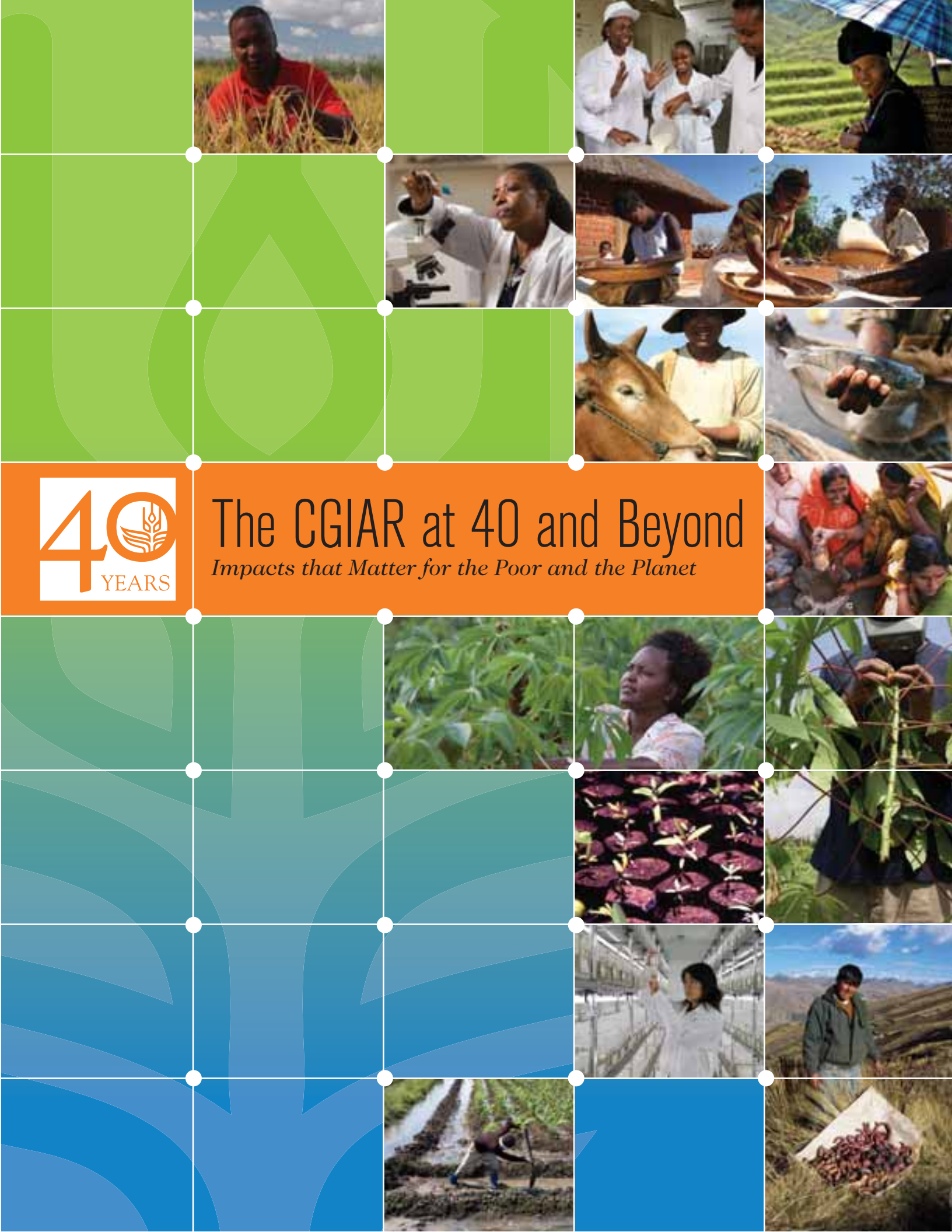

The CGIAR at 40 and Beyond

Impacts that Matter for the Poor and the Planet

Tribute to

Investors in the CGIAR

The Consultative Group on International Agricultural Research (CGIAR) would not be where it is today if not for 4 decades of dedicated support from its investors. As a community that believes in the power of research, we who work in the CGIAR salute the visionaries who gave their support to creating this unique organization. Forty years later, we remember and express our gratitude. Gratitude to the 18 countries and organizations that in May 1971 announced their decision to participate in the CGIAR as Members. And gratitude to the expanded fellowship of Members and other governments and institutions that demonstrated their confidence in the CGIAR by providing, with mounting generosity, the resources needed to carry out its mission. Our gratitude extends to host countries around the world that have given the CGIAR Centers homes in their nations. And to the farmers, scientists, technicians, partners and staff, who together have tirelessly advanced the CGIAR's mandate through the years. At this juncture, this time of reform and renewal, we celebrate all who have ever invested in the work of the CGIAR.

Thank you for helping to achieve this momentous milestone.

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Message from the CGIAR Leadership

RENEWING INTERNATIONAL RESEARCH ON AGRICULTURE AND NATURAL RESOURCES

A remarkable performance over the past 40 years provides a firm basis for a forceful response to the daunting challenges to come over the next 40 years

In 2011, as the Consultative Group on International Agricultural Research (CGIAR) embarks on its fifth decade, global circumstances bear a striking resemblance to those that gave birth to the organization 40 years ago.

The years just before the CGIAR's founding in 1971 posed grounds for serious concern about global hunger, as India, Pakistan and other Asian countries teetered on the brink of famine. But this period also provided convincing evidence that agricultural science was a powerful instrument for combating hunger. The proof came in dramatic increases in agricultural productivity resulting from the widespread adoption of new, high-yielding rice and wheat varieties, together with the increased use of fertilizers, irrigation and other inputs, in what came to be celebrated as the Green Revolution.

Humanitarian concerns, coupled with science-based conviction, brought together agricultural researchers and development donors who created the CGIAR. Their shared objective was to extend the early gains made possible by modern agricultural science by mobilizing resources to support research on a "long-term continuing basis," in the words of Robert McNamara, then president of the World Bank.

Forty years later, the world food system is again showing signs of severe strain. Despite decades of steady improvement in agriculture, a major food price crisis erupted in 2008, imposing great hardship on poor consumers. The crisis marked the beginning of a new era of food price inflation and volatility that, fueled by economic shocks and natural disasters, continues to the present. Since June 2010, rising food prices have driven into poverty an estimated 44 million people in the developing world.

These developments have prompted a worldwide renewal of concern about agriculture after nearly 2 decades of relative complacency and neglect (see Box 1 on page 5). The CGIAR has responded to this opportunity by seeking more effective ways to bring agricultural and environmental science to bear on entrenched hunger and poverty, and to maintain this work with stable, adequate financial support. The outcome is a broad portfolio of major new initiatives for strategic research, the CGIAR Research Programs, which are quickly being set in motion.

1970s

1971

4 Centers

18 Members

1979

12 Centers

32 Members (of which 2 are developing countries)

Greater capacity to meet bigger challenges

Notwithstanding the clear parallels between the CGIAR at birth and today, much about its work and circumstances has changed.

For one, the challenges of today are more complex than those of several decades ago. Agriculture and rural environments must supply goods and services for a much larger human population: 6.8 billion in 2011, almost double the 1971 population of 3.8 billion. The figure is expected to surpass 9 billion within the next 40 years, requiring targeted research efforts to achieve a 70% increase in agricultural production, according to the World Bank.

Meanwhile, improving agricultural productivity quickly enough to keep pace with rapidly rising demand has become more difficult. Many of the fairly easy gains have already been achieved. Further advances are complicated by institutional and policy weaknesses, as well as by the extensive degradation of soil, water and other natural resources caused in large part by more intensive food production using unsustainable practices.

Global climate change is expected to profoundly affect agriculture in the developing world over the next several decades. The combination of higher temperatures, shifting disease and pest pressures, and more frequent and severe droughts and flooding will depress and destabilize the output of crops and farm animals while further increasing pressure on water and other natural resources.

As the complexity of the challenges has grown, so has the responsive capacity of the CGIAR and of agricultural science generally. The research agenda of the CGIAR and its partners has expanded to encompass all of the world's major food crops as well as livestock and fish, together with a focus on health and nutrition, climate change, and the improved management of the natural resources that sustain rural livelihoods, including soil, water, forests and biodiversity.

Moreover, new tools from molecular biology, information science and other fields have enhanced the problem-solving power of this research. Broader partnerships embracing diverse actors at all levels have extended its reach, generating better research products and making them more widely available.

As a consequence, the early productivity gains that galvanized the donor community in 1971 have been augmented by deeper and wider impacts, which encompass key agricultural systems in all parts of the developing world. They derive from advances on multiple fronts including environmental stewardship, government policy, and understanding of gender and nutritional dynamics, as well as from agricultural productivity.

This remarkable performance over the past 40 years is a firm basis for a forceful response to the challenges that agriculture and rural environments must confront over the next 40 years.

Transforming the CGIAR research approach

In formulating that response, the CGIAR concluded during 2009, after extensive consultations, that a new approach was needed to reinvigorate agricultural and environmental research in the 21st century. Key to this new approach was the creation of the Global Conference on Agricultural Research for Development (GCARD), a biennial process organized

by the Global Forum on Agricultural Research (GFAR). GCARD brings together farmers, community development organizations, leading scientists and innovators to help the CGIAR identify demand-driven research and partnership opportunities. It also allows the CGIAR to take actions that improve the orientation of agricultural research systems, structures and processes for maximum progress toward key development objectives.

In December 2009, the CGIAR approved a plan to establish the CGIAR Consortium of International Agricultural Research Centers, uniting the 15 Centers of the CGIAR and their partners around a portfolio of major strategic research programs. The plan included creating the CGIAR Fund to mobilize funding from more than 60 donors that firmly support this research. The Consortium and Fund are united by the Strategy and Results Framework, which provides a robust yet flexible structure through which all 15 of the Consortium's member Centers can act in a more collective and concerted manner with hundreds of partners to deliver results through new research programs.

In doing so, this remarkable association of international actors will continue to build on CGIAR successes in improving crop varieties, developing better farming methods, promoting incisive policy analyses, and widely disseminating knowledge and information to improve the lives of millions of people in the world's rural areas. Readers of this publication are invited to glance back at this widely recognized record of achievement while also looking into the future toward a new era of results and impact that serve the urgent needs of the poor and hungry.

