this deficiency. Technology, by its very promise and dynamism, is presumed to be able to leap over gaps in infrastructure.

Meanwhile, a backlog of technology – developed through very substantial investment – accumulates. In the fields, the farmer

makes two rational decisions: not to produce more than he can profitably sell; and to use only those techniques that are known to work.

In rural areas of most developing countries, the underlying support system is well matched with traditional agricultural practices; indeed, the two evolved together over many centuries. The support system needed for higher food productivity (via modern agriculture) is rather different, and can exist only through deliberate action by government.

As Arthur Mosher observes,[11] basic infrastructure has five elements, and each is indispensable if the results of research are to be of benefit:

a) markets for farm products: although this seems self-evident, it must be noted that for centuries in many developing countries each farming district produced only enough to satisfy its own requirements;
b) local availability of farm supplies and equipment: this includes items such as seeds, fertilizer, feed supplements, and implements – and also staples such as water and irrigation systems;
c) distribution systems: an infrastructure of roads, rail service and storage facilities – for incoming supplies, and sending food to markets;
d) credit; and
e) adequate incentives for the farmer; pricing policies that allow profits; land tenure policies to encourage stewardship; means of insuring against risk.

Each element is essential: none is sufficient without the other four.

Once these *basic* components are in place, five additional elements are needed. These are the *efficiency* components of the infrastructure – in effect, accelerators of the pace of agricultural development. They are:

f) education for development;
g) group action by farmers;
h) improving and (where possible) expanding agricultural land;
i) planning for agricultural development; and
j) local supply of non-agricultural (consumer) goods.

Both the basic and the efficiency components have the effect of improving the facilities available to farmers, and thus the conditions under which farming is carried on. Agricultural technology, as embodied in extension services, requires a receptive *context* for its application. Rural infrastructure supplies this context; without it, technology cannot find its niche.

This melding of agricultural technology tailored to local conditions with a local infrastructure receptive to that technology's needs,

is the engine that powers rural development. As a consequence, food production is improved, beyond local requirements, and – quite as important – there is an increase in purchasing power, enabling poor and hungry people to buy food.

A dilemma exists for developed countries such as Canada. No matter how assiduously we sponsor or augment the food technology chain, it is doomed to languish at the village level unless an appropriate infrastructure and incentives are in place. Instead, all too frequently, an insurmountable gap remains.

Bridging the gap is quite clearly the responsibility of the host country. Assisting countries should not usurp this prerogative, but it is important that developing countries be fully informed when ranking their priorities. Planning has a heavily urban orientation in developing countries; far more attention is paid to urban needs than to rural infrastructure.

Generally, Canada should resolutely avoid the temptation to implement a rural support system itself. However, strenuous efforts should be made to facilitate, and encourage, the development of workable infrastructures by host nationals, on a country-by-country basis.

In Council's opinion the onus lies on CIDA, which supervises and builds physical infrastructure on request, to increase its competence for matching the infrastructure with local needs. CIDA needs a much more integrated viewpoint, rather than unduly concentrating on individual elements of physical infrastructure. CIDA should develop this competence, but IDRC, because it has concentrated on research for rural development for ten years, can help considerably.

A significant role also exists for NGO workers. Although they are quite involved in building social infrastructure, they must seek better links with technical workers to help close the technology-infrastructure gap.

V. The Will to Respond

Can we in Canada make more effective use of our knowledge – present and future – to help developing countries towards self-reliance in food? The previous chapter identified a number of steps to be taken – in training people, in generating and supporting research, and in applying this research more effectively. This chapter will address the *means* of responding to this task. How can we best *organize* to carry out the necessary action? How, for example, should existing institutions be strengthened? Which institutions need to be reorganized? Next, human resources: does Canada have sufficient numbers of people with the required skills? What are the implications for education and retraining?

These issues must be faced squarely and without delay. Positive attention to these matters implies a national willingness to get the job done. Not simply an accurate perception of the challenge, but also a will to respond.

Strengthening Canadian Institutions

New Directions for IDRC

IDRC has had an extraordinarily innovative and productive ten years. As it begins its second decade, however, IDRC should consider broadening its base of operations. Indeed, three changes in course are indicated:

1. *Tapping Canadian Basic Research.* With some notable exceptions, IARCs and national research institutes do not perform basic research themselves, but rely on a world stockpile. Canada has the means and the competence to help replenish this stockpile of basic knowledge, but should do so through a selective and orderly approach.

   Although to date it has rightly chosen to focus on activity in developing countries (over 90 per cent of its research budget has gone to the developing world), IDRC clearly has a mandate to draw more extensively on those Canadian research institutions performing basic and supporting research of global significance.* Its Act specifies that it "enlist the talents of natural and social scientists and technologists of Canada. . . ."

   Now, however, Third World countries have made a point of requesting greater research contributions from developed countries, including Canada.[1]

*At the outset, IDRC managed a few major CIDA-funded programs with Canadian university participation – most notably and successfully the cassava project (with the University of Guelph) and research on triticale (with the University of Manitoba). Since 1976, however, the trend has been towards a declining involvement by Canadian faculty.

To begin, we recommend that IDRC identify in the developing countries those research areas now presenting obvious constraints to quantum-leaps in application. Such areas might include:

- basic genetics of drought-resistant crops;
- basic genetics of saline-resistant crops;
- atmospheric nitrogen fixation by cereals and other non-legume crops; and
- genetic development of insect and pest resistance

These fundamental topics are not likely to be addressed in IARCs, or national research institutes, but are essential to their long-term existence. To a slight extent, IDRC is already a "broker" between the research communities in Canada and those in developing countries – but this role can be expanded many times.

