Renewal of the CGIAR
Sustainable Agriculture for Food Security
in Developing Countries

Ministerial-Level Meeting
Lucerne, Switzerland • February 9-10, 1995
Background Documents on Major Issues

Consultative Group on International Agricultural Research
About the CGIAR

The Consultative Group on International Agricultural Research (CGIAR) is an informal association of 48 public and private sector members that supports a network of 16 international agricultural research centers. The Group was established in 1971.

The World Bank, the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Programme (UNDP), and the United Nations Environment Programme (UNEP) are cosponsors of the CGIAR. The Chairman of the Group is a senior official of the World Bank, which provides the CGIAR System with a Secretariat in Washington, D.C. The CGIAR is assisted by a Technical Advisory Committee, with a Secretariat at FAO in Rome.

The mission of the CGIAR is to contribute, through its research, to promoting sustainable agriculture for food security in developing countries. International centers supported by the CGIAR are part of a global agricultural research system. The CGIAR conducts strategic and applied research, with its products being international public goods, and focuses its research agenda on problem solving through interdisciplinary programs implemented by one or more of its international centers, in collaboration with a full range of partners. Such programs concentrate on increasing productivity, protecting the environment, saving biodiversity, improving policies, and contributing to strengthening agricultural research in developing countries.

Food productivity in developing countries has increased through the combined efforts of CGIAR centers and their partners in developing countries. The same efforts have helped to bring about a range of other benefits, such as reduced prices of food, better nutrition, more rational policies, and stronger institutions. CGIAR centers have trained more than 45,000 agricultural scientists from developing countries during the past 20 years. Many of them form the nucleus of and provide leadership to national agricultural research systems in their own countries.
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Foreword

The Consultative Group on International Agricultural Research (CGIAR) launched a program of renewal and rededication at its Mid-Term Meeting in New Delhi, India in May 1994 to confront the challenges of environmentally sustainable, global agricultural development with even greater vigor and effectiveness than before.

Through the renewal program, the CGIAR is clarifying its vision, refocusing its research agenda, improving its governance and operations, restructuring its financial arrangements, and securing stable financial support for its mission. Underpinning this program is a commitment to ensuring that the CGIAR fully represents a South-North partnership at all levels of activity.

A "Renewal of the CGIAR" Ministerial-Level Meeting, held in Lucerne, Switzerland on February 9-10, 1995, 1 was a milestone in this 18-month process. Ministers, heads of foundations and international and regional aid agencies, and their representatives gathered in Lucerne to renew the legacy of Bellagio 2 and to define the future priorities and directions of the CGIAR to enable it to better meet the imperatives of a changed and changing global environment. The theme of the meeting was "Sustainable Agriculture for Food Security in Developing Countries." Participants adopted a Lucerne Declaration and Action Program that will guide the future research agenda and operations of the CGIAR.

Six interconnected studies defining the CGIAR’s new thinking were prepared to stimulate discussion, first among the CGIAR and, ultimately, among participants at the Ministerial-Level Meeting. The vision statement was adopted by the CGIAR after full discussion in New Delhi; the other studies continued to be developed and modified following the New Delhi meeting, and were discussed in detail by the CGIAR at International Centers Week 1994.

Collectively, these studies formed the background documents on major issues for the discussions at the Ministerial-Level Meeting. Distributed as drafts, these documents were viewed as "work in progress" for consideration and modification by ministers and heads of agencies in Lucerne. These documents proved indispensable to the discussions in Lucerne, and were adopted without modification by meeting participants, forming the basis of the "manifesto" of the renewed CGIAR. They are reproduced in this publication in final form.

Five of the documents cover specific subject areas: the global context in which the CGIAR functions; a vision for the CGIAR; a research agenda for the future; improving the CGIAR’s governance; and new financing arrangements. An Overview summarizes the main themes of the subject-specific documents.

THE GLOBAL CONTEXT IN WHICH THE CGIAR FUNCTIONS

The CGIAR was established in 1971 in response to specific global cir-

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1 The proceedings of the Lucerne meeting are being published as a companion volume to this publication, under the title Summary of Proceedings and Decisions.
2 A meeting of the international community in Bellagio, Italy in 1971 led to the establishment of the Group and the CGIAR System and to the formulation of a set of priorities and principles to guide it.
circumstances, including predictions of widespread famine in South Asia; optimism about the capacity of newly-developed, high-yielding strains of rice and wheat to help raise productivity in rice and wheat to unprecedented levels; and confidence among policymakers that sustained international agricultural research could make an invaluable contribution to development.

Many changes have taken place in the global context since then. Taking account of the need for a renewal of the CGIAR to be anchored in international realities, the global context document relates the work of the CGIAR to the contemporary economic and political context in which the CGIAR functions. The issues addressed include: the end of the Cold War; the liberalization of trade; the population-poverty-environment nexus; the impetus toward new forms of international cooperation following the conclusion of the United Nations Conference on Environment and Development and the adoption of Agenda 21; and the role of agriculture as a component and catalyst of sustainable development.

A VISION FOR THE CGIAR

A forward looking and compelling vision, characterized by compassion and defined with clarity, is an important precondition for the program of renewal of the CGIAR. As it faces the future, the goal of the CGIAR is to conduct research that will help liberate the deprived and disadvantaged from the grip of extreme poverty and hunger. The defining terms of the CGIAR’s vision are: less poverty; a healthier, better nourished human family; reduced pressure on fragile natural resources; and people-centered policies for sustainable development.

The vision statement was prepared by an external panel appointed by the Oversight Committee of the CGIAR, and was distributed as an illustrated volume entitled *Sustainable Agriculture for a Food Secure World—A Vision for International Agricultural Research*, published by the Swedish Agency for Research Cooperation with Developing Countries (SAREC) in July 1994. The vision document is a reproduction of the SAREC publication.

A RESEARCH AGENDA FOR THE FUTURE

For the very poor, most of whom depend on land for their livelihood, the way forward is through increased agricultural productivity that does not degrade the natural resources base upon which productivity depends. Sustainable agriculture is at the core of human development. Research generates new technologies and knowledge that drive the development process while conserving natural resources.

The CGIAR is only one component of the global agricultural research system. Its effectiveness depends both upon the results of its research and on its role as a catalyst and bridge builder, creating and fostering productive partnerships. The research agenda document examines the challenges and opportunities ahead of the CGIAR under five major thrusts: increasing productivity; protecting the environment; saving biodiversity; improving policy; and fortifying national programs in developing countries.
IMPROVING THE CGIAR'S GOVERNANCE

As part of the effort to renew the CGIAR, the CGIAR's governance has been carefully reviewed as a prelude to change. A cautious approach has been taken so that changes will not be at the expense of well established strengths, such as the CGIAR's sense of collegiality, its focus on strategic research as a gateway to development, its non-political character, and its informality.

A seven-member Study Panel, consisting of representatives from within the CGIAR and non-CGIAR management experts, examined the ways in which the CGIAR does business and proposed a number of changes, including a new rhythm of meetings and a tightening up of decisionmaking processes. The governance document highlights and explains the changes proposed.

NEW FINANCING ARRANGEMENTS

In recent years, the effectiveness of CGIAR centers has been hindered by a diminution of funds for their core research agenda and the diversion of funds for activities peripheral to that agenda. To meet this challenge, the CGIAR has proposed a series of reform measures to bring predictability to the budget as well as to increase transparency and accountability.

An important element of the changes proposed is the use of a matrix approach as an organizing framework to set the research agenda, allocate responsibilities for research programs, and secure appropriate levels of funding. The matrix plots activities in relation to programs (columns) and centers (rows). The transparency provided by this approach ensures that no part of the overall research agenda and work program adopted in the matrix remains unfunded and no individual cell of the matrix is oversubscribed. The finance document sets out the guiding principles that form the basis of the matrix approach and analyzes its organization and implementation.

The program of renewal will continue at the Mid-Term Meeting to be held in Nairobi, Kenya in May 1995, when detailed changes and instruments will be adopted, and at International Centers Week to be held in Washington, D.C. in October 1995, when the final adoption of new structures, programs, and procedures will take place. The renewed CGIAR will be in place in January 1996.

The "Renewal of the CGIAR" provides the CGIAR with the momentum and impetus to move forward vigorously as a rededicated South-North enterprise capable of fulfilling a global vision of less poverty in the world; a healthier, better nourished, human family; reduced pressure on fragile natural resources; and people-centered policies for sustainable agricultural development.

ACKNOWLEDGMENTS

Many individuals from both within and outside of the CGIAR contributed to the substance and production of the draft background documents on major issues. I extend my appreciation on behalf of the CGIAR to all those who worked tirelessly and with dedication. I am confident that the principles elaborated upon in the documents will continue to inspire and guide the CGIAR System for years to come.

Ismail Serageldin
Chairman
May 1995
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THE CONTEXT

The Changing Global Context

The new political balances and economic relationships that are emerging at the end of the Cold War point to a future world that will be increasingly interdependent. Markets are becoming more interconnected than ever before, in part because the recently endorsed Global Agreement on Tariffs and Trade (GATT) is removing many barriers to trade. The world economy, dominated for years by a few major poles, is giving way to a larger multipolar system with the emergence of new economic powers in the developing world. Events such as the fallout from Chernobyl in Russia, causing milk and meat to be destroyed in the United Kingdom, and the thinning of the ozone layer increasing the cancer risk to the entire human population, are raising the awareness of the world to global environmental connections and the increasing interdependencies they establish. The advances in electronic communication technology are rapidly removing barriers and shortening distances between individuals, institutions, countries, and continents, thus speeding up the pace at which a global society is emerging.

The world community has begun to develop priorities and programs for some of the discrete components of these increasing interdependencies, so that their combined effect on human development will be positive. A global agenda for change is beginning to take shape. Much progress has been made in addressing three of the items on this agenda (in the areas of environment, trade, and population), and preparatory work has advanced in addressing several others (such as social development and the role of women):

- In the environment area, the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro, Brazil touched multiple aspects of the environment and development linkage from the need to conserve biological diversity to managing hazardous wastes and strengthening the role of indigenous people. Agenda 21, the global plan of action it endorsed, emphasized the need for united action to achieve common goals.

- In trade, the Uruguay Round of global negotiations came to a close in 1994 with the signing of GATT. The new agreement fosters global interdependence, widens the markets where developing countries can compete, and begins a process of leveling the playing field across nations.

- On population, the International Conference on Population in Cairo, Egypt (1994) underscored the complexities involved in disentangling the connections among population growth, poverty, and environmental degradation and highlighted, in particular, the need to induce changes in women’s lives (such as their access to education, cash, and credit) in order to generate changes in demographic patterns.

- Lastly, the World Summit on Social Development (to be held in Copenhagen, Denmark in 1995) and the Fourth World Confer-
Despite its significant causal links with the concerns that have surfaced to the first ranks of the global agenda, agriculture has not so far received similar attention by the international community.

Agriculture: The Neglected Sector

The current lack of recognition of agriculture’s role in global change and development flies in the face of the emphasis given to agriculture and agricultural research in Agenda 21, and mirrors the treatment of the agriculture sector by developing countries and development assistance agencies.

Although it contributes substantially to income and employment generation in developing countries, the agriculture sector has been historically subjected to contradictory policies in many developing countries. This is in part because governments have sought to achieve an array of political, social, or economic objectives through their interventions in the sector, such as price stability, consumer protection, foreign exchange generation, or combating inflation, and partly because government policies usually have an urban bias. As a result, the agriculture sector in many developing countries is in disarray. To compound matters, investment in agriculture has been curtailed as a result of structural or sectoral adjustment in developing countries. In countries receiving structural or sectoral adjustment loans, agriculture’s share fell from 7.8 percent (average for 1972 to 1983) to 7.0 percent (1984 to 1988) of total government spending.

There is also a lack of interest in agriculture by development assistance agencies. The share of agriculture in total development assistance declined from 20 percent in 1980 to 14 percent in 1990 (or from US$12 billion to US$10 billion in 1985 dollars). Several factors account for this decline and the demotion of agriculture to a non-pivotal position on the global agenda for change and development:

- There is disillusionment in the donor community with the poor performance of some agricultural development projects. Several lending institutions shifted their emphasis from direct assistance to agriculture to structural adjustment and policy-based loans.
- Farm groups in developed countries began to lobby against funding for agricultural assistance to low income countries, with the hope of increased use of foreign
assistance funds to promote exports by developed countries. This was reinforced by the arguments of some environmental groups that agriculture is intrinsically hostile to the environment.

- Large food surpluses in industrial countries deflected attention from the reality of large food gaps in many developing countries, thus leading to the misconception among many that the problem, if any, is only in the distribution of food, not in its availability, and, therefore, can be solved through food aid.

- To make matters worse, as noted above, there was little political support for agriculture in the South, which led to insufficient pressure on the North to have it recognized as an important area for increased assistance.

The combined impact of these and related factors has been to distort and diminish the real potential of agriculture and agricultural research to facilitate sustainable, mutually (North and South) reinforcing human development, which clearly emerges as a goal of the post Cold War, post-Rio global context.

The Pivotal Role of Agriculture and Agricultural Research

A crucial fact is often overlooked in debates on development: few low-income developing countries have achieved rapid rates of growth without prior rapid agricultural growth. Agriculture is the principal engine of growth in many low-income developing countries, where it accounts for 60 to 80 percent of all employment and more than half of national income. Stimulating sustained growth is, therefore, not likely to succeed unless the agriculture sector is first energized.

Agriculture plays multiple roles in development: it serves as an engine of growth in low-income countries; and in both low- and middle-income countries it helps to alleviate rural and urban poverty, ensures food security and sustainable use of natural resources, and contributes to social cohesion.

There is no single recipe for improving the agriculture sector in developing countries. In some cases it may require redefining the roles that should be played by the government and the private sector in promoting the sector. In others it may be necessary to examine macroeconomic and industrial policies so that discriminatory practices against the agriculture sector can be eliminated. Many low-income countries need to improve their rural infrastructure, credit, or extension services to generate conditions favorable to rapid agricultural development.

While these interventions are all likely to lead to improvements in developing country agriculture, agricultural research leading to new ways of farming stands the best chance of generating significant improvements in agricultural output and incomes. For at least the past century, new technologies have been the most reliable source of higher productivity in agriculture. A recent examination of more than 100 studies of rates of return to agricultural research shows that the estimated rates of return are still in excess of 20 percent per year, in many cases reaching levels as high as 100 percent.

Investments in agricultural research and technology are needed in order to promote the most suitable agricultural technology to:

- raise agricultural productivity;
In theory, there are no major physiological, genetic, or agronomic constraints to achieving the necessary yield gains. In practice, however, there are severe economic, environmental, social, and technological obstacles to be overcome.

- generate environmentally-friendly farming techniques;
- enable developing countries to take advantage of the new opportunities offered by GATT;
- foster technology flows; and
- strengthen the role of women in development.

Most importantly, investments in agricultural research and technology are necessary to ensure food security for all.

**THE CHALLENGE: SUSTAINABLE AGRICULTURE FOR A FOOD SECURE WORLD**

Although we produce enough food for everyone to be adequately fed, hunger is common. More than 700 million people in the developing world do not have access to enough food to live healthy and productive lives. Because of malnourishment, many children die. If present trends continue, these numbers will rise.

While global population growth rates have declined in recent years, the size of the current annual increment is unprecedented. Until well into the next century, approximately 100 million people will be added to the world population each year. By the year 2025 the population of the globe will be about 8.5 billion, of which 7 billion will be in developing countries. They will have to depend on dwindling area of cropland per person and declining access to forests, rangelands, fisheries, and other natural resources. In Asia, for example, the current 0.15 hectares of cropland available per capita will fall to a mere 0.09 hectares by 2025.

More than half of the developing world’s poor live in South Asia and Africa, and their numbers are growing at an unprecedented rate. The population of South Asia will rise to about 2 billion by the year 2025, and in Africa from the current 500 million to 1.2 billion. Food production will be hard pressed to keep up. On current trends, by the year 2025 the food gaps could be as much as 255 million tons in South Asia and 214 million tons in Africa.

To achieve food security, poor households have to grow sufficient food or purchase the food they require by earning income through selling agricultural and natural resources products or engaging in agricultural or non-agricultural employment. A measure of the scale of the problem we face is that so many fail despite unprecedented low prices of food on the world markets. The only solutions to the problem lie in producing more food at lower cost, and in increasing the incomes of the poor from agricultural and non-agricultural employment.

**Three Crucial Questions**

**Can we produce enough food to feed this growing population?** In theory, there are no major physiological, genetic, or agronomic constraints to achieving the necessary yield gains. Conventional plant breeding techniques, augmented by genetic engineering, should be able to produce improved plant types. There is considerable potential for increased and more efficient fertilizer use, and for improving the supply of water through irrigation and various means of water conservation. In practice, however, there

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1 The food gap is the cereal equivalent requirement to meet the energy need of the population less the sum of domestic consumption and imports.
are severe economic, environmental, social, and technological obstacles to be overcome.

There are already signs that difficulties are being encountered. On a global scale, grain production per person has shown signs of stagnation, if not a slight decline since 1985. While this is partly due to reduced cereal hectarages in industrial countries, there are similar trends in the developing regions of Asia, Sub-Saharan Africa, and Latin America, despite constant or increasing cereal hectarages. In Asia rice and wheat yield increases are slowing; in Africa cereal yields are still growing, but with wide fluctuations.

Particularly worrying is the evidence, now well documented, of constraints to increased production in those areas of developing countries where the green revolution had its greatest impact. The Indian Punjab, for example, is threatened by worsening availability and poor management of water, exhaustion of micronutrients, salination, and build-up of pests and diseases.

On current trends, total cereal market demand in developing countries is projected to double to 2 billion tons by 2025. If we add to this the hidden needs of the poor who will be priced out of the market, another 400 million tons of cereals would be required for a well-fed world, bringing the total cereal need to 2.4 billion tons. If recent yield growth rates for cereals continue to 2025, then total cereal production in developing countries will increase to 1.7 billion, leaving a shortfall of 0.7 billion tons.

**Can we produce the food in a sustainable manner, without damaging the environment?** Despite the size of the challenge, we believe that it is possible to produce the needed food in a sustainable manner without damaging the environment. This will not come about, however, without a major effort to reverse some worrisome trends.

In recent decades over-exploitation of resources, unsuitable agricultural technologies, and lack of appropriate institutions and governmental policies have combined to damage both well-favored and environmentally-fragile lands, threatening the potential for future gains in production:

- Water and wind erosion, loss of soil nutrients, salinization, acidification, pollution, compaction, waterlogging, and subsidence have led to the degradation of about 17 percent of the world's vegetated areas.
- Competition for water for agriculture has greatly increased.
- Closed forests are being lost at an annual rate of about 16 million hectares.
- The global harvest of wild fisheries is stagnant or declining.
- In the most intensively farmed lands, nitrate levels in drinking water approach or exceed permitted levels and pesticides are causing serious harm.
- Agriculture is also a growing contributor to global pollution, producing significant levels of methane, carbon dioxide, and nitrous oxide—gases that contribute to global warming, the depletion of stratospheric ozone, and the build up of ozone levels in the lower atmosphere, which will, in turn, significantly affect agricultural production.

It is essential to reverse these negative tendencies and replace them with positive directions.

**Despite the size of the challenge, we believe that it is possible to produce the needed food in a sustainable manner without damaging the environment. This will not come about, however, without a major effort to reverse some worrisome trends.**
Can we ensure that food is accessible to all, so that everyone receives at least an adequate diet? Some argue that the food needs of the poor could be met by subsidized shipments from industrial countries, but this would place heavy burdens on developing countries and would be likely to depress local prices, adding to existing disincentives for local food production. Moreover, industrial countries would have to at least double food production, inevitably incurring high economic and environmental costs. A more fundamental objection to this scenario is that a significant portion of the population in the developing world would fail to participate in global economic growth.

The alternative scenario is for developing countries to undertake a rapid and broad-based growth, not only in food production, but in agricultural and natural resources development, as part of a larger development process. This scenario explicitly recognizes that food security is not simply a matter of producing enough food. It also depends on employment and incomes. The task is not only to meet the market demand for food, but to increase the market demand for food.

Experience shows agriculture, forestry, and fisheries to be powerful engines for development, helping to:
- create employment and incomes for the mass of the poor;
- deliver food security;
- reduce birth rates through increased food and income security;
- protect and conserve the environment;
- stimulate development in the rest of the economy; and
- ensure prosperity in the industrial world through the stimulation of global trade and greater political stability.

THE RESPONSE: SCIENTIFIC RESEARCH AND TECHNOLOGY

There is no single recipe for successful agricultural and natural resources development, but recent experience is clear on two counts:
- While economic liberalization and reform of international trading policies are necessary for significant agricultural growth, they are not sufficient. Accelerated growth output cannot be maintained without adequate investments in rural infrastructure and in agricultural research and extension.
- Investments in agricultural research to generate new technologies and knowledge continue to give consistently high rates of return.

What Are the Research Priorities?

The agricultural research challenge for the future is complex and demanding.

Research must continue to assist the intensification of high-potential areas, albeit on a more environmentally-friendly basis. At the same time, more research will be needed in lower potential areas where rural poverty and associated resource degradation is increasingly concentrated. The amount of additional agricultural output required will be large, more than doubling in South Asia and Africa by 2025. In effect we require a revolution that
is even more productive than the first green revolution and even more "green" in terms of conserving natural resources and the environment—a doubly-green or super-green revolution—that over the next three decades aims to:

- repeat the successes of the green revolution;
- on a global scale, in many diverse localities; and
- be equitable, sustainable, and environmentally-friendly.

While the first green revolution took as its starting point the biological challenge inherent in producing new high-yielding food crops and then looked to determine how the benefits could reach the poor, this new revolution has to reverse the chain of logic, starting with the socioeconomic demands of poor households and then seeking to identify the appropriate research priorities. Its goal is the creation of food security and sustainable livelihoods for the poor.

**Why Such Research Has to be Public and International**

In industrial countries, the private sector has taken the lead in producing new varieties and agronomic technologies. Better-off farmers, often heavily subsidized, are able to afford the products of expensive research. In contrast, research to feed the poor is less attractive to private interests. It tends to involve long lead times, is often risky, the beneficiaries have little capacity to pay, and intellectual property rights can rarely be protected. For some time to come in developing countries, public research aimed at low cost, sustainable, and environmentally-friendly food production technologies is more likely to produce benefits that spread to farmers, large and small, to other rural dwellers, and, most importantly, to poor consumers.

However, many of the countries where such research is most urgently needed still lack sufficient capacity. The required research typically draws on a range of disciplines and production specialties, and on data and resources from many countries, often on separate continents. This challenge transcends what individual countries can do, even those with well developed national agricultural research systems (NARS). An international research effort is essential to remedy these deficiencies and to provide outputs which have impacts that cross national boundaries. Often the problems are common and so are the solutions.

**How Can New Developments in Science Help?**

The challenge for research of providing the technologies and institutions to deliver sustainable food security for all in a world of rapid population growth is daunting in its complexity. Fortunately, two recent major scientific developments offer a basis for optimism.

The first is the emergence of molecular biology, whose immediate potential lies in the application of genetic engineering to design the new plant and animal types required for both high and low input systems.

The second is an ecological approach that, in tandem with economics, sociology and anthropology, is rapidly increasing our capacity to design, in partnership with farmers, sustainable agroecosystems and livelihoods.
The CGIAR has a remarkable record of research achievements that positions it to play a key role in fostering the effectiveness and further development of the global agricultural research system.

These developments are having considerable impact, not only on the laboratory and field practice of science and technology, but also on the ways of thinking and inquiring about biological, agricultural, and socio-economic phenomena. They are not alternatives. Indeed they are complementary, providing the means whereby farmers and field and laboratory scientists can collaborate in identifying and answering the research questions posed by the needs of poor households.

However, to fully exploit these new developments will require changes in the way research is organized. Whereas the successful breeding programs of the first green revolution relied on close collaboration between plant breeders and geneticists in the future such multi-disciplinary project teams will need even greater integration and a wider span of disciplines, encompassing both the natural and social sciences.

It will not be enough to rely on the simple transfer of technologies. The research institutions of industrial countries and of developing countries will need to be linked in new partnerships that reflect the opportunities created by the revolution in modern biotology.

THE ROLE OF THE CGIAR

The world community’s investment in the CGIAR amounts to less than 2 percent of annual public expenditures on agricultural research globally and less than 4 percent of expenditures by developing countries. Despite this relatively small investment, the CGIAR has a remarkable record of research achievements that positions it to play a key role in fostering the effectiveness and further development of the global agricultural research system. In particular, it is well placed to serve as a bridge between developing country research systems and advanced institutions in industrial countries—a bridge essential for the effective flow of technology from the North to the South.

The CGIAR’s work concentrates on generating significant international public goods—outputs for which proprietary claims are difficult to establish and for which there are large economies of size—in which it has cost or reliability advantages. Choices among specific CGIAR activities are further shaped by changing markets, by advances in science, by the emergence of other effective sources of supply for CGIAR products, and by stronger national programs better able to meet immediate national needs.

Taken together, and driven by concern for efficiency, these considerations imply a continued opening of the CGIAR System. This will be manifested in greater cooperation among CGIAR centers themselves, but more so through expanded collaboration with developing country national programs, with advanced scientific institutions wherever they are found, and in stronger working relationships with the private sector. In view of these changes, the CGIAR plans to give more emphasis in the future to catalytic roles on the one hand, and to strategic research on the other.

The CGIAR’s Future Research Agenda

Within this context, CGIAR undertakings over the next 20 years will feature:
increasing productivity;
• protecting the environment;
• saving biodiversity;
• improving policies; and
• fortifying national agricultural research programs.

Increasing Productivity. Today, about 20 percent of CGIAR resources are allocated to research aimed at improving genetic stocks, with another 25 percent focused on the development of new management strategies aimed at increasing the efficiency of producer-held resources. Over time, a growing research capacity in national programs and an increasing investment in selected areas by the private sector will lead the System to devote more of its resources to strategic concerns in genetic improvement, especially for crops. This work—aided by advances in molecular biology—will lead to the introgression of genes from a widening array of sources, which will also broaden the genetic base of major crops.

The CGIAR will meet many of its requirements in the arena of high science through collaboration with others, and some of its efforts will focus on tailoring methods developed by advanced laboratories to the needs of developing country researchers. Also, new patterns of demand for staple foods, due to rapid urbanization and to rising incomes, will lead to shifts in the relative importance of CGIAR products, changing its allocation of research resources. Taken together, these considerations will both permit and encourage some concentration of selected genetic improvement work within the CGIAR, while encouraging the decentralization to others of certain activities now in the CGIAR portfolio.

The System’s investment in research on production management strategies work that tends to be nonproprietary and to feature micrlevel activities—will be reduced as national programs become stronger. What remains within the CGIAR’s purview in 2015 will be closely related to the conservation of natural resources.