Inger Andersen
Chair
CGIAR Fund Council

Carlos Pérez del Castillo
Chair
CGIAR Consortium Board

The research agenda has expanded to encompass all of the world's major food crops as well as livestock and fish, together with the improved management of natural resources.

BOX 1

Witness to a National Research Awakening

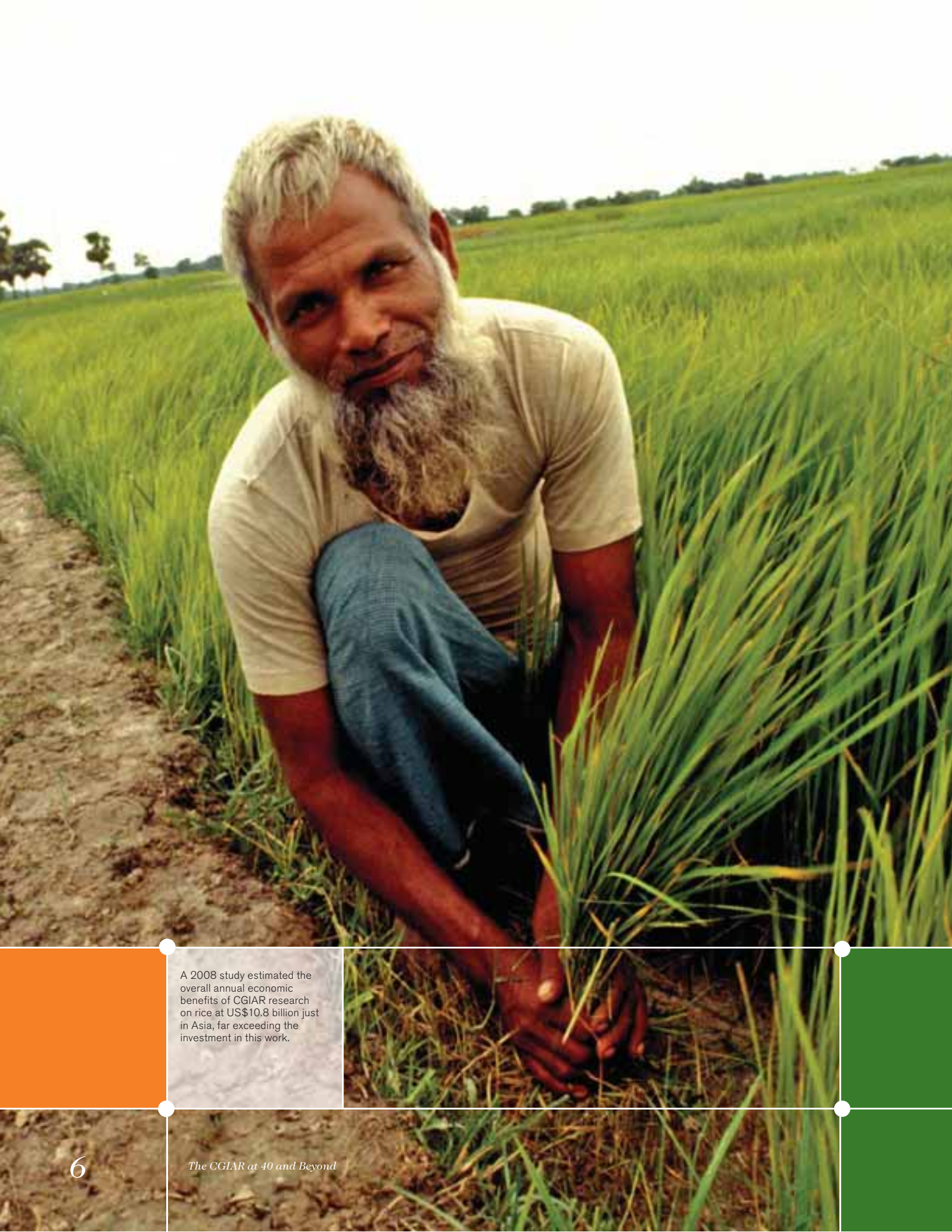
While the food price crisis of 2008 may have caught world leaders off guard, it came as no surprise to Segundo Ceballos, who labored as a field worker at the Santa Catalina Experiment Station of Ecuador's National Institute for Agricultural Research (INIAP by its Spanish abbreviation) from 1966 until 2009.

He vividly recalls the golden age of this country's wheat research in the 1970s. Scientists, technicians and field workers tended 15 or 20 hectares of international wheat nurseries sent by CGIAR researchers, using superior experimental lines to develop improved varieties. Norman Borlaug, the father of the Green Revolution, visited periodically to observe the team's progress and to cheer them on. As a result of harvests made bountiful by wheat improvement worldwide, the price of this staple grain declined steadily for several decades, offering large benefits for poor consumers.

By the turn of the century, however, wheat research in Ecuador had lost momentum. Successive governments, relying heavily on income from petroleum, had ignored food agriculture and the research needed to keep it strong and competitive. Domestic wheat production was particularly neglected, because low international prices and the political clout of the nation's wheat millers made it cheap and expedient to import ever larger quantities of the grain. Only a handful of staff at the Santa Catalina Experiment Station, including Ceballos, continued sowing a few improved wheat lines each year.

"When wheat prices spiked in 2008, Ecuador's government cushioned the blow by subsidizing imported wheat at great cost," says Julio César Delgado, INIAP director general. But, he explains, well aware of the shortcomings of such a policy, government policymakers sought, at the prompting of President Rafael Correa, INIAP's help in formulating a plan to revitalize wheat production and reduce the country's excessive dependence on purchases from the international wheat market.

Two improved wheat varieties from INIAP — Vivar and San Jacinto, both released in mid-2010 and derived from the CGIAR's collaborative research — are among the first products of the campaign. At a ceremony held for the release of Vivar, Ceballos said he was very happy about the new varieties and the wheat research revival. These developments vindicated years of struggle to keep wheat improvement, a central pillar of his country's food security, from falling.



A 2008 study estimated the overall annual economic benefits of CGIAR research on rice at US$10.8 billion just in Asia, far exceeding the investment in this work.

GROUNDS FOR CONFIDENCE:

Forty Findings on the Impacts of CGIAR Research, 1971-2011

Impact assessment finds that CGIAR research has generated – and continues to generate – profound benefits to poor people both within and outside agriculture

The CGIAR's collaborative research has brought about development impacts on a scale that is without parallel in the international community. They derive from "international public goods" – including improved crop seeds, better farming methods, incisive policy analysis and associated new knowledge – that are made freely available to national partners in developing countries, who transform them into locally adapted products that respond to the needs of rural households.

Following are 40 largely quantitative findings on CGIAR impacts since its inception in 1971. Most (the exceptions being numbers 7, 12, 13, 14, 20 and 27) were gleaned from a 2010 article in the journal *Food Policy*, which provides a comprehensive overview of hard evidence published in the last decade on CGIAR research impacts. The article was written by agricultural economics professor Mitch Renkow of North Carolina State University in the USA in collaboration with Derek Byerlee, a former economics adviser in the World Bank's Agriculture and Rural Development Department. Co-author of the *World Development Report 2008: Agriculture for Development,* Byerlee serves as chair of the Standing Panel on Impact Assessment of the CGIAR's Independent Science and Partnership Council.

Addressing concerns that an expanded mission and slower funding growth in the 1990s may have eroded the CGIAR's effectiveness, the *Food Policy* article concludes that the impacts of its crop improvement research "continue to be very large, generating profound benefits to poor people both within and outside the agricultural sector." The study also cites "substantial evidence . . . that other research areas within the CGIAR have had large beneficial impacts."

The evidence summarized here was gleaned from a large literature on research impacts. It bears eloquent testimony to the CGIAR's growing commitment over the last decade to rigorous impact assessment. Certainly, it shows that the CGIAR founders' early confidence in agricultural science was well placed. But more importantly, the evidence provides grounds for continued confidence, as CGIAR researchers and partners build on past successes to confront the acute development challenges of the 21st century.

Genetic improvement of staple foods

Most of the CGIAR's documented impact has resulted from research to improve crops. Its products — high-yielding seeds with wide adaptation and durable stress resistance — were central to the Green Revolution of the 1970s. They have also figured prominently in subsequent efforts to extend the initial gains in agricultural productivity (see Box 2 opposite).

1 As a result of crop improvement research within and beyond the CGIAR, 65% of the total area planted to the world's 10 most important food crops is sown to improved varieties.

2 About 60% of the food crop area planted to improved varieties is occupied by many of the approximately 7,250 varieties bred using genetic materials from the CGIAR.

3 A 2008 study estimated the overall annual economic benefits of CGIAR research on the three main cereals alone, and just in Asia, at US$10.8 billion for rice, $2.5 billion for wheat and $0.8 billion for maize, far exceeding the investment in this work. To a large extent, the benefits have come from lower food prices, which favor poor consumers in particular, since they spend about half of their income on staple foods.

4 Research on the genetic improvement of maize, rice and wheat has made possible rates of yield growth that have varied in recent years from 0.7 to 1.0% annually.

5 According to a 2008 study on potato improvement, varieties originating in the CGIAR were planted to more than 1 million hectares, double the area documented just 5 years before.

6 The estimated rates of return on the CGIAR's investment in all crop improvement research range from 39% in Latin America to more than 100% in Asia, the Middle East and North Africa.

In addition to improving all of the world's major food crops, CGIAR researchers have achieved, for the first time ever, dramatic productivity gains in a tropical food fish.

7 The selective breeding of Nile tilapia resulted in a highly productive strain that grows more quickly and survives better than local ones, offering yields that are from 25% to nearly 80% higher in the five Southeast Asian countries where the "super tilapia" was introduced and evaluated during the mid-1990s. In all of these countries, the new strain has generated additional income and employment on fish farms large and small, while easing market prices by about 10% and thus benefiting consumers significantly. In the Philippines alone, increased employment in the tilapia industry has benefited 300,000 people.