Having identified knowledge constraints, IDRC is uniquely qualified to develop research programs in partnership with appropriate Canadian institutions – such as the universities, Fisheries and Oceans, Agriculture Canada, and the National Research Council.

Furthermore, the financial resources are potentially available: As already noted, IDRC has been named as the lead agency in administering money pledged by Canada at UNCSTD ($12 million). It will, of course, include the Canadian scientific community and institutions in formulating this program, but we strongly urge a further step: collaboration on a full partnership basis. The research should begin as soon as possible.

2. *Increasing the Number of Scientists and Technologists in Developing Countries*. Through its innovative programs, IDRC has helped to train considerable numbers of Third World scientists and technologists, who are uniquely qualified to contribute to the development requirements of their respective countries. But many more are needed, and it is time for the process to become self-generating. These "first-generation" indigenous scientists, given proper support and encouragement, can in turn train future generations of scientists, possibly even better attuned to the specific needs of each country.

   Clearly, "second-generation" indigenous training of scientists and technologists implies further expansion of graduate programs in the developing countries themselves. Institution-building is CIDA's function. However, unless IDRC continues to support and sponsor project research in the graduate schools of Third World countries, CIDA's efforts will accomplish little.

A role for Canada's universities exists here also: the most effective means of building up new graduate schools is through shared research programs. (As discussed elsewhere in this Report, the shift in emphasis from assistance to undergraduate programs – which are, for the most part, in satisfactory condition – towards more advanced education should continue.) Attention should also be paid to sharing research programs with the IARCs.

3. *Linking Programs with CIDA*. IDRC and CIDA have always been at pains to maintain their mutual autonomy. It was especially important for IDRC, in its pioneering years, to avoid even the slightest suspicion of Canadian self-interest.

   Now that IDRC is firmly established as an organization deserving the confidence of developing countries, CIDA and IDRC should seek to rationalize their mutual roles, and indeed to maximize their complementary activity in these countries. This has happened occasionally in the past (for example, in the triticale and cassava projects), but should become quite deliberate policy during this decade.

   The initiative may well arise with either organization. CIDA, for example, must remain alert to the research findings that IDRC helps generate around the developing world. To be useful to any one country, these findings must be adapted to local conditions. CIDA must be ready to respond to governments' requests for practical application: in other words, pilot projects to test research results under field conditions, extension services to assist their implementation by farmers, and rural infrastructure to facilitate application. Without this readiness, it is highly likely that the original research investment will be lost. In a sense, IDRC sows the seed: it is CIDA's responsibility to water and fertilize the plant.

   Of course, quite frequently this order will be reversed. IDRC is far more flexible in its policies and administration than any government department, and can make excellent use of CIDA-built institutions. An example is the University of Ghana: CIDA's assistance has brought it to its present stage of development, and its researchers are qualified and enthusiastic. IDRC can now develop its research program, by supporting its graduates in work on indigenous research projects with the prospect of a short-term pay-off.

The principal message emerging from our examination of IDRC can be simply stated. Canada has a unique opportunity to innovate, and to involve our national science system in development research on a much larger scale than before, by capitalizing on the accumulated experience of IDRC and its network. *Collaborative research pro-*

grams, linking Canadian research units with developing country institutions via IDRC, is the preferred means. Given the will, our existing research collaboration, with the present number of university and other scientists, can be at least doubled. In particular, IDRC should immediately explore how best to involve Canadian university faculty in its programs, on a large scale.

CIDA: Greater Competence and Decentralization

CIDA is actively concerned with improving the quality of its development assistance. A significant corporate review, launched in 1976, has since provided the impetus for many specific changes. In particular, we commend CIDA's growing recognition of the importance of project evaluation. There are now encouraging new attempts to incorporate evaluation into the full life-cycle of a project; by this means CIDA intends to acquire a capability to learn, more methodically, from its development experience.

This learning process needs to be strengthened and accelerated. Particularly where CIDA is involved in attempts to improve the food system in developing countries, it is inextricably involved in rural development. And it is in the broad area of applying science and technology to rural development that CIDA most needs to improve its competence.

CIDA's Bilateral Branch most needs to innovate when facilitating rural development; in fact, the poorer the rural area, the greater the need for innovation. Research must find low-cost solutions, which can be spread throughout an area: solutions that will assist people to improve their lot with minimum continuing intervention from CIDA.

Rural life in poor countries must be revitalized so as to become more highly productive, equitable, and sustainable. This is primarily the responsibility of Third World countries themselves. They must place increasing emphasis on self-reliance and self-sufficiency in food production. This revitalization should also be the primary focus of Canada's scientific and technological aid, which, while recognizing other countries' sovereignty, should support developing country policies that relate to helping the rural poor and small farmers. In fact, a privileged place in rural development should be given to agricultural and fisheries development, for it provides not only food but the greatest source of employment in the poorest countries.

Currently, however, Canada is inadequately organized to assist poor countries to revitalize rural life. In this respect, CIDA stands in contrast to IDRC. At a sophisticated *research* level, IDRC has been very successful in supporting and catalyzing self-reliant development for rural areas. What CIDA needs is additional competence to facilitate and encourage rural revitalization. Networks of technologists and technological institutions whose actions are related to rural localities

should be fostered. These networks could help in identifying expertise which had proven successful in one area so that it can be adapted to others, through the development of technologies.

In short, CIDA needs a learning facility. But if it is to work effectively, it must heed the example of IDRC, and locate fewer staff in Ottawa, and many more in the field.

We are of the opinion that such an imaginative initiative would vastly improve the quality of CIDA's interventions in the developing world, redressing to a great extent our relative lack of expertise and experience in foreign rural development technologies.

