1988/89 Annual Report

Consultative Group on International Agricultural Research

CGIAR

Established in 1971, the Consultative Group on International Agricultural Research—CGIAR—is an association of countries, international and regional organizations, and private foundations dedicated to supporting a system of agricultural research centers and programs around the world. The purpose of the research effort is to improve the quantity and quality of food production in developing countries. The World Bank, the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Development Programme (UNDP) are cosponsors of this effort. The World Bank provides the CGIAR's chairman and secretariat. CGIAR is advised by a Technical Advisory Committee (TAC) whose secretariat is provided by the three cosponsors and located at FAO headquarters. CGIAR has 49 members, of which 37 were donors in 1988. Total contributions from all sources were about US$262 million.

CGIAR-supported international agricultural research centers

CIAT	Centro Internacional de Agricultura Tropical. Cali, Colombia.
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo El Batan, Mexico.
CIP	Centro Internacional de la Papa. Lima, Peru
IBPGR	International Board for Plant Genetic Resources Rome, Italy
ICARDA	International Center for Agricultural Research in the Dry Areas Aleppo, Syria
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics Hyderabad, India
IFPRI	International Food Policy Research Institute Washington, D.C., United States
IITA	International Institute of Tropical Agriculture Ibadan, Nigeria
ILCA	International Livestock Center for Africa Addis Ababa, Ethiopia
ILRAD	International Laboratory for Research on Animal Diseases Nairobi, Kenya
IRRI	International Rice Research Institute Los Banos, Philippines
ISNAR	International Service for National Agricultural Research. The Hague, Netherlands
WARDA	West Africa Rice Development Association. Bouake, Cote d'Ivoire

ISSN 0257-3156
Published by the Secretariat of the Consultative Group on International Agricultural Research (CGIAR), 1818 H Street, N W, Washington, D C, 20433 United States. October 1989

Citation Annual Report—Consultative Group on International Agricultural Research, 1988-89

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CGIAR Secretariat
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Washington, D.C. 20433
United States

Foreword

Pessimists have much to mull over in the world's food situation. The FAO reported in June 1989, for instance, that after two consecutive seasons of decline, global stocks of cereal would remain at barely the minimum level required for world food security over at least one more year. Harvests improved in 1989, to be sure, but sufficient only to maintain cereal consumption per person at a level below the established international trend. Even this discouraging prospect would not be realized unless normal weather is experienced for the rest of the season. Meanwhile, food aid dropped by some 25 per cent in 1988/89, falling below the annual minimum of 10 million tons urged by the World Food Conference in 1974. Flows of food aid are likely to remain low in 1989/90, and world trade in cereals is also likely to decline.

These projections appear even more stark than on their own, when they are set against anticipated growth in the world's population. Indeed, the Global Committee of Parliamentarians on Population Development meeting early in 1989 concluded that population issues were "more fundamental and their resolution more difficult" than those connected with international peace and security. The United Nations Population Fund estimates that total world population which now stands at some 5 billion will reach 6 billion before the end of the century, 7 billion by 2010 and 8 billion by 2022. These increases are expected despite a declining overall growth rate. Each enlargement of the world's population bulge increases pressure on the world's food supplies—as well as on the world's food production base.

For that reason, among others, there has continued to be a heightened and concerned awareness of how environmental issues shape and condition almost all aspects of development, including agriculture. Soil degradation, the unplanned exploitation of natural resources, the excessive use of chemicals, and possible changes in climate have all caused anxiety among those who are involved in ensuring the sustainability of food production over the long term.

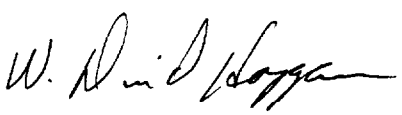
Pessimists are inclined to groan under the burden of these prognostications and assume that we are all heading madly toward self-destruction. Optimists, perennially convinced that better times are around the corner, tend to shrug their shoulders and assume that, with time, most of these problems will simply go away. The Consultative Group on International Agricultural Research (CGIAR) cannot afford the luxury of either extreme.

The CGIAR is, of course, only a small player in the larger development field. There are so many aspects of development that lie outside the Group's mandate and interests. Even within the area of agricultural research, the CGIAR occupies only a small niche. It is a very special niche, however, and the CGIAR system's demonstrated capacity to respond dynamically and effectively to changing circumstances makes it an exemplary organism. In the past, when it was feared—perhaps,

assumed—that the poor and the hungry in the world's developing regions were predestined victims of Malthusian doom, the vision and work of the CGIAR helped to feed many more mouths than would otherwise have been possible. Today, no less, circumstances demand that the CGIAR should carry out its tasks creatively and consistently.

In the period covered by this annual report, the CGIAR took several initiatives, each of them capable of making a significant contribution to agricultural development and food production. The mandate of the CGIAR was broadened to include research on the utilization of renewable resources related to agriculture, and specifically forestry. The Group approved a timetable and procedure for the work of 10 international centers outside the CGIAR system at present (described as "non-associated centers") to be reviewed, so that the Group could be provided with a scientific basis for judgments on how the research conducted at those centers might be integrated with that of the CGIAR. A system-wide committee on sustainability took the first steps toward defining the means by which all CGIAR-supported research could have a sustainability perspective. Opportunities were outlined for sustainability-related collaboration among centers, and also between centers and national systems of agricultural research. The CGIAR also renewed its commitment to strengthening and broadening the relationship between international centers and national research systems.

Some key aspects of the CGIAR programs are described and assessed on the pages that follow. They illustrate both the continuing relevance of CGIAR-supported research, and the need for resources to ensure that research is conducted in continuity.



W. David Hopper
Chairman
CGIAR

Washington, D.C.
September 1989

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Editor's note:

This report covers financial information in detail for calendar year 1988, the latest available. On other matters, the report deals with events through mid-1989.

1. Year in review: Readying for expansion

In 1989, the CGIAR agreed to broaden its mandate to include research on the utilization of renewable resources related to agriculture, and specifically forestry. It is the Group's first step toward adopting an expanded vision and enlarged constituency of centers for the coming decade, while at the same time affirming its initial purpose—to expand food production in developing countries.

CGIAR adoption of a declaration of intent regarding renewable resources at its May mid-term meeting in Canberra, Australia, is the outcome of simultaneous processes occurring inside and outside the CGIAR. In important respects, the initiative is responsive to the Group's internal deliberations on three issues: 1) how the CGIAR's priorities should be shaped over the long term; 2) which, if any, resource-based activities of 10 non-associated international research centers should be embraced by the CGIAR; and 3) how achieved gains in agricultural production can be sustained without depleting or jeopardizing the global or regional resource base. These topics will remain focal points of the CGIAR and its Technical Advisory Committee (TAC) for the near future. At the same time, an international task force on forestry, which first met at Bellagio in July 1987, has been forging an agenda for priorities in tropical forestry research. Following a second meeting of the task force in December 1988, its consortium of members invited the CGIAR to include forestry research in its research mandate. At Canberra, the Group agreed, deciding to envelop the topic within wider issues of management and utilization of renewable resources.

At Canberra, the Group also reconfirmed the need for a global program of vegetables research. The possibility of assigning a lead role to the Asian Vegetable Research and Development Center (Taiwan) was endorsed, but a scheduled TAC review visit to AVRDC was postponed, pending discussions with the Government of the People's Republic of China on outstanding issues. While issues remain under review, as an interim action a proposal for a vegetables research network in Africa will be developed for consideration at International Centers' Week 1989 (ICW89).

Addressing old and new challenges

As before in its 17-year history, the CGIAR was attempting to move with dispatch, despite the complexity of the topics broached, in order to deal with a rapidly changing world—developing country populations are still growing, food stocks again diminishing, agricultural thrusts on fragile, degraded or forested land continuing, and global concern about the environment intensifying. The converging challenges and demands are testing the institutional capacity and expertise of the CGIAR on the brink of an era of expansion. Questions being asked are: How can the

quality of research be kept high as the mandate is expanded? How can the consensus be kept fresh and strong as renewable resources related to agriculture become a shared focus along with food production? As it proceeds to address these questions, the Group made clear that it would take enough time to get careful advice from TAC and to consider alternatives before making decisions on the many weighty matters on its agenda. On forestry, TAC will report at ICW89 on appropriate mechanisms for encompassing this expanded interest.

Box 1.1. Meetings in 1988 through mid-1989.

CGIAR:
- October 31-November 4, 1988, Washington, D.C., United States
- May 29-June 1, 1989, Canberra, Australia

TAC:
- 47th Meeting, October 25-29, 1988, Washington, D.C., United States
- 48th Meeting, March 13-20, 1989, El Batan, Mexico
- 49th Meeting, June 19-24, 1989, Rome, Italy

Board Chairs:
- October 27-28, 1988, Washington, D.C., United States
- March 13-15, 1989, El Batan, Mexico

Center Directors:
- October 27-28, 1988, Washington, D.C., United States
- June 19-21, 1989, Rome, Italy

Australia's role

At the Canberra meeting, the Group seemed to be searching for its roots. Not only was it meeting in the home country of Sir John Crawford, first chairman of TAC, whose imprint was writ large on the program of the CGIAR, but it chose a meeting format reminiscent of earlier days, with very few observers, minimal representation of centers, and a round table with no raised dais. A new feature, a half-day executive session of donor representatives, could also be seen as an attempt to reintroduce the intimacy of earlier meetings of the Group, particularly the mid-year meetings at the World Bank office in Paris, where the size of the room forced a relatively small gathering. Generally, the participants found this smaller format congenial and conducive to the consideration of complex and difficult questions.

They also profited from an opportunity to learn about the manner in which agricultural research had contributed to the economic development of Australia, and in a review of Australian research accomplishments came to understand better why scientists from that country, in addition to Sir John, have had so much influence in the evolution of

centers supported by the CGIAR: the problems addressed in Australia have a much more direct relevance to conditions in tropical developing countries than is the case in the typical donor country.

At the meeting, Australia pledged A$500,000 over the next five years to the Crawford Trust (associated with the CGIAR) for financing training programs for developing country scientists, with the training linked to agricultural research projects supported by Australia.

Evaluating 10 prospective centers

The business dominating the CGIAR at Canberra, and indeed throughout the year, has been the relationship of its work to the 10 non-associated centers which were identified in 1988 as conducting research relevant to the achievement of CGIAR objectives, particularly given its enhanced focus on sustainability of agricultural production systems. At International Centers' Week 1988 (ICW88), the Group approved an overall approach to the review of these centers' work for possible inclusion in the CGIAR, as proposed by TAC chairman Alexander McCalla. A timetable was adopted under which TAC would put forward a priority framework and detailed process for the Group's consideration at ICW89, and specific proposals for action a year later. In discussing the timetable, members made clear that they did not want simply a yes or no decision on each non-associated center, but rather judgments on *whether and how* the research goals addressed by each of the 10 could best be married with existing CGIAR programs—without taking as sacred either the organizational structure of the non-associated centers or the current CGIAR centers.

To this end, TAC has commissioned working papers on the research focus of the non-associated centers and corresponding activities of the CGIAR centers and has prepared essays on issues of sustainable agriculture in the four major regions of the developing world. In addition, TAC sent missions to eight of the 10 centers, with at least two TAC members and a TAC or CGIAR secretariat staff member on each, plus an expert selected to address the scientific and technical focus of the center. These missions reported through two TAC panels to TAC's June meeting in Rome. A special meeting of TAC, called for September 1989, will be devoted entirely to this exercise.

Regarding forestry, TAC will review the work of existing research institutions outside the CGIAR, including the International Council for Research in Agroforestry (ICRAF) and the Special Program for Developing Countries (SPDC) of the International Union of Forestry Research Organizations (IUFRO), and make proposals concerning them along with its recommendations concerning the other non-associated centers. To this end, TAC has commissioned a panel of forestry experts to make a preliminary report, including a review of the work of SPDC.

Sustainability perspective

The discussion of forestry research at Canberra illustrated the close relationship between that topic and the general issue of sustainability which also continued under intensive review. Leslie Swindale, director general of ICRISAT, at the request of the chairman, is leading a committee of center and other scientists in a survey of center research as it relates to sustainability. The first report of this committee was favorably received at the Canberra meeting. It identified major sustainability issues as defined by a CGIAR policy paper, described present research programs directed toward these problems, noted gaps in the research, and suggested opportunities for collaboration among centers, and between centers and national programs. Among the subjects for further study are measurement and long-term studies of sustainability and the sustainability of farming systems that increase in intensity over time.

Box 1.2. Ten non-associated international research centers.

Center		Location	Focus
AVRDC	Asian Vegetable Research and Development Center	Tainan, Taiwan	Promote production, marketing, and utilization of vegetables with emphasis on Asia
IBSRAM	International Board for Soil Research and Management	Bangkok, Thailand	Apply principles of soil science to increase sustainable food production in developing countries
ICIPE	International Center of Insect Physiology and Ecology	Nairobi, Kenya	Conduct advanced research in insect science
ICLARM	International Center for Living Aquatic Resources Management	Manila, Philippines	Research topics pertaining to fisheries and aquaculture
ICRAF	International Center for Research in Agroforestry	Nairobi, Kenya	Develop methods for evaluating agroforestry technologies
IFDC	International Fertilizer Development Center	Muscle Shoals, Alabama, United States	Identify and remove agronomic, technological, and economic constraints to fertilizer use
IIMI	International Irrigation Management Institute	Colombo, Sri Lanka	Conduct research and communicate information on improved irrigation management
INIBAP	International Network for the Improvement of Banana and Plantain	Montpellier, France	Promote research and scientific cooperation in banana and plantain improvement
ITC	International Trypanotolerance Center	Banjul, The Gambia	Carry out studies to exploit trypanotolerance for commercial, agricultural, and food production purposes
IUFRO	International Union of Forestry Research Organizations	Vienna, Austria	Promote international cooperation in forestry studies; standardize systems of measurement

Issues concerning long-term sustainability confront small farmers who cultivate the steep slopes of the Rift Valley in Ethiopia.

Group members requested that as the work of the committee proceeds, it should consider more specifically what research activities should be changed or initiated to reflect even more fully a sustainability perspective. A second and final report is due to be presented in May 1990 at the mid-term meeting at the Hague, the Netherlands.

Partnership with national systems

A spirit of collaboration and partnership between the CGIAR centers and national agricultural research systems was endorsed in a proposal for sharing responsibilities that was tabled by TAC at Canberra. Productive partnerships through collaborative research networks, participation in setting research priorities, and viable financial arrangements were among the points emphasized by delegates. The paper will be revised by the CGIAR secretariat, taking into account comments made at Canberra, and circulated among donors after review by the TAC chairman.

TAC and CGIAR secretariats

As TAC undertakes the extensive review of non-associated centers, the TAC chairman reported that it was necessary to postpone a study of the relationship between the centers and the private sector, and a strategic analysis of individual commodities and activities, specifically decisions on aquaculture and coconuts (although both are under consideration in parallel with the non-associated center exercise). The revised TAC paper on systemwide priorities will be delayed until 1992, although some of the work involved is also required for the present exercise.

The Group also asked the TAC chairman to bring proposals to ICW89 concerning the future structure of TAC. During the Bellagio discussions of forestry research, participants expressed concern that the present TAC could not deal effectively with forestry, because it lacked appropriate expertise, and several possible forms of restructuring were proposed. As illustrated by the inclusion of experts on TAC's missions to non-associated centers, forestry is not the only field being considered where this problem arises. TAC itself has expressed the view that increasing the number of centers as well as the substantive breadth of the program, would necessitate a fresh look at its way of doing business. Mr. McCalla was therefore asked to propose a means by which TAC could both expand its technical range and handle a larger constituency. In giving him this charge, members of the Group made clear that they expect TAC to provide a coherent set of recommendations for the entire program, whatever expansion may take place.

As the CGIAR and its centers contend with expansion, a continuing effort to strengthen the CGIAR and TAC secretariats is ongoing. A committee appointed by the CGIAR chairman to review the work of the CGIAR secretariat reported to ICW88. The Group concurred with its suggestions of marginal changes, with no major redirection of the work of the secretariat. A similar study of the TAC secretariat is expected to be considered by ICW89. The latter will be better able than the former to consider the implications of an expanded mandate, coming as it does somewhat later in the process.