Stress resistance for more stable production

For smallholder farmers, the appeal of improved crop varieties lies not just in their higher yields but also in their resistance to diseases and pests and their adaptation to physical stresses like drought — traits that translate into more stable yields over time.

Modern crop varieties have replaced a large number of traditional landraces, creating initial concern that a narrower genetic base would make yields less stable. To mitigate this danger, CGIAR plant breeders have broadened the genetic diversity of modern varieties through strategies such as interspecific hybridization, or wide crossing, which introduces into domesticated species genes for pest resistance and other traits found in the wild relatives of these crops.

8 Recent research documents a steady decline in the variability of maize and wheat yields over the last 40 years, an improvement that is statistically associated with the spread of varieties with more stress resistance.

9 More stable yields generate benefits with an estimated annual value of US$149 million for maize and $143 million for wheat, more than the total

amounts spent annually on maize and wheat breeding for the developing world.

10 Research to maintain resistance to a single major disease of wheat – leaf rust – generated benefits from 1973 to 2007 that are currently worth $5.4 billion.

11 A 2009 study to quantify benefits from CGIAR research on yield stability estimated that the global economic value of genetic resistance to various wheat diseases amounts to as much as $2 billion annually.

Diseases pose a major threat to livestock production as well. Solutions such as vaccines are now being rolled out and should generate large impacts.

12 The production and delivery of a vaccine for East Coast fever – a tick-borne disease that threatens some 25 million cattle in 11 countries of East, Central and Southern Africa – is being placed in the hands of private sector partners. It is expected to save more than a million cattle, with benefits worth up to $270 million per year in the countries where the disease is now endemic.

As the impacts of climate change emerge, including more frequent and severe drought and flooding, CGIAR crop improvement research is developing new and more resilient cereal varieties.

13 More than 50 new maize varieties with drought tolerance have been adopted on a total of 1 million hectares across East and Southern Africa, giving an average yield advantage of 20-50%. A 2010 study projects that the further adoption of these maize varieties can boost harvests in 13 African countries by 10-34%, generating up to US$1.5 billion in benefits for producers and consumers.

14 A novel approach to seed dissemination has put a new flood-tolerant rice variety in the hands of 100,000 Indian farmers within a year after its

BOX 2

Seeds of Revolution

Starting in the late 1960s, rapidly spreading semi-dwarf varieties of rice and wheat with short, stiff stems made possible a quantum leap in the yields of these staple cereals across Asia and in other regions. Fed with fertilizer and irrigation, the new lines produced more grain without lodging, or falling over, under the weight of larger panicles as did the taller and more willowy traditional varieties they replaced.

In the world of rice, IR8 was the first major protagonist in this remarkable story of technological change. While offering high yields, it lacked resistance to various diseases and insect pests. CGIAR rice scientists worked quickly to correct this and other shortcomings, developing hundreds more new rice lines from the 1970s on that combined high yield potential with better grain quality as well as disease and pest resistance.

IR36 was the first improved rice variety to feature the most desirable attributes of all its predecessors. Early maturing and high-yielding, it showed multiple resistance to all the major diseases and pests of the Philippines as well as to the major rice pest in India and Sri Lanka. In wetlands, IR36 proved tolerant to soils that were saline, iron toxic or zinc deficient. In drylands, the versatile variety held up under iron deficiency and moderate drought. In its day, IR36 was the most widely grown rice variety in the world, covering some 10 million hectares.

But among superior rice lines, fame can be fleeting. Today, the variety that epitomizes the best that international rice breeding has to offer is IR64, which occupies more than 13 million hectares in 12 countries. It is among the 300 CGIAR breeding lines that have been released as more than 600 varieties in major rice-growing countries worldwide. About 70% of all rice land is sown to modern varieties, three-quarters of which are derived from CGIAR breeding materials.

The CGIAR contributed breeding materials toward three-quarters of the improved cultivars that now occupy more than two-thirds of all rice land.

release in 2009. The new variety offers a yield advantage of 1 ton per hectare even if submerged for 2 weeks, making it an attractive option for India's 12 million hectares of flood-prone agricultural land.

A world without the CGIAR

A landmark 2003 study on the impact of crop improvement research from 1965 to 1998 painted a counterfactual scenario of what the global food system would be like without CGIAR research:

15 Developing countries would produce 7-8% less food.

16 Their cultivated area would be 11-13 million hectares greater, at the expense of primary forests and other fragile environments.

17 Their food consumption per capita would be 5% lower on average.

18 Some 13-15 million more children would be malnourished.

The power of partnership

Achieving major development impact requires high-quality science that is relevant to the needs and conditions of the poor. Equally important are the partnerships through which research products are developed and shared with national organizations, which do the hard work of making them available to farmers on a large scale. Over the years, the CGIAR Centers have built up an extensive array of partnerships with diverse actors in research for development. These are not virtual, remote arrangements but reflect the presence of Center scientists throughout the developing world, where they work closely with national partners in the field.

Since the effectiveness of research collaboration depends on the capacity of individual colleagues, the CGIAR has made a considerable effort over the years to strengthen the capacity of national partners through formal and informal training and other learning activities that, together, absorb roughly 20% of CGIAR expenditures.

19 An estimated 80,000 professionals have received such training so far. According to an external evaluation carried out in 2006, this work is highly relevant to national capacity needs and of high quality, judging from the results of trainee surveys. Evidence from seven country case studies suggests that CGIAR training is a "significant contributor to positive outcomes from research."

The big picture of impact

A large body of evidence compiled since the 1990s indicates that gains in food production in the developing world have contributed importantly to reducing poverty by raising farm incomes, creating employment for farmworkers, reducing food prices and fueling economic growth.

20 A 2007 study showed that CGIAR research on rice enabled more than 6.75 million Chinese to escape poverty between 1981 and 1999, primarily as a result of lower grain prices from increased crop production.

21 The numbers for poverty reduction in India are even more impressive, as 14 million people rose out of poverty between 1991 and 1999.

Several studies published in recent years have documented the impacts of the CGIAR as a whole, either globally or in specific regions.

22 The overall economic benefits of the CGIAR were estimated to range from US$14 billion to more than $120 billion. Even under quite conservative assumptions, the benefits of research have been roughly double the investment.

23 For every $1 invested in CGIAR research, $9 worth of additional food is produced in the developing world.

24 A 2007 review of investments in agricultural research carried out by

five CGIAR Centers and their partners in South Asia since the end of the Green Revolution period in the early 1980s found average annual benefits of more than $1 billion from research on maize, rice and wheat alone, far above the CGIAR's total annual expenditures in the region.

African success stories

CGIAR research has had less impact in Africa than in Asia, where work began a decade earlier and under quite different conditions. Even so, a number of impact studies suggest that African agriculture can produce successes on a par with those unfolding elsewhere, delivering large returns on the CGIAR's significant investment in the region.

25 In the late 1980s, Africa witnessed one of the CGIAR's most spectacular research achievements since the Green Revolution: the biological control of two devastating insect pests of the tropical root crop cassava (see Box 3 right). The economic returns — reaching a current value of US$9 billion on research on just one of the pests, the cassava mealybug — far exceed the CGIAR's total investment in Africa since 1971. Biocontrol research in Africa subsequently achieved notable success in combating other pests, particularly the mango mealybug and water hyacinth.

Crop research has yielded important results in Africa as well, particularly by providing varieties whose improved pest resistance and tolerance to stresses such as drought have helped stabilize crop yields in the region's predominantly rainfed environments.

26 As a result of maize improvement in West and Central Africa from 1971 to 2005, farmers are planting improved varieties, derived mostly from CGIAR research, on 60% of the total maize area, with economic benefits estimated at US$2.9 billion annually. In 1998, the use of improved maize accounted for an additional 2.6 million tons of grain — enough to provide 9.4 million people with a full complement of 2,200 kilocalories per day.

When pests from cassava's home in South America ended the crop's pest holiday in Africa and Asia, the CGIAR introduced wasps that prey exclusively on them.

BOX 3

An International Sting Operation

Several centuries ago, Portuguese traders carried cassava from its original South American home to Africa and Asia. Offering high yields even under harsh growing conditions, the tropical root crop thrived in the Old World, partly because of the absence of insect pests that had evolved with cassava in its native land.

But in the 1970s, the cassava crop's extended pest holiday came to an abrupt end. Two pests — the cassava mealybug and cassava green mite — caught up with their host plant in sub-Saharan Africa, where they devastated crops across the region's cassava belt, posing a major threat to food security.

Believing biological control to offer the quickest and most effective solution, CGIAR researchers embarked on an intensive search in South America for natural enemies of the two pests. Their search was successful, enabling the large-scale introduction of predator species into Africa, but only after research confirmed that they would kill only the target pests, causing no harm to other insects, livestock, wildlife or people.

A parasitic wasp (*Anagyrus lopezi*) proved to be the most formidable natural enemy of the cassava mealybug, gradually reducing its population by feeding on it. Female wasps inject their eggs into the pest, and wasp larvae feed on the host insect.

The cassava mealybug has now reached Southeast Asia, initially Thailand, where it is causing yield losses of about 20%. As the country's cassava industry generates at least US$1.5 billion in farm income each year, losses of that magnitude translate into severe economic hardship. The costs will rise quickly if the pest is allowed to spread further in the Greater Mekong Region, where millions of rural households depend on cassava for income.

In an emergency campaign to stop the mealybug, Thai researchers reared hundreds of thousands of parasitic wasps from a colony supplied by CGIAR researchers and released them during 2010 in selected parts of the country.

27 By the end of the 1990s, the wide adoption of improved cassava with a 50% advantage over the average yields of traditional varieties had made possible the additional production of 10 million tons of fresh roots per year — enough to provide 14 million people with 2,200 kilocalories per day.

28 Improved varieties of cowpea, which provide both food and livestock feed, are being widely adopted in the dry savannas of West Africa, with estimated benefits of from US$299 million to $1.1 billion expected to accrue from 2000 to 2020.