Partnership Arrangements: At present, no explicit partnership exists whereby executing agents (such as the universities, or Agriculture Canada) can sit on a board or advisory council with CIDA to formulate policy. It is true that a Liaison Committee for International Development (LCID) has been set up by CIDA, IDRC, and the universities as a mechanism for communication at the senior level. This committee, which is close to the policy level of CIDA, is functioning well, and has brought about some degree of partnership between the organizations. There has also been set up a CIDA-Universities coordinating committee on higher education. CIDA is to be commended for working more closely with at least this one group of executing agents.

CIDA's Management: Enhancing the effectiveness of CIDA's various executing agents is a strong first step. CIDA must complement this by enhancing its own effectivenss. First and foremost, CIDA's project administration and management need attention. CIDA should rapidly carry out its intention of strengthening managerial competence in the food system, by establishing sectoral specialists in the Bilateral Branch where projects are administered. Presently, specialists are located in the Resources Branch, and have an advisory rather than a management function. CIDA should also increase its complement of specialists – there are only a dozen for the entire food system – and through short courses upgrade the food-system competence of existing non-specialist staff.

Furthermore, there are too few CIDA field officers located in the developing countries. Fifty handle the 2000 current projects of the Agency – helped, admittedly, by another 50 officers from the Department of External Affairs. First, the number of field officers should be increased. Second, their ranks should include specialists in agriculture, fisheries and rural development. (There are none at present.)

Continuity in project management is another area in which there is considerable room for improvement. It is quite common for executing agents to deal successively with three or four proj-

ect officers in the life of one project. At least two university projects have each involved six different project officers. Efficient administration is not possible under such circumstances.

One of the factors contributing to IDRC's success, and one which CIDA might well emulate, is the employment of developing country nationals. This poses a bureaucratic problem; as a federal government agency CIDA can employ only Canadians. Accordingly, we propose that the overseas competence within CIDA be granted "separate employer" status.

Considering its size, CIDA has shown itself a commendably adaptive organization. The objectives and principles it has established to govern Canadian assistance (*Strategy for International Development, 1975-1980*) place emphasis, quite rightly, on meeting the basic needs of developing peoples, and on giving highest priority to projects aimed at the poorest groups in recipient countries. We commend, too, the intention (although not yet the achievement) of involving Third World women as agents and beneficiaries of change on an equal basis with men.

Overall, the principle of self-reliance – transferring resources to support poor countries' capabilities to engineer their own development – cannot be bettered. However, to narrow the gap between principle and practice still further during the 1980s CIDA should:

- continue to strengthen its managerial competence;
- shift progressively from *implementation* (as, for example, through "turnkey" projects) in development cooperation to *facilitation*; and
- develop a capability to help others find, through experimentation, simple, low-cost, replicable solutions to rural development problems.

Non-Governmental Organizations: New Skills Needed

Canadian collaboration in development would be vastly impoverished without the activities of non-governmental organizations. They represent the most flexible, adaptable segment of any country's international outreach. Among other positive attributes, they can:[2]

- work on problems not yet urgent enough to command political attention;
- explore alternative futures and policy options on an unofficial basis;
- afford to make mistakes, and learn from them without embarrassment;
- organize unofficial dialogue across national or regional frontiers; and
- generate discussion among people of isolated or rival persuasions, who might otherwise never meet or talk to one another.

Moreover, these workers as a group have two characteristics that are indispensible to effective rural development:

- language skills, cultural sensitivity and interpersonal adaptability;
- a profound appreciation of the importance of "bottom-up" and local approaches to rural development.

In these ways they provide a highly effective complement to governmental approaches to development, especially when the latter rely on centrally-planned, "top-down", and high-technology approaches. *It is from the interplay of these two forces that true rural development emerges.*

Voluntary organizations are not without their limitations, of course. For example, more of their programs should encompass agricultural activities. Another cause for concern is their relative weakness in research capability.[3] Not only do they lack this capability themselves, but their links with research institutions are very weak. In recent years, agricultural research on subsistence crops has been greatly increased and expressly directed to the poor. NGOs should increase their acquaintance with such research. Working closely with people in individual rural communities gives them a signal opportunity to encourage increased agricultural productivity and processing in these communities.

A key to improving rural well-being is through new technology, through innovation. NGOs can ensure its appropriateness by providing a link between the communities they know well and the researchers. They can also assure its adoption by supplementing the work of extension agents. CIDA should encourage this trend by augmenting, through its bilateral funding, those NGOs that seek technical links and make provision for professional support.

Voluntary organizations are an important – indeed irreplaceable – part of Canada's response to world development. They constitute a resource which complements, rather than conflicts with, scientific resources. They also constitute the only major part of Canada's development effort which should remain active in the *implementation* of rural development work.

Agriculture Canada: Promise Yet Unrealised

Agriculture Canada, through its very considerable strength in skilled manpower, should become far more deeply involved in overseas development than at present, especially in research, the management of research, and in training and institution building. We recommend that it do so.

We commend Agriculture Canada for having made international development cooperation a departmental objective and, in addition, the direct responsibility of an assistant deputy minister. This

branch, Regional Development and International Affairs, addresses development issues both domestic and foreign.

Canada might well assume a major leadership role in the field of international dryland agriculture through the pooling and concentration of Canadian scientific resources. The department, which has been managing successful projects in India and Sri Lanka, might coordinate projects for other Canadian groups – such as the University of Saskatchewan, which has been successfully investigating new concepts for improving plant productivity under drought conditions. However, as initiatives in the field already exist in other countries, Agriculture Canada should study the international need for such a network (which could include the universities and IDRC).

Other Government Departments and Agencies

Canadian government departments and agencies (federal and provincial) with strengths in the food system should give serious consideration to declaring international cooperation an organizational objective.