Communications and inter-center collaboration

Reviews of the CGIAR system always seem to find that increased action needs to be taken to expand public awareness of the system's contribution to development goals, and the oversight report on the CGIAR secretariat is no exception. Not surprisingly, the year did see a considerable increase in activity in this field, including approval and publication of a policy statement on plant genetic resources, intended to make clear the depth of concern of the CGIAR system for this issue, and the extent to which IBPGR and other centers have made progress in dealing with it. Another example was the publication at the Canberra meeting of a new booklet, *An Act of Faith*, on the CGIAR system for the general reader, by the Australian Centre for International Agricultural Research (ACIAR). Numerous other publications have been issued. Perhaps the most important development was the creation of a public awareness association, an initiative of the centers, in which they have joined forces with a number of donors to provide information about the CGIAR and its accomplishments more broadly among donor countries and developing countries as well.

The association illustrates another trend, namely the growing inclination of centers to work collectively on matters of common interest. Some such collaborations, for example the committee on benefits, have been in existence for a long time. Others including inter-center committees on Africa, communications, information, donor relations, and training are more recent. The Africa committee published a contribution to thinking about research strategy for Africa, written by Peter Oram; organized an inter-center management training course for regional program leaders; and is planning a meeting of regional scientists and coordinators to harmonize approaches of different centers in working with national programs, including common features of training.

Also meeting more frequently, the center directors focused attention on the implications of possible expansion of the mandate of the CGIAR, as seen from a center viewpoint.

The two meetings each year of center board chairs have also enhanced center cooperation at the level of boards, dealing with a number of topics such as compensation for directors general and for board members. The board chairs have also delved into substantive issues such as applications of biotechnology and relations with developing country universities.

These examples of center collaboration have an important element of improved communication built in. The Group itself has been experimenting with improving communications, in part through the device of the heads of delegations dinners at each meeting, supplemented more recently by half-day sessions for donors only with no published record. Rapid publication of a summary of meeting outcomes has also contributed to this end, as has a series of letters from the CGIAR chairman to heads of donor delegations on important issues affecting the work of the Group. To make possible more effective consultations with members, the chairman called together in March 1989 an ad hoc committee to provide advice on how several complex issues might be brought effectively before the Group for resolution. This trial was judged successful and is to be repeated with different participation prior to ICW89.

At the first ad hoc meeting, it became apparent that two issues beyond sustainability and possible expansion of the system dominated the thinking of donor members. One is funding, where many donors are facing both an overall constraint on funds and competitive calls for fresh uses of line items which previously have provided the lion's share of CGIAR contributions. The second is the relationship with national systems, which many perceive to be weakening under the pressure of the financial/debt crisis in the developing world. Within its prescribed mandate, the CGIAR has limited capacity for strengthening national systems although it has actively promoted training, varietal nurseries, and networks as means to that end; yet, without effective national

programs, much of the output from the international research system remains unused on the shelf. TAC intends to make a major study of the latter issue, which involves not only CGIAR policy but donor attitudes in an important way, once the non-associated center exercise is concluded. Both questions, in fact, are expected to occupy major attention in the coming years.

Resource allocation

The normal business of the Group has gone ahead as usual. Eight of the 13 centers were allocated funds in 1989 on the basis of an approved five-year medium-term program. Two more such programs (ICRISAT and WARDA) were approved at Canberra, and three are expected to be completed at ICW89, so that 1989 would be the first year for which the new resource allocation system is fully operational. This will make possible an overall appraisal of the new system, an assignment taken on jointly by TAC and the CGIAR secretariat. It will also give much more informative insights into financial planning for the coming years.

External reviews of centers

ICARDA. The second set of external reviews of ICARDA, presented at ICW88, found that a sound scientific program had been developed. Unlike centers working in more favorable production environments, ICARDA had to stress risk aversion, tolerance for stresses, sustainability and the conservation of resources, rather than food production per se. A shift of the program away from grain legumes and toward cereals and livestock was suggested. The center's relationships with national programs were particularly praised.

The management review pointed to problems that had arisen because a large portion of top positions at the center had been vacant at the same time. It urged strengthening of the board's performance, appointment of a deputy with broad operational responsibility, and a number of other measures to tighten up the management structure and improve effectiveness.

Summing up the discussion, the chairman praised the management and board members of ICARDA for having successfully brought the center to maturity through difficult situations, making clear that the strictures of the management review should not be seen out of context.

CIMMYT. The reviews of CIMMYT found a center which was productive, creative and doing relevant research. The strategy prepared by the center which served as a basis for the review was a praiseworthy effort to apply quantitative measures to establishing priorities. An important element in this analysis was the division of the area for each crop into regions (mega-environments) sharing climatic and cultural

conditions which could form the basis of planning the scientific program for the crop and examining potential impact.

CIMMYT concurred with the program panel that the role of the scientific disciplines should be enhanced, although the board preferred to do this within the commodity programs rather than to adopt the matrix-of-projects approach recommended by the program review panel. Both CIMMYT's draft strategy and the review process were recognized by TAC and the center as parts of an ongoing planning exercise by the center and of a continuing discussion with TAC. Some of the issues mentioned in the documentation had already been resolved during TAC's consideration of the CIMMYT medium-term program.

The management review concentrated its attention on the board and senior managerial performance. It found CIMMYT in excellent shape, but pointed to a few areas where performance could be strengthened. The review suggested that the board put greater emphasis on monitoring center achievements, the implementation of board policies, relationships with the CGIAR, and on evaluating the performance of the director general and board members. Its strongest recommendations were for changes in the personnel management area, where it recommended appointment of an internationally recruited director. This and other staff and organizational adjustments suggested in the report were accepted and implemented by the center.

IBPGR. Since the presentation of the combined external program and management review of IBPGR in 1984, the center and FAO have been attempting to work out a mechanism through which IBPGR could remain within the FAO structure while adopting the management style of an international center as desired both by the board and the CGIAR. The situation was complicated by financial pressures on FAO which made it more difficult for that organization to comply with the requirements as presented by the board. FAO offered continuation of the arrangement, but had to withdraw financial support and ask IBPGR to pay for FAO support services and personnel which the organization had previously funded.

At its board meeting in February 1989, IBPGR considered studies it had prepared over the past year on its future location, and voted to accept an invitation from Denmark to relocate to Copenhagen, if the details could be worked out and the CGIAR approved. Subsequently this decision was broadened to include Rome and other suggested locations as possible headquarters sites. An exchange of correspondence between the CGIAR chairman and FAO's director general noted that it may be timely for IBPGR to separate administratively from FAO, but agreed that it was critical for the two organizations to collaborate closely on programs, since both had an interest in the conservation and use of plant genetic resources, an issue which continued to be of great importance. Following discussion at Canberra, the CGIAR chairman

CIP assumed responsibility for research on sweet potato in 1989, while IITA maintains collaborative involvement.

urged IBPGR to conduct speedy negotiations with FAO on future relationships. He appointed a small ad hoc committee, chaired by Nyle Brady of the United States, to facilitate such negotiations and monitor their progress from the viewpoint of the CGIAR.

Inter-center agreements

For some time, TAC and donors have been concerned about areas of overlap between center responsibilities and the difficulty of obtaining clear resolutions of these situations. During the year, CIMMYT reached agreement with IITA on the handling of maize research in West Africa, and with ICARDA on wheat responsibilities in the Near East and Mediterranean area. IITA and CIP reached agreement on the means of handling transfer of the responsibility of sweet potato to CIP, without losing the benefit of IITA's past research and germplasm collection, and with an expectation for collaboration where sweet potato entered into cropping systems in IITA's program. Finally, an agreement was completed among IRRI, IITA and WARDA on responsibilities over time for rice research in Africa, which covered both the WARDA area of West Africa and the remainder of the sub-Saharan portion of the continent.

Changes

Four new members joined TAC, which ceased to be an all-male body during the year with the appointments of Doris Calloway of the United States and Kamla Chowdhry of India. Calloway and Chowdhry bring new perspectives of nutrition and land settlement issues among the poor to the TAC. Ken-Ichi Hayashi of Japan and James G. Ryan of Australia also joined.

The King Baudouin award was given to CIMMYT for research leading to the development of the Veery lines of spring wheat, which represent a 10 percent yield improvement and embody tolerance to environmental stress and resistance to disease.

In memory of Forrest Hill, a founder of the CGIAR who died during the year, Cornell University (United States) has started an endowment fund for a fellowship which will permit a scientist from a center to spend a sabbatical leave at Cornell.

Curtis Farrar retired as executive secretary of the CGIAR and was replaced in early June by Alexander von der Osten. Mr. von der Osten in turn will be replaced as director-general of ISNAR, effective January 1, 1990, by C. H. Bonte-Friedheim, who leaves his position as FAO assistant director-general for agriculture, where one of his duties was representing FAO as one of the cosponsors of the CGIAR.

2. CGIAR and national programs: An ongoing commitment

Results from wheat production in Mexico influenced the formation of early CGIAR research centers.

The important relationship of international agricultural research centers of the CGIAR and national agricultural research systems is highlighted. However, the complexities and dynamics of institutional growth could only be briefly and selectively rendered here. The focus is on how two components in an emerging global agricultural research system have interacted over time and how the relationship is shaping up for the future.

Dynamics of mutual growth

A dominant and recurring theme in CGIAR activity is the strength and orientation of its relationship with national agricultural research systems. The aims and nature of this relationship, along with methods and modes of interacting, have evolved over time as both the CGIAR and its partners in national systems have developed in their capacity to handle the broad and complex process of conducting and managing agricultural research in today's environment.

The dynamics of growth and expanding capabilities for both centers and national systems have led to a continuing, but changing relationship. Change is especially apparent as the playing field becomes more even with the maturation of more and more national systems, and the CGIAR responds to their capacity to adapt materials and techniques, to develop fine-tuned packages of technology, and to build research, policymaking and managerial skills.

The interactions between CGIAR centers and national systems have thus broadened and deepened in significance as each actor becomes more adept in its own functions, which can and often do overlap, and as mutual benefits are clearly recognized. Evidence of these stronger ties seems to encourage observers to think increasingly in terms of a "global agricultural research system." (See Box 2.1.)

An accessible global system

For a select few, agricultural research has been global for a long time. For many decades, the main flow of basic and applied science went through channels of scientific societies, their journals and conferences. Some "invisible colleges" grew up around certain specialized areas of knowledge; members of the "college" shared their findings and their thinking with each other over interpersonal networks. In this informal system, most initiative rested with those who wanted to know. But few resources were committed internationally to filling what could be termed a bridging role, that of a person or institution to generate and convey technology to those who may be able to use it and to make needs for further technology known to researchers—in other words, a fulcrum between supply- and demand-driven forces in research.

By design, and to a certain degree by default, the CGIAR centers have become a bridging mechanism between the scientific community and developing country researchers, in addition to fulfilling their own research mandates. Those mandates are extensive and promise to become more complex and demanding over time, as new insights and concerns are brought to bear on the Group's activities and the system expands. (See Annex 2.)

The Mexico-Rockefeller Foundation wheat program in the 1940s that led to the creation of CIMMYT in 1966 illustrates the linking role that related world knowledge to problems in Mexico. Researchers in that innovative program drew from their own sources, mainly in other parts of North America, and borrowed materials and methods from the international community of science. Genetic materials from Turkey, Japan, Soviet Union, and the United States figured prominently in

Box 2.1. Key players in a global agricultural research system.

A "global agricultural research system" exists more in abstract and informal terms than as a coordinated or managed set of independent institutions and relationships. It can be depicted as made up of four main functional elements:

- Leading institutes of agricultural science—whose scientists generate basic and strategic research on which new technologies are based (most, but not all, are to be found in universities, government, or private-sector research departments in industrial societies);
- Institutes of applied research—which convert new knowledge into technologies that can be applied within systems of farming as they exist in the world (international agricultural research centers, such as those of the CGIAR, fall generally within this group, along with other similar ones—including regional, subregional, and some national centers);
- Institutes at which technologies are adapted to specific conditions of farmers (most often, national agricultural research systems, including their commodity institutes and networks of research stations and on-farm experiments);
- Farmers who adopt the technology (perhaps further adapting it to their situation) or reject it.

The idea of a global system, of course, implies communication and interaction among these elements. In simplest form, a breakthrough in scientific research proceeds to the applied level, where necessary technologies are worked out, and thence to the adaptive levels, where the technology is fitted to specific farming conditions.

In ideal form—and sometimes in reality—the system involves two-way flow. Farmers' experience, local knowledge, and needs of the farming system, as fed in from producers, may motivate the basic researcher and direct his or her line of scientific inquiry. And feedback from on-farm results with a new technology is vital to monitoring output and impact of its use at all stages.

wheat crosses that proved to be highly productive under Mexican conditions. Research teams were made up of scientists from many disciplines, and they drew from the resources of each discipline. And to deal with special problems, they called on international consultants from wherever the needed expertise was to be found. By adapting from that wide range of knowledge, the national program created noteworthy improvements in wheat production.

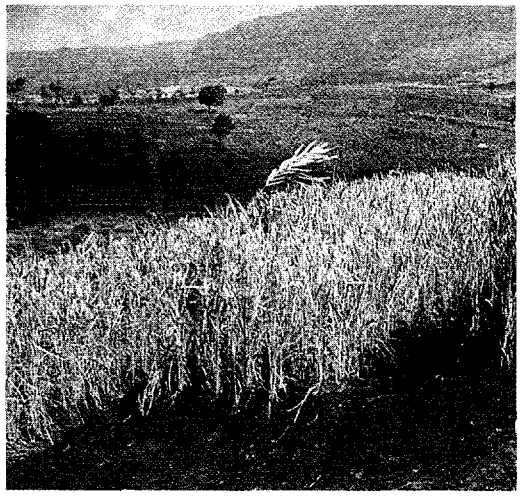
This two-handed approach—building national research capacity on the one hand and bringing in complementary international support on the other—strongly influenced what followed. The Mexican program evolved into a linkage model that has been central to all the 13 centers that now function under the CGIAR. These centers have helped most countries of the developing world participate—some much more than others—in the remarkable gains of agriculture in the past 25 years.

A multinational focus

CIMMYT, IRRI, and the other CGIAR centers that followed between 1967 and 1979, were new in concept as well as in actuality. Before they were formed, agricultural research was largely confined within national borders, with some transfer of technology by bilateral programs. The new centers had multinational mandates. Initially, in order to come to grips with pressing needs for more food as expeditiously as possible, they chose to work over geographically vast domains (for example, all of wheat, maize, and rice areas worldwide; cereals and grain legumes for the semi-arid tropics; livestock for Africa; and more) and to work in concert with the national systems in which their products would be used. Yet, they also recognized that their technology (and later, policy and institution-building advice) would have to be adapted and used in local situations. Against an array of different national conditions—to say nothing of internal variations—they could not promise to create materials for each and every situation. They did, however, set goals of wide adaptability of their material as starting points for national adoption and adaptation.

Knowledge and technology base

The key to these gains in agriculture—in both developed and developing countries—has been knowledge and the technology derived from knowledge. Striking changes have come from breakthroughs in technology and how farmers were helped to apply it. The case of wheat in India dramatizes the role of technology in increasing production. As FAO documents, India's national average yield for the years 1961-75 was 835 kg/ha. By 1984-86, the yield average had more than doubled to 1,915 kg/ha. With higher productivity and strong policy support, the nation's wheat area had grown over the same time from 13 million ha to over 23 million ha.



The uplands of Indonesia (top), rainfed areas of the Philippines (middle) and lowlands of Fiji (bottom) were among many sites in IRRI's early efforts to improve rice production through an extensive network of varietal nurseries.

The breakthroughs in wheat technology have been widely publicized: semi-dwarf varieties with stiff straw and wide resistance to rusts—plus packages of better practices (such as irrigation management, time, depth, and rate of planting, use of fertilizers, and more). Similar successes have been recorded in many other countries for wheat, rice, and maize—the early points of emphasis by CGIAR commodity-based centers. Potential for success is mounting for other commodities such as cassava and sorghum, as time brings payoffs from research efforts that began more recently in centers and national systems.

Evolution in relationship

The relations of CGIAR centers with national programs have evolved over time, reflecting an enlarged focus to CGIAR research and the benefits of experience, which fueled changing perceptions about 1) what centers could do best or ought to be doing to address priority issues in agricultural development and 2) the ability of national programs to develop and convey suitable technology to their farmers. The CGIAR's initial commodity orientation was motivated by a need to increase food production by farmers in developing countries. The centers sought to generate agricultural technology that farmers in developing countries could use—mainly better seed and practices—for staple food crops that are daily sustenance to billions of people. Centers soon discovered, however, that they did not have contact with those millions of individual farmers. They lacked direct knowledge of farmers' varied production constraints, as a basis for adapting specific technology; they also lacked a direct avenue that would put their technology in the hands of farmers.