Protecting the Environment. While increased productivity has contributed immeasurably, albeit indirectly, to protecting the environment (by reducing the need to expand agriculture into fragile areas), work aimed directly at resource conservation is an essential—and growing—part of the CGIAR’s portfolio. The System currently devotes about 10 percent of its resources to this work. It plays a leading role in the development of new research paradigms needed to ascertain long-term trends in major agricultural environments in developing countries, and in developing prototype solutions to pressing environmental problems. Into the future, the CGIAR will continue to develop new research paradigms in this arena, and will give special attention to how this work, with its many collaborators, can be efficiently managed. In addition, the System will treat broad strategic issues, including:
• water and irrigation management;
• the management of watersheds, coastal areas, and river basins;
• interactions among soils, water, nutrients, plants, and animals;
• ecosystem restoration; and,
• common property issues.

Many of these emerge from Agenda 21. Given the importance and essentially nonproprietary nature of this work, the potentially large economies of scale, and given the absence of other actors with the special advantages of conducting such research internation-
The CGIAR holds in trust for the future one of the largest ex situ collections of old and new varieties of the crops on which it works, and in substantial measure, the wild species from which those crops emerged. Duplicates of these materials are freely available to researchers around the world so that new gene combinations can be brought to bear on current problems.

Saving Biodiversity. The CGIAR holds in trust for the future one of the largest ex situ collections of old and new varieties of the crops on which it works and, in substantial measure, the wild species from which those crops emerged. Duplicates of these materials are freely available to researchers around the world so that new gene combinations can be brought to bear on current problems.

About 10 percent of the System's resources are currently allocated to this work, a proportion that will increase in the future. Additional resources are needed to improve the CGIAR's physical facilities to ensure adequate safekeeping of base collections, to expand somewhat the range of species conserved, to determine its role in in situ conservation, and to shore up the capacities, especially managerial, of conservation activities in many national programs. In addition, the CGIAR's vast storehouse of information on its collections will soon be opened to query via Internet. To facilitate its work, the CGIAR has established a system-wide initiative on genetic resources, involving all relevant centers and important non-CGIAR players.

Improving Policy. Agricultural producers are heavily influenced by public policy. Studying those effects offers insight into how policy and micro-level decisionmaking interact, and can suggest ways in which policy might be changed so as to promote socially desirable ends. Such work currently absorbs about 10 percent of CGIAR resources. This investment is scheduled to increase slightly toward 2015. In principle, the CGIAR embraces arguments for letting markets work. Still, there are reasons for the CGIAR to increase its investment in this arena. The System works on behalf of the poor, and concern for equity might well argue for rebalancing market-based income distributions. Policy measures may also be required to induce producers to adopt resource-conserving strategies. As well, clearer guidelines will be needed for policies that affect the allocation of research resources among an array of international public goods. Moreover, few agricultural researchers in developing countries are sufficiently sensitive to policy considerations, so that training should have a large payoff. There is an urgent need for research on managing common property so as to avoid what is widely called the "tragedy of the commons."

Fortifying National Programs. The CGIAR's role here is largely in capacity building—through formal training programs for research staff, side-by-side working relationships with colleagues in national programs, and strengthening skills in research administration and management. Today, the System allocates about 25 percent of its resources to capacity building, changing its offerings in response to the changing needs and capacities of national programs. In the future, the CGIAR will encourage further development of regional training programs managed by regional or national entities, and will increasingly streamline its own training programs. Training in research management and administration will grow, however, as science and new forms of collaboration add complexity to these areas. For similar reasons, the need for effective information management and communication will grow,
and the CGIAR must ensure both that its own requirements are met and that it can offer national programs the benefits of its experience.

One important aspect of the CGIAR’s work in each of the five thrusts noted above will be emphasis on gender and user perspectives. CGIAR centers will continue to incorporate gender perspectives systematically into their research planning and implementation. They will also continue to play a catalytic role in advocating wider use of such perspectives by NARS.

**Toward 2025**

As 2025 approaches, it is assumed that national systems, private and public, will be able to meet most internal needs and that there will be regional and ecoregional mechanisms for most transnational research, much of it also resting on collaboration. The CGIAR will be discharging its responsibilities primarily through collaborative strategic research and various catalytic activities. The principal components of its research work will include genetic resources conservation; genetic enhancement (much of it what some call “pre-breeding”) of selected plant, livestock, and fish species of transnational or global importance; strategic research on natural resources conservation and management; strategic research on public policy and management issues of global importance; and global information activities related to the research needs of the time. What ultimately emerges will depend on the scope for research as an international public good—almost certainly smaller than today—and on cost and reliability questions. In that context, the CGIAR’s principal advantages will be in its non-political character, its evenhandedness, and its ability to combine its special access to knowledge about the needs of producers and of the environment with knowledge about the opportunities through advanced science.

**A NEW GOVERNANCE**

Its future research agenda requires a CGIAR which is a more open and collaborative system than at present, a CGIAR which leads the global international research effort through its capacity to analyze problems, identify research priorities, and foster effective partnerships between research institutions of industrial and developing countries.

The CGIAR proposes to implement its future research agenda through a set of programs, carried out as at present by a set of autonomous CGIAR institutions, managed by independent boards of trustees. Separate, but related, mechanisms would be devised for coordinating the programs in the CGIAR portfolio involving several centers. The centers would be held accountable to the CGIAR through various reporting, evaluation, and financing measures.

The CGIAR also proposes that its future governance differ from the present arrangements in three respects:

1. It should enable the CGIAR to play a stronger catalytic role in facilitating agenda setting at the global level.
2. It should allow for much increased ownership of the System by developing countries.
3. It should aim to foster greater efficiency and stronger accountability throughout the System.
Three steps are proposed to generate these changes. First, with active support from its cosponsors, the CGIAR could play a stronger catalytic role in agenda setting by organizing a **Global Forum on Agricultural Research for Development**. Meeting once every 3 to 5 years, such a forum could include all actors involved with such research and would aim to:

- identify problems, describe progress, and establish needs for international agricultural research;
- assess and clarify global priorities;
- suggest roles for various actors; and
- explore ways to strengthen alliances and partnerships.

The Technical Advisory Committee (TAC) could serve as advisor to the forum, and TAC's analysis of global priorities could form the agenda for the forum in some years.

In addition, **Regional Forums** that meet the needs and interests of each region, and that are coordinated with existing similar efforts, could be organized as a complement to the Global Forum. These forums could be organized under the auspices of the cosponsors and regional organizations, with active roles by CGIAR members with interests and capacities in a region (such as the regional development banks and the regional arms of global institutions). International centers and NARS from the region would be expected to participate, as would TAC. Existing organizations and forums, such as the Special Program for African Agricultural Research (SPAAA), could be closely linked with, or serve as a substitute for, the CGIAR Regional Forums.

The proposed global and regional forums are expected to have some influence on CGIAR agenda setting and policy formulation, and enhance to some degree the participation of developing countries in that process. However, the CGIAR needs to take additional measures to enhance developing country participation within its own business forum.

With respect to the second area, the CGIAR proposes three new actions to ensure that the voices of beneficiary countries are heard more loudly in its business forum:

1. To invite countries hosting the headquarters of CGIAR centers to become members of the CGIAR if they are not already.
2. Through high-level contacts, to intensify efforts to encourage other beneficiary developing countries to become members of the CGIAR. It is encouraging to note the increased participation of developing countries in the last year.
3. Under exceptional cases, to allow groups of countries, such as small countries and island states, to pool their resources to meet the minimum contribution requirement and have a single membership in the CGIAR.

As a third step, with respect to efficiency and accountability, the CGIAR proposes to:

- Continue operating as an informal association, rather than constituting itself as a formal international organization.
- Keep decisionmaking power in the CGIAR's committee of the whole, which would be aided by preparatory work by a Steering
Committee, two standing committees (on oversight and finance), and ad hoc committees and working groups. This would make for slender, more productive plenaries while benefiting from the participation of all parties.

- Invite the United Nations Environment Programme (UNEP) to join the cosponsors group, which currently consists of the World Bank, FAO, and the United Nations Development Programme (UNDP). This would further the emphasis on sustainable development in the CGIAR's work and strengthen the international character of the Group.

- Establish an independent CGIAR Evaluation Unit to mount a system-wide effort to put in place systematic and continuous processes for impact assessment.

Recent reviews have concluded that the CGIAR's governance model—and its underlying principles, like total exclusion of politics from its operations, donor sovereignty, center autonomy, and informality and flexibility—are sound and relevant. The adjustments noted above would not modify this basic model, but they would help turn the CGIAR from an inward-looking to an outward-looking institution, break the image of the CGIAR as being a “club of donors” by generating a shift in the sense of ownership of the System, and foster greater efficiency and accountability.

NEW FINANCING ARRANGEMENTS

The CGIAR has reviewed proposals for re-engineering its financing arrangements so as to ensure full financing of the agreed research agenda, improve predictability and stability of funding for the centers, increase the transparency of financial arrangements, and strengthen accountability. The proposed arrangements are expected to result in a sharper focus by donors on the agreed research agenda of the CGIAR, to demonstrate the explicit link between CGIAR research and the international development agenda, and provide a clearer identification of the CGIAR's catalytic role in the global agricultural research system.

The re-engineering program is guided by several principles. These include the international character and public goods nature of CGIAR research, the System's need for stable, multi-year financing to be able to engage in long-term research programs, and maintaining donor independence and center autonomy. The program also assumes enhanced ownership of the enterprise by developing countries, determination of the CGIAR's research agenda in close partnership with developing country institutions, and greater collaboration between CGIAR institutions and other actors on the global research scene in the implementation of joint research programs.

The key instrument or tool of the re-engineering proposals is a matrix framework for planning and financing CGIAR activities. At the global level, the framework will identify the linkages between research at CGIAR centers and other international agricultural research relevant to the needs of developing countries. This will sharpen the CGIAR's focus in adopting an agenda of research programs to be carried out by the centers. The matrix framework will show how the CGIAR research agenda is linked with international development priorities (e.g. protection of the environment, food security, and poverty alleviation), while the focus of specific research programs
No matter whose projections one looks at, there will be over a billion people with inadequate food in 2025, if no action is taken to correct the situation now. Although agriculture is not the only corrective measure that can be taken, it is an indispensable one.

is maintained as well (e.g. genetic conservation, plant breeding, and policy research).

When agreement has been reached on the research agenda, the matrix framework can also be used to develop a financing plan, utilizing the sum of contributions by individual donors to centers, programs, and projects, in addition to funds from the World Bank, which contributes to the CGIAR System as a whole. To create a plan and give the centers firm guidance, the CGIAR will need to develop a process of consultations among the various parties involved to resolve differences on issues such as overfunding or underfunding of cells in the matrix. Given the long-term nature of research, financing arrangements should ideally be in the form of multi-year (three to five years) commitments.

The proposed arrangements would permit the CGIAR institutions to plan and implement programs with a greater assurance of predictable and stable funding than at present. The program approval and financing cycle would be as follows:

- Each year, the CGIAR would discuss its research agenda at the October meeting.
- Taking their guidance from this discussion, centers would prepare their program proposals for the following year by February and interact with TAC in March.
- The results of this interaction would be presented to the CGIAR at the May meeting by TAC in the form of a program and funding recommendation for the following year. The CGIAR would discuss the program recommendations along with a financing plan prepared by the Secretariat.
- Individual donors would discuss within their own agencies the financing requirements of the CGIAR's May meeting decisions, and make their financing decisions by October. The Secretariat would interact with each donor during this period to facilitate the matching of financing needs and supply.
- The resulting financing plan for the CGIAR as a whole would be approved by the CGIAR at its October meeting.
- Donors would be able to begin disbursement of funds as early as possible, with the goal of enabling each center to start implementing its programs for a calendar year with at least 50 percent of the funds in hand.

CONCLUSIONS

Agriculture is not only an engine of growth, but also a vehicle for environmental protection. At the same time, because of its importance to such large numbers of poor people, both rural and urban, its development can do more, and more rapidly, than any other sector to promote social cohesion. The industrial countries will benefit from the development of the agriculture sector in developing countries, at the least, through costs saved from food aid and emergency interventions.

No matter whose projections one looks at, there will be over a billion people with inadequate food in 2025, if no action is taken to correct the situation now. Although agriculture is not the only corrective measure that can be taken, it is an indispensable one. Of
all the actions that can be taken, investments in appropriate new technology to raise the productivity of developing country agriculture in a sustainable way, and the research needed to produce it, will yield excellent returns.

Mobilizing science in this way means significant investments in public research, both national and international. Because many of the problems that need to be researched are common across countries and regions, an international research effort is likely to be more efficient and productive. What is needed is a global agricultural research system that links a range of institutions with one another in new partnership modes.

As the only truly global, non-political public international agricultural system today, the CGIAR has a special role to play in the evolution of such a system. It could play a strong role in the identification of research problems of international significance, in the design and implementation of research programs, and in the assessment of their impact.

The CGIAR has been an exceptionally effective instrument of development in the past. Its current research agenda addresses the most significant challenges faced globally in international agricultural and natural resources management research, and the CGIAR's agenda setting mechanisms enable this agenda to evolve as circumstances change.

The proposed improvements in the governance of the CGIAR will turn it from an inward-looking to an outward-looking institution, will shift the sense of ownership of the System more toward beneficiary countries, and will bring greater efficiency, transparency, and stronger accountability to its operations. The proposed reforms in finance will strengthen the CGIAR's program orientation and help to increase predictability of finances, while maintaining the autonomy of centers and the sovereignty of donors. As a result, the CGIAR is poised to serve as an even stronger instrument of sustainable development in the future.
Renewal of the CGIAR:
Sustainable Agriculture for Food Security
in Developing Countries

The Global Context in which the CGIAR Functions
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The Global Context in which the CGIAR Functions

Agriculture and Agricultural Research in the Post Cold War Era

CONTEXT

The political and economic landscape around the globe has begun to change with the end of the Cold War, and the new political balances and economic relationships that are emerging point to a future world that will be increasingly interdependent. "Market forces" and "efficiency" are viewed as the source of transborder, even transoceanic, bonding and not as labels attached to one side of the global economic equation. Economies are becoming more interconnected and interdependent than ever before, thanks in part to the Uruguay Round of trade negotiations, which are paving the way for more liberalized markets in both the North and the South. The world economy, dominated for years by a few major poles, is giving way to a larger multi-polar system, with the emergence of new economic powers in East Asia. The advances in electronic communications technology are rapidly removing many barriers and shortening distances between individuals, institutions, countries, and continents, thus speeding up the pace at which a global society is emerging.

Events such as the fallout from Chernobyl in Russia, causing milk and meat to be destroyed in the United Kingdom, the impact in northern Europe of acid rain from distant sources, and the thinning of the ozone layer increasing the cancer risk to the entire human population from the rays of the sun, have also raised the awareness of the world to global environmental connections and the increasing interdependencies they establish.

The world community has begun to develop priorities and programs for some of the discrete components of these increasing interdependencies, so that their combined effect on human development will be positive. A global agenda for change is beginning to take shape. Much progress has been made in addressing three of the items on this agenda (in the areas of environment, trade, and population), and preparatory work has advanced for addressing several others (such as social development and the role of women).

Environment

The 1992 United Nations Conference on Environment and Development (UNCED), popularly known as the Earth Summit, in Rio de Janeiro, Brazil was the largest ever gathering of heads of government; the world’s most inclusive get-together. The conference was important not only in terms of its coverage (it touched multiple aspects of the environment and development linkage, from the need to conserve biological diversity to managing hazardous wastes and strengthening the role of indigenous people), but also in terms of its process (enabling many segments of society to participate in the deliberations).1 Agenda 21, the global plan of action it endorsed, articulated the accelerating threat from many factors, in-

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The increase in the world population is projected to be higher in the 1990s than in any previous decade, and over 90 percent of this increase is expected to take place in the developing world, with serious consequences for poverty, food security, social cohesion, and the environment.

Trade

The global trade negotiations, which were launched at Punta del Este in Uruguay in 1986 (the Uruguay Round), came to a close with the signing of the Final Act of the Uruguay Round by 111 countries in Marrakesh, Morocco on April 15, 1994. The GATT agreement creates a framework and new rules for international trade, which are in the direction of more liberal trade policies for both developed and developing countries. It also establishes a World Trade Organization, as a replacement for the GATT Secretariat and as the institution responsible for organizing future rounds of negotiations and monitoring the implementation of the current agreement. Important aspects of the agreement include conversion of all existing non-tariff barriers (such as import quotas) into bound duties (i.e., those that cannot be increased without negotiation with other countries) within agreed time schedules, reduction of export subsidies, and encouragement of less trade-distorting domestic support policies. These reforms foster global interdependence, widen the markets where developing countries can compete, and begin a process of leveling the playing field across nations.

Population

The International Conference on Population and Development in Cairo, Egypt (1994), which followed the two previous World Population Conferences in Bucharest and Mexico City (in 1974 and 1984), was attended by some 180 national delegations and 1,200 non-governmental organizations (NGOs). The conference underscored the complexities involved in disentangling the connections among population growth, poverty, and environmental degradation.

The increase in the world population is projected to be higher in the 1990s than in any previous decade, and over 90 percent of this increase is expected to take place in the developing world, with serious consequences for poverty, food security, social cohesion, and the environment. The Cairo Conference highlighted, in particular, the need to induce changes in women’s

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lives (such as their access to education, cash, and credit) in order to generate changes in demographic patterns.

Social Development and Women

The World Summit on Social Development (to be held in Copenhagen, Denmark in 1995) and the Fourth World Conference on Women (scheduled for Beijing, China in 1995) are expected to continue the trend, started in Rio, in defining the needs for international cooperation. The World Summit on Social Development presents the international community with an opportunity to reaffirm its commitment to participatory, people centered development and to the alleviation of poverty and human misery. It will also seek agreement on joint action for expanding productive employment and enhancing social integration.

The Fourth World Conference on Women, sharply focused on a discrete theme—"Action for Equality, Development, and Peace"—will deal with women's rights and participation in the definition of economic structures and policies. The conference will build on earlier agreements on environment and natural resources, indigenous knowledge, and food security, as they relate to women, that were reached at the Third World Conference on Women held in 1985 in Nairobi and at UNCED in 1992.

In sum, there is a greater awareness by the countries of the world of the need for collective action in addressing common concerns such as population growth, environmental degradation, and poverty and malnutrition. This is coupled with increased understanding of the intricate causal relationships that link them. However, despite its significant causal links with the concerns that have surfaced to the first ranks of the global agenda, agriculture has not so far received similar attention by the international community. It will assume central stage in international attention only in 1996, i.e., one year after both the Social Summit and the Conference on Women, through the currently planned FAO Food Security Summit. It is unfortunate that agriculture's central role in achieving some of the objectives of each of these prior summits has not been brought out more forcefully.

AGRICULTURE: THE NEGLECTED SECTOR

The current lack of recognition of agriculture's role in global change and development flies in the face of the emphasis on agriculture and agricultural research in Agenda 21, which devoted a full chapter to the topic, and mirrors the treatment of the agriculture sector by developing countries and development assistance agencies.

Although it contributes substantially to income and employment generation in developing countries, the agriculture sector has been historically subjected to contradictory policies in many developing countries. This is in part because governments have sought to achieve an array of political, social, or economic objectives through their interventions in the sector, e.g., price stability, consumer protection, foreign exchange generation, or combating inflation, and partly because government policies usually have an urban bias. Many developing country governments have tried to offset the policies discriminating against agriculture with more favorable interventions, such as subsidizing inputs like irrigation water, fer-
tilizers, pesticides and seeds. As a result, the agriculture sector in many developing countries is in disarray. To compound matters, investment in agriculture has been curtailed as a result of structural or sectoral adjustment in developing countries. In countries receiving structural or sectoral adjustment loans, agriculture's share fell from 7.8 percent (average for 1972 to 1983) to 7.0 percent (1984 to 1988) of total government spending.

The lack of attention to their own agriculture by developing countries has led, among others, to a declining interest in agriculture by development assistance agencies. The share of agriculture in total development assistance declined from 20 percent in 1980 to 14 percent in 1990 (or from US$12 billion to US$10 billion in 1985 dollars). Several factors account for this decline and the demotion of agriculture to a non-pivotal position on the global agenda for change and development.

- There is disillusionment in the donor community with the poor performance of some agricultural development projects.
- Several lending institutions shifted part of their loans from direct assistance to agriculture to structural adjustment and policy-based loans, with the argument that the macroeconomic adjustments expected from such lending would have a greater positive affect on agriculture than providing those funds directly to agriculture, without the macroeconomic reforms—an argument that is probably valid, but that does not respond to why both could not be done together.
- Farm groups in donor countries began to lobby against funding for agricultural assistance to low-income countries, with the hope of increased use of foreign assistance funds to promote exports by developed countries.
- Existence of large food surpluses in industrial countries deflected attention from the reality of the large food gaps in many developing countries, thus leading to the misconception among many that the problem, if any, is only in the distribution of food, not in its availability, and, therefore, can be solved through food aid.
- Some environmental groups in donor countries argued effectively that modern agriculture is intrinsically hostile to the environment, and thus reinforced the efforts of farm lobbies against funding for agricultural assistance to low-income countries.
- To make matters worse, as noted above, there was little political support for agriculture in the South, which led to insufficient attention to agriculture in national priorities and, accordingly, no pressure on the North to have it recognized as an important area for increased assistance.

8 von Braun, et. al., p. 11.
The combined impact of these and related factors has been to distort and diminish the real potential of agriculture to facilitate sustainable, mutually (North and South) reinforcing human development, which clearly emerges as a goal of the post Cold War, post-Rio global context.

AGRICULTURE’S PIVOTAL ROLE IN DEVELOPMENT

A crucial fact is often overlooked in debates on development: few low-income developing countries have achieved rapid rates of growth without prior rapid agricultural growth. Examination of the experiences of developing countries that grew rapidly during the 1980s shows that most experienced rapid agricultural growth in the preceding years. Agriculture plays multiple roles in development: it serves as an engine of growth in low-income countries, helps alleviate poverty, ensures food security and sustainable use of natural resources, and contributes to social cohesion.

Agriculture and Economic Growth

Agriculture is the principal engine of growth in many low-income developing countries, where it accounts for 60 to 80 percent of all employment and more than half of national income. Stimulating sustained growth is, therefore, not likely to succeed unless the agriculture sector is first energized.

Agricultural development contributes to economic growth in a variety of ways. First, agricultural development leads to higher levels of production, which translates into more food, feed, raw materials, and export crops for the national economy. Second, rising incomes of families engaged in agriculture generate additional demand for non-farm goods and services, thereby stimulating the entire economy. Third, increased agricultural incomes lead to higher government revenues, which can be used to stimulate other sectors, notably industry, or as capital for human resources development.10

Agriculture and Poverty Alleviation

In most parts of the world poverty and malnutrition are more prevalent in rural areas than in urban areas. For example, 91 percent of the poor in Indonesia live in rural areas. The proportion is 79 percent in India, 67 percent in the Philippines, 86 percent in Côte d’Ivoire, and 52 percent in Peru. Moreover, the poor constitute a significant share of the total population living in rural areas: 60 percent in Latin America and the Caribbean and in Sub-Saharan Africa, 31 percent in Asia, and 26 percent in the Middle East and North Africa.11 Clearly, the goal of alleviating poverty cannot be reached without an underpinning commitment to the development of agriculture.

Agricultural development increases the incomes of the rural poor. In addition, it contributes to the alleviation of urban poverty and malnutri-

tion by making staple foods more affordable. Thus both the rural and urban poor benefit from agricultural development.

Agriculture and Food Security

More than 700 million people in the developing world are hungry or malnourished and lack the purchasing power to feed themselves. This number is expected to increase to over 1 billion by 2025, when the world’s population is expected to reach 8.5 billion—an increase of 3 billion from 1994. When translated into production terms, these projections require, on the average, at least a 2 percent or higher per year increase in global food production to meet the needs of this expanded population, irrespective of where the added production takes place.12

While some of the needed additional food could be grown in industrial countries and provided to needy developing countries in the form of food aid or through trade, this would not necessarily ensure food security for much of the rural poor in developing countries, who are not well connected to markets and are hard to reach through food aid. Moreover, several food crops that are part of the diet of the world’s poor—for example, cassava, coarse grains and pulses—are not on the production agenda in industrial countries. The more lasting solution to the food security issue is a broad-based growth of the agriculture sector in developing countries.

Agriculture and Environment

The livelihoods of farmers depend on their interaction with and use of natural resources, such as land, water, air, and sunlight. In low-income countries, rural poverty, fueled by rapid population growth, often leaves the farmer no alternative but to eke a livelihood from whatever natural resources are accessible. This can lead to the degradation of land, water, or forest resources, which further reduces the production potential of the resource base the farmer uses, thus, in turn, reducing the farmer’s potential to escape the grip of poverty.13 The culprit here is neither the farmer nor his low productivity farming techniques, but poverty. In this instance, the answer lies in enabling the farmer to break this vicious circle and reach an environmentally-friendly equilibrium. A broad-based agricultural development strategy can help countries enable their poor farmers to break out of such vicious circles.

In middle- and high-income countries the agriculture sector is expected to produce higher and higher amounts of food to meet urban and rural demands. The major source of increased production in these countries is increased yields, as the potential for increasing land resources is limited. The demand for higher yields increases the pressures to use more chemicals and/or water, the misuse of which can lead to higher pollution, pesticide poisoning, and waterlogging and salinization of irrigated lands.14


14 World Bank, Agricultural Sector Review, op. cit. p. 5.
UNCED's Agenda 21 also recognizes poverty alleviation as central to solving the problems of the environment, and the development of agriculture in disadvantaged countries as a powerful contributor to achieving it. Several key environmental themes of Agenda 21 directly or indirectly relate to agriculture. Examples are: managing land sustainability, combating deforestation, combating desertification and drought, conservation of biological diversity, protecting the atmosphere, and protecting and managing fresh water.

**Agriculture and Social Cohesion**

Agricultural development contributes to social cohesion and political stability in three ways. First, there is increasing evidence that the degradation and depletion of natural resources, such as good land, water, forests, and fish, leads to environmental scarcities, which are a major cause of violent conflicts between nations or within a country or region. As a major user of natural resources, agriculture can help prevent some of these crises through more efficient use of such resources.

Second, large population movements are a major source of social turmoil in all countries. A major cause of rural-urban migration in developing countries is the absence or weakness of livelihood systems in rural areas, which leads to a "push" to migrate. These, when coupled with the "pull" of urban settings, lead to the migration of large numbers of poor people. Development of agriculture in rural areas helps reduce the "push" element in migration. As the rural poor begin to enjoy sustainable livelihoods, a more cohesive social system emerges in rural settings.

Third, there is an international dimension to the migration scenario. It is estimated that in the mid-1980s about 100 million people lived outside their countries of birth or citizenship. While the greater share of international migration takes place within developing country regions, movements from developing to industrial countries is also significant. These movers are attracted by the strong “pull” of the industrial country settings and include the poor as well as the well-to-do in developing countries. Agricultural development in low-income countries indirectly helps to reduce the pressures for more international migration, which has consequences on social cohesion in industrial countries.