29 Impressive gains have been registered with improved common beans, developed with farmer participation through regional networks in East, Central and Southern Africa. Offering a 30-50% yield advantage and multiple disease resistance, the new varieties have been adopted by 5.3 million rural households over the past 15 years and currently occupy half of the region's total bean area, according to a 2008 study. While strengthening household food and nutrition security, improved bean production also provides women (who are the main bean growers) with surplus grain to sell in local markets. The benefits of bean improvement research for Africa are estimated to have a current value of $200 million, more than a dozen times costs of $16 million.

30 New Rice for Africa, branded NERICA, combines the high yields of Asian rice with African varieties' resistance to local pests and diseases. It has spread to 250,000 hectares in upland areas, helping reduce national rice import bills and generating higher incomes in rural communities.

31 Recent research has begun to document the nutritional benefits from improved crop varieties. In Mozambique, the introduction of new orange-fleshed sweet potato rich in beta-carotene significantly increased the intake of this vegetable precursor of vitamin A among young children in 850 households, according to a 2007 study.

Positive returns from research on natural resources

The results of CGIAR research on natural resource management have proved harder to implement and evaluate than its work on crop improvement. Nonetheless, a set of seven case studies published in 2007 indicates that this research is yielding highly positive returns on investment, counting only the benefits for agricultural productivity. If methodologies were available for gauging the environmental benefits as well, the returns would no doubt be much higher.

32 The practice of no-tillage, which is spreading rapidly in the rice-wheat systems of South Asia's Indo-Gangetic Plains, has been shown to reduce farmers' production costs for labor, machinery, chemical inputs and fuel by 10% (see Box 4 opposite). The technique raises crop productivity by the same amount, partly because leaving crop residues on the soil surface improves fertility. These gains have generated economic benefits on the order of US$165 million from 1990 to the present, or 47 times the investment of $3.5 million. These benefits do not include the substantial environmental gains that accrue from the conservation of water, sequestration of carbon in the soil and reduction of greenhouse gas emissions.

33 By 2002, more than 66,000 farmers in Zambia had adopted an agroforestry system called "fertilizer tree fallows," which renews soil fertility using leguminous trees grown on the farm. The system has been shown to boost maize production while reducing production risks and soil erosion, with benefits of up to $20 million, compared with an investment of $3.5 million. Another promising option for improved fallows in Africa is to plant the leguminous climbing shrub *Mucuna pruriens* as a cover crop. During the 1990s, participatory research helped more than 10,000 farmers in Benin adopt this practice.

There is good scope for diversifying the rice-wheat system through the addition of maize, potato, sugarcane, vegetables and various grain legumes such as peanut.

BOX 4

Innovators in Research Collaboration

The Indo-Gangetic Plains of South Asia are a major food-producing region, where rice-wheat cropping rotations supply grain for more than 300 million people. Researchers were therefore alarmed to observe in farmers' fields during the late 1980s a marked decline in the yields of rice and a leveling off of wheat yields, caused largely by soil degradation.

Since the early 1990s, a consortium of researchers has been addressing this problem with remarkable success through an innovative model for regional collaboration in research on natural resource management. The consortium builds on strong ties between CGIAR Centers; the national agricultural research institutes of Bangladesh, India, Nepal and Pakistan; various advanced research institutes in the industrialized world; and dozens of private firms.

Thanks to their work, by the end of 2007, half a million smallholder farmers were planting some 4 million hectares (nearly a third of the region's total rice-wheat area of 13.5 million hectares) using various resource-conserving technologies. This includes 1.94 million hectares under zero or reduced tillage. The new technologies offer immediate economic benefits from reduced production costs and timely planting, which raises yields. In addition, farmers are rapidly diversifying the rice-wheat system through the addition of maize, potato, sugarcane, various grain legumes and vegetables.

These impacts may be attributed to various features of an evolving model for collaborative research. One is the farming systems perspective adopted early on. Another is the participatory approach to developing and disseminating technology, which broke the hierarchical barriers that had previously separated researchers, extension officers and farmers. This gave rise to a more dynamic process of technological innovation, in which all of those actors, together with private equipment manufacturers and input suppliers, work in teams.

Finally, all partners have gained effectiveness from an emphasis on sharing knowledge through traveling seminars and study tours — activities in which CGIAR scientists often serve as mentors and facilitators.

34 In Malawi, an integrated aquaculture-agriculture system, introduced during the mid-1990s with active farmer participation at a cost of $1.5 million, has created benefits worth nearly $3.5 million by doubling the income of rural households and dramatically increasing fish consumption. The system shows great promise for other areas of Southern Africa where the agricultural workforce has been devastated by HIV/AIDS.

35 New information and tools provided to conservationists during the 1990s are being used to monitor some 37 million hectares of forest globally, enabling the better management of this diminishing resource and contributing to more sustainable livelihoods for forest dwellers.

A growing record of policy impacts

Achieving development impact depends not just on new technologies but also on better policies that offer rural people the means and incentives to invest in sustainable agricultural production and resource use. While hard to measure, the impacts of CGIAR policy research and advocacy appear to be substantial, as suggested by recent case studies indicating benefits worth millions of dollars.

36 Research on the liberalization of rice prices in Vietnam during the mid-1990s informed the relaxation of rice export quotas and of internal restrictions on trade, generating benefits worth US$45-91 million.

37 A food-for-education program in Bangladesh catering to 2.1 million students in 17,811 schools created total benefits estimated at $248 million with the aid of capacity building and policy research, which guided the conception, evaluation and targeting of the initiative starting in the early 1990s.

38 Shifts in Syria's policies on fertilizer distribution and barley prices in arid zones starting in the mid-1980s made fertilizer use more efficient, contributing to increased barley output and improved livestock nutrition, with benefits worth $73.4 million.

39 Research and advocacy to decriminalize the marketing of milk by small-scale vendors in Kenya created benefits for producers and consumers with an estimated value of $44-283 million.

40 In the Philippines, improved policies on pesticides — starting in the late 1980s and involving the regulation of highly toxic products on rice and the training of rural health officers — has so far generated benefits valued at $117 million.

No grounds for complacency

As impressive as it may seem, the evidence of "substantial pro-poor impacts" compiled by Renkow and Byerlee offers no grounds for complacency. On the contrary, these authors insist, the evidence presents a "strong case . . . for continued and increased investment" in crop improvement and other key components of a "wide-ranging portfolio" of research.

To make good on greater investment requires, however, a new and better way of working, which is the subject of the section titled "A better way of working to create a better future for the world's poor," starting on page 19 of this publication.

A new CGIAR Research Program will help smallholder banana farmers to access markets for higher-value products, thus raising their incomes and fostering more diverse farming systems.

1980s

1980

13 Centers

35 Members (of which 4 are developing countries)

1989

13 Centers

40 Members (of which 6 are developing countries)

From Rio to Svalbard:

CGIAR GENEBANKS SAFEGUARD HUMANITY'S AGRICULTURAL HERITAGE

As primary conservators, CGIAR scientists inform debate on how best to protect and equitably share genetic resources and the intellectual property derived from them

When more than 150 countries signed the Convention on Biological Diversity at the Rio Earth Summit in 1992, CGIAR Centers were already operating genebanks in which they collected and conserved the crop biodiversity that is the common legacy of farmers since the dawn of agriculture. The Centers recognized — as signatories of the Rio convention would in the following decade — that monoculture and other unsustainable agricultural practices threatened the wholesale extinction of traditional crop, forage and agroforestry varieties. At the same time, habitat loss through agricultural expansion, environmental degradation and other causes threatened the wild relatives of crops that harbor agronomically valuable traits such as resilience against pests, disease, drought, flooding, excessive cold and heat, and problem soils.

The CGIAR Centers soon placed their collections under the authority of the Food and Agriculture Organization of the United Nations, holding the collections in trust on behalf of humanity. In 2006, the 11 Centers with genebanks signed superseding agreements that placed the collections under the International Treaty on Plant Genetic Resources for Food and Agriculture and adopted its standard contract for exchanging genetic materials.

The CGIAR invests $6 million annually to maintain in the public domain over 650,000 samples of crop, forage and agroforestry genetic resources. Of more than a million seed samples distributed in the past decade, 80% went to national researchers in developing countries to help breed more bountiful, efficient and resilient crops. Seed contributions from CGIAR genebanks have helped jumpstart agricultural recovery after conflict in Afghanistan, Angola, Mozambique and Somalia.

Through the CGIAR's Systemwide Genetic Resources Program, CGIAR Centers and their partners share information and knowledge about germplasm and its discovery and conservation, conduct joint research, establish common policies and practices, and contribute to international debate on how best to protect and equitably share genetic resources and the

Among the first to systematically conserve biodiversity, CGIAR Centers now maintain over 650,000 samples of crop, forage and agroforestry genetic resources.

intellectual property derived from them. The CGIAR's Systemwide Information Network on Genetic Resources (http://singer.cgiar.org/) provides users with a single entry point for learning about Center collections and identifying the materials they need. It forms the core of new efforts to develop a more comprehensive global information system that will enable searches of genebanks worldwide for genetic traits needed to combat new diseases and cope with climate change.

An initiative originating in the CGIAR created the Global Crop Diversity Trust, a public-private partnership raising an endowment of $260 million for conserving agricultural biodiversity. February 2008 saw the opening of the trust-funded Svalbard Global Seed Vault. Carved into a Norwegian island above the Arctic Circle and capable of preserving seed for thousands of years, Svalbard is the repository of last resort for humanity's agricultural heritage. At its opening, 21 national and international institutes deposited nearly 300,000 duplicate seed samples. Of them, more than 200,000 came from CGIAR genebanks, which plan to deposit an additional 300,000 samples in the coming years.

One way the CGIAR combats child malnutrition is by boosting the availability of foods that are naturally rich in micronutrients, such as livestock products, fish, vegetables and fruits.

A BETTER WAY OF WORKING

To Create a Better Future for the World's Poor

Mounting crises and evolving opportunities call for a more concerted and collaborative research effort

In 2008, the world food system received its biggest shock since the CGIAR was established. Sharp increases in the prices of staple foods pushed 100 million people back into poverty. Desperate consumers rioted in two dozen major cities across the developing world.