Some of these organizations (Health and Welfare Canada, for example) may not usually be considered as involved in aid to developing countries. Nevertheless, whether directly or indirectly, each department's specific expertise can make a vital contribution to the wide spectrum of knowledge required from the production of food to questions of consumer nutrition.

Enunciating international development as a departmental or agency objective should not necessarily entail organizational requests for more resources or people. Most organizations can do a lot more with what they have – simply through increased efficiency, through tighter organization, and by bringing their capabilities to the attention of the Third World.

We congratulate the National Research Council (NRC) for its leadership in creating a Third World Desk for overseas collaboration. NRC already has had a successful, if limited, involvement in food development abroad, principally through its excellent Prairie Regional Laboratory in Saskatoon. NRC's contribution should now be increased.

Universities: A Concerted Effort Needed

Although individual professors, and some faculties, are active in Third World development projects, Canadian universities themselves lack a coherent policy towards international development. This is a regrettable situation, for their potential contribution is great. Accordingly, each Canadian university with a faculty or college of agriculture or veterinary medicine, or with major fisheries groups, should consider designating development cooperation in the food system as a formal university objective. This would constitute

an important step towards encouraging, facilitating, and rewarding faculty participation.

The Science Council commends the establishment of the International Development Office (IDO) of the Association of Universities and Colleges of Canada. Its purpose is to coordinate higher education in international development programs, liaison and information. It has shown great promise in working towards a full partnership between Canadian universities and the aid agencies on one hand, and with developing country universities, on the other. IDO is actively promoting linkages between universities at home and abroad by receiving and relaying requests for Canadian partners from developing country universities. It also relays Canadian university concerns to Third World counterparts.

In general, each Canadian university, as a member of a global community of scholarly institutions, should formulate a policy concerning its involvement in international development. Among other elements, this policy should include:

- a means of formulating priorities overseas;
- guidelines for thesis and course content;
- courses or programs in development concepts for all students (Canadian and Third World); and
- guidelines for management of overseas projects.

Canadian universities should concentrate their resources on two categories of task:

1) building indigenous university capability, especially at the graduate level;
2) collaborative research with individuals and institutions in developing countries.

Universities in the developing world have made rapid progress over the past two decades, although self-reliance has not generally been achieved as yet. The universities are also in different stages of evolution. Increasingly, the need exists for assistance at the graduate studies level, where research frequently comes to grips with national problems. There is also need for assistance as indigenous universities reach out to communities, developing innovative forms of extension services. Activities most likely to be in demand, and most compatible with Canadian university capabilities are:

a) high quality, development-oriented graduate training, to staff the universities;
b) university-to-university cooperative projects, whether comprehensive or specialized; and
c) specialized courses, workshops and study periods to deal with special and discrete topics.

Collaborative research is required to assist developing countries meet their research needs through a) university consultancy services, b) graduate training, c) research in conjunction with interna-

tional and developing country institutions, and d) research on the development process itself.

Universities should sometimes combine resources. Strengthening developing country universities on a broad front has always occasioned difficulties in the Canadian universities involved, particularly in finding the faculty needed for the project. Canadian universities could increase their capability to embark on these projects if they pooled their efforts in planning, and shared faculty resources. Such a mechanism could also provide a means of linking Canadian universities with university groups in other donor countries. The Association of Faculties and Colleges of Agriculture and Veterinary Medicine should consider establishing a *consortium* to coordinate and further their activities in development cooperation. The consortium could react to CIDA proposals, but – just as important – could also take the initiative in identifying project possibilities in partnership with developing country institutions. They could then jointly develop a series of special programs, and as a group approach development agencies for support. This consortium would be concerned primarily with the actual operation of development projects, whereas the IDO's emphasis should remain at the policy level.

One area in which the pooling of resources would be effective is the post-harvest system: this covers activities from harvesting through preservation to family nutrition. A strong university group, with development experience in conjunction with IDRC, already exists at the University of Alberta. Another strong grouping at Laval's Centre for Research in Nutrition has a formal link with the food program of the United Nations University, and in this way is linked with the Institute of Food Technology in Sénégal. A network originating with these two universities could give Canada a major international thrust in a most important aspect of the food system, as well as a more prominent role in the United Nations University.

The Tokyo-based United Nations University is an innovative organization without classrooms, which acts through networks of individuals and institutions in 60 countries. Research is carried on and advanced training provided for young developing country professionals. One priority program concerns world hunger: more specifically, the determination of nutritional needs, post-harvest food conservation, and food policy. The network has so far remained independent of the IARC network. Laval is the only Canadian university involved. Canada should continue to monitor the progress of this organization, to assess the desirability of contributing financially to its support.

Universities have not participated in fisheries development to the same degree as in agriculture. With the new implications for fisheries resulting from the recent deliberations on the Law of the Sea, Canadian universities are in a good position to establish special programs on fisheries management. Here too, there is scope for insti-

tution building in developing countries and for collaborative research. However, the role of Canadian universities in fisheries has been little explored, and warrants further examination.

Finally, we stress that a concerted effort must be made to increase the number of trained people that Canada can place at the service of developing countries to support or augment their development. Its members must be capable, flexible, and experienced in developing country problems. As professionals, they must have the assurance of continuing employment, rather than being expected to contribute their services on an *ad hoc* basis. An excellent means of ensuring the availability of sufficient numbers of these professionals is by maintaining, through the university system, a number of supernumerary positions. This additional professional complement will permit universities to respond much more significantly to requests for assistance in tasks such as: building and inaugurating developing country universities; providing advice on institution building to IDRC and CIDA; and similar assignments of limited duration.

Innovative Companies: Latent Partners

Canada's increased contribution to the food supply of developing countries cannot be properly addressed without considering the important role of the private sector. In spite of the variety of socio-economic and political systems prevailing in developing countries, the fact remains that their national productive systems need to be considerably strengthened in the fields of technology and management: areas in which Canadian industry can make a unique contribution.