In sum, agriculture contributes significantly to income growth, poverty alleviation, and food security in both low- and middle-income developing countries. In addition, agriculture can be a strong contributor to solving the problems of the environment and to enhancing social cohesion in developing countries and, indirectly, in the developed world.

**THE POTENTIAL OF AGRICULTURAL RESEARCH AND TECHNOLOGY**

There is no single recipe for improving the agriculture sector in developing countries. In some cases it may require redefining the roles that should

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15 *The Earth Summit's Agenda for Change*, op. cit.
Investments in agricultural research and technology are needed, first and foremost, for raising agricultural productivity. Looking toward the future, meeting the food needs of the projected 1 billion plus hungry and malnourished people by 2025, will require at least a 2 percent or higher per year increase in global food production.

While these interventions are all likely to lead to improvements in developing country agriculture, agricultural research leading to new ways of farming stands the best chance of generating significant improvements in agricultural output and incomes. For at least the past century, new technologies have been the most reliable source of higher productivity in agriculture. A recent examination of more than 100 studies of rates of return to agricultural research shows that the estimated rates of return are still in excess of 20 percent per year, in many cases reaching levels as high as 100 percent.18

Raising Agricultural Productivity

Investments in agricultural research and technology are needed, first and foremost, for raising agricultural productivity. A review of the experience with the green revolution in parts of Asia shows that “broad-based agricultural growth, involving small- and medium-sized farms, and driven by productivity enhancing technological change, offers the only way to create productive employment and alleviate poverty on the scale required.”19

Looking toward the future, meeting the food needs of the projected 1 billion plus hungry and malnourished people by 2025, as noted above, will require at least a 2 percent or higher per year increase in global food production. A recent analysis of how the world might meet this challenge summarizes the possibilities in terms of the following scenarios.20

Scenario 1: The Conventional View. The increases in food production must come primarily from increased productivity (i.e., yield) as there is little potential to expand the area devoted to agricultural production. This scenario assumes that food would be grown primarily where it is needed, i.e., trade would remain at the current low level (at about 10 percent of supply), and countries would be chiefly responsible for their own food security.

Scenario 2: The Optimists. World food production will continue increasing at about the same rate as it has over the past 30 years, provided there are continuing investments in research. Global population growth rates will decline (from the current 1.74 percent to 1.4 percent in 2010), enabling production increases to keep pace with increases in demand.

Scenario 3: The Pessimists. The rates of growth in food production have slowed in the last ten years21 and may...
slow even more in the future because "the world is close to exceeding its carrying capacity." The constraints come mainly from a shrinking base of unused agricultural technology, limited capacities of fisheries and rangelands, hydrological limits of water resources, declining responses of crops to increased fertilizer inputs, and losses of cropland to non-agricultural uses. The solution to the growing imbalance between food and people would be a frontal attack on the population question.

Scenario 4: The Developed Countries Fill the Gap. Tropical and subtropical environments are too fragile to produce the quantities of food that will be needed in the developing world. One solution would be to reverse the roles of developing and industrial countries, i.e., developing countries could produce manufactured goods and trade them for food grown in developed countries, where temperate production environments, better technology, and the possibility to expand land devoted to agricultural production are more suitable for producing the quantities of food needed by the world.

These four scenarios, while agreeing on the demand side, yield widely divergent proposals about the supply. The variations are mainly due to the differences in the assumptions each scenario is based on, such as population or production growth rates. Seemingly insignificant differences in such rates can yield significant differences in estimates over a 25-year period. For example, the assumption that food production will grow at a compounded rate of 2 percent per year over 25 years (as in Scenario 2) yields a 64 percent increase in production over 25 years, as compared with a 28 percent increase assuming that the rate will be 1 percent per year (as in Scenario 3). The scenarios also differ markedly in terms of their implications on food trade, ranging from about 400 million metric tons (Scenario 1) to about 800 million metric tons (Scenario 4).

Despite these variations in assumptions and prescriptions, all four scenarios agree on one point: that sustained or increased investments in research and technology development will be necessary to reach the projected rates of growth in production. Under Scenario 4, a 4 percent per year increase in production is implied (in developed countries)—a rate never before attained on a sustained basis. Scenario 1 requires major yield gains in developing countries, whereas Scenario 2 calls for gains in developed countries. Scenario 3 projects more modest increases in yields, but recognizes the shrinking base of unused agricultural technology as a constraint for the future—one that can be addressed through increased investments in research.

In addition to raising agricultural productivity, investments in agricultural research and development are needed for:

- generating environmentally-friendly farming techniques;
- enabling developing countries to take advantage of the new opportunities offered by GATT;
- fostering technology flows; and
- strengthening the role of women in development.

"Greening" Agricultural Technology

Traditional agricultural technology, which is tuned to the conditions

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22 McCalla, p. 17.
Equally important is the “greening” of the agricultural technology used on more fertile lands. Research is essential to identify resource conserving management practices, design new plant varieties that have build-in insect and disease resistance, and generate techniques for producing harder livestock.

Equally important is the “greening” of the agricultural technology used on more fertile lands. Research is essential to identify resource conserving management practices, design new plant varieties that have built-in insect and disease resistance, and generate techniques for producing harder livestock.

Research can also help reduce pressure on fragile environments by having more of the needed production come from other lands through increased yields. It is estimated that “...every 0.1 percent of yield increase in the period 2010 to 2025 'substitutes' for about 25 million hectares of rainfed cropland.”

Taking Advantage of GATT

Market liberalization and trade reforms are creating unprecedented opportunities for developing countries to expand their agricultural production for both domestic and foreign markets. Developing countries have favorable resource endowments (low cost land and labor), but they cannot take advantage of market opportunities created by liberalized trade because they lack the technology that would make them competitive. Without investments in agricultural research that would generate or adapt the needed technologies, developing countries would be at a disadvantage vis-à-vis developed countries. Therefore, investments in agricultural research and technology are necessary to make the playing field more even for developing countries. Such investments are also attractive because they are exempt from the subsidy reduction commitments under GATT.

Fostering Technology Flows

Agenda 21 drew attention to the need to widen the availability of technology to the Third World. Difficulties in accessing recent rapid scientific advances, such as biotechnology, have given rise to new and increasing inequalities between the North and the South, which could be labeled as “technological apartheid.” The isolation of large parts of the South has been exacerbated by the dominance of technological research by the private sector in the industrial world and the recognition of trade related aspects of intellectual property rights under GATT through the TRIPS Agreement. Developing countries can reverse the imbalance generated by TRIPS by investing in their own research systems and generating intellectual property they or their private sectors can protect. The most efficient way developing countries can overcome this challenge would be by strengthening their NARS and “building bridges” to work with the best scientists in the North and the South on problems of interest to the South. The CGIAR offers one impartial forum for such collaboration.

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23 Gershon Feder and Andrew Keck, as quoted by McGalla, p. 25.
Strengthening the Role of Women

Women play important roles in food production, nutrition of family members, and protection of the environment in developing countries. Research geared toward improving agricultural technologies with women in mind or generating new technologies that are gender sensitive help enhance the contributions women make to the welfare of the family and community.

Understanding the farmers' indigenous knowledge would not be possible in most parts of the world without a focus on women. In Africa, for example, women farmers are responsible for 70 percent of staple food production.25 Similarly, generating effective farming techniques (such as new ways of clearing the land, pulling seedlings, or seed storage) requires examination of the roles women play in the farming system and the suitability of the techniques being designed to women. Gender sensitive agricultural research also enhances women's effectiveness as technology transfer and food marketing agents.

Thus, investments in agricultural research and technology contribute to sustainable development in general and agricultural development in particular in a number of important ways: (i) by raising agricultural productivity, and thereby, increasing incomes, reducing poverty, and providing global food security; (ii) by helping to preserve the environment through the generation of more environmentally-friendly farming techniques; (iii) by increasing the efficiency of developing country agriculture and enabling it to take advantage of the trade opportunities being created under the new GATT; (iv) by fostering flows of technology between the North and South; and, (v) by strengthening the role of women through the generation of gender-sensitive technologies.

CONCLUSIONS

Agriculture is not only an engine of growth, but also a vehicle for environmental protection. At the same time, because of its importance to such large numbers of poor people, both rural and urban, its development can do more, and more rapidly, than any other sector to promote social cohesion. The industrial countries will benefit from the development of the agriculture sector in developing countries, at the least, through costs saved from food aid and emergency interventions and, possibly, by less expensive agricultural products exported by developing countries.

The agriculture sector in many developing countries is, however, in disarray, with contradictory macroeconomic or sectoral policies, inadequate or inappropriate resources and services, and stable or declining real investments by governments.

There is a need to increase the overall efficiency of the sector. Using more resource saving or yield increasing technologies is one way the sector can be made more efficient. In addition to increased efficiency, investments in the generation of such technologies would also bring about huge returns in income growth, poverty alleviation, food security, and sustainable use of natural resources.

No matter whose projections one looks at, there will be over a billion

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people with inadequate food in 2025, 
if no action is taken to correct the situ-
ation now. Although agriculture is not 
the only corrective measure that can 
be taken, it is an indispensable one. 
Of all the actions that can be taken, 
investments in appropriate new tech-
nology to raise the productivity of 
developing country agriculture in a 
sustainable way, and the research 
needed to produce it, will yield excel-
rent returns.

Moreover, this action will enable 
developing countries to take better ad-
vantage of the new trade opportunities 
created by GATT and make agriculture 
and agricultural trade powerful vehicles 
for both poverty alleviation and envi-
ronmental rehabilitation.
Renewal of the CGIAR: Sustainable Agriculture for Food Security in Developing Countries

A Vision for the CGIAR: Sustainable Agriculture for a Food Secure World
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A Vision for CGIAR:  
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A Vision for International Agricultural Research  
A Statement by an External Panel  
Appointed by the Oversight Committee of the CGIAR  

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The work of the Panel was supported by a grant from the Swedish Agency for Research Cooperation with Developing Countries (SAREC). The statement reflects the opinion of only the panel and not necessarily of the Oversight Committee, which commissioned the effort, or of the parent organizations of the panel members.  

July 1994  

FOREWORD  

The challenge the CGIAR has been facing in 1993 and 1994 was the contrast between an extended mandate and stagnating or decreasing financial support from its donors. In this situation the need for a vision that is shared by its stakeholders and broadly understood was evident. Such a vision should be accessible to policymakers and scientists alike. It also should guide the adjustment process in the CGIAR. At its regular meeting in Washington, D.C. in October 1993, the Group, therefore, decided to commission an expert panel to prepare a future vision of international agricultural research with a view to making a convincing case for increased support to the CGIAR.  

What was needed was a vision that was imaginative, forward-looking and reflective, covering the next 20 to 30 years. To ascertain that it be fresh and unencumbered by internal CGIAR interests, it was felt that it should be written by scientists without close personal affiliation to the CGIAR.  

Recruitment of the expert panel and organization of its work was done by the CGIAR Oversight Committee. Professor Gordon Conway, Vice-Chancellor of the University of Sussex, UK, chaired the panel. Other panel members were Dr. Uma Lele, University of Florida, USA; Dr. W. James Peacock, Commonwealth Scientific and Industrial Research Organization, Canberra, Australia; and Dr. Martin Piñeiro, an independent consultant living in Buenos Aires, Argentina. Dr. Peter
The panel held two workshops. Panel members interacted with TAC and with the Oversight Committee. A final draft was compiled and presented by Professor Conway to the meeting of the CGIAR in New Delhi in late May 1994. Final editing of the draft was done first by Professor Conway and later, in July, by Henri Carsalade and Johan Holmberg to reflect the discussion in New Delhi as well as other comments on the draft.

Preparation of this report was, thus, very much a collective effort, and my sincere appreciation goes to all the individuals mentioned above who participated in the exercise. However, Professor Conway’s untiring efforts were instrumental in bringing the process to a successful conclusion under a very tight time schedule. It is, thus, first and foremost to him that the CGIAR owes much gratitude for this report.

Vision, adjustments in governance and financing, and the interphase with national programs are key components for a reinvigorated CGIAR. This vision statement is a contribution to this goal. SAREC’s support in financially supporting the work of the panel and in publishing this report is gratefully acknowledged.

Paul A. Egger
Chairman
CGIAR Oversight Committee

ACKNOWLEDGMENTS

The members of the panel gratefully acknowledge the helpful comments and criticisms they have received from many individuals, in particular from members of the CGIAR’s Technical Advisory Committee, from staff and directors of the CGIAR’s international agricultural research centers, from staff of a number of independent institutes, in particular the Institute of Development Studies at the University of Sussex, the International Institute for Environment and Development in London, and from staff of the panel members’ own institutions, the Centre for International Cooperation in Development-Oriented Agricultural Research (CIRAD), SAREC, the Commonwealth Scientific and Industrial Research Organization (CSIRO), and the Universities of Florida and Sussex.
THE CHALLENGE

By the year 2025 there will be about 8.5 billion people on the planet, of whom some 7 billion will be living in the developing countries of Asia, Africa, and Latin America. The questions we have to ask ourselves now are:

- Can we:
  - produce enough food to feed this population;
  - in a sustainable manner, without damaging the environment; and
  - ensure the food is accessible to all, so that everyone receives at least an adequate diet?

- Should we, and can we:
  - enable developing countries to meet most of their own food needs; and
  - ensure that agricultural production is more effectively linked with economic and social development?

In addressing these issues, we need to consider the role of agricultural research:

- private and public;
- international and national; and
- collaborative

In this document we attempt to provide answers to these questions, as far as we are able, and to outline an agenda for action, focusing primarily on the role of the CGIAR and its centers.

Our conclusions are that the world population in 2025 can be adequately fed, malnourishment can be eliminated, and this can be achieved in a way that prevents environmental degradation and conserves natural resources. We believe, however, that this can only be accomplished if there is significant investment in public research, both national and international, involving the CGIAR System in partnership with NARS, on a commonly agreed set of programs.

Who Are the Hungry?

Globally we produce enough food for everyone to be adequately fed, yet hunger is common. More than 700 million people in the developing world do not have access to enough food to live healthy and productive lives; they often go hungry not knowing when they will have their next meal.

Globally we produce enough food for everyone to be adequately fed, yet hunger is common. More than 700 million people in the developing world do not have access to enough food to live healthy and productive lives; they often go hungry not knowing when they will have their next meal.

1 We have chosen the year 2025 as our future reference point for a number of reasons: we know with reasonable accuracy the size of the world population and the amount of food they will need; 2025 lies within the lifetime of most of the people on this planet alive today; and, 2025 lies within the lifetime of many, if not most, of those who currently make or influence national and global policies.

2 In the document we distinguish between “industrial countries” and “developing countries.” The latter encompass a great variety of countries from those with GNP per capita exceeding US$2,000 in the newly industrialized countries to the poorest countries in the world with GNP per capita below US$250. The economies of all these developing countries can be expected to change, some markedly, by the year 2025, but for ease of comparison we assume that countries remain in the same categories (of the technical annex by Peter Hazell, IFPRI). [See Appendix II, page 72.]
More than half of the developing world's poor are in South Asia and Sub-Saharan Africa, and the numbers are growing at an alarming rate.

**What Are Their Prospects?**

If nothing is done, the numbers of poor and hungry will rise rapidly. While global population growth rates have declined from a high of 2.1 percent a year during 1965 to 1973 to 1.6 percent in the 1990s, the size of the current annual increment is unprecedented. Until well into the next century, approximately 100 million people will be added to the world population each year. By the year 2025 the population of the globe will be about 8.5 billion, of whom 7 billion will be in developing countries. [See Figure 1, page 65.]

Over half of this population will live in urban areas. They and the rural population will have to depend on a declining area of cropland per person and declining access to forests, range-lands, fisheries, and other natural resources. In Asia, the currently 0.15 hectares of cropland available per capita will fall to a mere 0.09 hectares in 2025. Africa will apparently fare better; but, the quality of the land is generally poorer than in Asia, with less potential for irrigation.

More than half of the developing world’s poor are in South Asia and Sub-Saharan Africa, and the numbers are growing at an alarming rate. The population of South Asia will have grown to about 2 billion, but the highest growth rates are in Sub-Saharan Africa. From the current 500 million, the African population will grow to 1.2 billion. Population growth in Africa will outstrip growth in food production for a long time to come unless much more is done to accelerate agricultural growth. If current trends continue, by the year 2025 Africa could well have an annual food gap of 214 million tons (this compares with current imports of 11 million tons).

It will take a long time before African countries can generate sufficient foreign exchange to purchase such large amounts of food. The real prices of Africa’s traditional export crops are low and declining, and the non-agriculture sector is small. It is also unlikely that African governments will be able to count on enough food aid to make up the difference. All indicators concur that poverty, malnutrition, and hunger will increase rapidly in the coming years unless action is taken to dramatically increase agricultural production.

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3 A “livelihood” is a means of living, and the capabilities, assets, and activities required for it. A “food secure livelihood” provides access at all times to the food required by a household for a healthy and productive life by all of its members. Households may grow sufficient food or may purchase the food they require by earning income through selling agricultural products or engaging in agricultural or non-agricultural employment.

4 In this document we define the “food gap” as the cereal-equivalent requirement to meet the energy “need” of the population less the sum of domestic consumption and imports. The “need” assumes a minimum of 3,000 cereal calories per person per day to cover food, livestock feed, seed, storage losses, and processing waste. [See Appendix II, page 72.]
through technological change that also increases agricultural employment.

While not as badly off as Sub-Saharan Africa, there are disquieting trends in South Asia. Yields are increasing at a slower rate than they did in the past three decades. Growth in Asian rice yields, for instance, has slowed from an annual rate of 3 percent in the late 1970s and early 1980s to less than 2 percent during the late 1980s. Total market demand for cereals is likely to increase to an annual 400 million tons by 2025, with an additional 210 million tons required to eradicate hunger. Total cereal production is only likely to increase to 355 million tons by 2025, and even less if yield growth rates continue to slow. The potential cereal need gap could, therefore, reach 255 million tons by 2025.

Although exports of manufactured goods are likely to rise more rapidly in South Asia than in Sub-Saharan Africa, it still will not have sufficient foreign exchange earnings to purchase the needed volume of cereals, even if it was available on the market.

**Why Should We Be Concerned?**

Over 2 billion people in the world regularly watch television. For the rich, the images on their screens provide a constant reminder of the horrors of natural disasters, civil war, and famine. For the poor, the screens portray the everyday luxuries of the affluent and well-fed. Globally, the consequence is a potentially explosive mix of fears, threats, and unsatisfied hopes.

The end of the Cold War has not brought about an increase in political stability. While conflict between East and West has declined, there is a fast growing divide between the world of the peoples, countries, and regions that “belong,” in global power terms, and those that are excluded. Confronting the increasing globalization of government, capital, technology, and trade are the surging expectations of the poor. Yet this growing conflict receives relatively little attention in industrial countries. The severe economic recession and the end of the Cold War have made political agendas inward-looking. Governments struggling with record-high unemployment, rising costs for welfare payments, growing budget deficits, and political polarization are paying little attention to the needs of poor nations overseas. The volume of aid going to developing countries is stagnating in real terms. The attention the industrial world is giving to external problems is being focused increasingly on the former Eastern Bloc countries.

Reductions in aid may be justifiable in the short-term, but, we would argue, are not in the long-, and even the medium-, term interest of industrial countries. An increasingly polarized world will result in growing political unrest. Already the consequences of economic stagnation, population growth, environmental degradation, and civil war are producing unprecedented movements of peoples. There are currently some 14 million refugees in need of assistance living in foreign countries and at least double that number who are refugees or displaced persons within their own countries. Unless developing countries are helped to realize sufficient food, employment, and shelter for their growing populations, or to gain the means to purchase food internationally, the political sta-

**All indicators concur that poverty, malnutrition, and hunger will increase rapidly in the coming years unless action is taken to dramatically increase agricultural production through technological change that also increases agricultural employment.**
Justice and equity also demand that poverty be eliminated. Moreover, it is a goal within our capacity. Globalization, while threatening on the one hand to concentrate power and increase division, on the other contains the economic and technological potential to transform the lives of rich and poor alike. Much depends on where our priorities lie and, in particular, whether there is sufficient access by the poor to the economic opportunities created by the products of new technologies. Here, as we will argue, international agricultural research has a particularly crucial role to play.

**FOOD PRODUCTION PROSPECTS**

**What Are the Current Trends?**

While a significant proportion of the growth in cereal production since the 1960s has come from the expansion of arable land, yields of major cereals have more than doubled in the past three decades. On past trends we ought to be able to continue to match the rising population with a comparable increase in food production on existing arable land, at least to the year 2025.

There are, in theory, no major physiological, genetic, or agronomic constraints to achieving the necessary yield gains. Conventional plant breeding techniques, increasingly augmented by genetic engineering, should be able to produce improved plant types capable of significantly higher yields in all parts of the world. There is considerable potential for increased and more efficient fertilizer use. Although appli-
cation rates are relatively high in those regions where the green revolution has occurred, the average in Asia is still only 30 kilograms of nitrogen per hectare, in Latin America it is 15 kilograms and in Africa 4 kilograms. This compares with national averages of 120 to 550 kilograms for the industrial countries of Western Europe, Japan, and China.

Equally significant is the potential for improving the supply of water through irrigation and various means of water conservation. Between 1960 and 1990 the area under irrigation grew from 100 to 170 million hectares. It is estimated that irrigated land in developing countries could be expanded by nearly 60 percent, with most of the potential in India, China, and other countries in Asia. However, in recent years there has been a significant decrease in the rate of expansion of irrigation as real costs of irrigation projects have risen.

**Are the Trends Sustainable?**

The desire for food security has left its mark on the environment, sometimes permanently. Hunger leads to desperate strategies for survival, and attempts to meet basic needs often take precedence in the short-term over longer-term sustainability. The blame should not be placed on the poor and hungry. Exploitation of resources by the rich, unsuitable agricultural technologies, and lack of appropriate institutions and governmental policies have combined to damage both well-tended and environmentally-fragile lands.

Globally about 2 billion hectares of soil, of which 1.5 billion lie in developing countries (17 percent of all vegetated areas), have become degraded due to human action since 1945. Degradation includes water and wind erosion, loss of soil nutrients, salinization, acidification, pollution, compaction, waterlogging, and subsidence. Most, but not all, results from inappropriate agricultural practices. Lack of terraces, failure to replace nutrients and organic matter, and excessive irrigation or drainage are damaging arable land. Rangeland is being degraded by overgrazing. Whether or not agriculture is a cause, soil degradation severely limits agricultural productivity. In some cases reclamation is bio-physically impossible. In others, the costs are high, but reclamation can be achieved with labor, ingenuity, and new technologies.

Other natural resources which also contribute directly or indirectly to food security are also being lost at unprecedented rates. The annual rate of destruction of closed forests is about 16 million hectares each year. This represents a substantial loss of potential income and employment from the sustainable harvest of timber, firewood, and other non-timber forest products. Forest destruction is also one of the prime causes of the increasing loss of global biodiversity. An estimated 15 percent of the world's plant and animal species could become extinct by 2025, many with potential for agricultural or forest exploitation.

Competition for water for agriculture has increased dramatically during the past two decades due to rapidly growing domestic and industrial demands. This situation will worsen through much of Africa and the Middle East by 2025. Significantly, the earlier high rates of expansion of irrigation appear to be unsustainable. Their continuation could exhaust irrigation potential in Asia well before 2025, would require an investment of US$500-1,000 billion, and would face formidable
While industry is the major source of global pollution, agriculture is a growing contributor, producing significant levels of methane, carbon dioxide, and nitrous oxide.

Individually, or in combination, these gases and their products are contributing to global warming, the depletion of stratospheric ozone, acid deposition, and the build up of ozone levels in the lower atmosphere. These will, in turn, significantly affect agricultural production. Global warming, for example, will have effects that vary with latitude. Heat and water stress at low latitudes, where most developing coun-

Global Pollution Caused by Agriculture

**Methane.** Forty-five percent of global emissions are produced by paddy fields, the guts of livestock, and the burning of vegetation. Methane contributes to increased tropospheric ozone, to destruction of ozone in the stratosphere, and to global warming.

**Nitrous oxide.** About 1 to 3 million tons of nitrous oxide is produced per year from nitrogen fertilizers, livestock waste, and the burning of vegetation. Levels are rising at about 0.2 to 0.3 percent per year, mostly driven by fertilizer use. Nitrous oxide, when converted to nitric oxide, contributes to the depletion of stratospheric ozone and to global warming.

**Carbon dioxide.** Burning biomass on savannah lands, in swidden agriculture, and as part of the permanent conversion of forest to agriculture contributes the equivalent of a quarter to a third of carbon dioxide produced from burning fossil fuels. Carbon dioxide emissions are responsible for about half of current and projected global warming.

**Ammonia** rises from nitrogen fertilizer applications and the volatilization of livestock waste and biomass burning. It contributes to acid deposition.
tries are situated, will result in significant losses in yield. However, in the middle and high latitudes, the combined effect of temperature increases and the direct physiological effect of higher levels of carbon dioxide is likely to result in higher yields. Current projections thus suggest yield increases in the temperate, industrial regions of the world, but significant reductions in tropical and subtropical developing countries, possibly on the order of 30 to 50 percent.

Are There Signs of Stagnation?

As a group, developing countries increased per capita food production by 13 percent during the 1980s, but some regions performed much better than the average and some much worse. East Asia is the star performer, increasing per capita food production by 22 percent during the 1980s. China's increase has been 35 percent. However, in Africa and West Asia there has been a continuing decline in per capita food production.

In 75 of the world's countries, less food per capita was produced at the end of the 1980s than at the beginning. In 15 countries per capita food production fell by 20 percent or more. In Asia, as a whole, the annual rate of increase in rice and wheat yields in the late 1980s was considerably less than in the 1970s and early 1980s. [See Figure 2a, page 66.] In Africa, yields are still apparently growing, but with wide fluctuations. [See Figure 2b, page 66.]

Particularly worrying is the evidence, as yet not well documented, of signs of stagnation in yield growth rates in those areas of developing countries where the green revolution had its greatest impact. In the Indian Punjab, for example, yield growth is being threatened by worsening availability and poor management of water, coupled with exhaustion of micronutrients, salinization, and build up of pests and diseases.

On a global scale, grain production per person has shown signs of stagnation if not a slight decline since 1985. [See Figure 3, page 67.] There have also been significant declines in non-cereal staples. In the 1980s per capita production of roots and tubers in developing countries fell by over 7 percent. There was a similar decline in production of plantains, and per capita banana production barely increased.

While per capita production of meat, milk, and other livestock products is continuing to increase in developing countries, per capita fish production is set to decline over the next 30 years unless aquaculture begins to grow at a much faster rate.

What is Forecast?