In 2011, continued price inflation and volatility prompted many observers to ask whether the world is again on the verge of a major food price crisis. In February 2011, the Food Price Index reached its highest level since its launch by the Food and Agriculture Organization of the United Nations in January 1990. Since then, political upheaval in North Africa and the Middle East provides new and dramatic lessons about the close connection between food and peace.

A string of recent natural disasters has contributed to uncertainty about food supplies and prices. Epic floods in Pakistan in 2010 ruined 1.6 million hectares of crops. And in early 2011, China's worst drought in 60 years briefly but worryingly threatened the winter wheat crop of the world's largest producer of this staple cereal.

Extreme weather wreaking havoc on agriculture in one country after another may or may not be a direct result of global climate change. But it certainly offers a preview of a more turbulent world, in which a fragile food system and unfavorable climate trends magnify the misfortunes of people living in extreme poverty, with the majority in rural areas and relying mainly on smallholder agriculture.

Rethinking agricultural research

The responsibility to create a better future for the world's poor rests on the shoulders of many individuals and organizations. Among them are the more than 8,000 scientists and other professionals of the CGIAR. They have 4 decades of experience in successfully reducing hunger and poverty and curbing the degradation of natural resources across the developing world.

Since the CGIAR's inception in 1971, its scientists and the donors who support them have worked together toward these ends on a largely informal basis. Over the years, donors have agreed to extend the work of CGIAR researchers many times in response to growing needs and emerging opportunities. But now multiple crises in the global economy and environment have converged to confront agriculture

with challenges of unprecedented scope and complexity (see Box 5 opposite). To meet them requires a more concerted and collaborative research effort than any the CGIAR has ever mounted before.

From the early 1990s until recently, complacency seemed to place the work of the CGIAR and its national partners on the backburner. But the food price crisis of 2008 and subsequent events have shaken decision makers from their prior complacency, restoring agriculture to its rightful place on the international development agenda. This is the clear signal of policy statements from the Group of Twenty industrialized and developing countries, the European Union, and many others.

In response to encouraging signs of renewed commitment, the CGIAR chose to thoroughly rethink the way it works. This put in motion a set of far-reaching reforms, starting with the complete overhaul of the CGIAR's governance architecture. The result is a more business-like partnership that links, in more binding and transparent ways, donors who fund research with the scientists and others who conduct it.

Under the new arrangement, donors can direct stable support toward major research initiatives through the CGIAR Fund, which is guided by the representative Fund Council. This should curb the recent tendency toward fragmentary funding of dispersed research efforts. The CGIAR Centers are united under the Consortium of International Agricultural Research Centers, a new legal entity with its own chief executive officer and board, which provides a stronger foundation for integrating research across Centers.

Bridge to a better future

The dual governance structure of the new CGIAR is held together by a conceptual bridge, the Strategy and Results Framework. Designed by the Consortium in close consultation with partners and approved by the Funders Forum, it provides, for the first time, a common basis for collective action by all CGIAR Centers.

The new strategy takes into account a range of new challenges and opportunities in today's global food-production system. It identifies the comparative advantages of CGIAR research toward addressing those issues and explains how this research will help the CGIAR achieve four system-level outcomes: reduced rural poverty, improved food security, improved nutrition and health, and the sustainable management of natural resources.

The strategy further outlines how research can be organized more effectively to deliver those impacts, describing the key areas in which the CGIAR and its partners have strong collective capacity or are building it. Finally, the strategy outlines a process for creating a diverse portfolio of global collaborative initiatives called CGIAR Research Programs (CRPs).

The CGIAR strategy is reinforced by three supports. One consists of a cascading series of performance agreements between, first, the Fund Council and the Consortium, then between the Consortium and the CGIAR Centers leading the CRPs, and finally between the lead Centers and their many partners. The other supports are the streamlined Monitoring and Evaluation System, designed to ensure that all actors are held accountable for their performance, and the Independent Science and Partnership Council, which provides Fund donors with expert advice on major issues.

The CGIAR's new overarching structure and strategy convert it from a loose coalition of like-minded but operationally distinct research and donor organizations into a coherent whole that is greater than the sum of its parts.

Opportunities for global agricultural research

The challenges for 21st century agriculture seem extraordinary by 20th century standards — but then so do the capacities of today's agricultural and ecological science.

The field of functional genomics, for example, is revealing previously unimagined knowledge about gene functions. Advanced research institutions and private companies are rapidly putting this knowledge to use through a variety of biotechnology methods, such as genetic transformation and the use of molecular markers, to enhance the yield potential and stress tolerance of modern crop varieties. As a complement to conventional breeding, biotechnology

Rising concern for the future has translated into renewed global awareness that smallholder agriculture is central to reducing poverty.

BOX 5

New Challenges for Global Agriculture

Global agriculture is quite different now than when the CGIAR was established in 1971. Most striking, perhaps, is the greater complexity of today's challenges, which arose as both new and longstanding pressures began to converge in recent years.

The primary forces shaping global agriculture include rapid population and income growth, more frequent and severe drought and flooding, rising energy prices, the subsidized development of biofuels, and counterproductive trade and market policies. These were the principal causes of the 2008 food price crisis, according to CGIAR food policy analysts, and they are the main drivers of continued price inflation and volatility.

Avoiding the recurrence of major food crises requires, among other measures, faster growth in agricultural productivity. This is critical for achieving the 70% production increase needed, according to the World Bank and others, to feed a projected population of 9 billion people in 2050.

There are major barriers to achieving such an increase that did not exist or were less limiting 40 years ago, when the Green Revolution delivered a quantum leap in the yields of rice and wheat. One of the greatest obstacles is the rampant degradation of the natural resources — water, arable land, biological diversity and forests — upon which agriculture and rural communities depend. To a large extent, degradation results from the more intensive and extensive agriculture that has evolved in the absence of policies and practices for sustainable resource management.

Among the consequences is a sharp decline in the annual rate of growth in developing country cereal yields from 3% in the 1970s to just below 1% since 2000. Worsening water scarcity and land degradation have kept farmers from realizing the benefits of new technologies and have thus undercut their incentive to adopt them.

In the coming decades, climate change will further raise barriers to increased productivity growth. According to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, the impacts will significantly threaten food production chiefly through more severe weather but also through more frequent and destructive disease and pest outbreaks. Smallholder producers are especially vulnerable because of their limited capacity to adapt.

Fortunately, though, there is a silver lining behind these dark clouds. Rising concern about new challenges for agriculture has translated into renewed global awareness that growth in smallholder agriculture is effective at reducing poverty and, indeed, necessary. The critical corollary of this principle is that sound policies and institutions are essential to enabling smallholders to achieve growth.

is rapidly becoming the standard of the trade. The emergence of powerful new techniques has prompted renewed interest in research toward the better understanding and use of crop and livestock genetic resources.

To take full advantage of the development opportunities offered by this research, the CGIAR and its partners must continue to address issues related to intellectual property rights. Proprietary technologies are no longer the exception in agricultural research and innovation but the norm. As the public and private sectors enter into new partnerships to address food and environmental challenges, they will need to handle the acquisition, protection and dissemination of intellectual property adeptly and creatively, if they are to succeed in putting new technologies to work for the poor.

As advanced science breaks down old barriers to crop improvement, new information and communications technologies are widening the scope for collaboration in research on crops and natural resources by creating new spaces for innovation that are partly virtual. In fact, the whole concept of technological innovation has evolved in recent years into a more collaborative enterprise involving more diverse actors. This has spurred researchers to assume new roles in development and enter into broader partnerships that involve not just the public sector but private companies and civil society as well, including local producer associations.

Yet public organizations are still the backbone of the global system of agricultural research for development. And, contrary to the overall trend of underinvestment in research, public organizations in some developing countries — notably Brazil, China, India, Mexico and South Africa — have built up enviable capacities in new areas of science. While expanding the global supply of agricultural knowledge, this has also widened the gap between technological "haves" and "have-nots," as the scientific capacity of countries in sub-Saharan Africa and Central America in particular has lagged behind in recent years.

The consolidation of various regional and subregional organizations has compensated somewhat for the loss of national capacity, employing collective action to tackle shared constraints in agriculture and natural resource management. The private sector has also filled gaps in agricultural research and development, becoming a key supplier of new gene technologies, improved crop seeds and veterinary products.

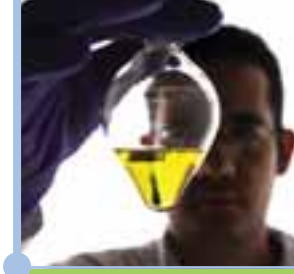
A catalytic role for the CGIAR

In the wide arena of agricultural research for development, the CGIAR has an important role to play in reducing hunger and poverty globally. No other international organization has as clear and comprehensive a mandate to achieve this goal through research. And few have such considerable assets, including a critical mass of scientists, wide support from donors, global research infrastructure and networks, and the world's most comprehensive collections of genetic resources.

In keeping with their original mandates, individual CGIAR Centers have so far worked more or less autonomously with their partners to generate development impact through research products related to crops, farm animals, natural resources or eco-regions. This approach has delivered significant impacts, as described earlier, but they have been spread somewhat unevenly across regions and research areas.

Now is the time for the CGIAR to perform a more catalytic role that better realizes the potential synergies between Centers and many other actors in the global research system (see Box 6 on page 26). Nothing less would be sufficient to deliver the greater and wider impacts that are needed to confront complex global challenges. In preparation for this more collective approach, the CGIAR put in place mechanisms designed to integrate research across Centers and partner organizations and to sharpen the focus of their joint work toward key development impacts.

To implement this new and better way of working, the CGIAR's Strategy and Results Framework calls for "results-based management." Originating in the business world, this concept has greatly influenced the public sector. It requires that organizations carefully define the results they want to achieve, systematically direct all their capacities and investments toward delivering them, and demonstrate measurable progress through rigorous monitoring and evaluation using clear performance indicators.



Bringing development impact within reach

The CGIAR's new strategy commits it to delivering results that are closely aligned with the Millennium Development Goals, around which a unique international consensus has formed. The strategy is particularly relevant to goals on hunger and poverty reduction and environmental sustainability, but it pertains to the others as well: primary education, gender equality, human health and global partnership for development. The Strategy and Results Framework defines, as summarized below, the basis by which the CGIAR Centers and their partners can deliver the four system-level outcomes.