Within the context of this Report, four distinct categories of "private" partners can be considered: the well-established manufacturing firm; the small, technologically-innovative firm; the consulting firm; and the groups of individuals who occasionally work in international development.

Manufacturing firms in the agricultural sector cover a wide spectrum, ranging from the production of fertilizers and foodstuffs, through the manufacture of machinery and entire processing plants and packaging equipment, to the marketing and sale of all kinds of food products and auxiliary equipment. Ways must be found to tap their vast expertise through cooperative endeavours with similar organizations in the developing countries, particularly to foster technology growth and managerial development.

Small technologically innovative firms are needed not only to introduce, develop, adapt and produce new technologies, well suited to the needs of developing countries, but also to encourage technological creativity and industrial entrepreneurship among the host nationals. Being themselves small, flexible and innovative, such firms can easily adapt to local conditions and develop a truly pro-

ductive partnership with bright young entrepreneurs. CIDA has already created a mechanism to foster this kind of endeavour through its Industrial Cooperation Program. If results should prove positive, CIDA should not hesitate to encourage further Canadian initiatives.

CIDA would be well advised to promote the growing involvement of sophisticated and technically adaptable private consulting firms, after encouraging them to acquire more intimate knowledge of tropical conditions.

The fourth category of "industrial" partner includes formal or informal groups of individuals who are interested, at one time or another, in sharing their expertise with nationals of developing countries. Cooperatives and groups of farmers or fishermen with broad experience in solving day-to-day problems fall within this category. Their contribution could become extremely valuable, particularly from a social point of view.

Recruiting and Training Canadians

Professional resources – scientific, technological and managerial – are a major limiting factor in development cooperation. Canada must make better use of existing expertise, and train people in those areas where our pool of talent is not adequate.

Utilizing Existing Resources

A comprehensive inventory is an indispensible first step to hastening the increased involvement of Canadian scientists in development projects.

In 1978, as an initial move towards such an inventory, the Science Council conducted a Canada-wide survey of suitable people, inquiring into their interest in, and availability for, food-system development work abroad. Age, sex, educational background, area of expertise, Third World experience, and language proficiency were taken into consideration.

People in federal departments and agencies (including Agriculture, Environment, Fisheries and Oceans, Health and Welfare, NRC, CIDA, and IDRC), provincial government departments, the NGO community, the universities, and the private sector were surveyed. Over 5000 questionnaires were distributed, and about 1900 were returned. Information on several hundred other people was collected from data banks.

The survey indicated that at present the number of experienced scientific, technological and managerial personnel is a factor limiting Canada's ability to provide assistance to the Third World. Superficially, Canada's potential seems ample; however, interested respondents without overseas experience considerably outnumber those with experience. Further, it is questionable whether experi-

enced personnel can be spared in substantial numbers from their work at home. However, disciplines thought to be especially constrained (for example, crop breeding and veterinary science) proved not to be so – at least potentially. Overall, the survey disclosed considerable interest in development work. The potential is clearly there, but nurturing is required. In addition, the practical question of finding replacements at home for professionals on overseas assignment remains unanswered.

CIDA should continue to improve its own roster of human resources for development assistance. It should also provide further support to its Canadian partners, so that they can do likewise (through individual agencies, or through umbrella organizations such as AUCC's IDO for the universities, or the CCIC for the voluntary organizations).*

Beyond maintaining comprehensive inventories, our ability to use existing Canadian expertise should be improved by:

a) better planning of long-term requirements;
b) providing attractive long-term career prospects;
c) additional money to government departments, universities and private firms for funding positions over and above those needed by these institutions; the objective is that they should devote an equivalent number of person-years to food-system development abroad. For example, an additional 25 person-years (the "supernumerary positions" discussed above) should be placed by CIDA among those Canadian universities wishing to participate in an expanded program. A comparable number should be placed in Agriculture Canada. Savings from reductions in food aid (from 200 to 250 million dollars annually) would more than fund these positions.

Developing New Resources

As the pool of experienced people immediately available in Canada is not large enough for a much higher level of cooperation, it should be developed by:

a) increasing the number of Canadian-financed FAO associateships awarded annually;
b) increasing the number of research associateships awarded by CIDA and IDRC; and
c) encouraging Canadian undergraduates to consider development work when planning their careers. Universities should include courses on development, and CIDA might sponsor, annually, field work in food-system development projects for 20 undergraduates.

*For example, returned CUSO volunteers in Canada number around 5000; of these, some 10 per cent have had experience in the food sector.

Employer Policies

A heavy Canadian demand for scientists and skilled technical experts in agricultural areas has made the recruitment process difficult. Many professionals are not interested in leaving good jobs in Canada to work in developing countries, especially when there is no guarantee of suitable re-employment after they complete their assignments.

Both federal and provincial government departments generally lack policies that encourage international development activities. Generally, they simply grant leave without pay. Some maintain employees' tenure, continue to grant salary increments and adjustments, and contribute to a superannuation fund; however, these employees are not generally eligible for promotion.

As the length of assignment increases, the difficulty in arranging release from some organizations increases. Special arrangements need to be worked out, particularly with government departments and universities.

Orientation

Suitable orientation should be provided in order to improve the effectiveness of Canadian professionals leaving for Third World assignments. CIDA's briefing centre provides general information to professionals and their spouses. However, a more comprehensive orientation is needed, especially for long-term postings. An effective program should include language instruction and training in the transfer of skills to rural populations, in cross-cultural communication, and in understanding of development issues. The quality of orientation programs can also be improved by systematic debriefing of professionals upon their return.