Total cereal market demand in developing countries for food and feed is projected to double to 2 billion tons by 2025. This estimate, it should be stressed, does not include the hidden needs of the poor who will be priced out of the market. In a well-fed world, another 400 million tons of cereals would likely be required, bringing the total cereal need in developing countries to 2.4 billion tons by 2025.

If recent yield growth rates for cereals continue to 2025, then total cereal production in developing countries will increase to 1.7 billion. This will leave a shortfall of 0.7 billion tons, over half occurring in South Asia and Sub-Saharan Africa. By 2025 the food need in South Asia will be 70 percent greater
than food production, and in Sub-Saharan Africa two and a half times as much. If the environmental constraints turn out to be as severe as some predict, and if the technologies are not available to deliver continuing yield growth rates, then these shortfalls could become even larger.

**TWO SCENARIOS**

If our analysis is correct, we can envisage two contrasting scenarios:

**Scenario 1.** Some industrial countries continue to produce food well in excess of their requirements and export this excess to meet the demand of developing countries. If it is assumed that the environmental constraints to increased food production can be overcome, and if the food needs of the poor are ignored, then there is little cause for concern. The food demands of developing countries, as expressed in national and international markets, will be met by national production in the areas of proven potential and by trade or aid from industrial countries. On present estimates this would entail some 300 million tons of cereals being sold to developing countries by the industrialized world in 2025, at today’s world prices.

If the food needs of the poor are not ignored, then under this scenario, a further 400 million tons would be required in 2025 as subsidized or free food aid. This is equivalent to over 20 times the current supply of direct food aid and would cost some US$44 billion (1988 prices). Such massive food aid would place heavy burdens on developing countries, particularly on the infrastructure for the receipt and distribution of the aid. It is also likely to depress local prices and add to existing disincentives for local food production.

To meet their own market demand and that of developing countries, and to provide the necessary food aid, industrial countries would have to at least double food production by the year 2025, from 860 million tons to 2 billion tons. This would necessitate considerable increases in yields per hectare and the bringing back into production of currently uncultivated land. Inevitably the environmental costs of such a scenario would be high.

**Scenario 2.** The developing countries greatly increase their own food production so as to largely meet their own needs, including the needs of the poor, investing in agricultural development as part of a larger development process. An alternative scenario envisages a rapid and broad-based growth in the developing world, not only in food production, but in agricultural and natural resources production generally. This scenario explicitly recognizes that food security is not simply a matter of producing enough food. It also depends on employment and incomes. Most of the world’s hungry and food insecure are rural based. If they are not growing enough food to meet their needs, they must have the means to purchase the food they require, and hence are dependent on

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5 Agriculture and natural resources use are inextricably related. In the following, therefore, agricultural development is throughout understood to mean the development of agriculture and natural resources, including forestry and fisheries; agricultural research means research in agriculture and natural resources.
rural employment and income created by agriculture and the development of natural resources. Agriculture, forestry, and fisheries are powerful engines of development. Increased production and employment in these sectors can generate considerable employment, income, and growth in the rest of the economy.

Very few countries have experienced rapid economic growth without preceding or accompanying growth in agriculture. Those countries who have achieved the most rapid agricultural growth in the past 20 years also have had rapid economic growth. Countries with real declines in agriculture have had the lowest growth rates in the economy.

The development of agriculture is, moreover, central to the challenge posed by population growth. Experience indicates that decline in birth rates is crucially dependent on food and income security, coupled with education and enhanced earning opportunities for women. Such opportunities can be provided by the production, processing, and trading activities generated by broad-based agricultural and natural resources development.

Environmental protection and conservation is also crucially dependent on appropriate agricultural and natural resources development. Sustainable approaches to food production and to forestry and fisheries management can reverse land degradation and pollution from agrochemicals, remove pressure on national parks and reserves, conserve biodiversity, and, at the same time, increase food security.

In summary a major investment in agriculture and natural resources in developing countries could:

- create employment and incomes for the mass of the poor;
- deliver food security;
- help to reduce birth rates through increased food and income security;
- protect and conserve the environment;
- stimulate development in the rest of the economy; and
- ensure prosperity in the industrialized world through the stimulation of global trade and an increased likelihood of political stability.

THE WAY AHEAD

What is Needed for Agricultural Development?

There is no single recipe for successful agricultural development, though there is a broad consensus on many of the essential ingredients. These include: an enabling policy environment that does not discriminate against agriculture, forestry, or fisheries; liberalized markets for farm inputs and outputs, with major private sector involvement; efficient rural financial institutions; adequate rural infrastructure; and effective institutions to develop and disseminate appropriate agricultural technologies.

Making sure that agricultural growth contributes to poverty alleviation, equity, and food security requires:

- the creation of employment for the land poor and landless;
- increased production on small, medium-sized, and large farms; and
- attention to regions of varying agroclimatic potential, not just the best.
The scope of bringing further land and water resources into production is now limited, and future growth will depend more and more on increasing the productivity of already utilized resources.

Instruments for achieving these goals include appropriate targeting of agricultural research and extension; ensuring adequate access by all types of farmers to credit, inputs, and marketing services; investments in rural education, clean water, health, family planning, and nutrition programs to improve human resources; attention to women's needs and legal rights; and, in some cases, land reform or redistribution.

The relative importance of these requirements is complex and country specific, but recent experience is clear on two counts. First, while economic liberalization within developing countries and reform of international trading policies are necessary prerequisites for significant agricultural growth, they are not sufficient. Accelerated growth in agricultural output cannot be maintained without adequate investments in rural infrastructure and in agricultural research and extension. Indeed without such investment the results of liberalization policies may well fall short of expectations and set governments against market-oriented approaches.

Second, investments in agricultural research to generate new technologies and knowledge continue to give consistently high rates of return. This has been demonstrated time and again in ex post cost/benefit analyses of individual research projects and programs. It also emerges from time-series analyses of the sources of growth in factor productivity in agriculture for individual countries.

What Are the Research Priorities?

High economic returns to agricultural research occurred during an era when new land and water resources were still being brought into production in many developing countries. The scope for bringing further land and water resources into production is now limited, and future growth will depend more and more on increasing the productivity of already utilized resources. Moreover, the benefits from agricultural research have still to reach large numbers of poor and hungry in the world.

Many of the past successes in research were due to concentration on high-potential areas (usually irrigated) and generic technologies that had widespread application (e.g. high-yielding varieties of rice and wheat). Such research must continue if the food demands of the escalating urban populations are to be met. Yet, in the future, achieving higher yields alone will not be enough; they have to be produced more cheaply and in a more sustainable manner.

In summary, future research on high-potential areas should be aimed at:
- higher yields per hectare;
- at less cost;
- with less environmental damage; and
- coupled with research on pricing, marketing, and distribution policies that ensure that the poor gain.

Research should also address the needs of the many rural poor who are landless or poor laborers living in the well-endowed, high agricultural production lands, providing it produces technologies that generate greater employment. The majority of the rural poor live in areas that are resource poor, highly heterogeneous, and risk prone. Agriculture here is limited by lower rainfall and less potential for irrigation, or steep slopes or poor soil structure, or lack of macro- or micro-
nutrients, or the presence of salts and other toxic compounds, or some combination of these. The yield response to research may be lower and the costs may be higher because of greater site specificity of the results, yet the benefits to the rural poor can be considerable.

This second type of research will be more complex, aimed at improving farming systems rather than specific commodities, with less reliance on the exploitation of resources originating outside the farm—fertilizers and pesticides. Such resources are often costly and sometimes unreliable, and frequently contribute to environmental degradation. They will continue to be essential if even higher productivity is to be attained. Equally, more attention will need to be paid to better use of resources internal to the farm. These are the under-recognized natural resources of agriculture, forestry, and fisheries:

- the natural parasites and predators of pests;
- algae, bacteria, and green manures that supply nitrogen;
- agroforestry and cropping systems that reduce erosion;
- underexploited wild tree and fish species; and
- genetic systems that increase tolerance to salts and toxins.

Inherently these are inexpensive resources, yet with skill and ingenuity they can be used to generate higher productivity on a sustainable basis.

Such research will also require greater involvement of farmers and local communities in research design. Because of the complexity of the problems and the site specificity of results, the initial focus should be on developing methods and approaches, and in demonstrating successes at case study sites.

In summary, future research on areas with relatively lower potential should be aimed at:

- higher yields per hectare;
- at very low cost;
- making maximal use of indigenous resources—physical, biological, and human;
- on a sustainable basis; and
- coupled with research on improving the livelihoods of rural poor households through agriculture and agriculturally related income and employment generating activities.

Using Natural Enemies to Kill Pests

Research showed that the damaging outbreaks of the brown planthopper on rice often were due to the pesticides which killed off the spiders and other natural enemies of the planthoppers. Farmers were trained to recognize and regularly monitor the pests and their natural enemies. They then used rules to determine the minimum necessary use of pesticides, reducing the average number of sprayings per season from over four to one, while simultaneously increasing yields from 6.1 tons to 7.4 tons per hectare.

A "Doubly Green" or "Super Green" Revolution

The agricultural research challenge for the future is complex and demanding. Research must continue to assist the intensification of high potential areas, albeit on a more environmentally-friendly basis. At the same time,
The agricultural research challenge for the future is complex and demanding. Research must continue to assist the intensification of high-potential areas, albeit on a more environmentally-friendly basis. At the same time, more research will be needed in lower-potential areas, where rural poverty and associated resource degradation is and will increasingly be concentrated. The amount of additional agricultural output required will be large, more than doubling in South Asia and Africa by 2025.

In effect we require a revolution that is even more productive than the first green revolution and even more "green" in terms of conserving natural resources and the environment, a "doubly green" or "super green" revolution.

Over the next three decades it must aim to:
- repeat the successes of the green revolution;
- on a global scale;
- in many diverse localities; and
- be suitable, sustainable, and environmentally-friendly.

While the first green revolution took as its starting point the biological challenge inherent in producing new high-yielding food crops and then looked to determine how the benefits could reach the poor, this new revolution has to reverse the chain of logic, starting with the socioeconomic demands of poor households and then seeking to identify appropriate research priorities.

In essence the new priorities should be: food security; income and employment generation; and conservation of natural resources and the environment, whose outcome is the creation of sustainable livelihoods for the poor.

We Need to Exploit New Research Paradigms

The successful breeding programs of the first green revolution relied on close collaboration between plant breeders, geneticists, agronomists, plant pathologists, and entomologists. In the future, such multi-disciplinary project teams will need even greater integration and a wider span of disciplines, encompassing both the natural and social sciences.

Present day biological and agricultural research institutions are in a state of change. They have different profiles of operation than they had a decade ago. Two developments in science are driving these changes:

The first is the emergence of molecular biology, a discipline, with its associated technologies, which is now integrated into all biological research fields. Molecular biology is concerned with the sub-cellular basis of life. It has been transformed by the recent revolutionary advances in laboratory technologies which have greatly increased not only our understanding of sub-cellular and genetic processes, but also have created opportunities for their manipulation.

The immediate potential of molecular biology lies in the design and engineering of new plant and animal types required for both high- and low-input systems. Plant breeders have been able to overcome some major limitations to yield by selecting needed characteristics from germplasm resources. Good examples are genes providing resistance to insect pests (brown plant hopper in rice) and disease (rust in wheat), tolerance to environmental stresses (aluminum tolerance in wheat), changes in plant architecture (semi-dwarf wheats), and alternatives in plant development (photoperiod control of flowering time in soybean).

There are major problems for which plant breeders have not been
able to identify or introduce appropriate new genetic variation. The problems potentially amenable to solutions through genetic engineering include: resistance to viruses, insects, and herbicides; tolerance to salt, drought, and heat; crop reserve improvement (carbohydrates, proteins, and oils); and nitrogen fixation. DNA technologies are beginning to make an impact in some of these cases. The key developments have been the development of gene transfer technologies for most of the major crop and pasture species. Molecular biologists can now design and build gene constructs which can be inserted into the genetic tape of a target plant to provide the transgenic plant with a new trait (e.g. pest resistance). As a result, the plant breeder is no longer restricted to the genetic variation that arises in traditional breeding programs.

Such genetic engineering has special value for agricultural production in developing countries. It has the potential to provide built-in solutions to biotic and abiotic challenges, reducing the need for chemical inputs such as fungicides and pesticides. The seed, with its enhanced genetic instructions, is a “farmer-friendly software package,” compatible with low-input agriculture and fitting the requirements of sustainability now placed on higher-input agricultural systems.

The second development is an ecological approach that, in tandem with economics, sociology, and anthropology, is rapidly increasing our understanding of the structure and dynamics of agroecosystems. Ecology is concerned with the interactions among organisms and between organisms and their environments. In recent years it has been transformed by sophisticated field experimentation based on quantitative and qualitative system models.

Recent advances in population, community, and ecosystem research are providing a better understanding of the complex dynamics that arise within crop populations and in multiple-cropping and agroforestry systems. Practical applications include the development of integrated pest management systems, where the use of natural parasites and predators can be substituted for pesticide applications, often involving savings in costs and reductions in environmental damage.

Ecological thinking has also begun to inform understanding of the livelihoods of poor households, particularly in their patterns of response to environmental stresses and shocks. Such knowledge contributes to better practical appreciation of the ways small farmers and poor households can utilize specific agricultural technologies to enhance their livelihoods and render them more sustainable.

Perhaps the most important outcome of this partnership between ecology and the social sciences has been the development of new methods and, more importantly, new approaches and attitudes to the involvement of farmers themselves in the analysis of their farming systems and livelihoods. Simple, yet powerful, methods have been developed that encourage farmer analysis, design,
Perhaps the most important outcome of this partnership between ecology and the social sciences has been the development of new methods and, more importantly, new approaches and attitudes to the involvement of farmers themselves in the analysis of their farming systems and livelihoods.

and management of agricultural and natural resources systems in partnership with research scientists and extension specialists. These are now showing practical results in their application to varietal selection, the development of integrated pest management systems, the construction and management of small-scale irrigation, reforestation, and the conservation of watersheds.

These developments in molecular biology and ecology, at the core of the new interdisciplinarity of biological research, are having considerable impact on laboratory and field research. More importantly, they provide novel ways of thinking and inquiring about biological, agricultural and socioeconomic phenomena, bringing new system perspectives, and enhancing our capacity to define critical answerable questions. They are not alternatives. Indeed they are complementary, providing the means whereby farmers and field and laboratory scientists can collaborate in identifying and answering the research questions posed by the socio-economic needs of poor households.

INTERNATIONAL PUBLIC RESEARCH

Why Do We Need Public Research?

In industrial countries the production of new varieties and agronomic technologies has increasingly been assigned to the private sector. Better-off farmers, often heavily subsidized, are able to afford the products of expensive research. Private companies can patent and protect their discoveries for sufficient time to realize an acceptable profit.

Inevitably private research focuses on the major high-value crops, on labor-saving technologies, and on the needs of capital-intensive farming. By contrast research to feed the poor is less attractive to private interests, because:

- It frequently involves long lead times, for example in developing new plant types of minor staples.
- It is risky, particularly when focused on heterogeneous environments that are subject to high climatic and other variability.
- The beneficiaries have little capacity to pay for the research.
- The products cannot be restricted to those who pay, if they can.

Farmer Participation in Agricultural Research and Development

CIAT has established “innovators’ workshops” in which farmers design and evaluate experiments. One experiment tackled the problem of lack of stakes for climbing snap beans. The farmers suggested growing the beans after tomatoes, thereby exploiting the tomato stakes and the residual fertilizer. Using various criteria of success that they devised, the farmers agreed on two snap bean varieties as outstanding for this system.

Collaborative research between IIMI and the Nepal Department of Irrigation has developed better methods for identifying hill irrigation systems with unrealized potential and participatory mechanisms in which farmers plan, design, and mobilize resources for the improvement of even quite large systems. The results are greater efficiency and sustainability of operation.
• Intellectual property rights can rarely be protected.

Thus, while private research carried out by national and multinational companies has much to contribute to well-endowed lands and the better-off farmers, most of the needs of the poor will have to be met by public research agencies.

Public research also has a crucial role to play in ensuring that technologies are sustainable. Inevitably the beneficiaries of environmentally appropriate technologies are often not the users, or at least the users alone. In contrast to private research, where the benefits are captured by private companies and a limited group of users, public research aimed at low cost, sustainable food production has benefits that spread to farmers, large and small, to other rural dwellers and, most importantly, to poor consumers. Public agricultural research aims to exploit the potential for positive externalities, especially as they benefit the poor.

**Why Do We Need a Continuing Effort in International Research?**

The major problems of food security, poverty alleviation, and conservation of the environment that we have described above are not restricted to one country or region of the world. They affect, and will continue to affect, a major proportion of the world's population in many regions of Africa, Asia, and South America.

As yet, many of the countries worst affected still lack sufficient agricultural and natural resources research capacities to deal with their problems. The required research typically draws on many disciplines and production specialties, often lacking even in well-developed NARS. An international research effort, involving partnerships between national and international centers, can help to remedy these deficiencies and provide outputs which have impacts that cross national boundaries. Often the problems are common and so are the solutions.

Thus, research activities that have significant economics of scale or scope are strong candidates for international agricultural research. In these cases, it is more cost-effective for individual countries to pool their resources and to conduct research on an international basis. This is especially true for small countries.

Second, research activities that involve important international externalities (such as spillover benefits or environmental costs and benefits) also have strong justification for international research. Since the costs and benefits of international externalities are not fully borne by the country that undertakes the research, there will be incentives to under- or over-invest in research when judged from the perspective of global welfare. For example, individual countries are unlikely to invest enough in research activities that have spillover benefits for other countries (e.g. germplasm that can be used in other countries), or that lead to reduced carbon emissions (e.g. sustainable forestry), which protect biodiversity, or prevent soil erosion into international waterways, because they do not capture all the benefits from the research.

Similarly, countries are likely to over-invest in research activities that indirectly promote deforestation or water pollution, if the environmental costs are borne by other countries. International agricultural research can
help correct for under-investment in globally appropriate research activities and for national over-investment in research activities that have negative environmental effects.

Third, international research can help strengthen NARS in the early stages of development and, in general, help improve the access of NARS to new knowledge and technology. This will ensure that NARS at all levels of development can benefit from the most recent advances in science and technology.

The NARS of developing countries encompass a wide range of institutions, varying in size and capability. From 1970 to 1990 many new public agricultural research institutes and universities were created. In the late 1980s public deficits gradually led governments to reduce research investment and operating expenses; as a consequence, many NARS have suffered major crises, the most severe in Africa.

One advocated solution was privatization. In practice this has proved difficult to achieve. There has also been slow progress in setting up farmer-supported research organizations. Producer cooperatives, in various guises, have proved successful at the organization of inputs and marketing, but few have extended their remit to research. Success has been more apparent in the research programs funded and supported by national and international NGOs.

Despite the financial stringencies they face, industrial countries have continued to provide support to NARS through collaborative links involving their own universities and research centers. A few European countries have maintained public organizations for international agricultural research and have recently set up the European Consortium for Agricultural Research in the Tropics (ECART). The United States has comparable programs, often involving the Land Grant universities, and funded by the U.S. Agency for International Development (USAID), Ford, Rockefeller, and other private foundations. Japan, Canada, and Australia have also set up institutions specializing in scientific cooperation. These efforts, however, are not well coordinated. Information circulates poorly, and there is little interaction between the different protagonists.

**What is the Role of the CGIAR System in the International Effort?**

Investments in the CGIAR constitute only 3 percent of annual public spending on agricultural research globally. Despite this small share, the CGIAR plays a key role in fostering the effectiveness and further development of the global agricultural research system.

For over 20 years the CGIAR has played a leadership role which stems from its scientific credibility and widely acknowledged achievements. The CGIAR is the only truly international, non-political agricultural research entity. The CGIAR has also served as a bridge between institutions, most notably between developing country research systems and advanced institutions in industrial and developing countries. Their knowledge of the conditions of NARS in various levels of development has enabled CGIAR centers to demonstrate best practices through networks, consortia, and other means, leading to greater South-South cooperation in research.
The CGIAR is an informal consortium of donors, encompassing national governments and international agencies, linked by the common purpose of eradicating hunger and poverty through research. To achieve this task it has created a family of 16 research centers. While each center has its own board and largely sets its own agenda, these conform to priorities and objectives determined by an independent TAC.

The essence of the CGIAR is independence, accountability, and research excellence, monitored and evaluated by external mechanisms. This provides a quality guarantee for donors who can make funding decisions within an analytical framework provided by a body that is independent of the ultimate recipients of support. Few institutions receiving aid funding can match this feature. These characteristics have contributed to a remarkable record of research achievement over the past 30 years, especially in germplasm characterization, plant breeding, pathology, pest control, crop, livestock, and agroforestry systems, and field application of new technologies of tillage and soil conservation.

In summary, the scientific and technological infrastructure of the CGIAR provides a unique capacity for focused research with worldwide application. From the donor and developing country perspectives the CGIAR provides public research of guaranteed high value, at relatively low cost.

A FUTURE FOR THE CGIAR

The Need for Change to a Program Based Approach

The problems of providing sustainable food security for all in a world of rapid population growth are daunting in their complexity. They cannot be solved by the simple transfer of technologies, but require genuine partnerships operating at both global and regional levels. The research institutes of industrial countries, both public and private, and the national agricultural research institutes of developing countries need to be linked in new ways that reflect the opportunities created by the revolution in modern biology.

The research institutes of industrial countries, both public and private, and the national agricultural research institutes of developing countries need to be linked in new ways that reflect the opportunities created by the revolution in modern biology.

Through international agricultural research and related activities, and in partnership with national research systems, to contribute to sustainable improvements in the productivity of agriculture, forestry, and fisheries in developing countries in ways that enhance nutrition and well-being, especially of low-income people.
Participants in Potential Partnerships in International Agricultural Research

**Industrial Countries**
- Research institutes
- Universities
- Private companies
- Consortia

**CGIAR**
- International agricultural research centers

**Developing Countries**
- Regional research institutes
- National research institutes
- Universities
- Private companies
- NGOs
- Farmers

- The opportunity to exploit the new paradigms (molecular biology and ecology), requiring interdisciplinary partnerships and links to advanced expertise.
- The increasing focus on a wide range of agroecosystems necessitating greater in-country expertise and farmer participation in research.
- The need to work to agendas of widely agreed research outcomes and outputs.

To operate in this context, the CGIAR will need broader-based advice on such issues as demography, natural resources, and food security, and be able to keep abreast of the developments and changing capabilities of modern biological science. So equipped, it can then formulate its agenda of collaborative programs within an overall agreed international agricultural research effort. One consequence will be that programs will commonly have funds from a number of different sources, within and outside of the CGIAR, and will be limited in their duration.

**The Underlying Principles for the Future**

Three principles should apply in defining the CGIAR's specific responsibilities and roles within the international research effort:

- **Subsidiarity.** As a general principle, the primary responsibility for a research activity should be devolved to the lowest level in the hierarchy, from global to regional to national, that can carry out the activity most appropriately and efficiently.
- **Partnership.** In carrying out a research activity, partnerships with agencies with complementary skills and experience should always be considered as an alternative to adding capacities to CGIAR centers.
- **Transfer.** Even if there is no clear gain in efficiency or expertise from the involvement of developing country research institutions, the objective of strengthening developing country NARS justifies placing priority on their involvement with international research efforts.

**The Nature of the Programs**

Applying the principles, we can envisage the CGIAR as contributing to international research activities through two types of programs:

- Global programs
- Regional action programs
Global programs would be geared toward strategic research problems of international significance. Regional action programs would address specific sustainable production problems faced in significant geographic regions. It is important to differentiate these two types of programs because of differences in the scope of the problems to be addressed and the range of actors likely to be involved, both in funding and in executing the research effort.

The CGIAR would progressively channel all of its funding into a set of well-defined research programs. This is a departure from the present practice of funding international centers. In the future, institutes should be receiving funding from the CGIAR, but only for their involvement in one or more specific programs of interest to the CGIAR.

We suggest three types of global programs:

- long-term, center-based programs;
- multi-center programs; and
- collaborative strategic research programs.

Long-term, Center-based Programs

The CGIAR would provide funding to these programs on a continuous and stable basis. The centers would be fewer in number than at present. As a group, they would focus on the heartland of the CGIAR mandate and carry out programs which have a long-term perspective. The CGIAR would approve programs, and the allocation of resources to centers for carrying out these programs would be as at present. Existing CGIAR mechanisms would be used in the monitoring and evaluation of their implementation.

These center-based programs should be tailored toward resolving problems:

- in regions where increased production is needed most urgently (such as in Sub-Saharan Africa and South Asia); and
- in situations where public research is most required because of market failures, and where sustainability concerns are most pressing.

Such programs would focus primarily on the development of genetic materials for selected crop, livestock, forestry, and fish species that are recognized as providing keys to the solutions of these problems. In their funding and execution, long-term programs would be designed to preserve and enhance the intellectual capital and the intellectual heartland of the CGIAR centers.

Multi-center Programs

Some of the programs supported by the CGIAR would be carried out by all or a subset of the centers. These programs would be continuous or long-term in duration. They would be managed through an inter-center mechanism and would require funding from the CGIAR, except for services which should be financed by their users.

Illustrative examples of multi-center programs include:

- the conservation, characterization, and evaluation of selected germplasm;
- the provision of information, materials, and training in research methods and approaches; and
- advice on institutional strengthening and on food production, dis-
In their funding and execution, long-term programs would be designed to preserve and enhance the intellectual capital and the intellectual heartland of the CGIAR centers.

Collaborative Strategic Research Programs

These would focus on research problems which are global in nature and which cut across the core themes covered by the centers. The programs would be of a finite duration, usually a 5 to 10 year period. The problems covered would represent a “good investment risk” for the CGIAR and other partners funding them. The research would be carried out by a set of collaborating institutes, including CGIAR centers. One of these would assume leadership of the effort. Funding for the programs would come from the CGIAR as well as other sources. The effort would be evaluated by existing CGIAR mechanisms.

Illustrative examples of research themes that fall in this category include:

- decline in yields of major cereals in intensively cropped, cereal-based systems;
- development of small-scale irrigation and water conservation systems;
- improved understanding of key biological, physical, social, and economic dynamics of selected critical ecosystems, such as coastal zones;
- reduced productivity of global pollutants, especially nitrous oxide and methane, from agricultural practices; and
- development and understanding of user participatory approaches in the design and management of irrigation, forestry, and fisheries systems.

Regional Action Programs

These would be problem-specific research programs, of a shorter duration than global strategic research programs. Agendas would be set by NARS, regional organizations, and interested donors, in partnership. Funding would come mainly from sources other than the CGIAR, although the CGIAR could also contribute to funding. Leadership of the programs would normally be assumed by NARS or other agencies, but in some cases the CGIAR centers could be asked to play a leading role. Monitoring and evaluation of the effort would be by a special mechanism agreed upon by participants. The CGIAR could use its own internal mechanism to monitor/evaluate aspects of the program involving CGIAR funding.