These outcomes overlap in that they are mutually reinforcing, but each still requires a dedicated strategy. Strong food security contributes to lower food prices, which reduces poverty and improves human nutrition. But if food security derives chiefly from improved cereal productivity in irrigated areas, it may have only a limited effect on poverty in marginal environments, where many of the poor live. Each development impact thus requires a distinct research strategy, which deals carefully with potential tradeoffs between, for example, more intensive crop production and more sustainable management of natural resources.

Reduced rural poverty

Some 1.4 billion people live in extreme poverty on incomes of less than US$1.25 day. About 70% of them reside in rural areas, where most depend on agriculture for a livelihood. Despite convincing evidence that agricultural growth is highly effective at reducing poverty, the sector, until 2008, received declining attention with negative consequences.

In South Asia, for example, rural poverty has become deeply entrenched, mainly in semi-arid and other neglected areas. In sub-Saharan Africa — the world's other major locus of rural poverty — it is more prevalent and widely distributed, though particularly intense in pastoral areas of arid and semi-arid environments. The depth and distribution of poverty in a given region determines the options that are most likely to prove effective in reducing poverty.

Making up for lost time and opportunities requires large investments in research toward achieving the diversification and sustainable intensification of agricultural production, bringing higher and more stable yields and greater resilience under stress. Improved dryland cereals, root crops, grain legumes, agroforestry and ruminant livestock are especially important for achieving these outcomes, reflected in measurable improvement of household food security and incomes.

Though potent, new technologies alone will not get the job done. They are rather blunt instruments for poverty reduction and must be accompanied by other more precise interventions, including microcredit, improved market access and clear property rights, especially for women. Such measures are critical for enabling the rural poor to invest more resources in development.

Opening pathways to rural prosperity requires a research strategy that takes into account distinct regional contexts; reflects a deep understanding of the changes needed to overcome poverty; promotes innovation simultaneously in agricultural production, natural resource management and market access; and employs novel approaches, such as involving community groups, to ensure gender and ethnic inclusiveness.

Improved food security

Providing poor consumers with affordable food depends heavily on ample and reliable global supplies of basic staples. The global food price crisis of 2008 demonstrated the harsh consequences of ignoring this fact. The initial price spike and continued price inflation and volatility have deprived more than 100 million people of their right to food, pushing the number living with chronic hunger beyond 1 billion.

Mending the fractured food security of urban and rural consumers worldwide requires, among other things, steady growth in agricultural productivity to make food prices lower and more stable. Since the 1960s, this growth has depended mainly on higher crop yields made possible in large part by improved cereal varieties that respond well to fertilizer and irrigation.

1990s

1990

16 Centers

40 Members (of which 6 are developing countries)

1993

18 Centers

43 Members (of which 8 are developing countries)

1999

16 Centers*

58 Members (of which 22 are developing countries)

* In 1994, the International Livestock Center for Africa and the International Laboratory for Research on Animal Diseases merged to create the International Livestock Research Center, and the International Network for the Improvement of Banana and Plantain became a program of the International Plant Genetic Resources Research Institute (since renamed Bioversity International).

Over the past decade, though, the rate of growth in rice and wheat yields in particular has declined sharply. Unless this trend is reversed, grain prices are likely to rise steadily in the coming decades.

Three key staple cereals — maize, rice and wheat — supply a third of the calories people consume globally. Major investments are needed to enhance their yield potential and stability in the breadbaskets of the tropics and subtropics. Developing new cereal varieties with higher yields and stronger stress resistance will require that plant genetic resources be more effectively exploited using the new tools of molecular biology. Even though farmers already cultivate breadbaskets quite intensively, better crop varieties and farming practices will enable them to produce more while using water and plant nutrients more efficiently to cope with water scarcity, land degradation and climate change.

While reinforcing global food security, agricultural research must pursue different strategies to shore up the food security of vulnerable regions, including sub-Saharan Africa, North Africa, West Asia and the parts of South Asia that lack irrigation. In these regions, long-neglected crop-livestock systems offer the most potential for increasing agricultural productivity.

Improved nutrition and health

The poor suffer not only chronic hunger but also malnutrition and ill health. Two billion people lack sufficient micronutrients in their diets, especially vitamin A, iron and zinc. These deficiencies stunt children's growth, make children and adults' more susceptible to disease, and expose mothers and infants to greater risks during childbirth. Often, the plight of these people is worsened by unsafe foods (infected with mycotoxins, for example), diseases transmitted through animals or water, and other problems related to agriculture.

Malnutrition in children is especially severe in sub-Saharan Africa and South Asia. In both regions, the problem occurs mainly in rural areas and is closely associated with women's limited access to education. Any strategy to reduce child malnutrition must create new options for women, since they bear the main responsibility for household diets as well as for much crop production, postharvest handling and food marketing.

Stronger food security, though critical for surmounting malnutrition, is not enough. Further interventions are needed in agriculture to bolster nutritional security and human health.

One option that shows promise is the biofortification of widely available staple foods — an approach that raises their micronutrient content through plant breeding. Another approach is to boost the output and consumption of foods that are naturally rich in micronutrients, such as livestock products, fish, vegetables and fruits. This can be accomplished through initiatives that diversify food production, strengthen agricultural value chains and support school meal programs.

Sustainable management of natural resources

Agriculture has more impact on the environment than any other human activity. Unsustainable farming and livestock grazing are major causes of deforestation, biodiversity loss, water scarcity and soil degradation. Agriculture accounts for as much as a third of global greenhouse gas emissions, both directly and, as a primary driver of deforestation, indirectly. At the same time, the sector is highly vulnerable to climate change.

Over the past 20 years, the CGIAR built up considerable capacity for research on the sustainable management of forests, water, fisheries, rangelands and soil. Moreover, it has experimented with different mechanisms, such as ecoregional programs, for organizing this research toward reversing current trends that degrade natural resources. Experience teaches that new research in this area will likely be able to deliver significant outcomes by following three closely related tracks.

One track is to improve the provision of ecosystem services. Schemes involving payments to rural communities for maintaining these services, such as through sustainable forest management for carbon capture or better watershed management, have sprung up around the world and show great potential.

A second track pursues the complementary goal of improved farming systems. Some of the research on systems must be toward using natural resources and

purchased inputs more efficiently in intensively cultivated breadbaskets. As mentioned above, these areas are critical for sustaining global food security. Other research should center on reversing land degradation in marginal areas, especially in sub-Saharan Africa, where rural poverty is prevalent.

To be effective, both lines of research must be directed along a third track addressing climate change, whose twin destinations are adaptation and mitigation. Better management of natural resources, including the carbon stored in forests and agricultural systems, is critical for achieving these aims.

Mobilizing the capacity to deliver

Over the past 4 decades, the CGIAR and its partners have built up strong capacities in improving crop and livestock production and in managing natural resources. These main lines of research have been organized rather differently, however, more often than not causing them to move in somewhat different directions.

To deliver new research results that translate into more rapid and measurable progress toward development impacts, as outlined above, the Consortium must now mobilize Center capacities far more efficiently in collaboration with partners (see Box 6 on page 26). The sections that follow describe how the CGIAR will build capacities in six areas, and how it will address crosscutting concerns.

Agricultural productivity

The CGIAR has an impressive record of success in improving all of the crops on which global and regional food supplies chiefly depend (see page 8). In this work, multidisciplinary teams of Center scientists combine conventional breeding and biotechnology to reach breeding goals informed by related disciplines such as agronomy, entomology, and plant pathology and physiology. These researchers draw on vast collections of plant genetic resources held in trust for humanity by CGIAR genebanks under the International Treaty on Genetic Resources for Food and Agriculture (see pages 16-17). All CGIAR crop research is tightly linked with that of national partners, generally through far-reaching commodity networks.

Natural resource management

Since the early 1990s, the CGIAR has undertaken research on the whole range of natural resources, including soil, water, forests, rangelands, fisheries and biodiversity. It is one of the few organizations whose work on these resources spans the local and global scales. For that reason, the CGIAR has a unique role to play in linking the development of better management practices with the creation of policies that pave the way for their wide adoption in rural areas.

In general, this research is well organized in the CGIAR and well connected with the efforts of the wider communities working in specific sectors. Nonetheless, pathways are open to the CGIAR and its partners for better integration — for example, between land and water management and in research on the use of payment for ecosystem services to benefit the rural poor in developing countries.

Social science perspectives

While the social sciences have received less emphasis in recent years because of reduced funding, the CGIAR still has the largest capacity in this area of any single organization engaged in public agricultural research for development. Its social scientists — distributed across Centers, including one dedicated to food policy research — have addressed a wide range of issues, such as global food supplies, human nutrition, natural resource management, the gender dimensions of technological change and impact assessment.

Farming systems

Past agricultural research has typically focused on single crops and livestock species. But farmers in developing countries seek to improve the productivity and profitability of whole farming systems. Therefore, to deliver key development impacts, the CGIAR and its partners must broaden their approach to improving production systems by learning from successful models such as collaborative research on South Asia's rice-wheat system (see Box 4 on page 13).

A central challenge for this research is to heighten the resource-use efficiency of quite diverse farming

BOX 6

Realizing Potential through Partnership

New science must be brought to bear more effectively on the complex challenges of smallholder agricultural production, which is a mainstay for most of the rural poor. If this science is to deliver on its promise, then clearly all participating organizations must work together to deliver the development outcomes that poor people urgently need.

This is a key purpose for which the CGIAR embarked on major reforms, and it is why the Global Forum on Agricultural Research organized in 2010 the first Global Conference on Agricultural Research for Development, to be followed by similar events every 2 years. The conference provides a venue for building a broad consensus around the steps needed to transform a currently fragmentary system of agricultural and environmental research into a more cohesive and effective effort.

Based on that consensus, the CGIAR is already broadening and strengthening its partnerships to assemble the capacities needed for research that catalyzes innovation locally and nationally. In rice research, for example, a coalition of three CGIAR Centers and three other international organizations has brought together about 900 partners worldwide. Their roles vary from upstream science to policy development and the grassroots dissemination of research results.