In theory—though often not in practice then—a national research system was the line of contact to farmers in a country. Though often weak and out of touch with farmers (especially poor and small farmers), the national systems became the center's intended client-partners, and farmers the intended beneficiaries. Some countries had well-established research efforts in some, if not all, commodities. Some had remnants of colonial research systems with expatriate scientists—many of whom had already left. Typically there was little research activity in the staple food crops of the centers' mandates. Some had only fragments of a research system, if any at all.

In many cases where the need for new technology was greatest, national systems were ill-equipped to collaborate with the centers, or to reach farmers. (In some cases, the same holds true today.) So the CGIAR centers found that they needed to function in two distinct areas. One was in generating technology; the second was contributing to the strengthening of elements in national systems so the technology could be utilized. The centers innovated in their relations to national systems

according to scientific, political, and cultural circumstances. They conceived and applied various ways to diffuse their output and relate to their clients. In most instances, their relationships included both substance of technology—such as seeds and farm practices—and research-building elements. They also learned that nurturing such capacity depended on the policy environment and the research focus, commitment and priorities of national institutions—another avenue needing development.

Emerging collaborative mode

Throughout, the process of center-national system collaboration has been developmental for both CGIAR staff and national researchers. Each has learned new skills and acquired confidence as it works with the others in many different ways and at different levels. Methods and modes of relating have evolved from largely a center initiative, to joint collaboration, and, in some cases, toward a largely national initiative. For example, in the early 1970s, IRRI initiated a training course that

Box 2.2. CGIAR impact on agricultural research capacity.

As the current decade nears its end, the individual CGIAR centers can look back at 10 to nearly 30 years of work with national agricultural research systems. That has been time enough for effects to appear in two areas: impact on yields and production of commodities under center mandates and impact on the agricultural research systems of developing countries.

The *CGIAR 1984 Annual Report* highlighted significant effects on outputs of major food crops, and authors of the CGIAR impact study (Anderson, *et al.*, 1988, *Science and Food*) surveyed the impact of CGIAR centers on agricultural research in the global sense. They cited five areas of impact:

- on links between agricultural research in the industrial and developing countries;
- on helping facilitate scientific cooperation among developing countries that otherwise would be unlikely to interact because of geographic and language barriers;
- on training of agricultural scientists and technicians from developing countries;
- as catalysts and coordinators for varietal nurseries and networks;
- and as producers of books, manuals, reports, newsletters, and other material that provide information on how to apply research methods to many problems of farming in the developing countries.

The centers' affect on the policy environment for research in many developing nations and with donors was also noted. Their results strengthened the belief that scientific research is essential to raising agricultural productivity.

Perhaps the most important impact noted was the centers' role in orienting national researchers toward solving farmers' problems. On-farm research approaches promoted by the centers are now widely used by national researchers.

spawned the Asian Cropping Systems Network, using trainees in its course as important nodes in the network. Eventually the trainees, placed in national programs, were planning research together with IRRI staff. Later, the national programs were doing the planning and used IRRI as the logistical coordinator. On the demand side of this relationship, needs and wants of national systems have also evolved.

The full arena of CGIAR center-national relations contains a wide range of complex interactions. A single center may work with a country whose commodity research is well-established and well-managed; at the same time, that national system may include a disparate range of readiness to collaborate, because its research units are far from equally developed. Examples include CIP's potato research in the Philippines, IITA's cassava work in Zaire and IRRI's rice research in Indonesia. In each case, pockets of research are strong, usually near the capital, but less so in outlying areas. The same CGIAR center may, on the other hand, need to relate to another national system that still is barely able to maintain its identity.

While the CGIAR centers must maintain their capability for response to varied relationships, most find their main thrust occupies them more and more with the advanced levels of collaboration. Increasingly, capable national systems can and want to move more "upstream" in their development of technology. And they are tending to push centers toward closer ties to the world community of agricultural science in order to satisfy needs of national systems for more sophisticated methods and materials. These strong national research programs are increasingly capable of sharing research responsibilities through networks and across regions.

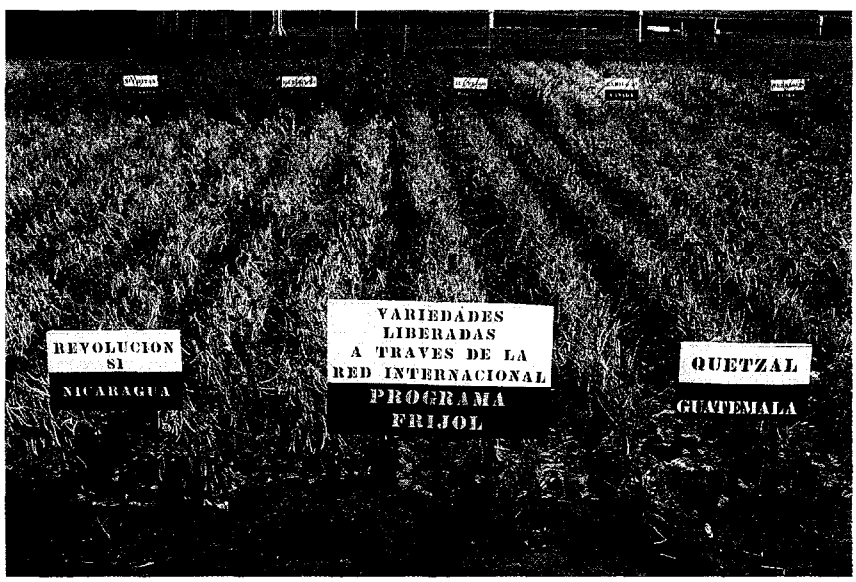
Below, a few methods of interaction between CGIAR centers and national programs are discussed, namely: international varietal testing nurseries, training and scientists' visits, research outposts, networks, contract research, and responses to special needs. Though a limited selection, the story of each illustrates the benefits and sometimes the necessary tension inherent to a dynamic of growth. The goal has been, and remains, to develop mutuality and respect—the genuine pillars of partnership—while pursuing shared research objectives that could make a difference in the well-being of developing country farmers and the poor.

Sharing genetic materials: international nurseries

For commodity-oriented centers, genetic materials were the main offering to national systems. At the beginning, that meant seeds of varieties of rice, wheat, and maize. They also offered know-how on practices and inputs that would exploit high-production potential—time, rate, and depth of planting, fertilizer, irrigation, etc.; also ideas about policies on prices, input supplies, and infrastructure.

IITA's cassava breeding lines (top) are posting higher yields in Nigeria. Below, Nigerian agriculturists review improved pearl millet and cowpea lines on IITA-sponsored field trip.

Generally the first outputs that centers could share were high-performance varieties. An early method of interaction was to engage national researchers as participants in varietal nurseries. The nursery approach was already on the world agricultural scene, in use within countries and in some cases between countries. Before the first Mexican wheats were introduced in India in the early 1960s, for example, researchers there were working on disease resistance with lines obtained from the United States. CGIAR centers brought nurseries to a new preeminence. Their web of nurseries put their materials in the hands of national crop breeders for testing on replicated plots where they could be grown and compared under local conditions. The national researcher was expected to follow explicit plot layout and cultural



Moroccan and ICARDA scientists review cereal trials conducted coordinately (top). Below, improved field bean varieties developed by CIAT researchers in conjunction with national programs in Latin America are ready for harvest.

methods, to write down observations during the season, to harvest, weigh, and send his/her results back to the center. They could also add local varieties for comparison; and they could harvest and use for themselves any lines that looked promising to them. Centers summarized the nursery trials and reported results to their cooperators and others around the world. Analysis of results told the centers about adaptability of their materials and provided leads to local materials that would enhance their work.

Some countries found lines that could go unchanged into further testing, seed increase, and introduction to their farmers. Others found promising lines among center materials, put them into their crossing programs, and sometimes came up with superior varieties for the national program. However, some national systems had trouble staffing

their part of the international nursery trials. Many simply could not exploit the new genetic materials and packages of technology they could get from the centers. And few national agricultural research systems had expertise to go it alone from the nursery stage.

Varietal nursery activities continue in use as an important means for sharing genetic materials with national systems. With time and increasing sophistication of national researchers, however, centers have streamlined the nurseries to provide fewer lines chosen more carefully for specific ecologies. National scientists had felt that generalized nurseries with many entries put a large testing burden on them, while they could expect only a small fraction to have relevance to their needs. (See Box 2.3.)

Exponential value to training

The CGIAR, as had many of its initial donors, quickly grasped the important role of training in moving technology—intermediate products—from centers to national programs onto farmers. The centers viewed resources invested in training and institution-building as leverage towards better uptake of their products. When the CGIAR centers began work in the 1960s and 1970s, many target countries were weakly equipped to respond to the new research initiatives. Many were newly independent and had no cadres of researchers with the advanced skills to adapt new agricultural technologies on their own. Many nations not only lacked manpower capable of using technology coming from the centers; they also lacked training expertise to upgrade their staffs to needed levels.

In response, the centers willingly found themselves involved in training—to build national capability to utilize the new technologies. Results quickly accrued from their training initiatives; to cite a few examples, CIAT's training in rice research had impact on national capacity in Colombia and Peru, among others; likewise for CIMMYT's wheat training in India and Pakistan, and later Bangladesh; IITA's cassava training in Ghana, Nigeria and Zaire; and IRRI's rice training in Indonesia and the Philippines. By their example, each new center soon moved to create training programs related specifically to its mandated commodities. Center training programs typically included: short-duration technical courses; field training in the months-long production cycle for a given crop; visiting scientist appointments; and sponsorship for advanced-degree studies in developed country universities. By 1984, nearly 20,000 persons had taken part in research and technical skills-development activities at the 13 centers. The great majority were from national systems of developing countries. In the early years, most training was provided at each center's headquarters. Now, as training needs have become more specific, an increasing share of center training occurs at regional and national levels.

IRRI's Asian Rice Farming Systems Network was at the forefront of investigating on-farm constraints, such as those experienced by farmers in Bangladesh, above.

In early years also, when training was a main method of diffusing technical knowledge, centers bore much of the cost for training. Donors played important roles, especially in the longer-term and high-cost support for nationals in advanced science studies in universities abroad. External donors also contributed special-project support for training programs through grants to centers and through bilateral support to national systems. At present, a decreasing share of training costs is borne through center core budgets.

Itinerant scientists

International nurseries and training programs created personal ties between personnel in national systems and those at the centers. Webs of personal acquaintance grew and spread throughout the world. And these person-to-person links served both national systems and centers. Nobel Prize-winner Norman Borlaug and his colleague at CIMMYT, Glenn Anderson, in the 1970s were spending half of each year circling the globe. In addition to consulting and nurturing links with national workers during these country visits, center scientists contacted policymakers. These contacts often helped improve the national climate for agricultural research in particular crops, and often for agricultural development in general.

Center scientists carried broad experience from which to advise national systems people about research in their specialization. However, they were often pressed to counsel on research for other crops, even on broad organizational and policy matters. This demand sowed the seeds that led later to new centers in the CGIAR system, to deal with needs beyond research on specific commodities. These included the International Board for Plant Genetic Resources (IBPGR), the International Food Policy Research Institute (IFPRI), and the International Service for National Agricultural Research (ISNAR).

Center outposts

CGIAR centers found situations where it was not enough to supply genetic materials and agronomic advice, provide training, and visit a national system once or twice a year. Some systems needed a more direct kind of support to get their work off the ground. Some needed continuing technical assistance to carry out research. Some needed frequent access to support in planning and managing the research activity. The CGIAR centers could not commit resources to continuous direct technical assistance to individual countries, yet most attempted to respond to these needs. In selected national systems, centers set up outposts manned by their own scientists.

A scientific mission to adapt technology for a country was by no means a new phenomenon. Such programs were widespread on a bilateral basis. The typical country-to-country program was short-term, perhaps averaging five or so years, and sponsored from an industrialized country. Direct support by a CGIAR center followed a different model. Its outposted staff represented an independent international body that worked from a worldwide mandate and had scientific linkages around the world. And its time commitment, based on national need, could be extended over a longer time frame.

Centers typically set up outposts where their staff could, in addition to helping the national system, try to solve special problems of adapting genetic materials and cultural practices within a region. For example, CIMMYT set up national program outposts throughout Latin America; also in Africa, such as in Tanzania and Zaire, where maize improvement seemed to hold great potential. IRRI based senior scientists in Asian countries where rice deficits posed major threats to the welfare of millions. India, Indonesia, and Thailand had early IRRI outposts. In the early 1980s, ICRISAT began work on establishing a Sahelian Center in Niger to work with cereals in the vast semi-arid region of Africa.

The International Potato Center (CIP) was first among CGIAR centers to adopt regional outposts to serve national systems worldwide. One reason for CIP's early move to regions was the nature of its output. Potato germplasm was shared in vegetative form; that meant problems

of maintaining quality in handling over great distances from its base in Peru to national cooperators, such as in Rwanda; also, import clearances were even more difficult for vegetative materials than for dry seeds as used in most germplasm exchanges. With regional centers, CIP could grow its genetic materials much nearer the points of use.

Over time, virtually all CGIAR centers outposted staff as means of meeting their mandates of service to national systems. Center outposts were set up with permission of the host government—often at its direct invitation. Initially, most operated as a branch of the parent center. The goal was mainly to help meet the center's mandate to provide technology that could be applied as widely as possible.

In time, the outpost became much more than a decentralized piece of the center. The hosts valued the outputs and services they received; in some cases they came to adopt outpost staff as their own, calling on them to help solve problems and to seek resources to meet national needs. When requests for outposting ran far ahead of resources, centers moved toward regional staffing—the approach CIP had pioneered. A scientific team outposted to a region divided attention among countries in that region. Often made up of an agronomist, a breeder, and an economist, such a team made an interdisciplinary approach to problems possible. Sometimes they were able to take on more ambitious, integrated research problems aimed at regional needs. But over time, the nature of work between centers and countries was changing. National systems were becoming better able to work in a collaborative mode. This was especially true of plant breeding: for example, for wheat in Asia and North Africa; maize in East Africa and parts of Asia and Latin America; rice in parts of Asia and Latin America; and cassava in parts of Africa, Asia and Latin America. The need for direct support was easing; more were able to work with centers, and fewer needed centers to work for them.

Developing networks

Center staffs also developed a catalytic role with national systems, helping researchers work together across national boundaries. The common format was networks. The first collaborative research network credited to a CGIAR center was the regional Asian Rice Farming Systems Network established by IRRI in 1974, which absorbed its precursor, the Asian Cropping Systems Network. Many others followed.

Networks linked researchers of like interests in nearby countries, usually on a regional or subregional basis. Through the network, they exchanged experiences and research results. Few networks among developing country researchers sprang up spontaneously, but initiatives by the CGIAR centers brought fruitful results. Center staffs often provided leadership to form networks and give logistical support; and

CIP technician discusses field problems with a Kenyan potato farmer.

centers or donors gave financial support for travel, meetings, and communication.

Dozens of research networks developed around the CGIAR centers' commodities. They provided an important means for more national systems to become part of the global agricultural research system. As the networks have matured, many national systems have assumed responsibility for managing and maintaining the activity. Centers have been able to ease off their once-dominant role in the network.

A pattern for a special kind of regional network came in a potato research network initiated by CIP. Known by the acronym of initial letters in its Spanish name, the PRECODEPA network united nine national potato research efforts in Central America into a member-managed collaboration. In each country, potato did not command a priority to support a full research program; but by joining together and pooling resources, each got the benefits of an integrated research program planned and carried out among the nine. (See Box 3.1 in Chapter 3.)

Native cattle in infested tse-tse area in Rwanda are target of trypanotolerant activity of ILRAD.

Regional networking, in various patterns, has spread to other commodities, other centers, and other parts of the world. Typically, a committee that represents the collaborators makes budget, policy, and work plans for the group. Examples include, among many others: the Regional Bean Programme in East Africa with CIAT (International Center for Tropical Agriculture); the Nile Valley Project involving ICARDA (International Center for Agricultural Research in the Dry Areas); the Trypanotolerant Livestock Network of ILCA (International Livestock Centre for Africa) and ILRAD (International Laboratory for Research on Animal Diseases).