The following illustrate outputs of possible regional action programs:

- better yielding crop varieties and agroeconomic systems appropriate to specific acid and mineral deficient soils in the savannas of Latin America;
- synergetic cropping and crop-livestock systems providing higher, more stable yields in the highlands of West Asia;
- more productive cereal-based farming systems in Eastern and Southern Africa;
- sustainable coffee and cocoa based farming systems in West Africa; and
- integrated aquaculture systems for coastal South and Southeast Asia.

In summary, we envisage a CGIAR which is a more open and collaborative system than at present, a CGIAR which leads the global international agricultural research effort by:
analyzing problems;
- developing agendas;
- fostering partnerships; and
- providing independent advice and evaluation to achieve solutions to the problems.

The CGIAR of tomorrow should use a wider range of institutional modalities in fulfilling its mandate than at present. [See Figure 4, page 68.]

CONCLUSIONS

Over the next 30 years the challenge we face is to:
- meet the food needs of the more than 700 million who go hungry today;
- provide food at affordable prices for almost 100 million more people every year (the largest annual population increase in history);
- increase production through greater productivity per unit of land (expansion in area is no longer feasible in most of the world); and
- do this in such a way as to conserve and not degrade natural resources and the environment.

These are challenges for the world community as a whole, not just the countries where the poor live. It is not simply a matter of justice and equity. The world is more interdependent than ever before. The growing globalization of institutions, ideas, capital, technology, and trade, and the opportunities created by the advances in information technology, are creating a world in which events in one country or region affect us all. Unless addressed smartly and in advance, poverty and hunger could lead to political destabilization and environmental destruction, with worldwide implications.

We have a collective responsibility to eradicate hunger from the face of the Earth in ways that protect our common environment. It is not simply a matter of meeting the market demand for food. The new mandate is to assure food security for all the world's population, through agricultural research that not only adds to food production but generates employment and income that, in turn, increases the market demand for food.

The panel believes we should turn to science for help—help in creating a new agricultural revolution, one that is global, equitable, sustainable, and environmentally-friendly. Science can meet this challenge, because new paradigms in science, particularly in molecular biology and ecology, are providing a better understanding of the complex interactions between physical, biological, and social systems, and are helping to create the tools and technologies needed to address the problems we face.

Mobilizing science in this way means significant investments in public research, both national and international. Because many of the problems that need to be researched are common across countries and regions, an international research effort is likely to be more efficient and productive. We advocate the creation of a global agricultural research system that links a range of institutions with one another in new partnership modes.

As the only truly global, apolitical public international agricultural research system today, the CGIAR has a special role to play in the evolution of such a system. It should lead in the identification of research problems of international significance, in the design of research programs, and in the as-
If these recommendations are adopted, we believe that, with adequate support from the donor community, the CGIAR can spearhead a new global movement to ensure sustainable agriculture for a food secure world.
Figure 1: Population by Regions, 1990 and 2025
Figure 2a: Crop Yields in Asia 1961 to 1991: Composite of Maize, Rice, and Wheat

Figure 2b: Crop Yields in Africa 1961 to 1991: Composite of Maize, Rice, and Wheat
Figure 3: World Grain Production per Person, 1950 to 1993
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APPENDIX I
ABOUT THE PANEL

Gordon Conway, Chair

Gordon Conway, of the United Kingdom, is Vice-Chancellor of the University of Sussex (since 1992), Chair of the Board of the Institute of Development Studies, and a Member of the Global Environmental Change Committee of the Economic and Social Science Research Council. Prior to his current appointment, he was Ford Foundation Representative for India, Nepal, and Sri Lanka, based in New Delhi. Earlier he was Professor of Environmental Technology at the University of London and Visiting Professor at the University of Chiang Mai, Thailand. Gordon Conway has a PhD in Systems Ecology from the University of California, Davis, Diplomas in Agricultural Science (University of Cambridge), and Tropical Agriculture (University of the West Indies, Trinidad), and B.Sc. in Zoology from the University College of North Wales, Bangor, UK.

Uma Lele

Uma Lele, an Indian national, is a Graduate Research Professor of Food and Resource Economics at the Institute of Food and Agricultural Sciences, University of Florida, Gainesville; she also serves as Director of the Global Development Initiative of the Carnegie Corporation and the Carter Center. Prior to her move to Florida in 1991, she held various positions at the World Bank in Washington, D.C. (which she joined in 1971), most recently in areas of policy and development strategy. Uma Lele has a Ph.D. and M.S. in Economics from Cornell University.

W. James Peacock

Jim Peacock, an Australian, is Chief of the Division of Plant Industry of CSIRO, in Canberra, a position he has held since 1978. During his research career in CSIRO (which began in 1965), he has held a number of visiting professorships in biology, biochemistry, and molecular biology, including at Stanford University, the University of California, Los Angeles, and the University of Oregon. Jim Peacock is a Fellow of the Australian Academy of Science and the Royal Society of London. He obtained his B.Sc. and Ph.D. in Botany and Genetics from the University of Sydney.

Martín Piñeiro

Martín Piñeiro, of Argentina, is an independent consultant who recently completed two terms as Director General of the Inter-American Institute for Cooperation on Agriculture (IICA), from 1986 to 1993. Prior to that appointment, he was Research Coordinator at the Center for Social Research on State and Management, Argentina and, earlier, was Undersecretary (Vice Minister) of the Secretariat for Agriculture and Livestock in Argentina. Martín Piñeiro received his Ph.D. in Agricultural Economics from the University of California at Davis, M.S. in Agronomy from Iowa State University, and completed his undergraduate studies in Agronomy at the University of Buenos Aires.

Panel Secretary

Selçuk Özgediz, a Turkish national, is Management Adviser at the CGIAR Secretariat. He received his B.S. in economics and statistics from the
Middle East Technical University (Ankara), M.S. in mathematical statistics and M.A. and Ph.D. in Political Science from Michigan State University.

Resource Persons

**Michel Griffon**, of France, is Director of the Agricultural Policies and Forecasts Research Unit, and Chief Economist (since 1986), CIRAD, France. He is an agricultural engineer and economist, and studied Research and Development Economics at the University of Paris (DEA Degree Program).

**Peter Hazell**, of the United Kingdom, is Director of the Environment and Production Technology Division, IFPRI. He is an agricultural economist, with M.S. and Ph.D. degrees from Cornell University, and College Diplomas in Agriculture and in Farm Management from Seale-Hayne Agricultural College, Devon.

Co-conveners on behalf of the CGIAR Oversight Committee

**Henri Carsalade**, of France, is currently on detachment from the Ministry of Agriculture to CIRAD, France, where he recently served as General Director (1990-1993). He is a Forestry Engineer and Agricultural Engineer, graduating from the Institute National Agronomique, France.

**Johan Holmberg**, of Sweden, is Director of Programmes of SAREC. He received his B.A. in Russian and English Languages and M.B.A. in Marketing Economics from Gothenburg School of Economics.
APPENDIX II
TECHNICAL ANNEX ON PROJECTION METHODOLOGY

Peter Hazell
International Food Policy Research Institute (IFPRI)

The projections of food production, demand, and imports for the year 2000 given in this document were derived from a global trade model developed by IFPRI, the International Food Policy and Trade Simulation Model (IFPTSIM). The model is fully documented in Agcaoili, Oga, and Rosegrant. IFPTSIM is a market equilibrium model of foodgrains and grain-fed livestock products that solves for prices, demand, production, and trade by major countries/regions and for the world. (See Table 1, page 74.) Population growth, income growth, and yield growth are all exogenous. (See Table 2, page 75.) However, growth in cereal production is endogenous because the cropped area is responsive to price. The model includes major livestock activities; hence, all cereal production, demand, and trade figures are aggregates of human food and livestock feed.

Cereal demand is endogenous and is driven by prices, income growth, and changes in the livestock sector. By definition, cereal demand for each region equals production plus imports less exports. At the global level, cereal demand equals production. There is no global cereal gap between market demand and supply because the endogenous price clears the market. The hungry are simply priced out of the market, as in the real world.

Because this document is concerned about the prospects for a well-fed world, the model projections have been supplemented by side calculations of the additional cereals that would be needed in 2025 to meet the “hidden” food needs of the poor. The hidden need is calculated as follows. For each region, the amount of cereals required to supply 3,000 calories per person per day was calculated using the population projections for 2025. This level of caloric availability is assumed to be an acceptable minimum for meeting human food needs while allowing for livestock feed, seed, storage losses, and processing waste. The total amount of cereals required in a region to meet this minimum need is then compared with the projected market demand from the IFPTSIM model, and the difference is taken to be the “hidden” cereals need. For regions with a positive hidden need, the total cereals gap is taken as the difference between total food need and projected production. In all other cases, the projected cereals gap is taken as the difference between projected market demand and production, which equals projected imports in the IFPTSIM results.

These calculations of hidden food needs hinge critically on the required calorie level assumed. Our assumption of 3,000 calories per person per day for cereals supply is hardly generous for a well-fed world, but it still leads to food gaps of 214 million tons for Sub-Saharan Africa and 255 million tons for South Asia in 2025. Table 3 (see page 76) shows how these gaps change under different assumptions about the minimum caloric need. The gaps escalate enor-
mously as the calorie requirement is increased. In 1988, average calorie availability from cereals in Sub-Saharan Africa and South Asia was only 1,290 and 1,638 calories per person per day, but this was associated with considerable malnutrition and hunger. Even when hidden foods needs are calculated using 1,500 calories per person per day, this still leads to food gaps in 2025 of 34 million tons for Africa and 46 million tons for South Asia.
<table>
<thead>
<tr>
<th>Classification</th>
<th>Country/Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developed Countries</td>
<td>USA</td>
</tr>
<tr>
<td></td>
<td>EC12</td>
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<tr>
<td></td>
<td>Japan</td>
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<tr>
<td></td>
<td>Other Western Europe</td>
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<tr>
<td></td>
<td>Canada</td>
</tr>
<tr>
<td></td>
<td>Australia</td>
</tr>
<tr>
<td></td>
<td>New Zealand</td>
</tr>
<tr>
<td></td>
<td>Other Developed Countries</td>
</tr>
<tr>
<td></td>
<td>Other Eastern Europe</td>
</tr>
<tr>
<td></td>
<td>Former Soviet Union</td>
</tr>
<tr>
<td>Developing</td>
<td>Latin America</td>
</tr>
<tr>
<td>Countries</td>
<td>Mexico</td>
</tr>
<tr>
<td></td>
<td>Brazil</td>
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<tr>
<td></td>
<td>Argentina</td>
</tr>
<tr>
<td></td>
<td>Other Latin America</td>
</tr>
<tr>
<td>Africa</td>
<td>Nigeria</td>
</tr>
<tr>
<td></td>
<td>Other Africa</td>
</tr>
<tr>
<td>Middle East</td>
<td>Egypt</td>
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<tr>
<td></td>
<td>Other Near East</td>
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<tr>
<td>Asian LDCs</td>
<td>India</td>
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<td></td>
<td>Pakistan</td>
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<td></td>
<td>Bangladesh</td>
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<td></td>
<td>Indonesia</td>
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<td>Thailand</td>
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<td>Malaysia</td>
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<td>Philippines</td>
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<td>Singapore</td>
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<td></td>
<td>South Korea</td>
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<td></td>
<td>China</td>
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<tr>
<td></td>
<td>Other Southeast Asia</td>
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<tr>
<td></td>
<td>Other South Asia</td>
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<tr>
<td></td>
<td>Other East Asia</td>
</tr>
<tr>
<td>Other</td>
<td>Other Developing Countries</td>
</tr>
<tr>
<td></td>
<td>Rest of the World</td>
</tr>
<tr>
<td>Commodities</td>
<td>Crops</td>
</tr>
<tr>
<td></td>
<td>Wheat, rice, maize, other coarse grains, soybean</td>
</tr>
<tr>
<td>Animal Products</td>
<td>Beef, pork, poultry, mutton and lamb, fluid milk, eggs</td>
</tr>
</tbody>
</table>
Table 2: Key Exogenous Parameters in the IFPRI Model

<table>
<thead>
<tr>
<th>Annual Growth Rates (%)</th>
<th>Sub-Saharan Africa</th>
<th>South Asia</th>
<th>Other Asia</th>
<th>WANA</th>
<th>LAC</th>
<th>Developing</th>
<th>Developed</th>
<th>World</th>
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<tr>
<td>Population</td>
<td>2.8</td>
<td>1.9</td>
<td>1.2</td>
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<td>1.2</td>
<td>1.6</td>
<td>3.5</td>
<td>1.4</td>
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<tr>
<td>GDP</td>
<td>3.2</td>
<td>3.8</td>
<td>4.8</td>
<td>3.2</td>
<td>2.8</td>
<td>3.8</td>
<td>2.8</td>
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<td>Yield:</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>2.3</td>
<td>1.9</td>
<td>2.1</td>
<td>2.0</td>
<td>1.8</td>
<td>1.9</td>
<td>1.6</td>
<td>-</td>
</tr>
<tr>
<td>Maize</td>
<td>2.0</td>
<td>2.0</td>
<td>1.7</td>
<td>2.3</td>
<td>2.0</td>
<td>1.9</td>
<td>1.6</td>
<td>-</td>
</tr>
<tr>
<td>Other Cereal Grains</td>
<td>2.4</td>
<td>2.0</td>
<td>1.3</td>
<td>1.6</td>
<td>1.3</td>
<td>1.8</td>
<td>1.2</td>
<td>-</td>
</tr>
<tr>
<td>Rice</td>
<td>2.2</td>
<td>1.9</td>
<td>1.6</td>
<td>1.6</td>
<td>1.8</td>
<td>1.7</td>
<td>1.3</td>
<td>-</td>
</tr>
<tr>
<td>Soybeans</td>
<td>0.7</td>
<td>2.2</td>
<td>2.3</td>
<td>2.3</td>
<td>2.2</td>
<td>2.2</td>
<td>2.0</td>
<td>-</td>
</tr>
<tr>
<td>Beef</td>
<td>2.1</td>
<td>1.6</td>
<td>2.4</td>
<td>3.0</td>
<td>1.5</td>
<td>1.9</td>
<td>1.1</td>
<td>-</td>
</tr>
<tr>
<td>Pigmeat</td>
<td>2.2</td>
<td>2.2</td>
<td>2.2</td>
<td>2.5</td>
<td>2.5</td>
<td>2.3</td>
<td>1.0</td>
<td>-</td>
</tr>
<tr>
<td>Sheepmeat</td>
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<td>2.4</td>
<td>2.3</td>
<td>2.3</td>
<td>1.9</td>
<td>2.2</td>
<td>2.0</td>
<td>-</td>
</tr>
<tr>
<td>Poultry</td>
<td>3.4</td>
<td>1.5</td>
<td>2.2</td>
<td>2.8</td>
<td>1.8</td>
<td>2.2</td>
<td>1.2</td>
<td>-</td>
</tr>
<tr>
<td>Eggs</td>
<td>4.0</td>
<td>2.0</td>
<td>2.8</td>
<td>2.5</td>
<td>2.7</td>
<td>2.7</td>
<td>1.7</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 3: Projected Gaps in 2025 for Different Assumptions about Hidden Needs

<table>
<thead>
<tr>
<th></th>
<th>Africa</th>
<th>South Asia</th>
<th>Other Asia</th>
<th>WANA</th>
<th>LAC</th>
<th>All Developing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model Projections</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>144.7</td>
<td>355.9</td>
<td>801.4</td>
<td>148.6</td>
<td>237.2</td>
<td>1,687.8</td>
</tr>
<tr>
<td>Market Demand</td>
<td>173.6</td>
<td>401.6</td>
<td>882.5</td>
<td>262.3</td>
<td>273.6</td>
<td>1,993.6</td>
</tr>
<tr>
<td>Commercial Imports</td>
<td>28.9</td>
<td>45.7</td>
<td>81.1</td>
<td>113.7</td>
<td>36.4</td>
<td>305.8</td>
</tr>
</tbody>
</table>

Hidden Need (additional demand above market demand)

<table>
<thead>
<tr>
<th>Calories per day</th>
<th>1,500</th>
<th>2,000</th>
<th>2,500</th>
<th>3,000</th>
<th>4,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Gap (imports plus hidden need)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calories per day</td>
<td>1,500</td>
<td>2,000</td>
<td>2,500</td>
<td>3,000</td>
<td>4,000</td>
</tr>
</tbody>
</table>

76
Renewal of the CGIAR:
Sustainable Agriculture for Food Security
in Developing Countries

A Research Agenda for the Future
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<td>............................................................................................................................. 87</td>
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A Research Agenda for the Future

Driven largely by population growth, global agricultural production must more than double over the next 30 years, even as the supply of water and productive land declines. To fail in this effort is to invite social, political, and environmental chaos, with costs so high that failure is simply unthinkable. Doubling production while protecting the natural resources upon which agriculture depends is one of humankind's most pressing challenges. This document highlights the critical role of agriculture and its research in meeting that challenge, and describes the contributions of one important group, the CGIAR.

CHALLENGES AND OPPORTUNITIES

It is widely observed that we have, today, the capacity to feed all the world's people. Yet nearly 1 billion go without adequate food, and each day some 40,000 people, most of them children, die from hunger and related causes, their deaths a grim testimonial to the effects of poverty. Relief costs are soaring while new opportunities for women and minorities are limited by a lack of resources. Natural resources vital to agriculture are in jeopardy, as the poor sacrifice tomorrow's production for survival today. Already we are on a treadmill leading to consequences widely judged to be unacceptable. Each day brings 250,000 newcomers, most of them at risk to the effects of poverty. How do we get off this treadmill, achieve our most noble social aims, and still protect the environment?

The Way Forward

Many in the development assistance community now endorse the idea of sustainable food security for the developing world as a worthy vision of the future.

But in the words of M. S. Swaminathan, sustainable food security requires sustainable economic security, and that requires a clear focus on reducing poverty. In developing countries, poverty and hunger go together. Poverty is also closely linked to environmental degradation. As the poor struggle to survive, protecting the environment quickly becomes a secondary concern, and public programs aimed at protecting natural resources in poor countries require large investments from already limited budgets. Having more children, too, is a practical response to living in poverty, one geared toward survival of the family.

Reducing widespread poverty, then, is the pivotal challenge confronting those who seek to improve, not only the human condition, but the condition of the world's ecosystems. Economic

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1 As used here, agricultural production refers to food from the land and sea, livestock, and forest products.
2 To the CGIAR, "agriculture" includes crops, livestock, forests, and fish.
development leads to higher incomes, less hunger and malnutrition, and the availability of resources for protecting the environment (and a willingness to invest in that purpose). Development also leads to slower rates of population growth, as rising incomes both reduce the need for larger families and provide resources for programs that specifically reduce birth rates by focusing on women. Paraphrasing one prominent leader in development, lasting peace and security depend on development that offers hope for the future. Indeed, it is doubtful that any of the goals for which the community of nations is working—not peace, not human rights or democratization, not environmental protection, not reduced population pressures, not disease control—can be achieved and sustained except in the context of development. Increasing the incomes of the poor, then, is the first essential step toward treating social, political, and environmental ills.

**Agriculture: The Cornerstone of Development**

How can we best promote broad based income growth in poor countries? In such countries, 60 to 80 percent of the population works in agriculture. Forty to fifty percent of the average family income is spent on food. Because of agriculture's prominence in such economies, increasing its productivity is critical to promoting growth. Indeed, few poor countries have progressed without first increasing the productivity of their agriculture sectors.

As agriculture becomes more productive, at least three important things happen. First, the incomes of those who work directly in agriculture go up, enabling them to improve the quality of their own lives—a better diet, better housing, more education, more tools, and so on. Second, spending that additional income adds to the incomes of others, who in turn contribute to widening rounds of spending that increase the demand for goods and services throughout the economy. In this way, agriculture serves as an engine of growth and development. Third, because higher productivity leads to increased supplies of food, real prices for staples decline—they become more affordable to more people. Less of the family budget is required for sustenance, more is available for a variety of other purposes. In effect, more productive agriculture lubricates the whole process of economic growth. The greater the relative importance of agriculture in a country, the more these processes will promote its development.

How, then, to make agriculture more productive? New agricultural technologies, improved infrastructure, better government policies, and more education all contribute in important ways to higher productivity—but one of these stands out.

**Agricultural Research: Laying the Cornerstone**

For at least the past century, new technologies have been the most reliable source of higher productivity in agriculture. This will undoubtedly hold true for the next century, as well. Today's new technologies take the form of resource conserving management practices, new plant varieties that have built in disease and insect resistance and that use available water and nutrients more efficiently, and techniques
for producing hardier livestock and more productive fisheries. Increasingly, prudent government policies encourage farmers and other agricultural producers to use these new technologies. However, new technologies do not simply appear when needed. They are a direct consequence of long-term, practical agricultural research, and of the political will to garner financial support for bringing cutting edge biological and social science to bear on the problems of the poor.

So the way forward in the poorest developing countries is to make agriculture more productive, and research is an essential piece of the productivity puzzle. Research generates the new technologies and knowledge that drive the development process while conserving natural resources. The end result is more food and fiber (produced more cheaply and with less impact on the environment), higher incomes in the agriculture sector, and, through lower prices for agricultural products, higher disposable incomes for the urban poor—in short, less poverty, a healthier environment, and then on to treating other ills.

A GLOBAL RESEARCH SYSTEM FOR DEVELOPING COUNTRIES

Agricultural producers in developing countries are served by a global research system—global in the sense that virtually all countries have some investment in such research, and a system in the sense that many researchers share results. These producers have access to the fruits of research from a wide spectrum of sources: the local and international private sector, local and developed country universities, publicly financed and usually publicly operated research systems, and from publicly funded, internationally oriented research like that of the CGIAR. How has this mix of agencies and institutions evolved?

Much of the research done on behalf of these producers is in the hands of public institutions funded by individual governments. To date, universities in developing countries have been little involved in agricultural research, and private investment in this activity was little encouraged. Largely because of studies that showed extraordinarily high payoffs to well focused research, governments and development assistance agencies began pouring money into national programs and, in the 1970s, there was a general expectation that, before long, they would provide the new technologies that farmers required.

Many institutions in developed countries, some privately financed, oth-

8 There are no accurate, up-to-date estimates of global public sector expenditures on agricultural research. The most comprehensive data on expenditures cover the 1981 to 1985 period and show an annual average expenditure of US$4.8 billion by developed countries and US$4.4 billion by developing countries (adding to US$9.2 billion globally— all expressed in 1980 dollars). The average annual funding for the CGIAR during the same period was about US$0.155 billion (in 1980 dollars), which places the CGIAR as a share of developing country expenditures at about 3.5 percent and of global expenditures at about 1.7 percent (for simplicity, rounded to 4 and 2 percent, respectively). (Anderson, Jock, Philip Pardey, and Johannes Roseboom. 1994. “Sustaining Growth in Agriculture: A Quantitative Review of Agricultural Research Investments.” Agricultural Economics, 10.) According to a recent set of preliminary and projected estimates, the 1990 CGIAR funding constituted a smaller share (than during 1981 to 1985) of the public expenditures by developing countries and globally. (Pardey, Philip. 1994. “Economic Perspectives on Setting Research Priorities at the Regional Level.” Paper presented at ISNAR Roundtable on Regional Priority Setting. The Hague: ISNAR.)
ers publicly funded, supplemented the array of research organizations focused on the needs of developing country producers. Training and education aside, their specific research concerns—usually centered on temperate production systems—seldom coincided with those of developing country producers. Although these centers of excellence offered notable advantages in some areas, especially basic research, their contributions to meeting the global challenge in agriculture could have been greater by relating their findings to the needs of the tropical and subtropical environments common in developing countries. Their contributions could also have been enhanced by an awareness of the relative importance of widespread, but not readily evident, problems to which they could have applied their vast human and physical resources.

In the 1960s, it was clear that national programs in developing countries lacked the human resources—trained and experienced scientific and managerial talent—to meet mounting challenges. This led to, among other things, the creation of international agricultural research centers to fill gaps, train national program staff, and show the way toward more effective institutions. The gap-filling side of this work produced the improved varieties of rice and wheat that led to immense increases in productivity, especially in Asia, and to improved varieties of beans, cassava, maize, millet, and other crops, each of which added its portion to higher farm level productivity. Along the way, the skills of over 45,000 national program staff were further enhanced by a variety of training programs offered by international research centers, and through side-by-side working relationships.

In general, national systems seemed to progress during the 1970s much as expected, but three developments changed the landscape for public sector research after the early 1980s. The first was that public funding for agricultural research began to dry up. The second was a growing awareness of the opportunities created by actively encouraging privately funded research. The third, already making its influence felt, but destined to play an even larger role in the future, was the growing complexity of the problems treated by an advancing science.

The fiscal stringency of the 1980s took its toll on public support for research. Agricultural research was especially susceptible because of the long lead time between investment and pay-off (typically 10 to 15 years) and because some of the promise of earlier years had not been realized. Meanwhile, the change in attitudes toward private investment in research encouraged increases there—some estimate that it now exceeds US$500 million annually. That investment is selective, occurring where proprietary claims can be established (not always easy to do in agricultural research) and where, because of market size, there are opportunities for profits.

Free trade and, some claim, greater access to intellectual property rights, will encourage further private investment in research. In time, as in the developed world, a growing portion of agricultural research will be in the hands of the private sector. As that happens, publicly funded research will be reoriented toward areas where it has a special advantage. The international
research portfolio will also change. In anticipation of that, the CGIAR is more strongly emphasizing those activities in which the private sector is not likely to invest and where international efforts are an efficient way to get things done. [See the next section for more on this point.]

As for the growing complexity of science, here it is enough to say that it opens new opportunities for collaboration and partnership, with implications for how research is implemented and managed. [This idea is treated more fully later.] There is, then, something of a global system catering to the needs of developing country producers. It is large, uneven in its capacities, funded in various ways, and loosely integrated. Much can be done to make it more effective. Even so, it works.

The individual researchers in this global system focus their efforts on particular outcomes, such as improved potatoes for a certain group of farmers or appropriate farming practices that will reduce erosion while raising yields. Although the system's individual research projects number in the thousands, for the most part they can be grouped into five major undertakings or thrusts most relevant to developing countries.

Increasing Productivity. The first thrust aims at making developing country agriculture more productive, either through genetic improvements in plants, livestock, fish, and trees, or through better management practices. In the past, and even today, the bulk of the global research system's resources have been dedicated to increasing productivity.

Protecting the Environment. A second thrust aims at conserving natural resources, especially soil and water, and reducing the impact of agriculture on the surrounding environment. To date, this thrust has occupied a notably small portion of the energies of the global system, but is now increasing in importance.

Saving Biodiversity. Third, and separated from the second because of a burgeoning interest, is the conservation of biodiversity. Again, while many countries operate genebanks that hold representative varieties of their primary crops, relatively little research attention has been given to this issue until recently, especially in developing countries.