Attracting the Best Scientists

Top quality scientists can be recruited only if career disruption is minimized. A satisfactory amount of research must be possible during the length of the contract, either in the scientist's home institution, or in an equivalent institution in the host country. Additional arrangements may be necessary: for example, providing technical assistance to maintain a basic research program in Canada, and providing for attendance at one scientific conference a year. In addition, when faculty members return from an assignment of two years or more, they should be granted up to six months of reduced teaching load for professional update and for the development of their research program, before reverting to a full teaching load.

The Supply of Canadian Scientists

For a number of years, agricultural research scientists have been in short supply in Canada. This state of affairs has tended to limit aid to developing countries, and even to limit Canadian agricultural research itself.

Part of the reason is that private sector starting salaries for graduates in agriculture at the bachelor level have been high, and salaries at the masters and doctoral level have been comparatively low; accordingly, embarking on a career in research has required some financial sacrifice. In fact, a recent survey has shown that the initial salary advantage of a doctoral over a bachelor's degree in agriculture (58 per cent higher in 1969) has actually declined in recent years; in 1979 it was only 38 per cent. Master's degrees in agriculture are similarly unrewarding financially. A Statistics Canada study indicates that two years after their graduation in 1976, master's graduates were earning only 19 per cent more than bachelor degree holders.[4]

Several years ago, the Agricultural Institute of Canada (AIC) noted, with some alarm, that the previous three to four years had seen a considerable decrease in the number of agricultural graduates electing to proceed to post-graduate study – even though enrolments in undergraduate courses were currently about 20 per cent higher than in the previous ten-year period.[5]

The number of Canadian graduate students in agriculture has since undergone a modest rise; from some 550 to about 650. Unfortunately, losses due to retirement from Agriculture Canada and from the universities are also rising, and are forecast to continue rising through the next decade.

In fact, a recent assessment of statistics from the eight faculties of agriculture shows a steady increase in the annual number of staff retirements, with the number doubling (from about 10 per year to 20) between 1980 and 1995. The same study shows an even more rapid rate of increase in annual retirements (from about 10 in 1980 to 40 in 1986) at Agriculture Canada.[6]

It is reasonable to conclude from this evidence that an inadequate number of the country's best undergraduate students are proceeding to graduate work. One may also conclude that the number of students enrolled in doctoral programs is inadequate to meet any major expansion of agricultural research in this country.

Canadian agricultural research must remain strong. This implies a steady infusion of young people with graduate degrees. The Science Council recommends (in the spirit of the AIC in 1977) that federal money be spent to increase assistantships for Canadian (and landed immigrant) graduate students, and provide new PhDs hired by Agriculture Canada with sufficiently high starting salaries to encourage the brightest undergraduates to enter post-graduate studies in agriculture.

VI. Summing Up

Despite massive transfers of development assistance over the last thirty years, only marginal improvement has been achieved in the standard of living of much of the world's population. It is now becoming clear that promoting international development is a long-term and complicated undertaking. Single-factor approaches – such as the transfers of capital that worked so effectively in post-war Europe – are neither sufficient nor affordable.

In the mid-1960s, developing countries began to view science and technology as a key component of economic development. Their hopes seemed to be confirmed by examples such as the success of new high-yielding varieties of rice and wheat – the "green revolution". The era of massive technical assistance had begun.

Mostly, this sharing of the developed world's technological knowledge was effected in three ways: by exporting it in the form of capital goods such as machinery; by sending experts and advisers abroad; and by training students in developed countries' educational facilities.

These measures, too, were found to have serious shortcomings. Western machinery is very often too complex, expensive and inflexible for developing countries, and "turnkey" projects engendered technological dependence. So, too, did the didactic use of Western experts, in what has been called "know-how, show-how" technical assistance: technological self-reliance remained elusive. Finally, Western education of Third World students, while desirable as an interim measure, did not prepare them well for the work awaiting on their return home – a journey, moreover, that many failed to make.

In the last few years a new consensus regarding development has begun to emerge. It is based on the concept of increasing self-reliance, not only in commodities, but also in the generation of knowledge. The growing realization, by developing countries, of the need for an indigenous science capability has profound implications for Canada's foreign aid policy. It implies a progressive diversion of funds from direct aid towards collaborating in the generation and application of scientific and technological knowledge.

There will always remain a need for traditional modes of technology transfer between countries. More and more, however, Third World countries will seek to transcend their fundamental limitation – their dependence on the existing stock of knowledge and on technologies devised in the developed world.

This move is to be welcomed, on at least two counts. First, collaboration amongst countries for the purpose of self-reliance is an expression of common self-interest. As Alexander King observed following the 1979 UNCTAD meeting in Manila,

> "there is as yet no realization of common self-interest between industrialized and developing countries to reduce the disparities between them. Governments of the former, and still more the

general citizenry, still consider development aid in terms of charity, while the latter in some instances regard aid as their due from guilt-complexed former colonial powers. Until there is a general understanding of the need for international life and the world economic system to be based on interdependence, this situation is likely to persist to the detriment of both rich and poor nations."[1]

Second, scientific collaboration constitutes a recognition that the fundamental scarcity in this world is not energy, nor food, nor natural resources, it is a shortage of human beings adequately prepared to begin developing solutions for basic and pervasive problems. Scientific and technological skills are in especially short supply in developing countries; this lack jeopardises their competence for effective absorption of fresh knowledge, as well as their ability to generate their own.

* * * * *

Two themes – collaboration and self-reliance – dominate this Report. At first glance they may appear almost conflicting, but they are inherently complementary. The path to increasing material self-reliance in each country is through collaborative efforts in science and technology.

Self-Reliance

It must be stressed that no country – Canada included – should wish to be totally self-sufficient in all food supplies. However, the goal for all countries should be to move towards increased self-reliance. (This should also be a goal for Canada. In recent years we have moved in the opposite direction.)