Contract research

National agricultural research systems—sometimes individual researchers—relate directly to the CGIAR centers through contract or collaborative research. One compilation in 1983 showed 288 such collaborative agreements in effect then between the centers and national systems. These collaborations may be generated when a national researcher has some specific skills and research problems important to a center's mission or when a national system faces a problem that has significance beyond its borders. Often the agreement provides for center and national collaborators to work jointly on a particular problem. One example is the Brazil-CIMMYT effort to breed and select wheat cultivars that can tolerate soils with toxic levels of aluminum; another is IBPGR's collaboration with national researchers in the effort to collect and maintain the world's plant genetic resources.

Some contract research is also with universities and institutes—mainly in industrialized countries and where feasible in developing countries—usually for basic or strategic research that calls for sophisticated techniques available only in a few places in the scientific world.

Some contracts may set up advanced levels of training—such as IBPGR has arranged for collaborators in germplasm conservation and preservation.

Collaborative agreements offer the International Food Policy Research Institute (IFPRI) a primary format for its work. Through such agreements, IFPRI helps a cooperating country get policy information it needs and, through the collaboration, the country strengthens its own capability in policy analysis. At the same time, IFPRI gathers data for its regional and global policy analyses. In 1988, IFPRI had collaborative agreements with 26 countries and one regional body.

Responses to special needs

A social science component. Centers have devised modes of response to many unique situations and special needs as they have worked with national systems. Many national agricultural research systems lacked a social science component. Social scientists were integral parts of the staffs of international agricultural research centers, but few counterparts were to be found in national systems. This meant gaps and weaknesses in country resources for policy studies, socioeconomic evaluations of technology, and appraisals of farmer needs and social impacts of technology.

Many national systems had no social scientists to participate in research design or to conduct economic analysis on their research findings. Most centers at some time were involved in providing this expertise until national systems could get their own people trained (usually abroad) and working. Here are some examples: CIMMYT economists conceived a multidisciplinary approach to defining farmer needs within geographic or agroecological zones. They carried out this approach in countries across the world; each time they trained personnel in the country, as well as gathered results of the studies that were important to the country and to CIMMYT. ICRISAT set up village studies that helped evaluate social as well as technological problems. Social scientists at these and other centers were thus in the forefront of what has become a worldwide interest in farming-systems research. They helped develop methodologies for such research and aided research managers in relating this kind of research to traditional experiment-station studies. (See *CGIAR 1987/88 Annual Report*, pp. 55-66.)

Access to research findings. A glaring weakness in many African systems was access to reports of research done in other national systems—especially animal-related research. If research reports had not appeared in international journals—which were not always widely available—many researchers had no access to results from other countries. The International Livestock Centre for Africa (ILCA) undertook a regional search for what has been called "fugitive" literature. Scientists visited countries, searching for relevant reports; ILCA then provided the documentation expertise to collect, copy, and circulate micro-fiche "libraries" among cooperating countries.

Box 2.3. Point-counterpoint: Two views on the CGIAR's relations with national systems.

A five-country tour in Africa in early 1989 by a consultant to the CGIAR secretariat prompted discussion of numerous issues in the CGIAR-national systems relationship. A synopsis of issues, personal and interpretive, is presented below. They are accompanied by a digest of issues cited in regional papers commissioned by the CGIAR impact study. Some of those issues are reflected upon by another consultant.

An African perspective—Commentary by A.Z.M. Obaidullah Khan

National agricultural research systems in sub-Saharan Africa are at different stages of development. It is not surprising then that national perspectives regarding relations and benefits of association with the CGIAR and other international centers are diverse, ranging from appreciation of mutuality and interdependence to concerns about a patron-client relationship to frustration over a sense of unequal competition regarding access to external resources.

Regional scientific meetings and workshops organized by the CGIAR centers and the information exchange they provide are valued by most national researchers in Africa. According to a senior Kenyan scientist, for example, the Pasture Network of Eastern and Southern Africa coordinated by ILCA provides opportunities for exchanging research information among participating scientists, for discussing shortcomings of ILCA's program in their countries, and for building up national programs themselves.

In Cameroon, Ghana, and Zimbabwe, researchers also agree about the highly beneficial impact of the training programs and regional workshops/meetings organized by international centers. They feel, however, that more attention should be paid to developing indigenous capability to generate agricultural technology through a long-term commitment to human resources development, particularly at the graduate level.

Despite this need, interface between national universities and CGIAR centers is marginal in some, if not most, cases. For example, the faculty of agriculture at the University of Nairobi in Kenya is nearby ILRAD's laboratories for basic veterinary research, yet faculty members complain about not having a beneficial relationship with ILRAD's staff and world-class research facilities.

While appreciating the contribution of international centers in providing elite genetic material for plant breeding, researchers and policymakers in Cameroon, Kenya, Mali and Senegal, for example, articulate that they would like to participate directly in the production of technology. As a Kenyan breeder puts it, "A trial should answer a researcher's own problems, or include lines in which he or she has participated in breeding. Otherwise national scientists feel that they have been used as technicians for the implementation of an external agenda."

Senior breeders from these countries are concerned that much of the material introduced by the centers is not suitable for local breeding programs because selections are not judiciously made. The sheer volume of the material to be tested and, quite often, the procedural complexities overtax the local land resources, as well as the scarce technical and human resources. On the other hand, they would like to see more CGIAR support for research pertaining to environmental sustainability, i.e., soil erosion and soil-water-nutrient interaction, tree-crop-animal interaction, etc.

Zimbabwe, with its long history of productive agricultural research, is an interesting case where the range of perspectives on the CGIAR relationship exists in the same national system. The national breeding program for wheat in Zimbabwe has been enriched by unrestricted provision of genetic materials from CIMMYT. Any new variety that is released by the national program is named by local breeders, who feel like partners in a common endeavor. Similarly, the availability of a large range of cow-pea materials from IITA has helped national researchers rapidly to establish a research program with a deliberate thrust towards the needs of small farmers in communal areas. On the other hand, the highly advanced national program for maize is inundated with CIMMYT trials which are viewed as having little benefit for the national research agenda. And according to some researchers, the equally advanced breeding program on soya beans has benefitted IITA more than the national program.

Importantly, a common, often expressed concern by African policymakers is that too many demands by the CGIAR and other international centers without coordination and joint formulation of research program bear the risk of implosion and fragmentation of the evolving national systems.

On the other hand, collaboration between CIP/IITA and the Centre for Development of Horticulture has led to an innovation in regionalization, i.e., the possibility of a regional research mandate being carried out by a national institution. The program for maize and cassava in 11 African countries, proposed by the countries themselves, initiated by the CGIAR and backstopped by IITA, illustrates the need for and potential of reconciling the global priorities of an international center with the perceived priorities of individual African countries in a regional/subregional framework. This type of practical arrangement wherein the national, regional and international research agendas coalesce and complement each other is considered by many in Africa as a better alternative to networking among grossly unequal partners. Horizontal cooperation rather than vertical intervention is the preferred approach.

Within an emerging global research system, agricultural research leaders in Africa feel that they should have opportunities to involve themselves substantially in the research programs and activities of relevant CGIAR centers. In addition to their traditional role of producing improved technology, the CGIAR centers, likewise, must work with national programs in articulating priorities, relating them to international efforts, and developing long-term institutional capability within the countries themselves.

CGIAR impact study's perspective—Commentary by K. Robert Kern.

Based on a series of research papers in the mid-1980s, some by researchers in national systems, the CGIAR impact study (Anderson, *et al.*, 1988) reflected on the centers' relations with national systems. A selection of viewpoints is highlighted below.

"There is no doubt," the authors of impact study said in a summary of the findings, "that the centers as a whole have been a prime force for technological advance in agriculture. Many of the national research programs chiefly express regret that some weaknesses in their own operations have made it difficult to collaborate with the centers as effectively as they would have wished."

The collaboration has not always been trouble-free, the study found. For the most part, the authors said, "progress the centers have helped to achieve has come through a process of give-and-take, negotiation, and mutual learning."

Overall, the study found a favorable and productive climate for most collaborations between centers and national systems. Other evaluations have come to similar conclusions. Yet there are contentious points in the CGIAR centers-national systems relationship.

Some national researchers, especially among those handling international nurseries, see themselves as doing the routine tasks, while the international center gets the data. Some do not feel themselves viewed as peers in collaborative activities, or feel slighted in collaborative work—that some national results have been "pirated" without full acknowledgment. Others complain of a lack of "bottom-up" thinking in cases where a center scientist may pursue activities based on his or her perception of problems, irrespective of national views.

Some stress points show up around priorities and programs within centers and for the CGIAR system as a whole—and about how those priorities are set. Some feel the developing countries do not carry enough influence. The record shows that the number of developing country representatives on the 13 centers' governing boards and policy committees has increased over the years; however, members from developing countries feel themselves to be a minority. Actually, among all CGIAR center boards, developing country members fill just over half the positions. The trend line shows that share to be increasing. (See Annex 6a.)

Some of the maturing national agricultural research systems would like to share more in specific tasks of the global agricultural research community. Growing expertise and experience among national researchers, many believe, earns them more central roles in developing technology as well as in adapting it. They would like financial backing of the global system for such work.

A number of national researchers, especially at the policy levels, have voiced a desire that centers coordinate their efforts within a given country. Nationals feel limited in their capacity to relate well and separately to three, four, or more different centers that have programs in their country. (Similar thoughts have come out concerning a number of different bilateral donors; sometimes concerning seemingly conflicting programs of a single donor within a country.)

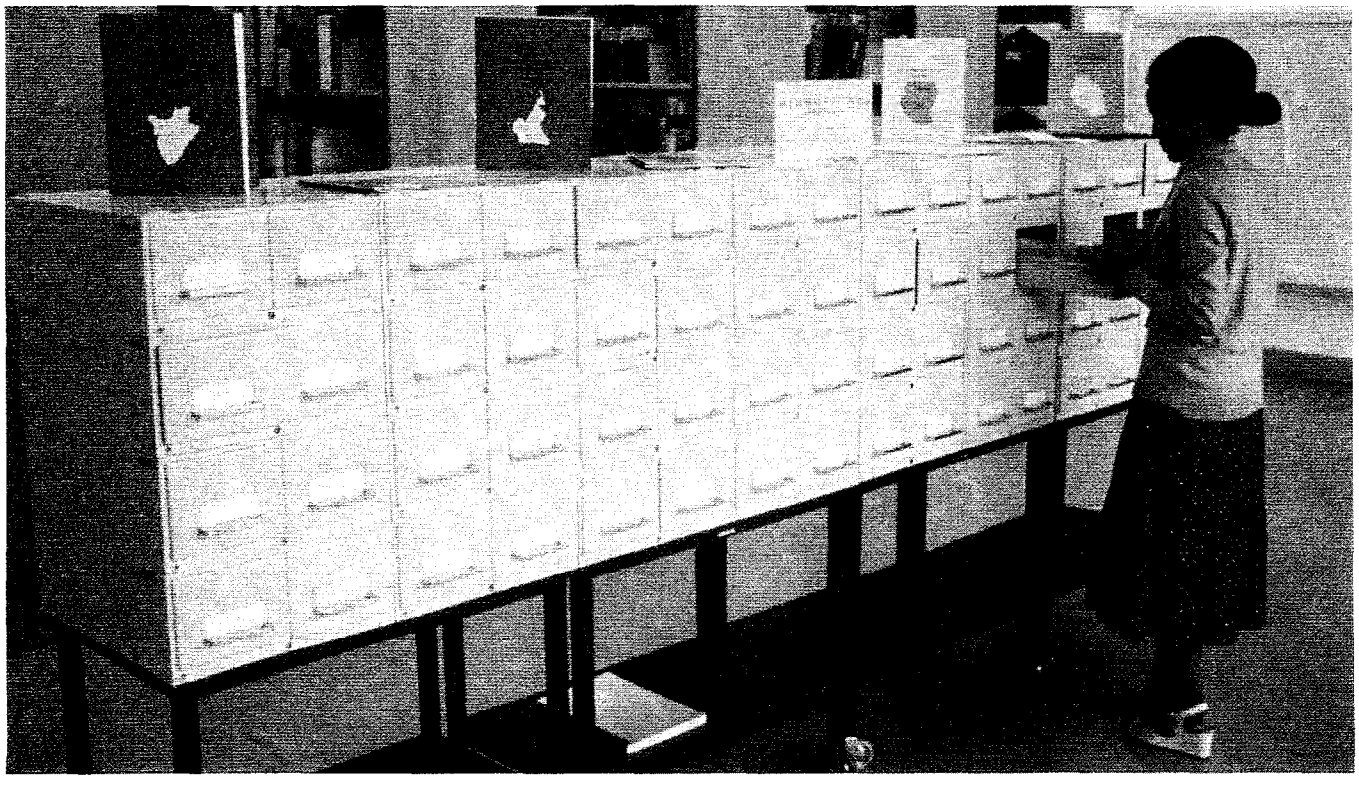
None of these is a new problem or issue. But the voicings seem to recur more as, on one hand, national systems have built their capabilities and, on another hand, as economic factors have put national research budgets under severe stress.

An IRRI initiative created the International Rice Research Newsletter to promote the exchange of a wide band of information among rice scientists. The newsletter has become a means of sharing accounts of significant research—by national systems as well as by IRRI—plus a lot of rice-related information. In addition to its value as a source of information to scattered and often-isolated rice workers, the newsletter gave such workers a medium in which to publish their own findings. Several other centers have initiated similar newsletters for their respective commodities, sometimes in more than one language, to bridge significant communication gaps. Importantly, they build collegial ties within and across disciplines.

Organizing and managing research

Commodity-center scientists had long been pressed to help national systems to develop and manage commodity research programs. Many national systems asked for broader help than commodity researchers felt qualified to give—for help with organizing and managing the whole system. In response to this need, the CGIAR created the International Service for National Agricultural Research (ISNAR).

ILCA's microfiche collection of 20,000 unpublished documents on African livestock assists researchers.



ISNAR drew together an experienced research-manager staff and a knowledge base on agricultural research management. It laid out a program of advisory services to national systems based on 12 functions considered critical in effective management of agricultural research. The functions embrace policy, organization, and management within a national agricultural research system. Supported by training and research programs, ISNAR collaborates with individual national systems to help them identify management constraints and plan and implement ways to overcome those constraints. ISNAR is primarily adviser, not the implementing agency to strengthen a system.

Under guidance of the same CGIAR system strategy, ISNAR helps national systems deal with management processes while other centers deal with the substance of agricultural research. In less than a decade it has set up continuing collaborative relations with more than 40 national systems.

Research management training

The research manpower situation was an ill-defined area in many national systems. It was especially true in African nations of the sub-Sahara. With grant support from a consortium of donors, ISNAR has initiated a number of regional training exercises for research managers. First ISNAR, with cooperation of an existing regional management institute and IITA, conducted training for more than 100 nationals. ISNAR and SACCAR (Southern African Centre for Cooperation in Agricultural Research, a group created by heads of nine African states) launched a four-year training program in agricultural research management. In the first two years, nearly 250 staff members from seven countries had participated in a total of nine training events. That program was at its half-way point in 1989. Eight francophone West African countries, in the Sahelian region, worked with ISNAR for a one-week workshop on agricultural research management in 1988.

Issues as opportunities

The CGIAR—both as a system and through 13 autonomous centers—continues to be responsive to changing needs of national programs. Many current problems and opportunities in the relationship are the focus of continuing debate both within and outside the CGIAR. Among them:

- The extent to which international centers should focus on "upstream" matters—such as biotechnology and basic commodity research. A corollary is the extent to which applied research—the primary focus of international centers—should be moved "downstream" for work by national systems.

Box 2.4. A Nile Valley Project update: Impact of cooperative research on faba beans.

Ten years ago the International Center for Agricultural Research in the Dry Areas (ICARDA) took steps to help expand production of the faba bean in the Nile Valley of North Africa (See 1984 *CGIAR Annual Report*). The move took the form of a collaborative effort with the governments of Sudan and Egypt. In 1985, the project was broadened to involve Ethiopia with work in its highlands.

Representatives of the three nations plan and direct activities that include genetic improvement of the nutritious faba bean, along with work on its pathology, entomology, and post-harvest conservation. In addition to the central research activities, the project involves national extension groups in key roles in farmer demonstrations and pilot production schemes.

The project has made tangible gains for the countries in genetic materials and production packages that produce bigger yields of this important food product. The new Egyptian cultivar, Giza 402, which has some resistance to the threatening *Orobanche* parasitic weed, is now in sufficient supply for planting nearly a third of Egypt's 140,000 hectares of faba bean.