Improving Policies. Fourth, and now a step removed from the goals of poverty alleviation and environmental protection, is work aimed at streamlining the government policies that so strongly influence the spread of new technologies and the use of natural resources.

Fortifying National Programs. Fifth are the training and institution building activities that improve national capacity to effect changes in the first four areas.

Each of these thrusts has consequences for alleviating poverty and protecting the environment in developing countries. Some of the global research system's projects fit in more than one category, and a few are not easily placed in any of the five. The projects of some agencies are more likely to be found in one arena than another; for example, the private sector's efforts are likely to focus more on increasing productivity than on anything else. On the other hand, basic research done by advanced institutions, usually publicly funded, tends to support more than one thrust.

There is something of a global system catering to the needs of developing country producers. It is large, uneven in its capacities, funded in various ways, and loosely integrated. Much can be done to make it more effective. Even so, it works.
THE ROLE OF THE CGIAR TODAY

The focus of the CGIAR has shifted over time as the concerns of the development assistance community, new opportunities in science, and stronger national research systems have changed its priorities. Initially, the CGIAR was established to complement the activities of national research systems and to provide a two way bridge to basic and strategic research institutions in industrial countries—both translating their output into forms more useful to national programs and bringing to their attention the aggregated research needs of developing countries.

Today, the most advanced developing country research systems are benefiting from collegial relationships with advanced country institutions. Only a few, however, are able to do so. For the many who cannot, bridging mechanisms are still required. Even so, the CGIAR more and more orients its research to the production of significant international public goods. These are products and services for which, no matter how valuable, proprietary claims are difficult to establish and, to make them international, for which there are large economies of size. The first condition makes it unlikely that the private sector will take part and the second reduces the probability that publicly funded national programs will be involved.

How, then, do current CGIAR efforts relate to the five major thrusts described above for the global system? A brief description of its participation follows, accompanied by selected examples of impact.

Increasing Productivity. Better, more productive plants, carefully tailored to specific growing environments, have been the centerpiece of CGIAR efforts in this arena. About 20 percent of the CGIAR’s resources are now allocated to research aimed at improving genetic stocks. The payoffs to this work have been quite high.

In the case of plant breeding, for example, many studies have shown that most of the resulting varieties are notably more efficient at assimilating and converting available water, sunlight, and soil nutrients to useful products, contributing to higher and more stable yields at whatever the availability of those resources.

Super Cassava

The contribution of genetic manipulation to productivity is usually measured in terms of moderate but steady changes in annual output. Sometimes, however, the results are dramatic. An example of the latter occurred recently in Ghana. Cassava, a dietary staple in Ghana, is a major food source for more than 200 million people throughout Africa. In 1993, Ghana released three new varieties of “super cassava” that, due to collaborative long-term breeding research by the Ghanaian national program and CGIAR scientists, carried genes for higher yield potential as well as resistance to the cassava green mite, an important insect pest that limits production in many environments. These new varieties are boosting yields in farmers’ fields by about 200 percent compared to traditional varieties. Increased supplies of the tuber are not only adding to the diets and incomes of the poor, but kindling commercial interest in processing cassava as a livestock feed, as well.
One important feature of the CGIAR’s breeding research is its focus on building into plants greater resistance to the insects and diseases that so adversely affect productivity and the stability of production in the tropics. While protecting farmers from losses, these improved plants protect the environment because they require little, and frequently no, chemical controls.

**Black Sigatoka**

Black sigatoka is a devastating fungal disease of plantain and banana, two critically important food sources in tropical Africa. The disease was inadvertently transmitted to the continent about 20 years ago. The traditional varieties grown there have little or no natural resistance to the disease, and the chemical controls in use are both expensive and environmentally dangerous. CGIAR researchers have developed hybrid plantains that are highly resistant to the disease and that produce twice the yield of existing varieties. Trials in 12 countries throughout Sub-Saharan Africa are expected to produce varieties adapted to farmers’ production circumstances by 1996. The benefit to farmers growing the resistant hybrids (a sustainable technology, as opposed to existing varieties that require the application of fungicides) is estimated at 10:1. If widely adopted, these new varieties could increase the value of annual plantain production from about US$2.8 billion to about US$6 billion, while reducing the production costs and environmental impacts associated with fungicide use.

Beyond improving genetic stocks, CGIAR researchers look for new plant combinations and new ways to manage land and water, capture the sun’s energy, and control important diseases, all in an effort to increase the efficiency of producer held resources. Some estimate that up to 50 percent of the gains in productivity come from more effective management of these resources.

**Integrated Pest Management**

In recent years, the stability of the Andean ecoregion’s potato crop has been threatened by an infestation of Andean potato weevils, which routinely damage 50 percent of a farmer’s crop. The problem is further complicated by the widespread use of hazardous and largely ineffective insecticide sprays. In response, CGIAR researchers have developed integrated pest management (IPM) practices that control weevils without chemicals. After four years of testing and refining these practices in farmers’ fields, weevil damage in the pilot areas has fallen to just 6 percent. Farmers who use the new practices have an average production increase of 3 tons per hectare—equivalent to about US$600 in additional income (per capita annual income in the Andes is US$300). So far, the IPM pilot research and extension projects on Andean potato weevils are generating a return of nearly 60 percent on the CGIAR investment in them.

By now, however, the CGIAR’s work on the management side has decreased, handed over to national programs or reshaped to give even more attention to environmental concerns. Still, about 25 percent of the CGIAR’s resources are devoted to improving the management of farmer held resources.

One further point about the CGIAR’s work on productivity: the pri-
Productivity improvements contribute, albeit indirectly, to protecting the environment. The point is a simple one: higher productivity in environments well suited to agriculture reduces the need to bring more fragile environments into production. For instance, were India to produce the wheat consumed there today with the technologies of the mid-1960s, farmers would need nearly 60 million hectares of additional land, similar in quality to the land in use back then. With such land no longer available, millions of hectares of hillsides and forest margins would have been drawn into production to meet the demand for wheat today, with truly extreme environmental consequences. An even more striking example can be found in the United States, where impressive productivity increases and improved agricultural technology have spared endless hectares of hillsides, forests, wildlife sanctuaries, and grasslands from devastation.

While these efforts have, on balance, benefited natural resources, work aimed directly at resource conservation is an essential—and growing—part of the CGIAR’s portfolio. Started in the late 1980s, this research seeks first to understand the interactions among the resource base, the biology of sustainable production systems, and the behavior of producers and consumers, and then to develop productivity increasing, resource conserving technologies that producers will use. Much of the work seems to require new research paradigms, and the CGIAR plays a leading role in their development. What should be measured, how to measure it, what statistical methods to use, and how far to pursue Nature’s endless chain of inter-actions are but a few of the questions that will shape the new paradigms. Research on erosion control, nutrient cycling, water management, and water quality—all important and widespread problems in natural resources management, and all complicated by an awareness that productivity must also be increased—is a part of this thrust.

This is not to suggest that all such work is strategic or the province of the CGIAR. Ascertaining the nature, influence, and projection of chemical and biological processes; laying out questions and methods for diagnosis; and developing prototypes are examples of the CGIAR’s terrain. The NARS, closer to the problems of their own farmers, draw on this accumulating knowledge and shape it to their local needs. While this work is crucial to natural resources conservation, little of it offers the profits that would attract private investments, and much of it promises the broad applications that lead to economies of size. This thrust now absorbs about 10 percent of CGIAR resources.

Saving Biodiversity. As in the case of protecting the environment more generally, CGIAR efforts to increase agricultural productivity contrib-
ute indirectly to conserving biodiversity: increased output in areas well suited to agriculture reduces the need to expand production into more fragile areas, thereby leaving more tropical and subtropical forests (where so many species reside), hillsides, and so on. But there is much more to be done, especially in the work dedicated to collecting and conserving selected species. Given that current law and custom limit pecuniary gains from these collections, the CGIAR is increasingly involved in this arena.

Roughly 10 percent of the CGIAR's resources are currently allocated to this work. In a recent development, an accord with FAO was signed that ties the CGIAR's collections into a global conservation effort.

The CGIAR holds in trust one of the largest ex situ collections of old and new varieties of the crops on which it works and, in substantial measure, the wild species from which those crops emerged. These species and varieties are held in ways designed to assure their viability far into the future, so they can be available to meet challenges from new pests or other changes in the environment. Duplicates of the varieties held in trust are made available to researchers around the world so that new gene combinations can be brought to bear on current problems. Their use of those duplicates creates new information, widening our knowledge on the performance characteristics of conserved materials, adding to their value. Whole new opportunities are at hand in this arena, but more on that as discussion turns to the future.

**Improving Policy.** Agricultural producers are heavily influenced by public policy, and studying those effects offers insights into how policy and

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**CGIAR Genetic Resources and FAO**

To strengthen international solidarity, the CGIAR and its centers have accepted the invitation of FAO's Director General to place their collections of genetic material containing more than 600,000 accessions of more than 3,000 crop, forage, and pasture species, one of the world's largest collections—under the auspices of that organization as the first part of an international network of ex situ collections. It is hoped that others will follow the CGIAR's example and place their collections under the auspices of the FAO Inter-Governmental Commission on Plant Genetic Resources.

The CGIAR has introduced a system wide approach to its work in the area of genetic resources, and has developed a policy regarding intellectual property rights as they relate to the management of those resources. Individual centers and the CGIAR as a whole are increasing their participation in international fora where issues of intellectual property and access to genetic resources are debated. These include the FAO Commission on Plant Genetic Resources and various groups charged with implementation of the Convention on Biological Diversity and the preparation of its first Conference of the Parties to the Convention. The CGIAR has also committed its support to the preparation of FAO's Fourth Technical Conference on Plant Genetic Resources, which will prepare a status report on the world's genetic resources and a global plan of action.

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A growing awareness of the true costs of poor policies and of the payoffs from improving them, along with the pressure to use policy to liberalize rather than to constrain markets, will soon produce numerous examples of measurable impact resulting from CGIAR research on policy.

Such studies also reveal the true costs of current policies and can suggest ways in which policy might be changed so as to promote socially desirable ends. Their impact will be manifested in large measure through other thrusts.

Several CGIAR centers work on policy related issues. Virtually all of this work is done in collaboration with specialists in national programs. While examples of these efforts abound, their impact on policy itself has not yet emerged. A growing awareness of the true costs of poor policies and of the payoffs from improving them, along with the pressure to use policy to liberalize rather than to constrain markets, will soon produce numerous examples of measurable impact resulting from CGIAR research on policy.

Such work currently absorbs about 10 percent of CGIAR resources. While much of this work is done by social scientists, not all of the CGIAR’s social science is focused on policy; it is also an integral part of the three preceding thrusts.

Fortifying National Programs

Many agencies are involved in this work, from educational institutions developing human capital to private firms offering counseling on management, to those financing the physical capital required for research. Focusing on what it does well, the CGIAR’s role is largely in capacity building—through formal training programs for research staff, side-by-side working relationships with colleagues in national programs, and strengthening skills in research administration and management. As science and the demand for research services change,

Agricultural Development Drives Economic Growth

Following the green revolution in Asia, agricultural development was a central force driving overall economic growth in rural areas. Higher productivity led to lower real prices for food (benefiting the poor in rural and urban areas), higher net incomes for farmers, and increased demand for non-food items. It also provided the widespread and sustained level of purchasing power needed to make industrialization feasible. Each extra dollar of agricultural income gave rise to an additional 80 cents worth of non-agricultural output from local businesses that were stimulated by the spending of farm households.

In Africa, however, where benefits of the green revolution were harder to discern, similar studies had drawn more pessimistic conclusions. More recent in depth case studies in Burkina Faso, Niger, Senegal, and Zambia have shown that higher rural incomes from increased production of tradable agricultural products can greatly stimulate further growth in rural incomes. In these countries, the production of each additional dollar’s worth of exportable agricultural goods is estimated to generate as much as two dollars of additional income in the countryside, through new spending on nontradable rural goods, like perishable foods, local handicrafts, and services of all kinds. Awareness of such relationships helps policymakers to better decide where to invest scarce public funds.
new pressures emerge in both the research and management arenas. For example, the new emphasis on the environment requires new skills among research staff, new working relationships in the field, and new ways to measure progress. These changes imply the need for new skills in management, if the national systems are to be effective.

In recent years, the CGIAR has allocated up to 25 percent of its resources to capacity building, changing its offerings in response to the changing needs and capacities of national programs.

One important aspect of the CGIAR's work in each of the five thrusts noted above is the emphasis of gender and user perspectives. CGIAR centers are increasingly incorporating gender perspectives systematically into their research planning and implementation. They also play an important catalytic role in advocating wider use of such perspectives by NARS.

DEFINING THE RESEARCH AGENDA FOR 1996 AND BEYOND

The CGIAR has taken important and decisive steps in planning its future research agenda. Its comparative advantage is clear: to research key problems in agriculture relevant to many developing countries. The CGIAR's intention, as national research services grow stronger, is to retreat from its many support roles to focus on the production of strategic scientific information widely useful in developing countries.

Several steps have already been taken toward a new structure for the global agricultural research system, with a changing role for the CGIAR. The fact that the genetic resources collections of the CGIAR centers are held in trust for the world community has recently been formalized by placing the collections under the auspices of the FAO Intergovernmental Commission on Plant Genetic Resources. At the same time, a CGIAR-wide Genetic Resources

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Regional Training in Crop Management Research

Training courses offered by the CGIAR continually evolve in response to the changing capacities of national programs, and are becoming ever more collaborative ventures. Maize crop management research (CMR) in Africa is a good example. It became clear in the late 1980s that national programs in Africa and elsewhere had a growing need for staff training in CMR, a far greater need, in fact, than could be met by the CGIAR centers. No alternative suppliers for such training were readily available, so in 1990 training officers from one CGIAR center joined forces with the Kenya Agricultural Research Institute (KARI) and Egerton University in Nairobi in the first of a series of six-month training courses in region specific maize CMR. The course was designed for young professionals from eastern and southern Africa, and emphasized direct practical experience in the planning, execution, and follow-up of a CMR program that stresses on-farm work. This course is continuing today, with responsibility for content and execution now largely in the hands of KARI and Egerton University. Its success has motivated similar collaborative efforts in Latin America and Asia. Meanwhile, the center has shifted its training to mid-career researchers.

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The CGIAR's intention, as national research services grow stronger, is to retreat from its many support roles to focus on the production of strategic scientific information widely useful in developing countries.
National programs need to be strengthened. Human capital is their most costly resource, but is no longer limiting progress. The current constraint on effectiveness is inadequate recurrent funding to mobilize skills and implement priority research programs, and thereby to motivate their scientists.

Program has been set up to be led by IPGRI. This has created a single point for the international community and the CGIAR to interface, offering greater coherence in international actions on plant genetic resources.

Similarly, the CGIAR has moved to establish Global and Regional Fora on international agricultural research in which NARS interact with centers and donors in developing priorities for the global system as a whole. A trial of such fora was held recently under the auspices of the International Fund for Agricultural Development (IFAD), to develop a vision of the CGIAR from the perspective of the NARS. The NARS vision offers an emerging counterpoint to CGIAR priorities and strategies, historically developed internally within the CGIAR itself.

The Lucerne meeting is a part of this transition. We hope the insights gained will guide the CGIAR to a transition which is appealing to our donor stakeholders and can be adopted by the Group at the Mid-Term Meeting in Nairobi, Kenya in May 1995.

THE ROLE OF THE CGIAR TOMORROW?

What will be the role of the CGIAR in the longer run, in 2010 or in 2025? Will the challenges that introduced this document be met? Will international public goods still be in demand? As for the first question, several reputable studies draw distinctly different conclusions. For the most part there is agreement on likely needs—the demand side—but there are strong differences of opinion regarding our ability to meet those needs—the supply side. Some are sanguine, some apocalyptic. What separates the two extremes is a seemingly trivial difference in the projected annual growth of output. Each position, however, sees improved technologies and agricultural research as critical to its projections. And even those holding to the most sanguine view would see diminished rates of technological change as threatening.

Planning the future research agenda of the CGIAR required the prediction of trends in four important factors. First, the goals of the international community supporting the Group. As noted earlier, their primary concerns are the alleviation of poverty and the protection of the environment, and these are projected to remain the driving forces behind investments in international agricultural research.

A second important factor is the future of national agricultural research systems and others that use products from the CGIAR centers. National programs need to be strengthened. Human capital is their most costly resource, but is no longer limiting progress. The current constraint on effectiveness is inadequate recurrent funding to mobilize skills and implement priority research programs, and thereby to motivate their scientists. Raising governments’ awareness of the pivotal role of agriculture in development will lead to better funding and more effective research pro-


This is reminiscent of Charles Dickens’ character, Mr. Micawber, differentiating between happiness and misery in terms of a few pence per week.
grams. An alternative processor of research information will be private investment. This will grow as market access improves and the agriculture sector grows. NGOs will continue to advocate greater attention to the needs of the poor and the environment, and increasingly adapt research information to the needs of the communities they serve.

Science, the third factor, will continue to change rapidly, and each turn of its wheel will bring new understanding, new complexities, and new opportunities. The new complexities will suggest new ways to organize work, and these will favor modifications in the CGIAR’s structure. Changes will occur in every aspect of the CGIAR’s work, probably most notably in molecular biology, in data processing and communications, and perhaps in the microbiology aimed at the fundamental understanding of biological and physical relationships in the soil. Advances in science carry special implications for work that relates natural resources, biology, and the human element in the pursuit of useful productivity-increasing, resource-conserving technologies.

Fourth, important changes will occur in the markets for agricultural inputs and products. Some of these changes will come about because of rising incomes, which will change what consumers want to buy. Others will relate to urbanization (virtually all developing country population growth will be visible in urban areas10), to GATT and trade liberalization, to intellectual property rights, to UNCED’s implications for claims on genetic resources, and to experience with transgenic plants. All seem likely to make invest-

ment in research more susceptible to economic forces. And beyond these considerations will be the extent of the commitments to Agenda 21 and to the Desertification Convention. Other conventions will certainly emerge, each of which must be assessed for its implications for research in general and for the CGIAR in particular.

Two other, more general points need to be made here. The first relates to the openness of the CGIAR. Growing complexity in science will make it likely that any given effort might involve all parts of the research continuum, from basic through adaptive research. The result is that individual centers, indeed perhaps the CGIAR itself, will probably not have staff to cover all relevant specialties. To be efficient, then, individual parts of the CGIAR must open up to new forms of collaboration. The CGIAR’s innovations in “system-wide initiatives” and “ecoregional initiatives”11 are a response to this challenge.

Greater openness also has implications for priority setting. Some participants (national program staff, for example) will know better the needs and likely responses of producers, while others might have a better idea about the probabilities of success for alternative research efforts. Given the critical importance of these two considerations in setting priorities, the CGIAR must find ways to get relevant

Science will continue to change rapidly, and each turn of its wheel will bring new understanding, new complexities, and new opportunities. The new complexities will suggest new ways to organize work, and these will favor modifications in the CGIAR’s structure. Changes will occur in every aspect of the CGIAR’s work.


11 Such initiatives rest on an approach that brings new balance into international agricultural research. The approach features sustainable improvement of productivity as well as a strategy for the mobilization of the global research system to meet the sustainability challenge. It focuses on both the human and technical dimensions of sustainable production systems, and relies on effective partnerships with national programs and other agencies.
views on the table early. [This point is a principal theme in the document on Governance, which describes new approaches for obtaining input from national public- and private-sector representatives.] What about producers themselves? How are their needs and knowledge to be reflected in priority setting? CGIAR centers will largely rely on national program researchers and NGOs to reflect the needs and priorities of farmers.

**Toward 2015**

The points made here are taken from CGIAR documents and relate to decisions taken in recent meetings of the Group. Plans are projected to 2015; their implementation can be changed as needed to accommodate new developments in major external environments.

**Increasing Productivity.** While a number of factors will lead to changes in the productivity research portfolio, several promise potentially large effects. The first is in the growing capacity of national programs and the increasing investment in selected areas by the private sector. These changes will lead the CGIAR to give more emphasis to strategic concerns in genetic improvement, especially for crops, including raising yield plateaus, improving resistance to important pests, and added buffering for other stresses of particular significance like drought, soil acidity, and soil salinity. This work will lead to the introduction of genes from a widening array of sources, including near and wild relatives, and even unrelated species through the use of transformation technologies. These breeding strategies will

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**Improving Productivity through Synthetic Wheats**

Six thousand years ago, quite by chance, a wild grass with 28 chromosomes captured the pollen of another having only 14. The resulting hybrid became one of the world’s most important cereals - bread wheat. Scientists at one CGIAR center had the idea that, by duplicating Nature’s chance encounter hundreds of times over, they could both improve the productivity and add to the genetic diversity of this long domesticated crop. The early 28 chromosome parent of bread wheat evolved into durum wheat, an important crop in its own right. Using innovative breeding techniques, elite durums are being crossed with the 14 chromosome ancestor of bread wheat—known as goat grass *Triticum tauschii*—to produce “synthetic” bread wheats. These synthetics are themselves of little direct use to farmers, but they do carry desirable traits from the *T. tauschii* parent, such as resistance to certain diseases, tolerance to saline soils and to drought, and higher rates of photosynthesis. Because they are true bread wheats, the synthetics can be easily crossed to elite bread wheat lines, in effect serving as a bridge for transporting useful traits in *T. tauschii* to elite bread wheats. This novel research—part of an ongoing effort to broaden the genetic base of bread wheat—is providing two important products: bread wheats with higher, more stable yields, and an efficient method for tapping the genetic potential in the wild relatives of modern wheat varieties.

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also have the important effect of broadening the genetic base of major crops, a critical counterbalance to the tendencies of the past 40 to 50 years, tendencies that raise the risk of pandemics like the 1970s southern leaf blight episode in the United States. It should be noted, however, that thanks to modern plant breeding, any given improved variety of recent vintage, grown where recommended, is likely to be notably more resistant to pests than the varieties of even 20 years ago. Significant work is already underway in strategic breeding, and such efforts will receive a rising proportion of CGIAR resources.

Genetic improvement will be aided by advances in molecular biology. Part of the CGIAR's requirements here will be met through collaboration with others, including contractual arrangements. Some CGIAR efforts will focus on tailoring methods developed by advanced laboratories to the needs of developing country researchers.

Urbanization, predicted to increase rapidly, and rising incomes, essential to achieving the goals of the development assistance community, will lead to new patterns of demand for staple foods. These trends will shift the relative importance of the CGIAR's products, changing its allocation of research resources.

Taken together, these considerations will lead to a rebalancing of the CGIAR's work in genetic improvement, both permitting and encouraging some concentration of tasks and, at the same time, encouraging the decentralization to others of some activities now important within the CGIAR.

As noted earlier, much research on the management of production systems tends to be nonproprietary and to feature micro-level activities. As national programs become stronger, CGIAR investment in this work will be reduced. What remains within the CGIAR's purview will have a strong connection with the conservation of natural resources and most will shift to that part of the CGIAR portfolio. Even so, management of production systems will remain an important consideration. It should be added that national programs will be encouraged to see their own work on production systems in the context of resource conservation.

A New Plant Type for Irrigated Rice

The yield frontier for irrigated rice has been stagnant at about 10 tons per hectare since the first modern rice varieties were released. In the early decades of the green revolution, there was a substantial gap between the technological potential and farm-level yields. Today the exploitable gap is small, making it necessary to increase yield potential in order to raise farm-level productivity. The ultimate target is an irrigated rice plant that raises yield potential by 50 percent, from 10 to 15 tons per hectare in the tropics. The first generation of the new plant type was designed in 1989, and today experimental lines with a target of 12 tons per hectare are being evaluated in the field. This rice plant will be released to national programs by 1998. Other generations will follow to reach the ultimate target of 15 tons per hectare. This new plant type will allow Asia to meet the 50 percent increase in rice demand that is projected by the year 2030.

Significant work is already underway in strategic breeding, and such efforts will receive a rising proportion of CGIAR resources. Genetic improvements will be aided by advances in molecular biology.
Two final points should be made here. The measure of success in this domain will be declining real prices for basic commodities in poor countries. If real prices do not decline, development will be impeded, with evident consequences for poverty alleviation, population growth, and the environment. To be truly effective, these price declines must result from productivity increases in the areas where poor producers live. Results here will continue to have indirect benefits for parts of the environment.

Protecting the Environment. This research thrust will be one of the most challenging over the next 15 years. Reference was made earlier to the need for new research paradigms to support this work and of the CGIAR's role in their development. Beyond that already formidable task there are questions about how to best manage such work, with its many collaborators. Ultimately much of this work must be done in a hands-on way at the micro-level where the natural, biological, and human elements come together. The likely production systems will involve a range of activities, some complementary and some competitive, but each potentially benefiting from the inputs of specialists. Furthermore, investment in relevant basic research is expanding in several advanced institutions. For some portion of the work, macro-level considerations and policies must be brought into play in order to ensure that resource conserving practices are adopted, and much training must be done to sensitize research partners to the important elements and, indeed, to the very importance of such work. Combining these considerations in fruitful ways will require management skill and some patience. Even so, practitio-

Research on Asia's Rice/Wheat Rotation

Nowhere are rice and wheat more important than in South Asia. The area devoted to wheat, grown in the winter season after rice, expanded significantly in the region during the late 1960s with the advent of earlier maturing varieties. Rice and wheat are now grown there in annual rotation on nearly 12 million hectares, providing food for tens of millions of rural and urban families. But in the mid-1980s, researchers became concerned that the cropping system might not be sustainable. Although such a trend was not yet evident in most farmers' fields, scientists from four national programs in the region and two CGIAR centers began detailed diagnostic surveys in the late 1980s. Information from farmers indicates that the productivity of the system is, in fact, declining. To determine why and to develop recommendations for making the system more sustainable will require extended, strategic research—a strong suit of the CGIAR. The CGIAR and its collaborators have established an innovative ecoregional initiative aimed at developing sustainable farming practices for rice-wheat cropping on the Indo-Gangetic Plain. The initiative involves the four original national programs and several CGIAR centers. A lead center in the region will coordinate the work, with research priorities established by an advisory committee containing one member from each participating institution. Innovative institutional arrangements will facilitate the interdisciplinary research needed to address the problem, and all partners are committed to developing practical solutions relevant across sites and national boundaries.
ners are confident that a problem solving orientation will provide the framework through which roles can be identified, effective collaboration initiated, and the desired results can be achieved.

Success here will require effective research paradigms and robust frameworks for participation and collaboration, perhaps more than in any other area of research. The CGIAR’s response to these challenges features an ecoregional approach and several ecoregional initiatives.

In addition, other research will look at broad strategic issues. Some argue that work on increasing water use efficiency may well be the single most important research issue of the next 15 years. Overall, given the widespread implications of the problems, the CGIAR will emphasize five themes: (i) water and irrigation management; (ii) watershed, coastal areas, and river basins; (iii) interactions among soils, water, nutrients, plants and animals; (iv) ecosystem restoration; and (v) common property issues. Many of these emerge from Agenda 21. Principles derived from research on these problems will be broadly applicable.