It is difficult to overstate the magnitude of the technological challenge facing developing countries. Estimates by the International Food Policy Research Institute indicate that many of the developing countries must double their food crop output within 15 years, some in as few as eight years, if they are not to remain dependent on external sources (if external sources still exist by then) for their basic food commodities. These countries are forced into a totally new era of agricultural development, as they attempt to accelerate agricultural production at rates far greater than those ever experienced in the developed countries – and to do so with limited resources and, in many cases, under unfavourable soil, water, or climatic conditions.

To achieve these rates will require quite exceptional (and substantial) research and application efforts; further, these efforts must be supported by long-term national commitments which accord a high priority to agricultural production. Moreover, the poorest countries spend so little on research that they cannot make effective use of the output from the IARCs. Even the international research net-

work, although an outstanding achievement, needs strengthening. The total annual budget ($124 million) of all thirteen institutes, serving most of the world's population, is rather less than Agriculture Canada's modest annual research expenditure ($138 million in 1979).

There is also a critical shortage of managerial expertise and experience in developing countries. Agriculture is inherently complex, a combination of biological sciences practised in a variety of physical and socio-economic environments, subject to erratic climate and seasonal fluctuations. With advances in technology, agriculture is becoming steadily more complex. One result is an increasing demand for qualified managers to plan and implement projects.

It is becoming increasingly evident, however, that shortages of capital will set limits to developing countries' ability to modernize food production. Moreover, there is growing evidence that the sustainability of these techniques is limited. Accordingly, in recent years there has been renewed recognition that simple, low-cost, non-capital-intensive agricultural technologies can make a substantial contribution to food supply. It now seems likely that both "industrial" and "appropriate" agriculture will be needed for self-reliance: the key issues are their social acceptability and sustainability.

There can be no doubt that most countries will achieve greater self-reliance only through dedicated and unstinting efforts. For some poorer countries, particularly those with unfavourable soil or climatic conditions or with little arable land per person, overall self-reliance will long remain a distant, elusive goal. It is vitally important, however, that all countries recognise that the key ingredient is access to knowledge, for which no amount of money can compensate.

The road to increasing self-reliance in food is long, with the prospect of only gradual year-by-year gains. To expect breakthroughs or short-cuts is to invite disappointment. It is particularly important to dispel myths – such as the prospect of cheap protein from hydrocarbons, or greatly increased harvesting of fish from the sea. It is also vital to appreciate the enormous heterogeneity of developing countries; each has unique needs and opportunities, and each must rely primarily on its own physical and human resources. For each country, self-reliance in food is a component of a much more fundamental process: self-development.

Collaboration

The main thrust of this Report is that Canada's most effective contribution to the world food problem is through collaboration in science and technology. This recommendation is, to a large extent, simply affirming the direction of the past twenty years. However, there are several changes indicated in the *mode* of future collaboration.

First, Canada must increasingly aim at *facilitating* the adaptation and use of appropriate S&T for food production and handling. Conversely, it should resist the temptation of becoming overly involved in implementation.

Second, Canada should encourage collaboration between institutions on a like-to-like basis. Canadian universities helping developing country universities; Canadian government departments helping their counterparts; and so on.

Third, the locus of future collaborative work (whether training, or research, or application) should continue to shift from Canada to developing countries.

There is, however, a very significant impediment to stepping up Canada's collaboration with developing countries. The great majority of Canadians are, quite simply, unaware both of the nature of the challenge and of the magnitude of this country's potential contribution.

The Limiting Constraint: An Informed Public

There is in Canada a dedicated and enthusiastic army of people working – in government, at universities, and through non-governmental agencies – to help Third World people to meet their basic needs. However, far greater efforts are possible – and are urgently needed. Despite this urgency, without greater awareness and correspondingly broad-based, popular support, there is little prospect of significant increases in our collaborative efforts in the near future.

Failure to rally popular support for increases in Canada-Third World collaboration is a serious obstacle to further progress. As the Parliamentary Task Force on North-South Relations noted in its Interim Report in July 1980:

> "Unquestionably, most Canadians are unaware of the importance of North-South issues and of how they bear on their day to day concerns such as energy, food and jobs . . . . The Task Force has no more important job . . . than to demonstrate in concrete and practical ways that our interests . . . are bound up . . . with the well-being of the developing countries."[2]

Although we are justly proud of our international reputation as peacekeepers, as a people we still fail to appreciate the mutuality of global interests. This interdependence can be expressed in concrete, financial terms. In 1979, the Brandt Commission listed the following among the mutual interests linking the rich countries of the North with the poor countries of the South:

- the $500 billion per year in trade;
- the $300 billion owed by the Third World to the developed countries; and
- the $80 billion invested in the Third World by multinational companies based in the developed world.

Despite these ties, developing countries are extremely vulnerable to protectionist tendencies in the North, and the terms of trade seem constantly to be moving to their disadvantage. It is, however, important to dispel the misconception that developing countries are supplicants, totally dependent on aid. The fact is that Third World countries finance most of their own development. Even the poorest countries are now investing up to 15 per cent of their GNP in development – in other words, investing more than the developed countries did during their period of industrial development.[3]

In short, more Canadians must come to perceive that developing countries are not a threat, but rather hold the key to our common destiny. The Third World exists, and the real task facing us is how to build mutually beneficial linkages. The challenge is essentially one of human relationships; although governments can initiate the process, both the private sector and voluntary organizations are indispensible to the success of this enterprise.

This perception is not yet widespread. In fact, too few Canadians have to date shown an interest in these issues, or in the resultant national policies on international development. It is also the case that very few are aware of Canada's considerable accomplishments abroad.