Faba bean has been a costly food import in Sudan to make up for production shortfalls. Project scientists there have been able to come up with production packages for areas south of Khartoum, where the crop could not even be grown before. A year ago, 150 farmers grew the crop with good results. Observers foresee a doubling of Sudan's present area devoted to faba bean.

While praising the tangible production gains, national leaders credit the project equally as an innovative model of research cooperation and research management. Each of the countries has applied the model to other crops: Sudan to its nationwide wheat research and to all crops in its 850,000 ha Gezira scheme; Egypt to its field crops, cotton, and sugarcane in the Small Farmers' project; Ethiopia to research on pulses.

While the effort is now under the three cooperating nations, ICARDA continues to play a supporting role. One ICARDA scientist-administrator, based in Cairo, serves the project directly. An ICARDA breeder-pathologist, outposted in Ethiopia to another related project, also contributes. ICARDA also provides: linkage to several donors involved (who provide about US$700,000 annually); logistical support; specialized training; and germplasm.

Donors associated with the Nile Valley Project include the Government of Italy, International Fund for Agricultural Development, and the U.S. Agency for International Development.

- The matter of planning, priority setting, and allocation of resources by the CGIAR system and the centers and "decentralization" or "devolution" of those functions to national and regional bodies, taking into account their increasing capacity to assume broader and deeper responsibilities.
- The pending issue of whether "factor research"—on topics such as management of natural resources or of irrigation systems, for example—and other agricultural commodities should be incorporated in the CGIAR research agenda.
- The importance of coordination across donors and within units of the same donor—whether a donor's bilateral funding of a national program needs to be framed within the same global context as its multilateral support to a CGIAR center—if the coherence and momentum achieved by the Rockefeller and Ford Foundations' early research efforts are to be replicated.

Looking back on 25 years

A look back over more than a quarter century of CGIAR centers' relationships with national agricultural research systems suggests that both elements have been functioning as parts of a larger research system. And the larger system, on the whole, is stronger and more effective than it was before international centers came on the world scene.

National agricultural research systems have much more direct access to knowledge and technology—from whatever sources—for adaptation to their needs. CGIAR centers have played leading roles in making that possible.

While no articulated and managed global agricultural research system can be said to exist, many vital functions of such a system do, and have clearly improved over the almost two decades of CGIAR activity.

CGIAR centers contribute to the two-way flow of information among key players on the global scene. Open communication throughout the system tends to make it demand-driven: real needs of and constraints on farmers can then become the dynamic that defines and directs the system.

There remain many national systems who share weakly, if at all, in this global improvement. Just as world food production problems are far from solved, so also remain great needs in building agricultural research institutions that can adequately serve their nations. These realities continue to challenge the CGIAR, both the system as a whole and the autonomous centers that it embraces.

Box 2.5. A self-managed network: Regional programme for beans in southern Africa.

Nine national agricultural research systems in Africa have joined in a program that promises to improve production of beans within their countries. The group is concerned broadly with improvement of beans, a main source of protein in diets of many Africans with limited access to meat and milk products.

Members include: Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia, and Zimbabwe.

This self-managed network provides a variety of supports for the programs in individual countries, giving a framework for all to share in the benefits of the work in each country. Key sponsors are the Colombia-based International Center for Tropical Agriculture (CIAT) and the Southern African Centre for Cooperation in Agricultural Research (SACCAR). SACCAR functions on behalf of the Southern African Development Coordination Conference. The Canadian International Development Agency (CIDA) is the major financial donor.

A regional steering committee, one person from each member country, plays the key management and programming role. It determines the annual budget and the major activities of the network. Day-to-day functions at headquarters in Tanzania are handled by a CIAT professional as regional coordinator and four technical specialists (three are African)—with a training officer yet to be named. Other CIAT staff stationed in the region provide additional technical support. And the center's training programs in Colombia have been attended by a number of national bean program staff. The program provides for national coordinators and some technicians to work in each member country.

The network's first year of programming began in 1986. A sampling of country reports disclosed a sharp increase in research activities on beans. Specific work included variety tests, identifying local problems, and the start of breeding efforts.

This network is still early in its development. Training has been a major emphasis. The steering committee has identified seven nationals for academic scholarship awards, two for M.Sc. and five for Ph.D. studies in developed-country universities. Nine African staff have taken short-term professional training at CIAT headquarters. Within the region, eight workshops have been held, plus two training events for technicians.

Collaborative research projects are underway within the network countries, with each project funded through the program approved by the steering committee, based on a detailed project proposal.

Through 1988, seven publications had appeared, including two audiotutorial training programs and several articles in international journals.

3. Gathering, protecting, and processing a quality harvest

The post-harvest continuum

Much attention in agricultural development has understandably focused on breakthroughs in raising crop and livestock yields. Greatly expanded food production in many areas due to breeding efforts and improved agronomy has alleviated hunger and increased employment. Nevertheless, close to a quarter of the global crop production is lost every year during or after harvest due to improper handling, numerous pests and diseases, and inefficient processing.

In developing countries, damage to harvests from spoilage, insects, and rodents often exceeds one quarter of the crop yield. In Africa, an estimated 30 percent of the total grain production by subsistence farmers is lost to storage pests (Ngugi, 1989). Post-harvest losses in developing regions may be as high as 40 percent with cereals and 50 percent for fruits and vegetables (Scrimshaw, 1988). In all situations, but particularly when resources are precious and limited, a post-harvest loss represents the worst wastage of energy, labor and other resources that have been expended to bring the crop to maturity. As human populations continue to increase in the Third World, the need to reduce harvest, storage, and processing losses for crops and livestock becomes ever more urgent.

Post-harvest technologies are often perceived as applying only to the storage or processing of crops. But a quality harvest begins before the seed, tuber, or cutting is planted. A plant structured to withstand lodging in a brisk breeze or a hard grain that mills into a fine flour contain characteristics that, through breeding, aim to optimize harvest output and utilization. Also, seeds that resist destructive fungi or beetles in storage usually require protracted breeding efforts that tap a wide range of genetic resources. Indeed, post-harvest technologies, agronomy, and plant and animal breeding are all interlinked. Post-harvest technologies should be viewed more as a continuum with agricultural production technologies, rather than a discrete research and development activity.

Scientists and technicians in the CGIAR system are engaged in a wide spectrum of activities related to post-harvest technologies. Although the overall investment in such activities by the international centers is modest, the CGIAR recognizes the importance of post-harvest technologies. The TAC study on *CGIAR Priorities and Future Studies*, for example, identifies enhancing commodity conversion and utilization as a major objective of the CGIAR system (TAC, 1986:27). One of CIP's nine research thrusts focuses specifically on post-harvest technology (Rhoades and Booth, 1982).

Rather than examine exhaustively all the myriad research thrusts at the international centers directed at enhancing the quality of harvests

The genetic diversity of potatoes in the Andes mountains of South America is an important resource for future genetic research on post-harvest and other applications.

and reducing storage losses, a few examples highlight the diversity and widespread nature of such efforts. This selective review includes gathering the harvest, protecting the harvest, evaluating product quality, processing, and greater utilization of crop products. Finally some emerging issues are explored and some lessons learned are extracted.

Innovations for gathering the harvest

Once a cereal or pulse crop has been harvested, farmers typically face a critical period in which grains must be rapidly separated from stalks or pods and dried before they spoil. IRRI has developed a line of inexpensive machinery to assist small farmers in the harvesting and drying of their rice crops. Such machines play a valuable role in speeding up turn-around time for the next crop cycle.

Improved threshers and dryers, for example, permit some farmers to compress cropping cycles so that they can reap three or more harvests. Hand-threshing with nail-studded boards is time-consuming, and if it rains heavily at harvest time, seeds can sprout prematurely. IRRI's axial-flow thresher, now produced by small and medium-sized shops in many parts of Southeast Asia, is an economical way to greatly accelerate the removal of rice harvests from the field. By the mid-1980s, over 50,000 axial-flow threshers had been commercially produced in tropical Asia (IRRI, 1985:100).

Manual threshing of highly productive IR42 rice is time-consuming and labor-intensive for Philippino farmer (left). At right, use of axial-flow thresher accelerates harvesting of IR64.

Several versions of axial-flow threshers have been developed by IRRI since the first machine was introduced in 1973. The portable TH6 model has an especially high threshing efficiency and produces less broken straw. Axial-flow threshers can easily pay for themselves within a few years due to more rapid turn-around between crops and income from renting the machines. Axial-flow threshers are well adapted to cooperatives in which the purchasing and maintenance of the machines are shared by all members.

Another relatively simple and inexpensive post-harvest technology for rice farmers is the heated floor dryer. The heated floor dryer is built under a shed adjacent to open-air pads used for solar drying rice. The IRRI-designed heated floor dryer burns rice straw, hulls, corncobs, or fuelwood, and is an invaluable complement to traditional solar-drying techniques on rainy or cloudy days. The heated floor dryer can pay for itself in a little over two years (IRRI, 1984:448).

After drying, rice grains need to be de-husked for human consumption. A problem with early generation semi-dwarf rices, such as IR8, was that they did not fare well when being de-husked and polished. The agitation needed to release the husks, either by machines or wooden mortars, tended to crack an unusually large number of grains, thereby reducing their market value. Later generation rice lines developed by IRRI, in collaboration with national programs, retain high-yielding characteristics while producing a far superior grain.

Protecting the harvest

Cereals. The introduction of semi-dwarf wheats and rices in developing countries has greatly reduced harvest losses due to lodging. Many traditional wheats and rices are tall and easily collapse during storms. Prostrate plants bring seeds in contact with the humid ground where they rot and are more accessible to birds and rodents. The development of Green Revolution wheats and rices by CIMMYT and IRRI in the 1960s was a major achievement not only because the new varieties were more responsive to fertilizer, but because the shorter and stiffer cultivars were less prone to lodging.

A wide range of pests and diseases attack crops in the field. The onslaught continues right after harvest, and typically grows progressively worse as the crop remains in storage. Damaging insects, fungi, and bacteria may gain a foothold while the crop is ripening and proliferate after the grains are reaped.

Pulses. Grain quality can be adversely affected by invading pathogens, especially fungi. While some farmers may resort to pesticides, resource-poor farmers often cannot afford such measures. Genetic resistance to such pathogens is thus a highly desirable trait. Aflatoxin, a poison found in many stored grains, particularly groundnuts, can cause cancer. Scientists at ICRISAT have identified several genetically-distinct

In Colombia, wild beans (*Phaseolus vulgaris*) are undergoing evaluation in CIAT's breeding activities for bruchid resistance.

groundnut plants that resist pre-harvest seed invasion by *Aspergillis flavus*, one of two species of *Aspergillus* responsible for producing aflatoxin (ICRISAT, 1986:16). Breeders are now crossing the resistant material with other groundnut lines for further evaluation.

In Latin America, bean storage losses due to weevils are in the order of 13-15 percent, while along the Transamazon Highway in Brazil, virtually all stored beans can be destroyed by the tunneling pests within a few months. In Africa, losses are also known to exceed two-thirds of stored beans in some cases (CIAT, 1988b). Concern for beetle damage to stored beans is one reason farmers often sell soon after harvest, when prices are usually at their lowest.

If beans could be safely stored, consumers in the Third World would also benefit from a better supply of quality beans less subject to wide price swings. Bruchid or weevil damage to pulses and grains is particularly critical for planting seed. Farmers are obliged to find ways to protect their own planting seed, such as sealing them in containers with ash or insecticide, or purchase planting seed at harvest, often at exorbitant prices.

To address this widespread storage problem, CIAT and IITA are working to improve resistance of beans and cowpea to bruchid beetles. CIAT scientists recently discovered sources of resistance to the weevils *Zabrotes subfasciatus* and *Acanthoscelides obtectus* in accessions of wild beans (*Phaseolus vulgaris*) from Mexico. The resistant beans prevent the ubiquitous pests from surviving after reproduction. At the University of Wisconsin, scientists collaborating with CIAT identified a protein in the wild beans, absent in cultivated forms, which apparently confers resistance to bruchid beetles. The responsible protein has been named arcelin, after the town in Mexico near where the wild beans were collected. Scientists are now at work attempting to transfer this antibiotic trait to agronomically-desired bean types.

IITA has conducted a similar line of research with cowpeas. Scientists at IITA screened over 8,000 accessions of cowpea in the germplasm collection at Ibadan, Nigeria, until they found three cowpea lines that withstood attack from *Callosobruchus maculatus*, another bruchid beetle. Genes from those resistant cowpeas have now been incorporated into several high-yielding lines that have been distributed to dozens of national programs.

Root crops. IITA is also conducting research on weevil resistance for sweet potato so that storage losses are reduced. In cooler climates, seed potatoes are used to plant the crop and considerable damage can occur between harvest and planting. In warmer areas, weevils can damage sweet potatoes destined for the market.

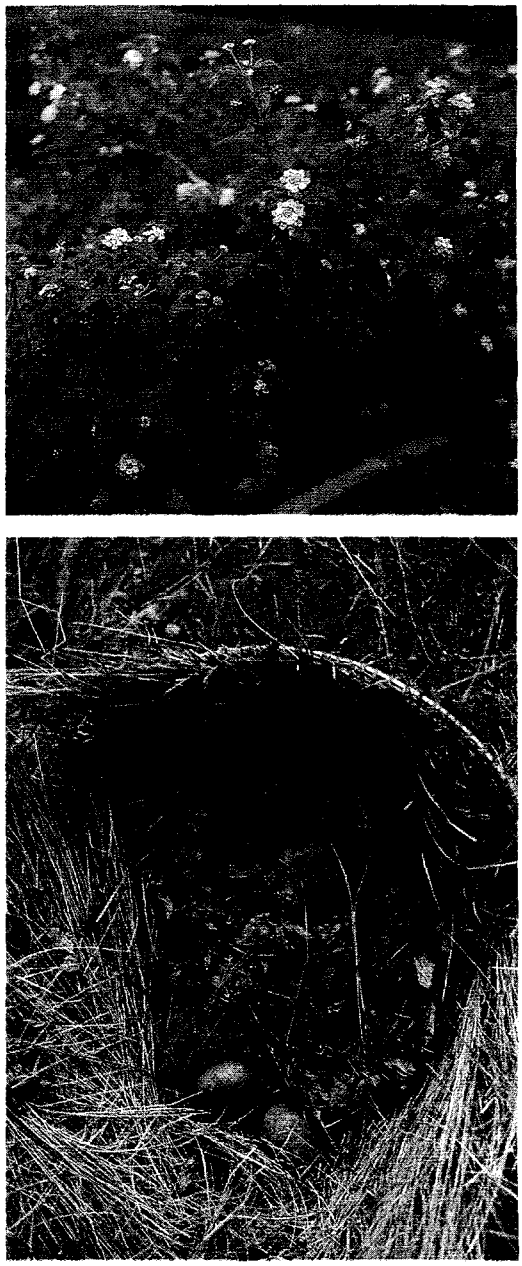
Storage can also be a problem for potato farmers. Seed potatoes are highly susceptible to two species of tuber moth in tropical and subtropical regions. Tuber moths lay eggs on stored potatoes and the

hatched larvae bore into the potatoes, thereby disfiguring and seriously damaging them. Fungi and bacteria exploit lesions caused by the voracious larvae. Some potato varieties have long dormancy periods that necessitate protracted storage under less than ideal conditions. Traditional storage techniques for seed potatoes range from wooden crates stacked in cramped houses in Guatemala, piling potatoes in the corners of rooms in Peru, under beds in Burundi, and under straw and earth in highland Kenya. While such techniques have worked for hundreds or even thousands of years in some cases, spoilage can be high due to the warm and damp conditions. Losses as high as 50 percent have been encountered among stored seed potatoes in highland Ethiopia (Borgel *et al.* 1980:87).

Many farmers cannot afford cold storage for seed or ware potatoes, even if such facilities are available. Farmers are then forced to sell their crop soon after harvest (Durr and Lorenz, 1980:116). If inexpensive and effective methods were available for safeguarding stored potatoes, farmers would be more likely to achieve higher, and more regular, incomes. Fortunately, a new storage method has been devised in recent years which promises to alleviate storage problems for potato farmers in developing countries.

Diffuse light sheds for storage of seed or ware potatoes dramatically reduce storage spoilage. Diffuse light sheds are built with locally available materials and can be assembled adjacent to, or separate from, houses. Such well-aerated sheds discourage fungal attacks and discourage premature sprouting. This improved technology is being promoted widely by CIP through regional potato research networks such as PRECODEPA in Central America, PRAPAC in Africa, SAPPRAD in Southeast Asia (See Box 3.1.)