For research on climate change, to cite another example, CGIAR scientists spread across all 15 of the CGIAR Consortium member Centers are forming an extensive network of global, regional and local partners. Particularly novel is their new alliance with the Earth System Science Partnership, which combines the CGIAR's expertise in research on agriculture and natural resources with the world's best climate science. This combination of talents will enable higher-quality assessments of climate change impacts, which should provide a more reliable basis for dialogue and collaboration toward climate change adaptation and mitigation.

All of the CGIAR Research Programs now being developed and launched are making similar efforts to realize the full potential of collaborative research through partnerships that are strong and inclusive.

systems involving multiple crops, livestock and natural resources. Since no single Center or partner has all the capacity needed to achieve this, a more integrated research approach is essential.

Global climate change

Several decades ago, CGIAR scientists began searching for ways to help farmers cope more effectively with harsh and erratic weather. For that reason, the CGIAR as a whole is already well along in research that is relevant to global climate change, with clear comparative advantages in crop improvement and natural resource management.

To realize the full potential of this research, however, the CGIAR must extend its current capacities. Better expertise in spatial modeling and risk management, for example, is critical to the more accurate targeting of measures toward climate change adaptation. Likewise, stronger capacity in policy and institutional development is essential to mitigating climate change through viable schemes for carbon trading based on the sustainable management of forests and agricultural landscapes. The success of the CGIAR and its partners in climate change adaptation and mitigation will greatly affect their progress in delivering all four of the development impacts identified in the Strategic Results Framework document.

Nutrition and health

CGIAR research on crop biofortification provides — along with important efforts to combat livestock diseases, diversify agricultural systems and increase food safety — a firm foundation for progress in generating large nutritional and health benefits from agriculture. Nonetheless, to achieve significant impacts, the CGIAR's capacities must be linked more closely with those of the nutrition and health communities.

Stronger links between these historically divided interests will enable them to work far more effectively to devise and target sustainable means of reaching the most vulnerable populations with more nutritious foods. Stronger collaboration between them is also essential to the complex task of reliably measuring changes in nutrition and health that result from interventions in agriculture.

Crosscutting concerns

To support new research in the areas described above, the CGIAR will address three key crosscutting concerns, as explained here.

Gender inequality in agriculture. Though women account for more than half of agricultural output in developing countries, they are underrepresented in research and development. Their limited inclusion translates into huge missed opportunities for poverty reduction, stronger food and nutritional security, and better stewardship of natural resources. Under its new strategy, the CGIAR will employ gender analysis strategically to identify the most appropriate points of intervention — such as land rights, nutritional education, and access to inputs and services — for reducing gender inequality. It will reinforce this work through capacity strengthening, particularly in South Asia and sub-Saharan Africa, where the problem is most pronounced.

National research capacity. The quality of CGIAR research depends on the strength of its partnerships, which depends in turn on collective and individual capacities at the national level. In all of its collaborative research, the CGIAR will emphasize strengthening partners' research capacities through innovative learning approaches. It will seek to enhance their participation in knowledge networks and exchange, partly through the better use of new information and communication strategies.

Data management. The CGIAR possesses a unique capacity to amass data on agriculture and natural resources across the developing world. Though costly to generate, these data are essential ingredients of useful research results. Yet, the project-by-project approach that has prevailed in funding research in recent years greatly complicates the task of properly archiving and sharing data sets.

The CGIAR's new research strategy, with its emphasis on more-integrated research approaches, provides an opportunity to collect, analyze, use and disseminate data more systematically. This is essential not only for achieving better results from collaborative research but also for more thoroughly measuring development impacts.

A better way of working

The CGIAR Research Programs (CRPs) are the mechanism by which the research capacities described above will be deployed to deliver key development impacts. These programs mark the beginning of a new and better way of working in the CGIAR toward creating a better future for the world's poor.

The hallmarks of these programs are their strategic focus on development impacts, their integration of research capacities within and outside the CGIAR, and their commitment to working through open partnerships. Implementing a comprehensive portfolio of CRPs will require a substantial increase in funding for international and national research. All the programs will provide clarity about the way in which additional funds are used and about the results that donors can expect from increased investment.

Two such programs were launched in late 2010:

- Global Rice Science Partnership. With an initial 5-year budget of nearly US$600 million, this program will deliver innovations in rice genetics, agronomy, postharvest processing and policy that strengthen food security through large and sustainable increases in

Gender and Diversity Program of the CGIAR

In July 1999 the CGIAR launched its Gender and Diversity Program to help Centers leverage rich staff diversity to strengthen research and management excellence. Between 2003 and 2008, women's holding of CGIAR science positions rose from 20 to 26% and of leadership positions almost doubled from 9 to 16%. In 2008, the program launched African Women in Agricultural Research and Development (AWARD). By 2010 AWARD had reached 416 scientists in 139 organizations. AWARD aims to strengthen the research and leadership skills of African women in agricultural science, empowering them to contribute more effectively to poverty alleviation and food security in sub-Saharan Africa.

CGIAR research aims to unlock the potential of the world's vast drylands, which occupy 40% of the earth's land area, support a third of its population and are especially vulnerable to climate change.

BOX 7

Unlocking the Potential of Drylands

As CGIAR researchers and their partners address new challenges and opportunities in agriculture, they must also confront various problems that have proved especially recalcitrant over the years, despite determined research efforts. This time, though, researchers expect to prevail by building on recent successes and by working in a new way to mobilize more research capacity and more resources.

One particularly large piece of unfinished business for CGIAR research is to unlock the potential of the world's vast drylands, which occupy 40% of the earth's land area, support a third of its population and are especially vulnerable to climate change. Impressive results from a number of initiatives now under way are helping define the keys to success.

Research in North Africa, for example, that successfully integrated shrubs for livestock fodder into farmers' barley-based cropping systems underlines the importance of focusing on whole agro-ecosystems rather than on single crops. A more recent regional initiative to boost water productivity in 10 countries of the Middle East further demonstrates the effectiveness of an integrated systems approach. Together with participatory methods, this has encouraged farmers in Egypt to adopt multiple technologies such as supplemental irrigation and planting wheat on raised beds, enabling water savings of 30% and a 30% increase in farmers' incomes.

Community-based, participatory approaches have also proved their worth through integrated watershed programs in South Asia. Such approaches have stimulated demand for new technologies, boosting the adoption of products that had previously gathered dust on the shelf, including new varieties of cereals and grain legumes, more efficient irrigation techniques, and improved livestock breeds and agroforestry techniques. As a result, watersheds across Asia are becoming engines of sustainable growth in rainfed agriculture, delivering higher productivity, enhanced rural livelihoods and better ecological services, such as groundwater recharge and reduced soil erosion. Impressed with the results, India's national and state governments have been especially supportive of community watershed programs.

Moreover, the stream of dryland innovations continues. An innovative livestock insurance scheme introduced in Kenya's drought-prone Marsabit District during 2010, for example, shows great promise for reducing pastoralists' vulnerability to catastrophic livestock losses.

Drawing on such experiences, new CGIAR research will strive to get the mix of innovations right in diverse dryland environments, channeling benefits to women in particular, who are often the de facto heads of households in drylands.

crop yields (led by the International Rice Research Institute).

- **Climate Change, Agriculture and Food Security.** With an initial 5-year budget of US$392 million, this program will offer smallholder farmers new options for climate change adaptation and mitigation that closely match their circumstances (led by the International Center for Tropical Agriculture).

Three more programs received donor approval in early 2011:

- **Forests, trees and agroforestry: livelihoods, landscapes and governance.** Better conservation and more sustainable management of these resources will mitigate climate change while enhancing rural livelihoods (led by the Center for International Forestry Research).

- **Maize: global alliance for improving food security and livelihoods of the resource-poor in the developing world.** More intensive, sustainable and resilient maize-based farming systems will boost productivity, with essentially no expansion of area sown to this crop (led by the International Maize and Wheat Improvement Center).

- **Integrated agricultural production systems for the poor and vulnerable in dry areas.** Improved technologies and policies will enable smallholders to raise their incomes and better manage risk through more diverse and sustainable systems (led by the International Center for Agriculture in the Dry Areas).

Approval of more CRPs is expected in 2011:

- **Agricultural systems in the humid tropics.** Research will strengthen local capacity to adopt a widening array of technologies and innovations that improve rural livelihoods (led by the International Institute of Tropical Agriculture).

- **Harnessing the development potential of aquatic agricultural systems for the poor and vulnerable.** Research will address the various constraints that rural households face in managing aquatic agricultural systems (led by the WorldFish Center).

- **Policies, institutions and markets to strengthen food security and incomes for the rural poor.** Policies that improve rural households' access to markets and service institutions will foster the wider adoption of new technologies that increase agricultural productivity and incomes (led by the International Food Policy Research Institute).

- **Wheat : global alliance for improving food security and livelihoods of the resource-poor in the developing world.** Sharp increases in wheat yield growth, stronger resistance to globally important diseases and pests, and enhanced adaptation to warmer climates will boost and stabilize the production of this staple grain (led by the International Maize and Wheat Improvement Center).

- **Roots, tubers and bananas for food security and income.** New methods will better enable smallholder farmers to access markets for higher-value products, thus raising their incomes and fostering more diverse farming systems (led by the International Potato Center).

- **Grain legumes: enhancing food and feed security, nutritional balance, economic growth and soil health for smallholder farmers.** Grain legumes such as chickpea, pigeonpea and groundnut will be used more effectively to enhance human nutrition, raise livestock feed quality and maintain soil health (led by the International Crops Research Institute for the Semi-Arid Tropics).

- **Dryland cereals: food security and growth for the world's most vulnerable poor.** More efficient research on inherently hardy dryland cereals such as sorghum and pearl millet will better satisfy the requirements of smallholder farmers (led by the International Crops Research Institute for the Semi-Arid Tropics).

- **More meat, milk and fish by and for the poor.** More productive smallholder livestock and fish

systems will make meat, milk and fish more affordable to poor consumers while raising rural incomes (led by the International Livestock Research Institute).