Given the essentially nonproprietary nature of this work and potentially large economies of size, its apparent importance, and the absence of others with the advantages of the CGIAR—strong connections with national programs, advanced institutions, and expanding connections with NGOs—the CGIAR will invest a rising proportion of its resources in this area. Some part of that will have been transferred from production systems research. Again, it is recognized that there is no possibility that the CGIAR could, or should, do all such research for all relevant ecoregions of the developing world. National programs in particular will carry out the bulk of this work; their advantage is obvious. The CGIAR’s success will be gauged in terms of shaping effective research paradigms which lead to desirable technologies that producers adopt, and in shaping useful research management strategies, the kind others can apply effectively.

**Saving Biodiversity.** A rising portion of CGIAR funding over the next 15 years will be dedicated to saving biodiversity. Among other things, additional resources are needed to improve the CGIAR’s physical facilities to ensure adequate safekeeping of base collections, to add to selected base collections, to expand somewhat the range of species conserved, to investigate and then to decide on a role in *in situ* conservation, and to shore up the capacities, especially managerial, of conservation activities in many national programs. In addition, the CGIAR’s vast storehouse of information on its collections will soon be opened to electronic query via Internet. Many outside the CGIAR will participate fully in these activities, from priority setting to execution.

The next decade or so will see analysis, discussion, debate, and reflection on many issues pertaining to the conservation of biodiversity, involving a myriad of actors, including the CGIAR. [See “CGIAR Genetic Resources and FAO” on page 89.] The strategy pursued by the CGIAR must reflect these exchanges. Through it all, it seems likely that the current intent to commit more resources here will be maintained. To facilitate its work, the CGIAR has established a system-wide initiative in genetic resources, involving all relevant centers and other important players as well.

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The **CGIAR’s success** will be gauged in terms of shaping effective research paradigms which lead to desirable technologies that producers adopt, and in shaping useful research management strategies, the kind others can apply effectively.
**Improving Policy.** CGIAR investment here is scheduled to increase slightly over the next 15 years from its current level of 10 percent. Before deciding to do this, the CGIAR noted that much of the conventional wisdom about policy argues for letting markets work and that such a generic strategy will require ever less research as evidence mounts to demonstrate its efficacy.

Several considerations, however, call for CGIAR work in this field. The first is equity. The CGIAR works on behalf of the poor, and concern for equity might well argue for rebalancing market-based income distributions. The second is the clear possibility that policy measures will be required to induce producers to adopt resource conserving strategies, even though these strategies also increase incomes over the long-term. The third is the need for clearer guidelines for policy research concerned with marginal allocations among an array of international public goods. The fourth is that there are relatively few professionals in developing countries who are sufficiently sensitive to these considerations and trained in articulating clear-cut choices for policymakers.

In addition, but in a category by itself, is the urgent need for research on managing common property so as to avoid what is widely called the “tragedy of the commons.” Many are searching for solutions here and the CGIAR, with its considerable experience on the ground, will be an important participant.

Again, it should be noted that other work goes on in the social sciences as a part of the three preceding thrusts.

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**Reforming Agricultural Markets**

For most developing countries, the past three decades have seen heavy government intervention in agricultural markets. Not only have public interventions been expensive, they have constrained agricultural and rural development rather than fostering it. Many of these governments are now trying to reform their markets. In response, one CGIAR center has developed an ambitious research program focused on reforming agricultural markets in developing countries, particularly in Africa. Projects have been initiated in Ghana, Senegal, Cameroon, Malawi, Tanzania, and Uganda that will design market reform strategies and build the in-country capacity necessary to implement and monitor them. New projects are also being developed for Vietnam, Kyrgyzstan, and the Philippines, and will help to guide policymakers through the reform process. The impact of agricultural market reforms, widely promoted by the international community including CGIAR policy researchers, will be on monetary resources, and agricultural production will be enormous. The CGIAR’s work on such reforms in Bangladesh and Pakistan demonstrated that a US$3 million investment for research and training on market reform can help a government save US$124 million. In Bangladesh, 35 percent of recent increased food production is attributed to market liberalization.

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**Fortifying National Programs.**
The CGIAR will rebalanced the focus of its work in this area. In the past, much effort has gone into training, especially for entry-level national program staff.
The CGIAR is now encouraging the development of regional training programs largely, or ultimately, in the hands of regional or national entities. [See “Regional Training in Crop Management Research” on page 91.] Second, the CGIAR is streamlining its own training programs, especially in Sub-Saharan Africa, which should lead to significant efficiencies. Finally, loans and grants to national programs from bilateral and multilateral sources include larger amounts to defray the costs of training with the result that national funds can be substituted for CGIAR funds. Training still goes on within the CGIAR; it has been scaled down and focused more on mid-career professionals. With these changes in circumstance, there will be some opportunity for scaling back CGIAR financial support in the affected areas.

There is a continuing need for research and training in management and administration. To the extent that research administration and management have common elements across many countries, this activity is characterized by economies of size. It is expected that demands will remain strong for another decade or so, and again there is the possibility of substituting loans for CGIAR funds.

An area of institution building that will increase pertains to information management and communication. Advances in this field have been so notable and cost reductions so dramatic that collaboration is ever more favored and division of labor ever more advantageous. With knowledge-guided collaboration of various kinds increasing at all levels, the need for information management and effective communication can only grow. The CGIAR must ensure that it meets its own require-

ments, which include effective links with all relevant actors, and that it can offer national programs the benefit of its experience.

**Toward 2025**

While what might happen in 2025 is quite uncertain, still the CGIAR has given some thought to that period, if for no other reason than to reflect intentions and to point out some areas of concern and call for an international effort. It is assumed that by 2025 national systems, private and public, will be adequate to meet most internal needs and that there will be regional and ecoregional mechanisms for most transnational research, much of it also resting on collaboration.

The CGIAR will then be a largely collaborative system, primarily discharging its responsibilities through contracts with other research institutions. The principal components of its work will include genetic resource conservation; genetic enhancement (much of it what some call “prebreeding”) of selected plant, livestock, and fish species of transnational or global importance; strategic research on natural resources conservation and management; strategic research on public policy and management issues of global importance; and global information activities related to the research needs of the time. To the extent that its role is catalytic, the CGIAR itself could have significantly fewer staff than it has today.

What ultimately emerges will depend on the scope for research as an international public good—almost certainly smaller than today—and on cost and reliability questions. In that context, the CGIAR’s principal advantages will be in its non-political character, its
It is quite evident that the CGIAR must carefully monitor developments and be responsive to new trends. The evidence of past change encourages confidence about the CGIAR’s capacity for further change and about a culture that sustains change.

CONCLUSIONS

The evolution of the CGIAR research agenda described here rests directly on several assumptions. The most important of these relate to (i) the strength of national programs and participation by the private sector, (ii) what happens in science, (iii) changes in the policies, laws, and institutions that influence markets and contracts, and (iv) the concerns of the development assistance community. Other forces will also be at play, but these appear to have the largest consequences for the CGIAR’s work.

While all projections are uncertain, some are more so than others. In this case, the third and fourth assumptions on which these projections rest seem to be more certain calls than the others. In any case, it is quite evident that the CGIAR must carefully monitor developments and be responsive to new trends. The evidence of past change encourages confidence about the CGIAR’s capacity for further change and about a culture that sustains change.

As for the first two considerations, what if national programs do not progress as projected, or what if the promise of, for example, biotechnology, is not realized on the currently anticipated schedule? With very fragile boundaries separating the prophets of plenty and the prophets of doom, falling behind in these critical areas can only tip the balance one way. In particular, if developing country governments fail to strengthen their agricultural research programs, the CGIAR would be obliged to compromise on its comparative advantage. As in the past, more resources would go directly into technology development. It would revert to its role of the 1970s and 1980s rather than the international strategic role predicted for it once NARS were strong.

One final consideration is important to note. In a world so filled with uncertainty, where the consequences of limited food production are so prejudicial to the goals of the global community, why not reinforce research for agriculture, fisheries, livestock, and forestry? Prudence alone would favor this strategy. At the very least, two substantive gains would follow—ever lower real prices for foodstuffs (with all that implies) and ever stronger protection for the environment than will otherwise emerge.
Renewal of the CGIAR:
Sustainable Agriculture for Food Security
in Developing Countries

Improving the CGIAR's Governance
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Improving the CGIAR's Governance

This document outlines the areas in which the CGIAR proposes to reform its governance arrangements. It is divided into four sections. The first two provide background information on the CGIAR's organizational structure and governance principles. The proposed changes in governance are summarized in the third section. The fourth section draws conclusions from the changes outlined about the CGIAR's future governance.

BACKGROUND

The CGIAR has no constitution, by-laws, or written rules of procedure. It reaches its decisions by consensus. It has no direct authority over the international centers under its umbrella because each center is a separate, autonomous institution with its own legal make-up, board of trustees, and management. Each CGIAR donor decides independently the contributions it wishes to make to which centers or programs. Collectively, however, the CGIAR "System" [see System Components below] attempts to fulfill research priorities established through technical analyses of needs.

The CGIAR meets twice a year, in May and October. The May meeting, also called the Mid-Term Meeting, is usually held in a country that has offered to host it. Recent meetings have been held in Australia, Canada, France, Germany, India, the Netherlands, Puerto Rico, and Turkey. The October meeting is held in Washington, D.C. and is attended by delegations of CGIAR members, CGIAR centers, non-CGIAR centers, and other observers, including those from environmental groups and other members of the NGO community. Until recent years a large portion of the October meeting was devoted to presentations by the centers on their programs, budgets, and strategic plans. Hence, the meeting is known as International Centers Week. This is the Group's principal business meeting.

System Components

The CGIAR system is made up of four major components:

1. **The Consultative Group.** Members of this group are the Chairman, cosponsors (the World Bank, FAO, and UNDP), other donors, and non-donor representatives from developing countries elected for fixed terms through FAO's regional conferences. The World Bank provides the CGIAR System with its Chairman and Secretariat, in addition to an annual financial contribution. Decisionmaking is facilitated by a Steering Committee, chaired by the CGIAR Chairman and composed of the membership of the two donor standing committees (the Oversight Committee and the Finance Committee), which were established in May 1993. The CGIAR also establishes "ad hoc" committees or cross-system "working groups" as necessary (such as the Committee on Plant Genetic Resources established at International Centers Week 1994).

2. **International Agricultural Research Centers.** As of January 1, 1995, all but three of the sixteen...
The CGIAR is governed by the principles established at its inception in 1971: non-political operation strengthened by independent technical advice, donor sovereignty, center autonomy, and informality and flexibility in operations.

3. **Partners.** NARS of developing countries are both principal clients and close collaborators of the centers. Other partners include advanced research institutions in industrial countries, universities, and NGOs.

4. **Central Advisory and Support Structure.** The CGIAR System is advised and supported by TAC and by the CGIAR Secretariat. TAC is made up of a number (currently 14) of distinguished scientists and science managers from around the world. Although TAC members are selected in their personal capacities, usually half come from developing and half from industrial countries. The TAC Chair and members are nominated by the cosponsors. TAC has its own secretariat housed at FAO in Rome. Major system-wide functions, such as planning and priority setting, resource mobilization, resource allocation, evaluation, public information, and external relations, are carried out by or with input from TAC and the CGIAR Secretariat.

**PRINCIPLES**

The CGIAR is governed by the principles established at its inception in 1971: non-political operation strengthened by independent technical advice, donor sovereignty, center autonomy, and informality and flexibility in operations. The System's success and rapid growth is proof that there is much merit to these principles. The CGIAR has reaffirmed its strong support for them in its discussions of governance and decision-making issues throughout its history.

**Non-political Operation**

The non-political nature of the CGIAR and the fact that it is advised by a TAC, made up of experts serving in their personal capacities, have always been seen as strong assets by most observers of the CGIAR. The independent international centers have focused on their research mission and donors have supported that mission without reference to the changing politics of host countries.

In the early years of the CGIAR, the System's focus was on using science to find ways to increase food production; the centers were less involved with politically-laden issues. The changes in the debate on development and poverty and the increased emphasis on germplasm conservation and intellectual property rights have introduced more value-laden and sensitive issues in the activities of the CGIAR. The CGIAR-financed research agenda now includes themes that exceed the traditional area of agriculture and food
production and which relate more directly to values and political priorities. This has led some to ask whether, or to what extent, the CGIAR should continue to be completely non-political.

The CGIAR has been consistently firm in its answer to this question: the System's strength lies in its scientific excellence and dedication to produce relevant research results in the form of international public goods. In the future, it plans to continue playing a scientific leadership role in the international arena by making scientific contributions to the resolution of policy questions, without reference to the political positions of donors or host countries. The fact that it reaches its decisions after considering the advice of a nonpolitical scientific and technical committee increases the CGIAR's credibility and effectiveness as an instrument for promoting long-term sustainable development.

Although CGIAR research is conducted by autonomous centers, this research is part and parcel of a CGIAR-wide portfolio of activities that are geared toward attaining a broader mission. TAC advises the CGIAR both on the broader priorities for the System, as well as on the value and contribution of each center.

If sovereign donors were to fund activities of autonomous centers through an informal consultation process but without any system-wide guidance from TAC, it would be difficult to maintain the requisite commitment to important but long-term issues. Some popular research activities might be oversubscribed by donors and some centers might have to discontinue their research on long-term issues because of a lack of sufficient and sustained donor support. Some globally important programs geared toward generating international public goods may not be feasible if a lack of sustained support makes it impossible to maintain the minimum critical mass of scientists needed to implement them. TAC's advice influences donor funding decisions and the allocation of the contributions from the World Bank, which serves as a "balancing donor."

In sum, rigorous scientific analysis pervades all aspects of the CGIAR's operations—from the work of the bench scientist to the deliberations of the Group. Although the political preferences of donors are reflected in some individual donor funding decisions, and thereby influence some of this work, these are minimized by seeking a group consensus on the objectives of the research activities and on the balance between activities. The main principle is not to compromise the CGIAR's commitment to impartial, scientific analysis.

**Donor Sovereignty**

Another characteristic that makes the CGIAR an attractive option for investing in development is that, by and large, each donor is free to choose the level and composition of its contributions to the centers and the programs they implement. The financial relations between donors and centers are bilateral; donors send their contributions directly to each center (with the exception of a few who use the Secretariat as a disbursing agent). There is no common pool into which donors are required to contribute, nor is there a burden sharing formula for funding.

Naturally there are some bounds to donor sovereignty. By their willingness to become CGIAR members do-
Another characteristic that makes the CGIAR an attractive option for investing in development is that, by and large, each donor is free to choose the level and composition of its contributions to the centers and the programs they implement.

Center Autonomy

Like donors, the centers are sovereign and make individual choices. First, they are sovereign in the sense that each is an autonomous legal entity. Second, each has an independent governing board, with members serving in their individual capacities. Although about one-fourth of each center’s board members are nominated by or in consultation with the CGIAR, these members also serve in their personal capacities, not as CGIAR representatives. Third, each center formulates its own goals and strategies independently, but in light of signals received from donors and TAC. In this regard, for example, centers usually present their strategic plans to TAC and the CGIAR for comment, but not for approval; boards have the ultimate authority to approve center strategies.

It is true that each center exists at the pleasure of the donors, collectively. This simply means that each center would continue to exist so long as it maintains a program of sufficient interest to donors and has a good record of accomplishment. Therefore, in formulating their goals and priorities, the centers pay close attention both to the changing interests and priorities of individual donors as well as to the priorities of the System as a whole.

Supporting a group of autonomous centers is a reflection of the donors’ belief that the decentralized management of the CGIAR is more efficient than a centralized, hierarchical operation would be. This was confirmed recently at the May 1994 meeting in New Delhi, where several restructuring options formulated by the CGIAR Oversight Committee were discussed. These included, for example, centralizing CGIAR operations under a single or very few boards. The CGIAR saw merit in continuing with the present arrangement, where the CGIAR provides each center with its overall mandate, but does not get involved in the management of research, which is left to each center’s own board. Such a decentralized operation delegates power to managers of science. This is a more effective arrangement because managers are close to the problems. Thus they are better able to generate a work environment that is conducive to creativity and innovation on the part of the individual scientist than is an operation managed from a distance, which may carry the risk of introducing re-
strictions that might jeopardize the work environment.

The CGIAR balances the autonomy granted to the centers with a strong system of accountability. A cornerstone of this system is the program and management reviews of centers conducted through external panels of experts every five years. Commissioned jointly by TAC and the CGIAR Secretariat, external reviews provide the donors and other stakeholders with information about the overall quality and relevance of each center's activities, its past and likely future impact, and how effectively it is managed. In addition, there are TAC-commissioned inter-center reviews of programs and subjects of system-wide interest (such as genetic resources, rice research, and training).

**Informality and Flexibility**

The CGIAR deliberation and decisionmaking processes are informal, which stems, in part, from not having been constituted as a formal organization. All agenda items are discussed by the “committee of the whole,” although previous work by the standing and ad hoc committees shortens and facilitates this discussion. As noted earlier, the CGIAR reaches its decisions by consensus. No votes are taken. “Stakeholder group” meetings and “heads of delegation” sessions lead to frank exchanges. All members have equal status at the meetings, regardless of their level or nature of funding. The informal processes used favor a personalized style of operation to influence decisions or generate consensus. They also demand absolute impartiality from the Chairman.

The cosponsors also meet informally and there are informal meetings among subgroups of donors. For example, European and North American donors meet occasionally to consult colleagues from the same continent about CGIAR business.

There is also frequent informal interaction among centers. There is a Center Directors Committee, which started as an informal gathering of center directors, but is now structured more formally for handling programmatic and administrative issues common to the centers. There is a similar committee at the level of center boards, called the Committee of Board Chairs, which meets less frequently and operates more informally than the Center Directors Committee. Both the Committee of Board Chairs and the Center Directors Committee report to the CGIAR annually on their deliberations.

**PROPOSED CHANGES IN GOVERNANCE**

Ways to improve the CGIAR’s governance and its decisionmaking processes have been on the Group’s agenda at every meeting for the last several years. Several changes, including the establishment of two standing committees, were introduced in 1993, following the work of an ad hoc working group on deliberation and decisionmaking processes. One of these, the Oversight Committee, carried out further work on the governance and organization of the System. Its recommendations led to reaffirmation by the CGIAR at the May 1994 meeting of the basic governance principles noted above and of the System’s continuing need for TAC as an institution.
Most recently, the CGIAR Chairman commissioned a Study Panel to make recommendations on the CGIAR's long-term governance and financing structure. The Panel's recommendations were discussed and broadly endorsed by the CGIAR at the October 1994 meeting for consideration by the Lucerne Ministerial-Level Meeting. They form the bases of the proposed improvements in the CGIAR's governance.

The proposed changes in governance aim at achieving the following objectives:
- enhancing the CGIAR's contributions to research agenda setting at the global level;
- increasing the ownership of the CGIAR System by developing countries;
- improving the efficiency of the CGIAR's decisionmaking processes;
- improving research agenda setting within the CGIAR;
- strengthening the evaluation of the CGIAR's impact; and
- promoting a program orientation and new research partnership modes.

Changes proposed in each of these areas are discussed below.

Research Agenda Setting at the Global Level

Agenda setting at the global level is not the responsibility of any one actor. Rather, agendas are set through the often independent actions of a host of actors. In this sense, the global research agenda is set through a marketplace for research where various actors carry out research depending on their assessment of research needs and the availability of funds and other resources. The term "agenda setting" at the global level is, therefore, a misnomer, as the global agenda is more an outcome of independent actions by multiple actors than the result of deliberate action by a few. Having said this, it is also clear that facilitating the exchange of information among the actors in the global research arena can help each actor, including the CGIAR, make more informed decisions about its research agenda and contribute to greater collaboration among the actors.

The CGIAR is an important but small actor in the international agricultural research arena, accounting for less than 2 percent of global public expenditures on agricultural research. At times the CGIAR has had significant influence on the global research agenda and that of other actors without ever dealing directly with global priorities. There are other actors, such as FAO and research systems and bodies in several industrial countries. In addition, many universities in industrial countries and some in developing countries are specializing in problems of tropical agriculture and agricultural development. Finally, national and regional agricultural research institutions and NGOs are playing stronger roles as leaders of, or partners in, international agricultural research efforts.

Thus the institutional landscape for international agricultural research has been widening and becoming more complex. However, there is no global scientific forum where global research agenda issues are discussed with the participation of the major actors. True,

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2 This covers public expenditures on agricultural research by both developing and developed countries.
the CGIAR serves partly as one such forum, but in the final analysis it is interested more in the research agenda of its own operations than in the global research agenda. This is in part because the present CGIAR forum does not incorporate all the major actors that would be needed for discussion of global agenda issues. It is also because it would not be efficient to discuss, within the same forum, both business issues concerning only the CGIAR and global research agenda issues concerning a much larger group.

The CGIAR, with the resources of its members and the scientific capacity of its centers, has the strength and competence to play a stronger catalytic role in facilitating agenda setting at the global level. In the past the CGIAR has been relatively inward-looking in its approach to global agenda issues. This stance will need to change in the future. This means that the CGIAR could assume additional responsibilities in facilitating discussion of global research agenda issues by all key actors. Were the CGIAR to assume such a role, the new forum that would be initiated for discussion of global research agenda questions would also enable the CGIAR to subject its own planned agenda to the scrutiny of other actors. The same opportunity would be available to other key actors as well.

The Group agreed at the October 1994 meeting that, with the support of its cosponsors, the CGIAR could play a catalytic leadership role in agenda setting by organizing a Global Forum on Agricultural Research for Development. The forum would include all actors involved with such research and would aim to:

- identify problems, describe progress, and establish needs for international agricultural research;
- assess and clarify global priorities;
- suggest roles for various actors; and
- explore ways to strengthen alliances and partnerships.

The Global Forum would meet once every 3 to 5 years. Although the timing within a particular calendar year could be variable, organizing it following the discussions at that year's International Centers Week would enable the results of the forum to be considered at the intra-CGIAR agenda setting discussions of TAC in March and the CGIAR in May.

The forum would consist of representatives of governments, international organizations, donor agencies, NGOs, and research institutions, including NARS and CGIAR centers, all of which would participate on an equal basis. Each participating institution would cover its own costs, although donors might wish to make arrangements to facilitate the participation of some developing country institutions.

TAC would serve as advisor to the forum. TAC's analysis of global priorities could form the agenda for the forum in some years. Agendas in other years could focus on one or more research themes of international significance.

Regional Forums that meet the needs and interests of each region, and which are coordinated with existing similar efforts, could be a valuable complement to the Global Forum. These forums could be organized under the auspices of the cosponsors and regional organizations. It would also be desirable for CGIAR members with interests and capacity in a region (such as the regional development banks and the regional arms of global institutions) to take the lead in organizing these fo-
Scientists and managers from developing countries have been deeply involved from the beginning of the CGIAR as members of boards of trustees, scientists at the centers, and members of TAC and other committees.

Regional forums would aim to:

- identify regional problems and needs for international research programs;
- clarify regional priorities and the roles of actors (including the CGIAR centers and NARS);
- explore ways of strengthening alliances and partnerships; and
- recommend policies.

The Regional Forums would meet on an as needed basis. Existing organizations and forums, such as the Special Program for African Agricultural Research (SPAAR), could be closely linked with, or serve as a substitute for, CGIAR forums. This would strengthen links between the CGIAR and other donor initiatives like SPAAR.

Ownership of the System

The CGIAR was originally a group of donor representatives who decided to meet annually in the form of a “consultative group,” collectively supporting research to increase food production in developing countries. This image of the CGIAR being a “club of donors” still exists, although developing countries have begun to be increasingly involved as donors/funders. Scientists and managers from developing countries have, however, been deeply involved from the beginning of the CGIAR as members of boards of trustees, scientists at the centers, and members of TAC and other committees. There is a growing sentiment within the CGIAR that, in the future, the need for increased collaboration among various actors would necessitate broadening the “club” to more directly incorporate the concerns of “users.”

The issue of representation and participation by developing countries within the CGIAR should be seen at two different levels:

1. At the technical and scientific level the need is to mobilize more human talent, resources, and specific knowledge which exists in developing countries, and to promote a greater sense of partnership and ownership of CGIAR activities by developing countries.

2. At the broad policy level the need is to secure political support for the System by developing countries (essential for the continued funding and long-term viability of the System), which demands the wider involvement of developing countries in the setting of priorities and identifying long-term needs.

As noted earlier, the proposed global and regional forums would have some influence on CGIAR agenda setting and policy formulation, and would enhance to some degree the participation of developing countries in that process. However, the CGIAR needs to take additional measures to enhance developing country participation within its own business forum.

The CGIAR proposes three new steps in this regard:

1. Countries hosting the headquarters of CGIAR centers could be invited to become members of the CGIAR if they are not already.

2. Through high-level contacts, efforts can be intensified to encourage other beneficiary developing countries to become members.
3. Under exceptional cases, groups of countries, such as small countries and island states, could be allowed to pool their resources to meet the minimum contribution requirement and have a single membership in the CGIAR.

Over time, these steps are likely to increase developing country ownership of the CGIAR. When the voice of developing country members making financial contributions to the System increases appreciably within the CGIAR business forum, there will be significantly higher credibility for the CGIAR’s responsiveness to the needs of developing countries.

The CGIAR’s Decisionmaking Structure

Two aspects of decisionmaking have been recently reviewed by the CGIAR. One concerns the CGIAR’s legal status as an organization, and the other its structure and processes for conducting business.

Legal status. As noted earlier, the informality of the Group has been a great asset for efficiency and stimulating discussion. At the New Delhi meeting the CGIAR reaffirmed the importance it attaches to collegiality and informality in its deliberations. However, some members of the Group believe that it would be better for the CGIAR to constitute itself as a formal international organization to enhance its ability to:

- play a strong leadership role in the international arena;
- speak authoritatively and with one voice for the System as a whole;
- enter into formal agreements with other organizations; and
- adhere to a commonly agreed upon set of decision rules in its work procedures.

A recent analysis of issues involved in establishing the CGIAR as an international organization, conducted as background to the work of the Study Panel on Governance and Finance, argues that formalizing the CGIAR is not necessarily the right answer to these concerns because they can be addressed efficiently under the CGIAR’s current, informal framework. Based on this analysis, the CGIAR proposes not to seek to be established as an international organization. Collegiality and informality are valued CGIAR traits. They are much admired by other international organizations, and the CGIAR wishes to preserve them to the extent possible. However, this view reflects issues and concerns faced today, which the current informal framework is able to address adequately, with the cooperation of the centers and other components of the System. The question of establishing the CGIAR as an international organization could be re-opened if there are compelling reasons to do so.

Decisionmaking structure. The business forum of the CGIAR, i.e., the Consultative Group itself, is constituted of:

- cosponsors;
- representatives from developing countries; and
- countries or institutions from industrial and developing countries that finance activities within the CGIAR’s approved agenda through annual cash contributions above a fixed minimum level (presently at US$500,000 a year).