To combat tuber moths in stored potatoes, CIP has helped disseminate two biocontrol measures: sexual pheromone traps and repellent leaves. Sexual pheromones of both tuber moth species have been synthesized and are relatively inexpensive to use since only minute quantities of the chemical, normally exuded by the female moths, are needed. In the Andes, farmers often use the aromatic leaves of eucalyptus or a native mint to discourage tuber moths (Werge, 1980:25). Following this example, CIP scientists in Central Africa decided to use lantana, a pantropical weed, instead. Many farmers in Burundi and the Kivu province of Zaire are now successfully employing the pungent leaves of lantana to eliminate tuber moths from their seed potatoes stored in diffuse light sheds.



Leaves from *Lantana camara* (top) are used, once dried (bottom), for biocontrol of tuber moths in seed potatoes in Burundi.

Evaluating product quality

Grain quality is a paramount concern to CGIAR centers. At CIMMYT, for example, grain samples from experimental wheat lines are tested in a grain quality laboratory at CIMMYT's headquarters in El Batan, Mex-

Box 3.1. CIP's five regional networks help countries diffuse technology.

Over the past decade, CIP has promoted the initiation of five collaborative research networks—three in Latin America, one in East Africa, and one in Southeast Asia—dedicated to the improvement of the potato crop through research and transfer of technology. These networks provide a cost-efficient way of generating and transferring technology among countries with similar ecological conditions and common limiting factors. The collaborative country research networks have attracted the attention of international funding agencies, who see them as efficient vehicles for financing regional agricultural research and development programs.

Creating a network. The initial procedure by which CIP networks are created has been similar in all cases. Potential member countries are invited to attend a meeting. A least one participant from each country should be at the decision-making level for national agricultural research and another participant should be technically oriented, preferably the leader of the potato program if one exists. Areas for possible research of common interest are identified.

At the same time, research capabilities within the group are assessed in order to distribute responsibilities for the study of selected problems. Part of the responsibility of those countries which accept leadership for a specific research project is to provide consultancies and training to the other members of the network. Countries with little or no expertise to offer the group are accepted as members, principally as recipients of technical help or as regional evaluation sites for testing of technologies.

A budget for research, training, communication, and coordinating activities is prepared, including in-country as well as regional financial requirements. Projects are normally supported partially through personnel and physical facilities of national programs. External funding covers most of the operational expenses within the country, international travel, and coordinating expenses.

In all the networks, a memorandum of agreement has been signed by the country representatives and CIP. This document provides the legal base needed by CIP to seek external funding support.

Direction and supervision. Each of the networks has a directors' committee, which is the ultimate authority. This committee meets once a year to decide on budget and staff allocation. CIP acts as a member of the committee, establishing its financial and technical commitment to the projects through it.

Coordination. The coordinator is appointed by CIP for the first one or two years of a network's operation. After this initial period, the position is turned over to a national staff member appointed by the group, usually on a rotating basis.

CIP's role. CIP plays a vital role in suggesting projects and seeing them through their initial technical stages. All responsibility is passed on to the national institutions as rapidly as possible, and CIP maintains only the right to one vote on the directors' committee, with no powers of veto.

Another important role for CIP is to provide the technical assistance services, consultancies, and training required to get the various research projects underway as quickly as possible. With heavy technical input in the first two or three years, most projects are able to produce results quickly, thus having a substantial impact on production early in the life of the networks. Subsequently, CIP's technical input is reduced, being provided only at the request of the technical committees to meet special needs.

A third important role for CIP is to provide fiduciary services, both to the countries and the donors. External funding is approved by the donor for bilateral support, yet CIP is expected to supervise the dispersal of funds.

And perhaps most importantly, CIP—through its regional support program—provides continuity and stability to the networks, as they build upon the strengths of partner countries.

Network	Year	Countries	Cooperating source
PRECODEPA Programa Regional Cooperativo de Papa	1978	Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Panama	Swiss Development Corporation
SAPPRAD Southeast Asian Program for Potato Research and Development	1980	Indonesia, Malaysia, Papua New Guinea, Philippines, Sri Lanka, Thailand	ADAB (Australia)
PRACIPA Programa Andino Cooperativo de Investigacion en Papa	1982	Bolivia, Colombia, Ecuador, Peru, Venezuela	IDRC (Canada)
PRAPAC Programme Regional d'Amelioration de la Culture de Pomme de Terre en Afrique Centrale	1982	Burundi, Rwanda, Uganda, Zaire	USAID (United States)
PROCIPA Program Cooperativo de Investigaciones en Papa	1982	Argentina, Brazil, Chile, Paraguay, Uruguay	CIP

PRAPAC's techniques for solar-drying potatoes are being demonstrated and adopted in Zaire.

ico. In this way, breeders are alerted to deficiencies in nutritional and baking quality before a protovariety is developed.

IRRI and WARDA also systematically evaluate the milling quality of rice. Research at WARDA has shown a strong relationship between milling and husking yields and moisture content, shape, hardness, and number of damaged kernels. Such research has led to techniques to predict milling recovery much quicker than conventional methods.

Processing techniques and marketability

Root crops often do not store well, so they are frequently processed into flour or chips soon after harvesting. Potatoes can be stored for several months after harvesting, but surplus production is sometimes converted into flour or dried chips. Several regional potato research networks, initiated or coordinated by CIP, are exploring cost-effective ways to make potato chips and flour. Scientists linked by PRECODEPA and PRAPAC are exploring solar-drying techniques for processing surplus potatoes for industrial use.

Other root crops have to be eaten or processed soon after harvest, otherwise they perish. Fresh cassava, for example, must be consumed within a day or two of harvest which restricts its marketability. Much of the cassava produced in developing countries is converted into chips for livestock feed, flour, large pancakes called *beiju* in Amazonia, or the tubers are boiled and dehydrated for later use, as in Central Africa.

To facilitate the penetration of fresh cassava into growing urban markets, CIAT has developed a method to keep cassava roots fresh for at least two weeks (CIAT, 1988a). In collaboration with the Overseas Development and National Resource Institute in the United Kingdom, CIAT devised a technique to store fresh cassava treated with a thiabendazole-based fungicide in plastic bags. The safe, tasteless fungicide retards microbial infection, while the polyethylene bags inhibit physiological deterioration of the tubers.

Before embarking on a project to develop methods for preserving fresh cassava, CIAT conducted socioeconomic baseline studies to gauge the demand for fresh cassava in several Colombian cities. Satisfied that sufficient interest in purchasing fresh cassava existed in such towns as Bucaramanga and Baranquilla, commercial testing of the new technology began in 1986. Several cooperatives are now successfully selling bagged cassava treated with fungicide to supermarkets in Colombia and Ecuador. Ecuador now exports fresh cassava to the United States as a result of the new method for preserving the tubers. This innovative approach to expanding the availability of a popular food among urban dwellers has created a much-appreciated boost to cassava growers in Colombia and Ecuador. Other regions in Latin America, and possibly Africa and Asia too, are soon likely to benefit from this simple, farm-level technology.

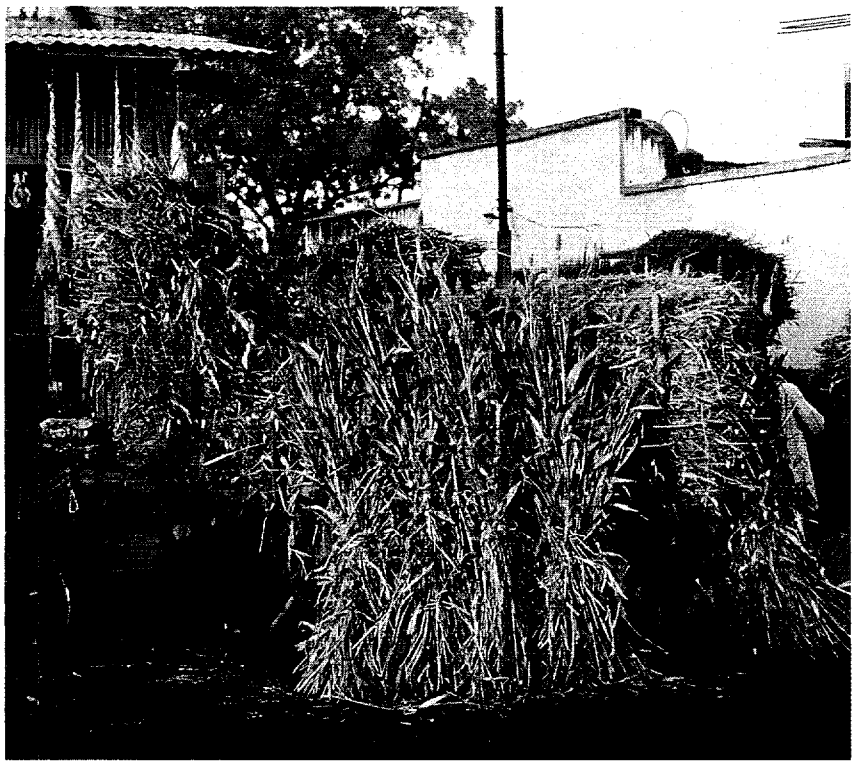
Greater utilization of crop byproducts

Another way to reduce wastage after harvest is to take fuller advantage of crop byproducts. In this manner, village-based processing enterprises create more employment opportunities. Furthermore, better utilization of crop byproducts for livestock feed improves the nutrition of local peoples. Scientists at ILCA, for example, are fostering the African Research Network on Agricultural Byproducts (ARNAB). Formed in 1981, participants in ARNAB are exploring ways to incorporate groundnut and cacao byproducts, as well as corn stover, in livestock feed. ARNAB publishes a newsletter in English and French four times a year and organizes periodic workshops around selected themes. The 1986 ARNAB workshop focused on the utilization of crop residues and agro-industrial byproducts with emphasis on technologies for small-scale farmers.

Emerging issues

Sometimes crop qualities that facilitate harvesting, such as short stature, detract from other qualities desired by farmers. Large quantities of straw are often needed by farmers to supplement the diet of their livestock, particularly in densely settled regions with little grazing land. In such areas, farmers have selected for hardy, long-stemmed cereals. Similarly, determinate cowpeas may be easier to harvest than elongated varieties, but the latter provide valuable fodder for cattle, goats, and pigs.

It is hard to maximize the genetic expression of all variables. Crop breeders are generally doing a laudable job of tailoring varieties to suit multiple needs and tastes. In spite of the drawbacks of some crop varieties designed to facilitate harvesting, such cultivars clearly have secured a place on small- and large-scale farms. Farmers have the op-



Sorghum stalks are an important crop byproduct—as a source of fodder for many small farmers in India.

tion of planting a mix of traditional and modern varieties, the former usually for domestic consumption, while the latter are often sold.

Lessons learned

Three main lessons can be drawn from the CGIAR centers' experience in post-harvest technology. First, genetic resources are vital to combat harvest and storage losses. Genebanks are tapped constantly by breeders to reduce crop height and to locate sources of resistance to seed weevils and other pests. Without comprehensive and carefully evaluated germplasm collections, breeders will encounter difficulties tackling future challenges to crop harvests and storage.

Second, agricultural research centers need to tap a wide range of disciplines in order to develop viable post-harvest technologies. Many disciplines, ranging from genetics, socio-economics, engineering, plant pathology, and entomology to plant physiology are drawn into research efforts to improve the quality of harvests and to reduce storage losses. When such expertise is not available in-house, collaborative arrangements can be forged with other institutions.

Third, networking is a valuable mechanism for facilitating research on post-harvest technologies. While few networks focus exclusively on post-harvest research, many incorporate such themes as improved storage for root crops and the use of crop byproducts for livestock feed. Networks can be a cost-effective means to share information and accelerate the exchange of new technologies. International nursery networks are used extensively to test germplasm for resistance

to diseases and pests that attack crops while in the field and after harvest. New networks, focusing on specific aspects of post-harvest research, are likely to arise in the future.

Future of post-harvest research

In setting priorities and allocating funds, there is not unanimity among the CGIAR centers regarding the value of and pay-off to research on harvest and post-harvest technology. Due to program and funding tensions, the centers have responded to post-harvest considerations by being quite selective; their activities in this arena are usually commodity-specific and have direct bearing on the problems faced by farmers and demands made by consumers of that commodity. The needs are critical to producers of beans and root crops. And in the case of wheat and rice, respectively, the centers have no choice but to be mindful of baking quality and grain quality for consumers. Quantitatively, such research probably does not exceed TAC's recommendation that it absorb 2 percent of CGIAR resources. From a small base, its share is likely to rise in the future.

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4. The financial situation

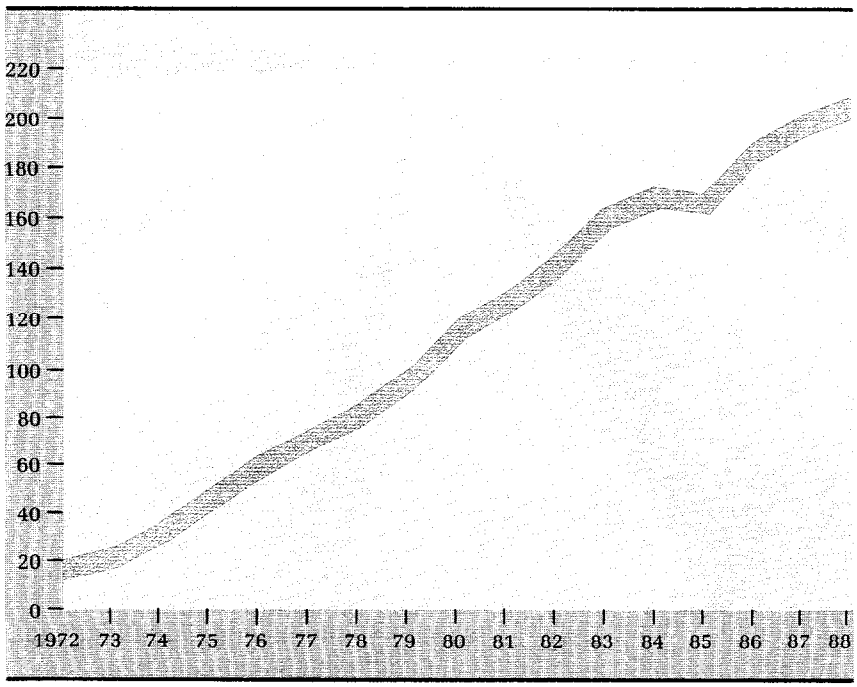
Contributions to the CGIAR in 1988 increased by US$18.6 million, the net result of a US$10.2 million increase in core/essential contributions and a US$8.4 million increase in special project contributions. Total funding amounted to US$262 million, or 8 percent more than in 1987. This increase is noteworthy, given the significant turn-around in U.S. dollar exchange rates in 1988 which reduced the value of non-dollar contributions compared to ICW1987 by US$6 million.

Of the 37[1] donor members of the CGIAR, 35 contributed to the centers' core programs in 1988. Several donors (Belgium, Canada, Denmark, France, Finland, IDB, the Netherlands), significantly increased their support. The Asian Development Bank did not contribute core funds, though it actively supports several special programs of the centers. Discussions on new memberships are underway with several potential donors.

Core/essential funding in 1988 was US$211.8 million. After a net set-aside of US$0.8 million for the stabilization fund and US$1.0 million for systemwide special programs, the amount available from donor contributions to the centers' core programs was US$210 million (Table 4.1). Despite the U.S. dollar's strength, relative changes in the donor support base reduced the proportion of contributions made in U.S.

[1]The Leverhulme Trust withdrew as a donor member in 1987.

Figure 4.1. CGIAR core funding, 1972-88 (US$ million).



dollars to 48 percent, compared to 49 percent in 1987 and 51 percent in 1986. Since more than 50 percent of centers' expenditures is in dollars, this slight mismatch in currency funding and spending exposes centers to possible currency risk in the future. In the first half of 1988, donor disbursements to centers continued to decline, with only about 42 percent of pledged funds disbursed (compared to 45 percent in 1987). By end-1988, 6 percent of pledged contributions remained undisbursed.

The healthy funding picture allowed, for the second year, most center programs to be fully financed in 1988.

Table 4.1. CGIAR funding, 1986-88 (current US$ million).