To foster a greater awareness of Canada's role in international development, both present and prospective, we suggest that,

- the federal government prepare a discussion paper on Canadian international development policies, and give it wide exposure;[4]
- the Canadian universities assume a more active role in public information. Through IDO, they should explore possibilities for joint action with CCIC (which already has a public awareness program).

There is an urgent need to broaden the base of support for Canada's international efforts, well beyond the current professional aid coterie. Clearly, new approaches are called for.

In the meantime, there is an important job to be done.

Canada's Role in the 1980s

Three principles should guide Canada's future scientific and technological contributions to the food sector in developing countries.

1. *Leading from strength.* To a large extent, Canada's current involvement in international development is based on many individual and institutional initiatives: often an effective, but piecemeal approach. In the last two years coordinating mechanisms (such as IDO) have begun to emerge, bringing a measure of order to international collaborative activities. (They have contributed to badly needed collaboration among institutions *within* Canada – for example, between CIDA and

the universities.) It is vital that Canada clearly identify those scientific strengths that are appropriate to the needs of developing countries, and focus its international contributions accordingly.

2. *Make participation possible.* Many Canadian scientists with food-related skills have expressed keen interest in participating in international development. However, only a small proportion of them have prior experience, and the most competent can seldom be spared from their regular duties. Moreover, it has been the experience of some scientists to suffer disruption of research or teaching careers while on overseas assignments.

   These are significant impediments to Canadian participation. However, they can be overcome and at relatively little cost.

3. *Do much more.* Although it is valuable, our scientific collaboration is at present numerically small: on any one day, there are a total of less than 100 Canadian scientists in Third World countries, assisting in collaborative research projects. This number should be doubled at least, and as quickly as possible. The cost would be an insignificant fraction of Canada's direct food aid – and would confer lasting benefits.

Is there a unique role for Canada in international food research? Probably not: we have considerable prowess and specialized skills to offer, but so do many other countries – the Netherlands and Sweden, for example. However, Canada does have abundant scientific and technological expertise that could be more extensively used, and what matters most is that we share our skills and knowledge unstintingly: the herculean demands to which research must respond in this decade will absorb the efforts of a hundred Canadas. Moreover we must act *now*, for the matter is urgent.

Appendix

The IARCs: The CGIAR Network

In 1960, the International Rice Research Institute (IRRI) was established in the Philippines to develop the necessary technology and to train the people necessary to increase rice output in the tropics. The early success of this institute led to the establishment of the International Maize and Wheat Improvement Centre (CIMMYT) in Mexico.

In 1967, the International Institute of Tropical Agriculture (IITA) was established in Nigeria to work on the agricultural commodities and systems important in sub-Sahara Africa. At about the same time the International Centre for Tropical Agriculture (CIAT) was established near Cali, Colombia, and has concentrated on work on cassava, beans, and pasture-beef systems. Each of the above institutes was established through the cooperative efforts of the Ford and Rockefeller Foundations and the government of the country concerned.

In 1969, the leaders of a number of international and bilateral agencies, meeting in Italy, recognized that such international agricultural research centres, located in the tropics or subtropics, are vital to national agricultural and rural development efforts throughout Africa, Asia, and Latin America. Subsequently, an international consortium, the CGIAR, was formed to finance the existing institutes and to establish and support new ones. CGIAR operates under the auspices of the World Bank, the United Nations Development Program and Food and Agriculture Organization (FAO),as well as CIDA. Members include the Asian, African, and Interamerican development banks; the European Economic Community; the International Fund for Agricultural Development; most of the bilateral assistance agencies, the Ford, Kellogg, and Rockefeller Foundations; the Interna-

tional Development Research Centre; the Leverhume Trust; plus governments of a growing number of oil-exporting and developing countries. In 1971, this club of donors marshalled some $15 million for what was then four institutes. In 1980, CGIAR is supporting work at 13 centres with a combined budget of about $124 million.

The more recently established crop research institutes are as follows. In India, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) serves as the developing world centre for work on sorghum and millets, the fourth and fifth food crops in world importance. The International Potato Centre (CIP), located in Lima, Peru, is concerned with the improvement of the white potato and the technical support of national potato improvement programs around the world. The International Centre for Agricultural Research in Dry Areas (ICARDA), located in Lebanon and Syria, primarily works on improvement of durum wheat and barley, on pulses, and on improvement of cropping systems for rain-fed areas in North Africa and the Middle East.

Livestock research is conducted at the International Laboratory for Research on Animal Diseases (ILRAD), located in Kenya, and the International Livestock Center for Africa (ILCA), headquartered in Ethiopia. The West African Rice Development Association (WARDA) and the International Board for Plant Genetic Research (IBPGR) are also noteworthy.

In 1979, the International Food Policy Research Institute, based in Washington, DC, became a member of the CGIAR system. Its efforts are devoted, as its name implies, to research on policies important to the alleviation of hunger and malnutrition in individual countries.

Core Budgets for the International Centres, 1980

	$ millions (US)
CIAT	15.0
CIMMYT	16.8
CIP	8.0
IBPGR	3.1
ICARDA	11.8
ICRISAT	12.4
IFPRI	2.4
IITA	15.1
ILCA	9.0
ILRAD	10.4
IRRI	16.1
ISNAR	1.2
WARDA	2.7
	124.0

The Technical Advisory Committee of CGIAR includes 13 authorities in the area of agricultural research – with representation from both the biological and social sciences – from developing and developed countries. The committee is concerned with the establishment of global priorities for future research, for monitoring the progress of each international center in the system, and for recommending to the CGIAR the principles to be considered in allocation of financial support.

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Food Research Institute,
Agriculture Canada,
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Canadian Broadcasting
Corporation,
Toronto, Ontario.

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