The CGIAR proposes that, to remain as members, all donors should...
Including UNEP among its cosponsors would signal the importance the CGIAR attaches to addressing environmental issues.

satisfy the System's required minimum contribution.

The CGIAR also proposes that it should not delegate powers to an executive committee to act for it in between meetings. This sentiment was made clear at both 1994 meetings (in New Delhi and Washington, D.C.) during the discussion of the reports of the Oversight Committee and the Study Panel on Governance and Finance.

Thus decisionmaking powers would continue to reside in the CGIAR's committee of the whole, which would be aided in this task by preparatory work by the Steering Committee and subcommittees. The two standing committees (Oversight and Finance) would continue to assist the CGIAR's decisionmaking in their respective areas. Ad hoc committees and working groups would be established as needed. An Ad Hoc Evaluation Committee was established at the October 1994 meeting to handle two evaluation related items on the agenda, which by all accounts was a quite successful experiment. Another ad hoc committee (on the CGIAR's research agenda) also helped to advance thinking and speed decision-making by the plenary.

While these proposed changes are only marginal, important changes in two areas could further improve CGIAR decisionmaking. One of these is structural, the other relates to the CGIAR's decision processes. First, the CGIAR could invite UNEP, which has been a member of the CGIAR since 1974, to join the cosponsors group (which currently consists of the World Bank, FAO, and UNDP). Including UNEP among its cosponsors would signal the importance the CGIAR attaches to addressing environmental issues. The sponsorship of the CGIAR by these four international organizations would give the Group greater international legitimacy, particularly when it has no formal status of its own.

Second, the CGIAR proposes to continue its two-meetings-a-year format, with some modifications. The most important modification would be in the agenda of the Mid-Term Meeting. In essence, the May meeting would gain in significance because it would be at this meeting that the CGIAR would agree on the research agenda and financing plan for the following year, leaving the period between the May and October meetings for negotiations with donors on the financing of the agreed upon agenda. The November to December period should be used to position the centers for starting the new year with a clear work program and budget. In this scheme, the October (and larger) meeting would spend more time on the reports of ongoing research, exchanges of ideas, and setting the directions for the next agenda to be discussed and approved at the next May meeting.

Agenda Setting in the CGIAR

Agenda setting within the CGIAR involves the determination of programs that should be supported by the CGIAR (i.e., system level planning and priority setting) and the identification of specific programs and projects that should be implemented by each center (center level planning and priority setting). TAC plays a critical role in this process and in monitoring the implementation of the agreed upon programs. The process is both bottom-up and top-down. Center input is received
at various stages in the process, as is input from donors. TAC’s analysis of global research needs provides a broad, macro-priorities perspective within which individual center needs are examined.

Despite improvements made in recent years, the process for setting the CGIAR research agenda can be further improved. Doing so will make the CGIAR more effective. Improvements are needed in the transparency of the process, in participation by developing countries, and in the evidence that the primary goals of the CGIAR are being pursued efficiently.

To enhance transparency in agenda setting, a first step will be to broaden consensus about the primary goals of poverty alleviation, food security, and protecting the environment. For example, whose poverty is of most concern, that of rural people only or of both the rural and urban? Are all levels of poverty of equal concern? For example, how much more weight should be given to the desperately poor than to the evidently poor? Also required is a sharper sense of the relative importance of each goal. Answers here will come from discussion of these issues in global and regional forums as well as within the CGIAR. Although such discussion may not yield a consensus, it nevertheless would help to clarify the rationale for the diversity in views.

With the goals made more specific, TAC, the centers, and others will more effectively set priorities among the many potential activities undertaken by the System. All those involved will want to make explicit their assumptions about other critical elements in the decisionmaking process, e.g., other suppliers and the probability of success. Some part of priority setting will involve rigorous analysis and some part will require making judgment calls; care will be taken to report which is being employed. This done, recommendations will be more easily linked to goals.

Participation by developing countries has important implications for agenda setting within the CGIAR, and additional implications for other aspects, such as funding. Participation by developing countries in the CGIAR’s agenda setting processes—such as through increased membership in the CGIAR’s business forum—will strengthen the identification of high-priority problems, provide a more accurate sense of alternative sources of supply for the products needed, and yield better estimates of the probabilities of success. Beyond this, increased participation will foster more effective collaboration among NARS and centers.

Evidence of efficiency in pursuing the System’s primary goals lies first in demonstrating that, through its activities, the System has had significant and timely impact on the lives of the poor or on critical environments. [See below for the steps planned to strengthen the evaluation function.] While impact studies reveal most about work done in the past, they also suggest possibilities for the future because of what past impact implies about the quality of staff, the supporting infrastructure, and the culture which guides the energies involved. Obviously, reasonable amounts of time must pass before significant impact can be expected. In the interim, donors and clients can be reassured about efficiency through systematic monitoring of the quality and

The process for setting the CGIAR research agenda can be further improved. Doing so will make the CGIAR more effective. Improvements are needed in the transparency of the process, in participation by developing countries, and in the evidence that the primary goals of the CGIAR are being pursued efficiently.
Impact Evaluation

Future support for the CGIAR and its centers will depend on the ability of the centers and the System to demonstrate their effectiveness and impact. Strengthening the evaluation function is imperative for the continued credibility of the System as a whole as well as the individual centers.

Effectiveness is defined here as the ability of the System to produce relevant information and technology (high-quality outputs) in a timely and cost-effective way (efficiency or value for money). Impact, on the other hand, is measured by outcome; i.e., the difference research products have made to production, poverty alleviation, biodiversity, environment, and other development objectives. Outputs can be specified and measured as they occur; impact is often assessed at a different location and time.

Effectiveness is very much under the control of the CGIAR and its centers, while impact is more dependent on external factors, i.e., on partners in NARS and extension systems in developing countries, as well as the private sector, NGOs, and farmers’ groups. However, the CGIAR recognizes it will increasingly need to understand and interact with these external partners in order to remain effective and sustain its leading position and international standing. Thus the CGIAR intends to:

- continue to strengthen its skills in policy formulation, and its understanding of social concerns and development issues and problems;
- represent itself at international debates and be responsive to international concerns and plans of action; and
- develop credible output and performance measures and evaluation systems.

There is a considerable amount of literature available within the CGIAR and elsewhere on factors which influence the effectiveness and impact of research. These factors include: clear identification of beneficiaries and their involvement in research planning and implementation; establishing well-articulated objectives on researchable problems; employing an interdisciplinary approach; effective dissemination of results in an accessible format; engaging in purposeful partnerships; and managing resources efficiently.

The current system of external program and management reviews, together with the quality control and priority setting functions of TAC and the organizational and financial scrutiny of the Secretariat, have served the CGIAR well. They have been responsive to the changing and sometimes divergent needs of the CGIAR. They have sustained “confidence” within the donor community, but the System is oriented primarily toward center-based activities.

The movement toward a matrix approach with system-wide programs that involve several centers and other
partners will require a different system of direction, efficiency assurance, and impact assessment. It will also provide an opportunity to review the roles, division of labor, and responsibilities among players in the CGIAR.

It will be in the centers’ interest to demonstrate their effectiveness and efficiency in the use of resources and in sustaining their comparative advantage by working with their partners. It will be in the donors’ interest to demonstrate that the System makes effective use of its resources and that it has a positive impact on development processes. The CGIAR System will need, therefore, to take a greater interest in the design and implementation of programs, in the incorporation, utilization, and dissemination of outputs, and in the evaluation of the impact of the System’s products. There have been periodic evaluations of the impact of the CGIAR’s activities, but they have tended to be ad hoc and system-driven.

For the reasons outlined above, the CGIAR proposes to mount a new system-wide effort to put in place systematic and continuous processes for impact assessment to supplement the existing processes for reviewing the program and management performance of the centers. Establishment of a new CGIAR evaluation unit is proposed as the focal point of this effort. This unit would have an independent status and would report to the CGIAR, and between meetings to the Chairman. Possible locations are being studied by the Secretariat. The funding for such a unit should be covered by the cosponsors, although donor contributions to the activities of the unit would also be welcome (similar to the arrangement for IAC).

**Program Orientation and New Research Partnership Modes**

Throughout its history the CGIAR has relied on a set of “international centers of excellence” for carrying out its programs. Introduction of new CGIAR programs has been either through the addition of new centers or the expansion of the mandates of existing centers. In general, “the centers” have been at the forefront, and “the programs” in the background.

While this mode of operation has served the System well in the past, the future calls for much greater collaboration among research actors. This is in part because no single institution has all the competencies needed to address increasingly complex problems. Also new approaches to research demand greater collaboration and participation among a larger number of actors.

The axes of new collaboration would be international research problems and programs of common interest. This would require giving greater prominence to programs that are on the CGIAR’s research agenda by moving them from the shadow of the centers. This would provide them with an identity separable from that of the centers. Initiation of program funding (to complement funding of centers) would help inter-center programs strengthen their identities. [See Background Document on Finance.] A research agenda defined in terms of programs would also help foster new research partnerships.

Partnerships could be a strong asset for and a vehicle to improve the relevance and ownership of research activities; facilitate incorporation, utilization, and dissemination, and hence impact, of the results; enhance partici-
The CGIAR intends to provide incentives for the formation of productive partnerships—including those among the CGIAR centers—and to adjust its funding systems to facilitate these collaborative modes of working. The objective must be for the CGIAR to become more outward-looking in its mode of operation and accountable to a wider constituency through partnerships.

The centers currently form partnerships with a wide range of bodies: other centers, developed and developing country research institutions, universities, NGOs, United Nations bodies, and the private and commercial sectors. The CGIAR recognizes that, in forming consortia or other collaborative links, it is necessary to ensure that there are clear objectives and responsibilities, and that intellectual property issues are considered and clarified at the outset.

The CGIAR intends to provide incentives for the formation of productive partnerships—including those among CGIAR centers—and to adjust its funding systems to facilitate these collaborative modes of working. Consortia and partnerships need to be built on the win-win principle, and must avoid the danger of forming inward-looking "cartels." The objective must be for the CGIAR to become more outward-looking in its mode of operation and accountable to a wider constituency through partnerships.

Effective coordination of programs involving several partners will present a fresh challenge—and a learning opportunity—to the System. Identifying an appropriate program coordination model will require consideration of issues such as:

- means to ensure all participants, centers, and others that their needs are considered on an equal basis with those of the managing entity;
- evaluating program collaboration costs and the means for ensuring that partners are compensated for costs, except those they agree to meet themselves;
- identifying relatively low-cost and effective means of integrating activities within programs;
- creating incentive systems to encourage participating researchers to value the total enterprise above their personal interests or those of their own organizations; and
- ensuring that there is clear leadership responsibility and accountability for the program.

**CONCLUSIONS**

The CGIAR's governance model has been effective in the past. A remarkable feature of this framework is how it facilitates consensus building and decisionmaking informally in an environment of multiple groups of autonomous actors. The CGIAR model works because participants are committed to its cause. The depth of their commitment enables them to make the necessary effort to reach a consensus. A consensus is possible because the proposals are based on sound, impartial analysis.

The most recent reviews of the CGIAR's governance have concluded that the model and its underlying principles are sound and relevant, although some adjustments can be made to enable the CGIAR to play a stronger catalytic role in the global agricultural research arena.

The most important of these adjustments is attitudinal, turning the CGIAR from an inward-looking to an
outward-looking institution. The CGIAR has strong analytical capacity on questions of international agricultural research. This is a global asset and can and should be used more widely. Also, the CGIAR institutions—which have traditionally concerned themselves primarily with research problems mandated to them, linking with outside partners only when necessary—can and should conduct their mandated research in greater partnership with other actors. The proposed global and regional forums on agricultural research would help foster a more outward-looking stance for the CGIAR and its institutions.

A second adjustment is a shift in the sense of ownership of the System. The CGIAR will break the image of being a “club of donors” when the voices of the beneficiary countries begin to be heard more loudly in the CGIAR business forum.

Practically all of the developing countries which are major beneficiaries of the CGIAR’s work are in a position to contribute financially, and at much higher levels than the current required minimum of US$500,000 a year, as demonstrated by the Government of Colombia which joined the CGIAR earlier this year. When these countries feel a strong sense of CGIAR ownership, they will make sure that its research agenda is more responsive to their needs and that the needed research is conducted in full partnership with the research institutions in their countries.

A third adjustment is a renewed push for greater efficiency and transparency and stronger accountability throughout the System. The changes already initiated in the direction of greater program orientation will bring with it greater transparency. Impact assessments conducted by the proposed evaluation unit will foster a stronger sense of accountability for the centers and the CGIAR. The proposed changes in decisionmaking structures and processes and in research agenda setting are likely to increase the System’s overall efficiency.

Finally, having UNEP as a co-sponsor would further the emphasis being given to sustainable development in the CGIAR’s work and would strengthen the international character of the CGIAR.

With these adjustments in governance, the CGIAR will be better positioned to address the research challenges of tomorrow with renewed commitment and vigor.
Renewal of the CGIAR: Sustainable Agriculture for Food Security in Developing Countries

New Financing Arrangements for the CGIAR: Re-engineering the Planning, Budgeting, and Funding Systems
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New Financing Arrangement for the CGIAR: Re-Engineering the Planning, Budgeting, and Funding Systems

INTRODUCTION

The CGIAR is an informal association whose membership is open to any government, agency, or organization, public or private, that is willing to provide financial support to its goals on a sustained basis.

The CGIAR was established through cooperation between the philanthropic private sector (the Ford and Rockefeller Foundations in the United States) and the international community (represented by governments as well as international agencies). The reasons for the involvement of the international community are:

- CGIAR research is aimed at benefiting the poor in developing countries. The CGIAR's research products are in the public domain to ensure that researchers and farmers in developing countries can have free access to them.
- The research undertaking requires genuine international cooperation to ensure that researchers can collaborate across national borders and have unhindered access to germplasm from different environments.

The CGIAR's financial operations are governed by the following precepts:

- The CGIAR agrees, as a group, to a common research agenda, based on advice from TAC.
- The agreed agenda is derived from research proposals presented by the sixteen CGIAR centers, which are legally independent entities.
- The member donors directly fund research activities of the individual centers of their choice, according to their own policies and priorities.

These precepts have accomplished two fundamental goals: (i) they have fostered an entrepreneurial environment for researchers that has been responsible for the CGIAR's successes, and (ii) they have given the donors an unmatched level of transparency and accountability for their funding.

Although the overall level of resources available to the CGIAR has remained remarkably robust despite the cutbacks in aid (evidenced by the 10 percent drop in overseas development assistance in 1993), the CGIAR faced a financial crisis in 1994. At the start of 1994, the CGIAR was faced with a US$30 million shortfall on its basic research agenda of US$270 million.

To resolve this financial crisis, the CGIAR embarked on a program to reform its governance and financing arrangements. The short-term component of the reform program, a financial stabilization program for 1994 to 1995, co-financed by the World Bank, has been successful in leading to full and stable funding in 1994 and 1995. The longer-term component of the reform program is a major re-engineering of the CGIAR's financing arrangements. This phase involves a sharper focus on the CGIAR's agreed research agenda, an explicit link to the global development agenda, and a clearer identification of the CGIAR's
The CGIAR should continue to focus on research which generates international public goods, leaving to the private sector what it does best, and to national institutes what is strictly national in orientation.

Guiding Principles

The financing strategy for the CGIAR recognizes the increasing limits on development assistance. However, it is premised on continuing development assistance support for two sound reasons.

1. The CGIAR has an outstanding track record. Studies conducted in many parts of the world and by different actors have confirmed that the CGIAR is one of the best investments in terms of returns. In relation to the largely troubled record of agricultural investments by international agencies as well as bilateral donors, the CGIAR is notable for consistently returning to humanity benefits far in excess of initial investments.

2. The CGIAR contributes to the development agenda. CGIAR products, by leading to cheaper and more food while conserving the environment, have a direct impact on the development goals of poverty reduction and natural resources conservation.

The re-engineering program reflects the following principles:

- The CGIAR should continue to focus on research which generates international public goods, leaving to the private sector what it does best, and to national institutes what is strictly national in orientation. The CGIAR should promote research networking and partnerships, and not seek to commercialize its outputs as a source of funding for the System.

- The CGIAR is an international enterprise with global benefits accruing from its research and, therefore, should be supported multilaterally.

- Multi-year support is essential to guarantee that CGIAR researchers working on priority long-term programs have stable funding over the minimum of 8 to 10 years required to develop new research products.

- Equal participation and joint ownership must replace outdated concepts of “donors” and “recipients.” In this environment, more developing countries should contribute financially and participate fully in decisionmaking, thus becoming “owners” of the CGIAR.

Underlying Premises

The following premises underpin the proposed reforms:

- The agreed research agenda, defined by the needs of research partners and other beneficiaries in the developing world, remains the central focus of the CGIAR. In the past, donors could allocate their resources without reference to the research agenda to which they agreed. Now, full funding of the common agenda is the priority for
donors, collectively and individually. The agreed research agenda should drive the budget of the individual centers, not vice versa.

- Donor autonomy and center independence remain the principles guiding CGIAR governance. Donors may select what part of the agreed agenda they wish to support and how they wish to do so. Center boards and management have the responsibility and authority to manage the programs of research within their mandate.

- The CGIAR must retain its flexible funding arrangements, which allow donors to provide unrestricted support to centers, restricted support to discrete components of center programs, or a combination of both approaches.

**THE PROGRAM STRUCTURE**

The key concept behind the re-engineering is a matrix framework for planning and financing CGIAR activities.

**Defining the Agenda at the Global Level**

At the global level, the framework will identify the linkages between the work of the CGIAR and that of other actors in the international agricultural research community relevant to developing countries. This will sharpen the CGIAR’s focus in the design of center programs and the agreed research agenda. [See Table 1, page 130.]

The global programs will be expressed as common themes; the cells in the table will be cohesive sets of research activities with timed objectives, expected outputs, and cost requirements. The new structure will illustrate, in both qualitative and quantitative terms, how the CGIAR contribution (modest in the broad perspective) plays a catalytic role as a bridge among other research entities. It will also identify more clearly the contribution of research to the global development agenda. Using the matrix framework in the CGIAR’s priority setting processes, the CGIAR will be able to delineate its position in the international agricultural community, based on factors such as identified knowledge gaps, the CGIAR’s comparative advantage in particular research activities, and its role in ensuring the international public goods nature of its research products.

**Executing the Agenda at the CGIAR Level**

To ensure effective management, the CGIAR’s revised program and financial structure must facilitate the allocation of donor contributions, assist in negotiating among donors a balanced funding of the common agenda, and give donors control over the use of their funds. With this structure, it will be possible to show how the research agenda is linked with the development agenda (for example, environment, food, and poverty) and still maintain the focus of specific research programs (for example, breeding, genetic conservation, and policy). At the same time, the new structure should be consistent with center operational arrangements for implementing research programs, such as project based management and budgeting.

Each cell in the matrix will represent a cohesive set of activities. [See Table 2, page 131.] These activities will have an objective that is consistent with

Using the matrix framework in the CGIAR’s priority setting processes, the CGIAR will be able to delineate its position in the international agricultural community, based on factors such as identified knowledge gaps, the CGIAR’s comparative advantage in particular research activities, and its role in ensuring the international public goods nature of its research products.
All research organizations must have a reasonable provision for "unconstrained" or "unprogrammed" research to foster innovation and creativity, and to provide flexibility to management.

The research program to which they contribute, expected outputs or performance or impact indicators, partnerships, and financial allocations.

The CGIAR considers strategic research capacity and managerial and physical infrastructure prerequisites for any research project. It recognizes that centers must have a basic institutional foundation and research capacity before they can develop and conduct research programs. This, in turn, requires adequate and sustained funding.

Two other factors are relevant in establishing the program structure. The first is that all CGIAR centers have overhead costs. Some of these fixed overhead costs, such as a board of directors, a director general, finance and administrative staff, are somewhat independent of the size of the center. In addition there are the "normal" overhead costs within which we must distinguish between those costs intended for quality enhancement and assurance, such as external reviews and peer reviews (which should be protected), and other overhead costs, such as maintenance of plant and facilities.

The second is that all research organizations must have a reasonable provision for "unconstrained" or "unprogrammed" research to foster innovation and creativity and to provide flexibility to management.

Table 3 [see page 131] illustrates these costs as columns in the matrix for fixed overhead and unconstrained research. Associated with each activity (each cell of the matrix) there is a bit of variable overhead. There is a transaction cost to executing each of these activities and they must be identified and coupled to the activity with which they are associated. Only thus will true transparency be obtained.

FINANCING THE RESEARCH AGENDA: METHODS OF FUNDING

This section illustrates ways in which the CGIAR's various funding methods could be applied to the program matrix to develop a comprehensive financing plan for the agreed research agenda.

System Support—World Bank Funding

The World Bank funds 15 percent of the CGIAR's agreed research agenda and work program. The contributions are provided to the System as a whole and are allocated to individual centers on the basis of CGIAR decisions. [See Table 4, page 131] This practice is not likely to change; the Bank will continue to support the agreed research agenda. Its contributions, in conjunction with funding from other donors, will be available to cofinance either centers (rows) or programs (columns). The Bank may also cover a portion of the fixed costs of the centers.

Center Funding

A significant proportion of the CGIAR's resources (55 percent, excluding the World Bank) is in the form of unrestricted contributions to individual centers. By their nature, these contributions provide a critical element of flexibility to center management and, hence, this approach will continue to be encouraged. The matrix approach facilitates these contributions. [See Table 5, page 132]
Program Funding

The CGIAR recognizes a need to develop intercenter research programs that can address the multidimensional nature of problems in the agriculture sector, particularly in the areas of natural resources management and sustainability. CGIAR donors have demonstrated strong support for such cross-center system-wide programs being implemented under the 1994 to 1998 Medium-Term Plan. [See Table 6, page 132.1]

Funding of Specific Activities

In the final funding approach, specific cells or discrete projects within the matrix are funded. [See Table 7, page 132.1] Although only a few CGIAR donors use this approach, it permits financing by donor agencies whose regulations limit their contributions to project funding.

THE FINANCING PLAN

Each Donor’s Contribution

The financing plan for the CGIAR research agenda is the sum of contributions by individual donors to centers, programs, and projects in addition to the contributions by the World Bank, which finances the CGIAR System as a whole. Table 8 [see page 133] shows how one donor might contribute through each of these methods.

Center and Program Budgets

Because standardization of information is essential to a transparent and predictable financial system, one early step in the development of the CGIAR financing plan will be to solicit contribution information from all donors in a format that transparently links the contributions to individual centers or to the program structure. The next step in formulating the CGIAR financial plan will be to aggregate allocations by individual donors. [See page 9, page 133.1]

To create a plan and give centers firm guidance, the CGIAR will have to develop operational procedures for resolving differences, such as overfunding or underfunding of cells, in a timely manner. These will take the form of consultations with donors, followed by a review of funding prospects by the Finance Committee, leading to the adoption of the financing plan by the CGIAR.

OPERATIONAL CONSIDERATIONS

Schedule of Decisions

Implementation of the new financing arrangements raises several operational issues related to timing; Table 10 [see page 133] illustrates the schedule that will be used in the future. Points worth highlighting in this schedule are:

- Decisions on the agenda for next year and its financing will be made at the Mid-Term Meeting in May to facilitate discussion within donor agencies before International Centers Week in October and to harmonize decisions about the CGIAR with other annual overseas development assistance (ODA) decisions in those agencies.
- Discussions about the CGIAR financing plan will take place between the Mid-Term Meeting in May and International Centers Week in October to ensure that a

The financing plan for the CGIAR research agenda is the sum of contributions by individual donors to centers, programs, and projects in addition to the contributions by the World Bank, which finances the CGIAR System as a whole.
The CGIAR will continue to collaborate with the private sector on technical issues as long as the exchange remains within the bounds of its guiding principles. Private sector financial support could be solicited as corporate philanthropy with appropriate safeguards to avoid an appearance of privileged access to CGIAR research products.

Multi-year Financing

Because CGIAR research involves medium- to long-term programs, the financing process ideally should involve multi-year funding commensurate with the time span of these programs (for example, three to five years). The CGIAR recognizes, however, that some donors are not in a position to provide multi-year funding for reasons that range from internal financial regulations to conflicting schedules of financial decisions. For this reason, the new financing arrangements will encourage multi-year commitments from all donors, but accommodate annual financing procedures and varying forms and durations of commitments.

It should be noted, however, that given the relatively small amount that CGIAR funding represents in the total budget of each donor, a strong political commitment by ministers/heads of agencies would be a reasonably good guarantor of predictability without requiring any new legal or procedural arrangements.

Private Sector Support

The CGIAR will continue to collaborate with the private sector on technical issues as long as the exchange remains within the bounds of its guiding principles. Private sector financial support could be solicited as corporate philanthropy with appropriate safeguards to avoid an appearance of privileged access to CGIAR research products. In this respect, the participation of the two US foundations would be the obvious model. What may be worth exploring is whether the CGIAR ought to extend its efforts to solicit philanthropic participation from the private sector through a “CGIAR foundation.”

IMPLEMENTATION

A transition to the new financing arrangement, including the matrix approach, has already begun; the new system is expected to be in place by the start of 1996.

Table 1.

Defining the Agenda: Actors and Programs

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Table 3.  
Overheads and Unconstrained Research

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Table 4.  
World Bank Funding

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Center Funding

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Agreed Agenda and Work Program

Table 6.

Program Funding

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Agreed Agenda and Work Program

Table 7.

Funding Specific Activities

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Agreed Agenda and Work Program
### CGIAR Members

#### Industrialized Countries
- Australia
- Austria
- Belgium
- Canada
- Denmark
- Finland
- France
- Germany
- Ireland
- Italy
- Japan
- Luxembourg
- The Netherlands
- Norway
- Russian Federation
- Spain
- Sweden
- Switzerland
- United Kingdom
- USA

#### Developing Countries
- Brazil
- China
- Colombia
- Côte d'Ivoire
- Egypt
- India
- Indonesia
- Iran
- Kenya
- Korea
- Mexico
- Nigeria
- The Philippines

#### International and Regional Organizations
- African Development Bank
- Arab Fund for Economic and Social Development
- Asian Development Bank
- European Commission
- Food and Agriculture Organization of the United Nations
- Inter-American Development Bank
- International Fund for Agricultural Development
- Opec Fund for International Development
- United Nations Development Programme
- United Nations Environment Programme
- World Bank

### CGIAR Centers

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<th>Center</th>
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<th>Research Focus</th>
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<td>International Center for Tropical Agriculture</td>
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<td>CIFOR</td>
<td>Bangor, Indonesia</td>
<td>Center for International Forestry Research</td>
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<td>CIMMYT</td>
<td>Mexico City, Mexico</td>
<td>International Center for the Improvement of Maize and Wheat</td>
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