	1986	1987	1988
Total donor core funding[a] (stabilization mechanism included)	192.2 [3.8]	201.6 [6.7]	211.8 [0.8]
Total core expended[b]	189.4	203.2	219.6
Operations	175.2	188.2	203.6
Capital[c]	14.2	15.0	16.0
Non-core (special project) donor funding[b]	43.3	41.4	49.8
Total non-core expended			
Operations	41.3	40.2	41.1
Capital	1.2	2.6	1.0
Total donor funding	235.5	243.0	261.6
Percent change from previous year			
in core funding	13	5	5
in non-core funding	9	−4	20
in total funding	12	3	8

[a]Funding represents donor contributions only; centers also finance programs from income, carry-overs, and changes in working capital. In 1988, the stabilization mechanism supplemented donor contributions by about US$5 million.
[b]Core programs are those recommended by TAC and approved annually by the Group. Special projects are activities within the overall scope of each center, but not part of the currently approved program.
[c]Capital expenditures exclude additions to operating funds and special purpose reserves.

At ICW88, the CGIAR secretariat estimated funding availability for 1989 at US$228 million. By early 1989, the U.S. dollar had weakened and the availability of funding was revised upwards to about US$232 million, compared to the centers' estimated need for US$238 million to cover approved plans, of which they were able to defer some US$6 million. By end-June 1989, the U.S. dollar had fluctuated upward again, yet in the short run, center programs are not affected since the stabilization mechanism protects against exchange losses.

Table 4.2. Center operating expenditures, 1986-88.

Center	[In constant 1988 US$ million] 1986	1987	1988
CIAT	22.8	23.6	23.1
CIMMYT	25.2	24.7	25.0
CIP	13.5	13.6	13.1
IBPGR	5.0	5.3	6.2
ICARDA	19.5	19.3	20.4
ICRISAT	23.5	24.3	24.0
IFPRI	4.8	6.0	8.2
IITA	19.3	18.9	17.2
ILCA	15.3	14.4	16.1
ILRAD	10.2	11.3	12.3
IRRI	25.6	26.1	26.7
ISNAR	4.6	5.3	6.0
WARDA	4.0	5.9	5.3
Total	193.6	198.6	203.6
Percent change	1.3	2.6	2.5
Additional expenditures (current US$ million)			
Capital	14.2	15.0	16.0
Non-core expenditures	42.5	42.8	42.0

[a]WARDA's total research program. Prior amounts relate to its core research program only.

Expenditure trends

In aggregate, spending on operations in 1988 was 2 percent below the levels planned at the start of the year. Centers spent US$203.6 million on operations, 2.5 percent more in real terms than in 1987 (Table 4.2). Higher inflationary cost increases, 5 percent compared with 4 percent in 1987, held the real increase below the 1987 level. Centers also spent US$16 million on capital items, US$1 million higher than in 1987, mainly due to changes in accounting rules to record large replacements such as airplanes under capital expenditures. Funds set aside in the form of increased operating funds or reserves to cover potential liabilities amounted to about US$11 million.

In real terms, operational expenditures by CIAT, CIP, ICRISAT, IITA and WARDA registered marginal declines from the 1987 levels. Expenditures rose relatively rapidly in the cases of IBPGR, IFPRI, ILCA and ISNAR. While these changes from 1987 are reflected in the financial calculations, none of the centers identifies them as being of major operational significance. They appear to be a result of technical budget reclassifications (IFPRI and ILRAD), recruitment patterns and rephasing of work programs.

Figure 4.2. Core expenditures, 1988.

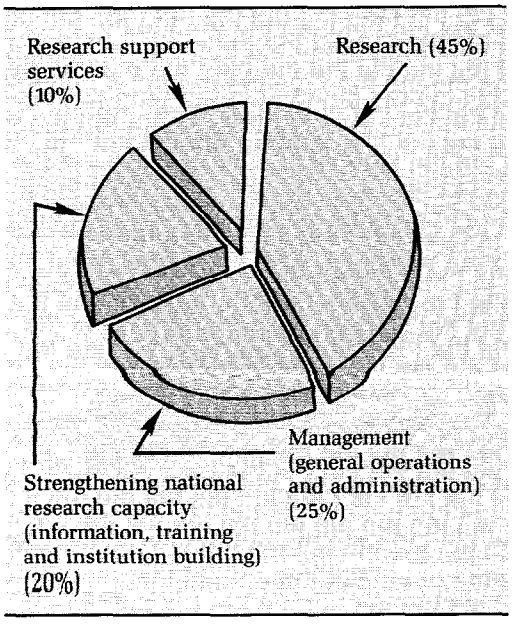
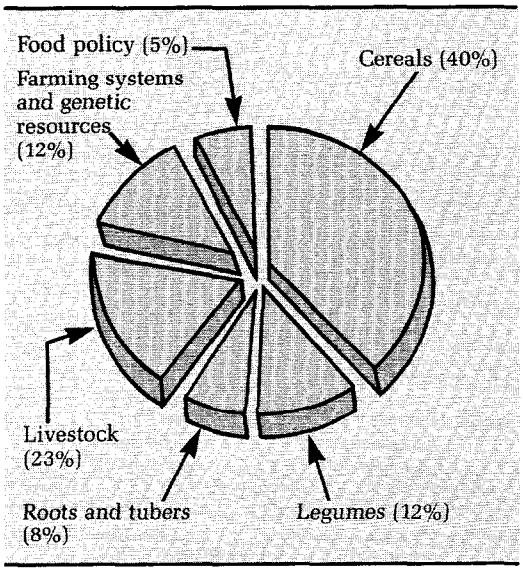


Figure 4.3. Core research expenditures, 1988.



The aggregation of center spending in terms of the CGIAR program structure also shows little variation from plans. Research programs absorbed US$92.5 million, while US$19.4 million was spent on research support, with the two categories accounting for 55 percent of total spending (Table 4.5).

Table 4.3. Core expenditures by program (percent), 1986-88.

Program	1986	1987	1988
Research	44	44	45
Research management[a]	25	25	25
Strengthening national research capacity[b]	20	20	20
Research support	11	11	10
	100	100	100

[a]Comprises general operations and administration.
[b]Through information, training and institution building.

Table 4.4. Core expenditures by research commodity/activity (percent), 1986-88.

Commodity/activity	1986	1987	1988
Cereals	39	37	40
Legumes	12	13	12
Roots and tubers	11	8	8
Livestock	20	19	23
Farming systems and genetic resources	14	18	12
Food policy	4	5	5
	100	100	100

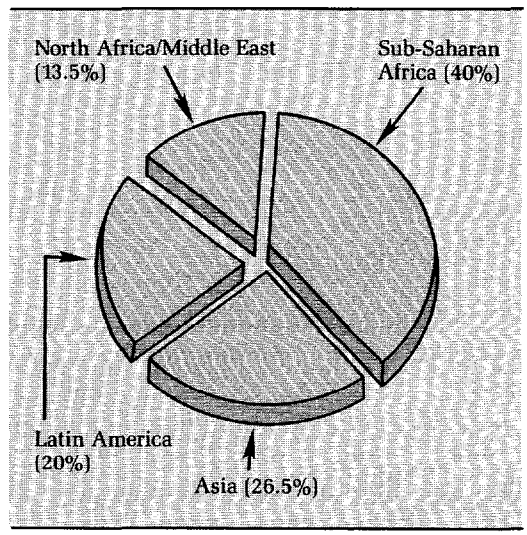
World Bank contributions

As the balancing donor to the CGIAR, the World Bank allocated its 1988 funds after other donors' intentions were known. To fund the approved programs of the centers, the Bank contributed US$28.2 million to 12 centers, with IBPGR, as in 1987, being the only center not requiring Bank funds. Of the 12, CIAT, as in 1987, needed less than 5 percent of its approved funding from the Bank. Six centers required contributions larger than 15 percent of their approved funding levels, compared to five centers in 1987. The remaining five centers received contributions ranging from 5 to 15 percent.

Table 4.5. Center core program expenditures, 1986-88.

Program/Activity	1986	1987	1988	Percent change 1988 over 1987
	[In constant 1988 US$ million]			
Research				
Cereals	35.8	35.7	37.3	4.5
Legumes	10.4	11.3	11.0	−2.7
Roots and tubers	7.0	6.9	7.7	11.6
Livestock	17.0	16.7	20.9	25.1
Farming systems and genetic resources	12.6	13.1	11.5	−12.2
Food Policy	3.2	4.3	4.1	−4.7
Subtotal research	86.0	88.0	92.5	5.1
Research management	47.7	48.6	50.8	4.5
Strengthening national research capacity	37.6	40.5	40.9	0.1
Research support	22.3	21.5	19.4	−9.8
Total operations	193.6	198.6	203.6	2.5

Figure 4.4. Core expenditures by region, 1988.



Stabilization fund

In 1988, for the first time, there was a decrease in the stabilization fund. The fund was set up in 1984 to protect centers from short-term fluctuations in exchange rates and inflation, by guaranteeing exchange rates vis-à-vis the U.S. dollar and inflation assumptions at the start of the year. The decrease was roughly US$3 million, taking into account claims of US$5.7 million (US1.7 million net in inflation-related and US$4 million in exchange losses) and inflows of US$2.9 million (US$1.4 million in contributions and US$1.5 million in interest). Inflation-related claims came from CIMMYT (US$1.9 million due to price increases in Mexico which were not offset by a devaluation of the peso) and from IRRI (US$0.2 million due to a mandatory revision of local salary scales in the Philippines). This US$2.1 million in overall inflation-related claims was partially offset (US$0.4 million) by the continuing downward realignment of the national currency in Nigeria vis-à-vis the U.S. dollar for the net of US$1.7 million. Claims for exchange losses on donors' contributions were paid to all centers except IBPGR, IFPRI and ILCA. The claims from IBPGR and IFPRI did not appear significant enough to warrant a call on the stabilization fund in 1988. ILCA, reflecting lower spending requirements due to recruitment lags, did not press its claim from the fund. At the start of 1989, some US$15 million was available to meet future inflation/exchange rate risks.

Annex 1. About the CGIAR.

The Consultative Group on International Agricultural Research (CGIAR) is an informal association of governments, international organizations, and private institutions, cosponsored by the World Bank, the Food and Agriculture Organization of the United Nations (FAO), and the United Nations Development Programme (UNDP) The CGIAR first met in 1971 when members agreed to support, on a sustained basis, a well-defined and closely monitored program of research on food commodities and on food production in agroecological zones. CGIAR operates without a formal charter, relying on the consensus deriving from a sense of common purpose.

CGIAR started with a nucleus of four existing international agricultural research centers—CIAT, CIMMYT, IITA, and IRRI—established by the Rockefeller and Ford Foundations in Colombia, Mexico, Nigeria, and the Philippines, respectively. At the start, 15 donors provided about US$20 million The number of centers has since increased to 13, supported by 37 donor members and other contributors who provided about US$262 million in 1988

Each center supported by the CGIAR is independent and autonomous, with a particular structure, mandate and objectives, and each governed by an international board of trustees. Some centers focus on one commodity for which they have a global mandate, while others have a regional or ecological mandate with, in some cases, a global mandate for one or more commodities. Others perform specialized functions in the fields of food policy research, genetic resource conservation, and strengthening national agricultural research in developing countries

The programs of the commodity-oriented centers vary, but common components include genetic resource conservation and classification; biological research to increase yields by genetic improvement and greater resistance to pests and diseases, farming systems studies to better understand farm-level constraints and improve traditional practises, and training and other activities to strengthen national research systems.

The CGIAR's objectives, as summarized by its Technical Advisory Committee (TAC), are as follows "Through international research and related activities, to contribute to increasing sustainable food production in developing countries in such a way that the nutritional level and general economic well-being of the low-income people are improved "

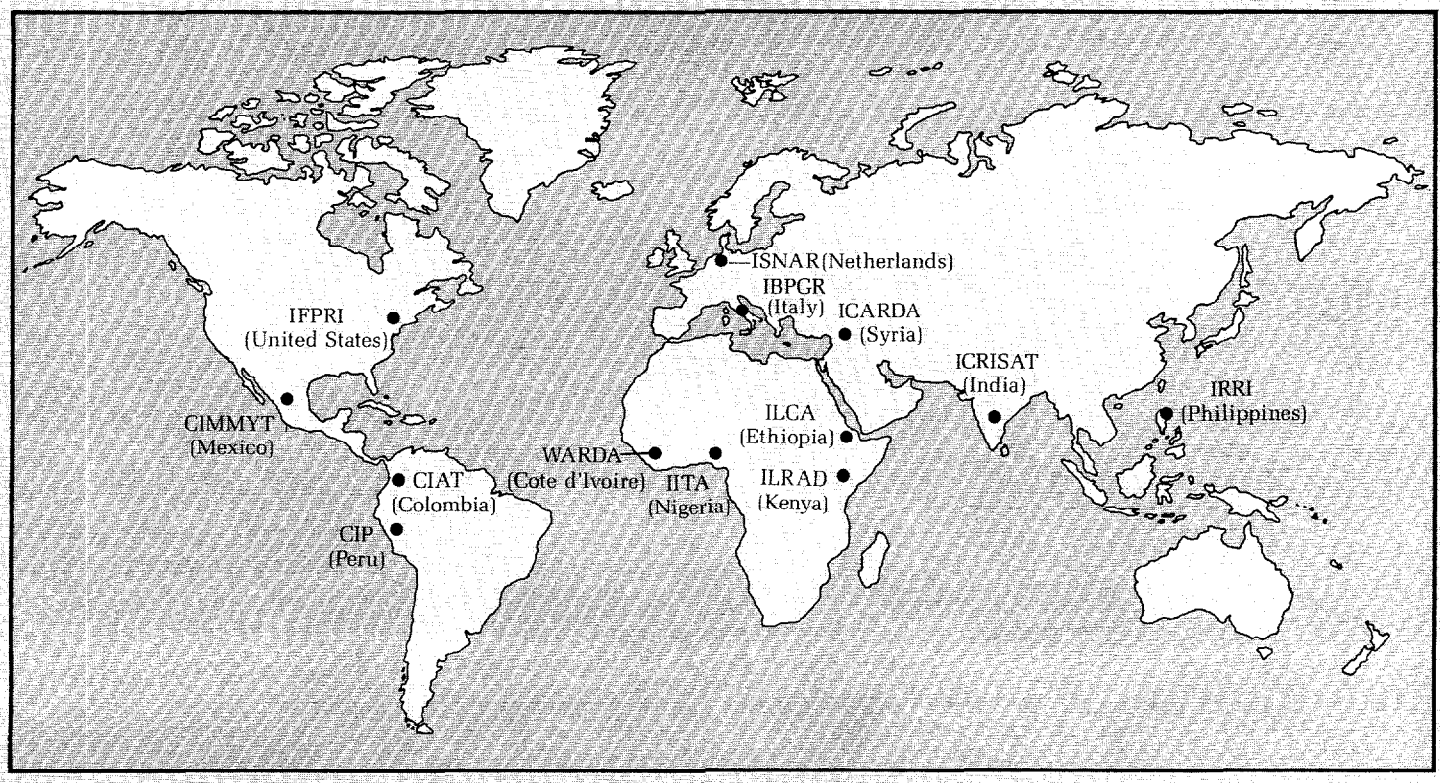
TAC comprises a chairman and 14 scientists drawn equally from developed and developing countries The committee makes recommendations on research programs and priorities, monitors performance through program and budget reviews, and supervises periodic external reviews of the centers undertaken by panels of independent scientists TAC is supported by a secretariat, provided by the three cosponsors of CGIAR and located at FAO headquarters in Rome.

The CGIAR is also served by an executive secretariat, located in Washington, D.C. and provided by the World Bank. The secretariat reports to the CGIAR chairman, a vice president of the World Bank designated by the Bank's president after consultation with CGIAR members. It confers with donor members about fund raising and organizes two meetings of the members each year. Besides providing administrative services, the secretariat helps keep donors informed about the scientific programs, finances and management practises at the centers.

Meetings of the CGIAR are held twice a year, once in Washington, D.C. in October/November and once elsewhere in May. The meetings receive and discuss recommendations on overall research strategy, programs and budgetary needs of individual centers, and management issues pertaining to the centers as a group. Critical independent reviews of center performance are presented and discussed. Developing country interests are represented by several donors from this group of countries, and by 10 delegates selected by regional conferences of FAO.

Individual donors allocate their contributions to centers of their choice. The World Bank balances the centers' finances by making up as much as possible of the difference between approved budgets and collective donor contributions.

Global location of the 13 CGIAR-supported centers.



Annex 2. CGIAR major crops and activities.

Objectives	Center	Regional focus
Barley	CIMMYT	Latin America
	ICARDA	Developing countries
Cassava	CIAT	Developing countries
	IITA	Sub-Saharan Africa
Chickpea	ICRISAT	Developing countries
	ICARDA	North Africa/Middle East
Cowpea	IITA	Developing countries
Faba bean	ICARDA	Developing countries
Groundnut	ICRISAT	Developing countries
Lentil	ICARDA	Developing countries
Maize	CIMMYT	Developing countries
	IITA	Sub-Saharan Africa
Millet	ICRISAT	Developing countries
Pigeonpea	ICRISAT	Developing countries
Potato	CIP	Developing countries
Pastures	CIAT	Latin America
	ILCA	Sub-Saharan Africa
Phaseolus (field bean)	CIAT	Developing countries
Rice	IRRI	Developing countries
	CIAT	Latin America
	IITA	Sub-Saharan Africa
	WARDA	West Africa
Soybean	IITA	Sub-Saharan Africa
Sorghum	ICRISAT	Developing countries
Sweet potato	CIP	Developing countries
	IITA	Sub-Saharan Africa
Triticale	CIMMYT	Developing countries
Wheat	CIMMYT	Developing countries
	ICARDA	North Africa/Middle East
Yam	IITA	Developing countries
Livestock	ILCA	Sub-Saharan Africa
Theileriosis	ILRAD	Sub-Saharan Africa
Trypanosomiasis	ILRAD	Sub-Saharan Africa
Food policy	IFPRI	Developing countries
Plant genetic resources	IBPGR	Global
National research systems	ISNAR	Developing countries

Annex 3. CGIAR organization, June 1989

Continuing members.

Australia	Germany, Fed Rep.	Philippines
Austria	India	Saudi Arabia
Belgium	Ireland	Spain
Brazil[1]	Italy	Sweden
Canada	Japan	Switzerland
China	Mexico	United Kingdom
Denmark	Netherlands	United States
Finland	Nigeria	
France	Norway	

African Development Bank
Arab Fund for Economic and Social Development
Asian Development Bank
Commission of the European Communities
Food and Agriculture Organization of the United Nations
Ford Foundation
Inter-American Development Bank
International Bank for Reconstruction and Development (World Bank)
International Development Research Centre
International Fund for Agricultural Development
Kellogg Foundation
OPEC Fund for International Development
Rockefeller Foundation
United Nations Development Programme
United Nations Environment Programme

[1]See fixed-term members below

Fixed-term members of developing countries:

Africa—Mauritius and Zambia
Asia and Pacific—Bangladesh and Thailand
Latin America and the Caribbean—Brazil and Venezuela
Near East and North Africa—Jordan and Turkey
Southern and Eastern Europe—Poland and Portugal

CGIAR Chairman:

W David Hopper
World Bank
1818 H St , N W.
Washington, D.C 20433, United States

CGIAR Executive Secretary:

Alexander von der Osten
World Bank
1818 H St , N.W
Washington, D C. 20433, United States

Technical Advisory Committee:

TAC Chairman:

Alexander McCalla
University of California
Department of Agricultural Economics
Davis, California 95616-5224, United States

TAC Members:

Michael H. Arnold
Doris Howes Calloway
Charan Chantalakhana
Kamla Chowdhry
C.T de Wit
Raoul J.A. Dudal
Ken-Ichi Hayashi
Amir Muhammed
Ibrahim Nahal
Gustavo Nores
Ernesto Paterniani
James G Ryan
Abdoulaye Sawadogo
Gian Tommaso Scarascia Mugnozza

TAC Executive Secretary:

John H Monyo
TAC Secretariat
Food and Agriculture Organization of the United Nations
Via delle Terme di Caracalla
Rome 00100, Italy

CGIAR-supported Centers:

CIAT Centro Internacional de Agricultura Tropical
Apartado Aereo 6713
Cali, Colombia

Director General: John L Nickel
Chair: Frederick Hutchinson

CIMMYT Centro Internacional de Mejoramiento de Maiz y Trigo
PO Box 6-641
Mexico 06600, D F. Mexico
Director General. Donald L. Winkelmann
Chair Lucio Reca

CIP Centro Internacional de la Papa
Apartado 5969
Lima, Peru
Director General Richard L. Sawyer
Chair David Call

IBPGR International Board for Plant Genetic Resources
c/o Food and Agriculture Organization of the United Nations
Via delle Sette Chiese
Rome 00147, Italy
Acting Director: Dick H. van Sloten
Chair William E Tossell

ICARDA International Center for Agricultural Research in the Dry Areas
PO Box 5466
Aleppo, Syria
Director General. Nasrat Fadda
Chair Jose I Cubero

ICRISAT International Crops Research Institute for the Semi-Arid Tropics
ICRISAT Patancheru PO
Andhra Pradesh 502 324, India
ICRISAT Sahelian Center
B.P 12404
Niamey, Niger (via Paris)
Director General Leslie D Swindale
Chair: William T Mashler

IFPRI International Food Policy Research Institute
1776 Massachusetts Avenue, N.W
Washington, D.C., 20036-1998, United States
Director. John W. Mellor
Chair. Dick de Zeeuw

IITA International Institute of Tropical Agriculture
PMB 5320
Ibadan, Nigeria
Mailing address
IITA, Ibadan, Nigeria
c/o Ms Maureen Larkin
L W Lambourn & Co.
Carolyn House, 26 Dingwall Road
Croydon CR9 3EE, United Kingdom

Director General: Laurence D. Stifel[2]
Chair Lawrence A Wilson [3]

ILCA International Livestock Center for Africa
P.O Box 5689
Addis Ababa, Ethiopia

Director General. John P. Walsh
Chair. Ralph Cummings, Sr.

ILRAD International Laboratory for Research on Animal Diseases
PO Box 30709
Nairobi, Kenya

Director General A R. Gray
Chair. Ingemar Maansson

IRRI International Rice Research Institute
P.O. Box 933
Manila, Philippines

Director General· Klaus Lampe
Chair. Walter P. Falcon

ISNAR International Service for National Agricultural Research
PO Box 93375
2509 AJ The Hague
Netherlands

Acting Director General. Howard Elliott
Chair: M Henri Carsalade

WARDA West Africa Rice Development Association
01 B.P. 2551
Bouake 01, Cote d'Ivoire

Director General Eugene R Terry
Chair Heinrich C Weltzien

[2]Chair, Directors General Group
[3]Chair, Board Chair Group

Annex 4. Donor contributions to center programs, 1972-88 (in US$ million).

	Core Programs					Total (Core + Non-core)					
Donor	1972-76	1977-81	1982-86	1987	1988	1983	1984	1985	1986	1987	1988
Australia	4.00	13.28	20.53	2.92	3.13	4.11	4.03	4.27	4.85	3.50	4.31
Austria	—	—	1.00	1.00	1.00	—	—	—	1.01	1.00	1.00
Belgium	3.48	13.70	9.22	2.74	2.53	2.46	2.31	2.66	2.48	3.74	3.50
Brazil	—	—	1.00	—	0.02	—	1.00	—	0.01	0.05	0.02
Canada	17.37	36.14	48.62	11.79	13.76	10.74	11.58	12.74	14.26	14.76	18.63
China	—	—	1.48	0.30	0.30	—	0.50	0.50	0.48	0.30	0.30
Denmark	1.71	4.69	5.92	2.26	2.53	0.95	1.24	1.26	1.67	2.36	2.74
Finland	—	—	2.09	2.29	2.74	—	0.50	0.60	0.99	2.44	2.93
France	1.05	3.14	6.09	3.22	3.30	1.10	0.94	1.39	2.15	3.31	4.11
Germany, Fed. Rep.	13.27	39.06	36.58	10.38	10.81	8.68	7.39	8.14	8.90	12.17	13.32
India	—	0.50	2.49	0.50	0.49	0.50	0.50	0.49	0.50	0.50	0.49
Iran	1.98	3.00	—	—	—	—	—	—	—	—	—
Ireland	—	0.38	1.94	0.69	0.16	0.34	0.41	0.40	0.58	0.72	0.24
Italy	0.10	1.90	29.13	10.08	8.09	6.10	6.62	6.78	9.73	10.72	10.14
Japan	2.49	26.25	54.68	17.98	20.21	9.48	10.46	12.05	18.92	20.19	23.36
Mexico	—	1.45	2.04	0.10	—	0.15	1.44	0.47	0.25	0.10	—
Netherlands	4.11	11.54	20.64	5.60	6.26	4.12	3.79	4.53	7.88	6.37	7.01
New Zealand	0.11	0.14	0.08	—	—	0.02	0.02	0.01	0.01	—	—
Nigeria	1.30	5.36	4.17	0.18	0.12	1.40	1.60	1.29	0.38	0.22	0.15
Norway	3.33	9.27	11.37	3.23	3.85	2.19	1.92	2.27	3.40	3.59	4.20
Philippines	—	0.65	1.62	0.26	0.25	0.35	0.32	0.23	0.27	0.26	0.25
Saudi Arabia	1.00	1.00	3.00	—	—	1.50	1.50	—	—	—	—
Spain	—	0.50	2.50	0.50	0.50	0.52	0.52	0.50	0.50	0.50	0.50
Sweden	7.19	14.80	16.52	4.86	5.41	3.05	3.07	3.02	4.21	4.87	5.46
Switzerland	1.87	9.47	26.63	7.70	9.59	5.91	8.21	7.80	9.08	9.70	11.17
United Kingdom	9.02	27.51	32.64	10.27	11.51	5.98	5.74	6.33	8.55	10.27	11.55
United States	41.60	128.09	222.00	40.22	42.22	55.02	56.85	60.19	60.22	55.10	58.40
Country Subtotal	114.98	351.82	563.98	139.07	148.78	124.67	132.46	137.92	161.28	166.74	183.78
Ford	16.79	6.20	4.91	0.94	0.79	1.75	1.37	1.68	1.73	1.65	1.39
Kellogg	1.32	0.63	0.97	—	—	0.69	0.41	—	—	0.18	0.23
Kresge	0.75	—	—	—	—	—	—	—	—	—	—
Leverhulme	—	1.08	3.43	—	—	0.75	0.81	0.60	0.62	—	—
Rockefeller	17.10	6.67	3.53	0.88	0.93	0.54	0.55	0.99	1.22	1.47	1.49
Foundation Subtotal	35.96	14.58	12.84	1.82	1.72	3.73	3.14	3.27	3.57	3.30	3.11
ADB	0.30	1.20	—	—	—	0.17	0.45	0.64	0.71	0.92	0.72
AFDB	—	0.15	0.61	0.71	0.72	—	—	—	0.59	0.71	0.72
AFESD	—	1.12	1.38	0.37	0.35	0.23	0.23	0.34	0.34	0.37	0.39
EC	—	17.38	28.32	9.12	9.19	6.25	6.01	7.95	8.47	10.00	9.40
IDB	11.15	32.19	42.55	10.28	10.55	8.16	8.73	8.17	9.44	10.29	10.55
IDRC	3.95	5.68	6.49	0.81	0.63	2.45	2.78	3.12	3.51	3.02	2.31
IFAD	—	11.05	24.93	0.25	0.28	10.31	8.67	5.26	1.22	1.00	0.99
OPEC	—	1.90	9.49	0.51	0.28	2.25	2.19	1.05	0.87	0.63	0.34
UNDP	7.42	21.59	37.02	8.68	8.99	7.16	9.12	8.85	8.87	8.88	9.20
UNEP	0.94	0.49	0.34	—	0.05	0.17	0.03	0.02	0.03	0.04	0.05
World Bank (IBRD)	16.15	53.33	116.10	30.00	30.00	19.50	24.68	28.87	29.61	30.39	30.20
International Donor subtotal	39.91	146.08	267.23	60.73	61.04	56.65	62.89	64.27	63.66	66.25	64.87
Other Donors	—	—	—	—	0.24	3.29	4.60	4.37	7.01	6.77	10.21
Total	190.85	512.48	844.05	201.62	211.78	188.34	203.09	209.83	235.52	243.06	261.97

Annex 5. CGIAR-supported center expenditures, 1971-88 (current US$ million).

	Core Operating Expenditures				
Center	1971-76	1977-81	1982-86	1987	1988
CIAT	24 5	61 6	102 0	22 7	23 1
CIMMYT	34 0	71 5	98 3	21 8	25 0
CIP	8.7	31 3	50 2	12 9	13 1
IBPGR	1 4	12 0	20 8	5 1	6 2
ICARDA	1 4	32 8	74 1	18 2	20 4
ICRISAT	11 7	43 0	87 8	23 4	24 0
IFPRI	—	10 3	9 8	5 7	8 2
IITA	31 6	65 4	95 4	18 3	17 2
ILCA	4 4	33 7	56 4	13 4	16 1
ILRAD	2 5	28 3	42 5	10 9	12 3
IRRI	24 2	66 9	105 9	24 8	26 7
ISNAR	—	2 4	17 1	5 2	6 0
WARDA	1 8	8 6	12 8	5 8	5 3
Total	146 2	467 8	783 1	188 2	203 6

	1971-88 Cumulative			
Center	Operations	Capital	Special Projects	Total
CIAT	233 9	21 5	25 4	280 8
CIMMYT	250 6	12 0	44 7	307 3
CIP	116 2	14 3	9 8	140 3
IBPGR	45 5	—	1 4	46 9
ICARDA	146 9	40 9	16 6	204 4
ICRISAT	189 9	44.3	42 0	276 2
IFPRI	44 0	1 1	10 7	55 8
IITA	227 9	34 0	93 4	355 3
ILCA	124 0	20 1	11 9	156 0
ILRAD	96 5	22 3	2 0	120 8
IRRI	248 5	18 8	69 2	336 5
ISNAR	30 7	1 6	6 2	38 5
WARDA	34 3	2 2	17 7	54 2
Total	1788 9	233 1	351 0	2373 0

Annex 6a. Regional origin of internationally recruited staff and board trustees, 1988.

Region	Staff	%	Trustees	%
Asia	155	17	31	17
Sub-Saharan Africa	137	15	32	17.5
N Africa/M. East	27	3	9	5
Latin America/Caribbean	112	12	23	13
Europe	242	26	44	24
North America	214	23	31	17
Australia/New Zealand	38	4	12	6 5
Total	925	100	182	100

Annex 6b. Regional origin of internationally recruited staff by center, 1988.

Center	Asia	Sub-Saharan Africa	N Africa/ M East	L America/ Caribbean	Europe	N America	Australia/ New Zealand	Total
CIAT	5	3	2	35	21	31	3	100
CIMMYT	13	5	2	25	16	34	9	104
CIP	14	2	5	35	25	19	—	100
IBPGR	1	1	3	1	11	2	4	23
ICARDA	7	3	12	3	20	10	3	58
ICRISAT	28	17	—	1	27	17	6	96
IFPRI	15	1	—	2	2	14	—	34
IITA	26	56	1	3	34	35	1	156
ILCA	4	14	—	—	29	7	2	56
ILRAD	2	8	—	—	37	10	1	58
IRRI	35	—	1	2	8	19	7	72
ISNAR	4	3	1	5	12	13	2	40
WARDA	1	24	—	—	—	3	—	28
Total	155	137	27	112	242	214	38	925

Annex 6c. Regional origin of board trustees by center, 1988.

Center	Asia	Sub-Saharan Africa	N Africa/ M. East	L America/ Caribbean	Europe	N America	Australia/ New Zealand	Total
CIAT	1	1	—	8	3	4	—	17
CIMMYT	3	2	1	4	2	3	1	16
CIP	2	—	1	2	2	2	1	10
IBPGR	4	1	—	1	5	2	2	15
ICARDA	—	—	6	—	7	2	1	16
ICRISAT	4	2	—	1	3	3	2	15
IFPRI	4	2	1	2	3	3	1	16
IITA	1	5	—	3	3	3	—	15
ILCA	—	5	—	—	4	2	1	12
ILRAD	—	5	—	—	3	2	1	11
IRRI	8	1	—	1	2	2	1	15
ISNAR	2	2	—	1	4	1	1	11
WARDA	2	6	—	—	3	2	—	13
Total	31	32	9	23	44	31	12	182

Consultative Group
on International
Agricultural Research
CGIAR Secretariat
1818 H Street, N.W.
Washington, D.C. 20433
United States

ISSN 0257-3156