- Agriculture for improved nutrition and health. Changes in agriculture and food systems will accelerate progress in improving the nutrition and health of the poor (led by the International Food Policy Research Institute).

- Water, land and ecosystems. Research will pursue solutions to water scarcity and land degradation while contributing to the sustainable management of ecosystems (led by the International Water Management Institute).

With the likely approval of more of these CRPs by mid-2011, the CGIAR's shift to research through major global programs will be more than 50% complete.

Striking a chord of optimism

World events in recent years make it increasingly difficult to be optimistic about fulfilling the Millennium Development Goals. The goal of halving hunger and poverty by 2015 seems remote indeed in the aftermath of the 2008 food price crisis, which swelled the ranks of the poor and hungry by tens of millions.

Against this backdrop, the CGIAR's new research strategy and programs strike a chord of optimism. Going beyond vague promises, they set ambitious but realistic targets, with clear timelines for reaching them, based on well-founded projections and a strong record of development impact. Guided by that analysis and experience, the CGIAR and its partners are confident that they can boost agriculture's future performance in the developing world and avoid the unacceptable human suffering that will surely result in the absence of a thorough renewal of international and national research on agriculture and natural resource management.

The large projected benefits of this research are premised on substantially increased investment. To achieve global food security through sustainable agricultural development, research funding for developing countries will have to more than triple from US$5.1 billion annually today (including both national and international efforts) to $16.4 billion per year by 2025, according to CGIAR food policy experts.[1]

Investment in CGIAR research amounts to just over 10% of total public spending on agricultural research for development. Keeping this proportion more or less constant, and maintaining the CGIAR's unique role in delivering significant development impacts, would require the budget of the CGIAR to increase to at least $1.6 billion by 2025.

Investing more heavily in agricultural research comes at a cost. However, this cost pales next to the cost of later trying to reverse the unimaginable economic, social and environmental consequences of failing to act now.

1. A. Nin-Pratt & S. Fan (2009), *R&D Investment in National and International Agricultural Research: An Ex-ante Analysis of Productivity and Poverty Impact,* International Food Policy Research Institute background paper for developing the CGIAR Strategy and Results Framework.

Any strategy to reduce child malnutrition depends on enabling women, who bear the main responsibility for household diets and for much crop production, postharvest handling and food marketing.

2000s

2000

16 Centers

58 Members (of which 22 are developing countries)

2009

15 Centers*

64 Members (of which 25 are developing countries)

*In 2004, the International Service for National Agricultural Research was folded into the International Food Policy Research Institute.

A new CGIAR Research Program will address the various constraints that rural households face in managing aquatic agricultural systems.

CGIAR FINANCIAL HIGHLIGHTS, 1971-2011

Steady improvements in financial management and oversight – and now institutional reform – sustain the CGIAR despite decades of mandate expansion that outpaced funding support

Overview

As its research agenda evolved during the CGIAR's first 40 years, its funding and fiduciary policies and practices evolved in tandem to remain relevant to the prevailing research paradigm. Four broad phases of research and financing can be seen in the CGIAR's first 4 decades.

During the first decade, CGIAR research focused on boosting the productivity of the major cereal crops rice, wheat and maize, which underpinned the Green Revolution in Asia and Latin America. In those early days, research was conducted by autonomous Centers with mandates that sharply focused on the key commodities and seldom overlapped. The success and promise of the Green Revolution translated into generous funding from the rising budgets of members of the Development Assistance Committee for agricultural official development assistance (ODA). During the next 2 decades to the end of the 20th century, the CGIAR broadened its research to include sustainability, environmental protection, and socioeconomics and markets, as the number of Centers increased to 18. By the beginning of the 1990s, funding sources had expanded beyond traditional agricultural ODA, which was coming under competitive pressure from emerging development challenges linked to health, gender, education, the environment, infrastructure and energy. There was a sense of drift in the focus of research, and the quality of funding declined. These factors conspired in the mid-1990s to create the deepest financial crisis in the CGIAR's history.

At the beginning of the new millennium, as it became clearer that agricultural research needed to demonstrate its relevance to long-term food security and sustainable natural resource management, the CGIAR began to shift toward a more collaborative and partnership-oriented approach to tackling important crosscutting issues in research. In the financial realm, in addition to accelerating efforts to expand the funding base beyond maturing traditional sources, the CGIAR began to pay closer attention to sound financial management policies and practices, efficiency and cost-effectiveness, and financial risk management. The latest phase in the evolution of the CGIAR's research paradigm began to emerge toward the end of the first decade of the 21st century, propelled by a need to respond to new global challenges such as climate change and the food price crisis that exploded in 2008, with political reverberations reaching all the way to the Group of Eight Industrialized Nations. The CGIAR has again attempted to respond to the latest global circumstances by undertaking far-reaching reforms affecting how it carries out and evaluates its research and how it manages financial resources.

The first decade: the growth years

The first decade of the CGIAR was characterized by rapid growth in funding propelled by a favorable ODA environment and the expansion of both membership and the number of Centers. The success of the Green Revolution in Asia and Latin America in the late 1960s and early 1970s inspired confidence that research could deliver results with other crops, with livestock, and in more challenging environments. But first, to meet escalating funding needs, it was necessary to bring the original four Centers under the sponsorship of a larger donor group beyond the Ford and Rockefeller foundations. The formal establishment of the CGIAR in 1971 coincided with a shift in ODA priorities toward rural development and helping smallholder farmers in developing countries. As agricultural ODA expanded from $1.7 billion in 1971 to $7.9 billion in 1985 (www.oecd.org/dac/stats/agriculture), CGIAR funding also expanded. CGIAR membership increased from the 18 founding Members in 1971 to 35 in 1980, and the number of Centers expanded from the original 4 to 13 over the same period. The result of these developments was a rapid increase in CGIAR funding, which grew from $20 million in 1971 to $123 million by the end of the first decade.

Well-defined mandates centered on crop productivity, livestock in Africa, and overcoming constraints on agricultural development through better food policies, stronger institutions and germplasm conservation meant that financing CGIAR research was a relatively straightforward affair. Most funding was provided to Centers as whole institutions to carry out their approved research agendas, rather than constrained for use in specific programs or projects. The 1970s were probably the period when Centers enjoyed the most financial flexibility, as budgets were generally adequately funded and the quality of funding gave management and boards the ability to deploy resources as they judged best to implement the approved research agenda. Financial oversight was vested mainly in boards, at the Center level, though the annual program and budget review, first adopted in 1974, provided the beginnings of a mechanism for system oversight. Financial policy was developed and promoted by the CGIAR Secretariat mainly through budget guidelines, annual adjustments in response to changes in funding, and technical adjustments to accommodate inflation and foreign exchange fluctuations.

The second decade: moderation and consolidation

Although the number of Centers had stabilized at 13, the rapid growth in funding experienced in the first decade of the CGIAR's existence continued into the first half of the 1980s along with a favorable ODA environment. From 1980 to 1985, total funding increased by over 41% to $170 million. However, by the middle of the 1980s, the outlook began to look less rosy for the CGIAR. Although agricultural ODA continued to increase from $6.3 billion (21.3% of total ODA) in 1980 to peak at $7.9 billion (25.6%) in 1985, competing development priorities began to chip away at agricultural ODA. Fatigue regarding agricultural development seemed to emerge as attention in development circles shifted to emerging health crises (particularly HIV/AIDS), gender issues (especially girls' education), the environment, infrastructure and energy. Agricultural ODA fell to $6.2 bilion (10.2% of total ODA) in 1990, a trend that continued past the end of the decade. As growth in CGIAR funding began to slow, funding demands began to outstrip supply. CGIAR membership seemed to reach a plateau at 40 during the 1990s.

In the midst of moderation in growth, the CGIAR started to attend to a number of internal housekeeping matters, including the fiduciary and governance areas of programming and budgeting, policies and reporting, and oversight. Annual programming and budgeting gave way to a 3-year medium-term cycle, and the CGIAR Secretariat coordinated the initiation of a fiduciary framework comprising a series of guidelines on accounting, financial management and auditing to complement those on budgeting. Until the mid-1980s, CGIAR decision-makers had relied solely on the annual integrative report for information on the health of system programs and finances. The first CGIAR annual report, which included a review of financial performance at the Center and system level, was for 1984. The first set of Center board guidelines, complementing individual board bylaws, also emerged from this housekeeping exercise and established Center boards' clear accountability regarding fiduciary matters.

The third decade: challenging expansion

CGIAR research became more complex at the beginning of the 1990s, as its mandate expanded to include forestry, agroforestry, fisheries, and crosscutting issues such as gender, the environment, biodiversity and sustainability. Five new Centers were added to tackle the expanding mandate, bringing the total to 18. Membership also expanded with the addition of five developing countries (Colombia, Cote d'Ivoire, Egypt, Iran and Kenya) and two transitional economies (Russia and Romania), bringing total membership to 58 by the end of the decade. Figure 1 illustrates membership and funding growth.

Despite expansion on all these fronts, the funding outlook looked grim. The funding challenges that had started to emerge at the end of the 1980s seemed to accelerate during the early 1990s. Although funding seemed to be increasing in total, there were questions about the quality of growth because much of the incremental funding was tied to specific projects, which stymied financial flexibility while increasing the cost of management and reporting. This expansion of non-core funding resulted partly from pressure within donor agencies to demonstrate the efficiency and cost-effectiveness (or value for money) of their CGIAR investments. Moreover, the perceived loss of focus of CGIAR research and the need for structural reforms meant that responders to other development challenges that could demonstrate their effectiveness were able to divert high-quality funding away from the CGIAR. The apparent increase in funding in the first half of the 1990s masked two critical problems: (i) the widening gap between the real cost of approved research programs and available funding and (ii) inflation at a rate that exceeded funding growth, which meant there was effectively no funding growth in real terms. Figure 2 illustrates the CGIAR funding trends. Faced with these realities, Centers took drastic steps to control internal costs and reduce expenses, mainly through staff retrenchment, and improve operational efficiency. Unfortunately, these steps were insufficient, and the financial crisis of the early 1990s only deepened.

FIGURE 1

A Growing CGIAR

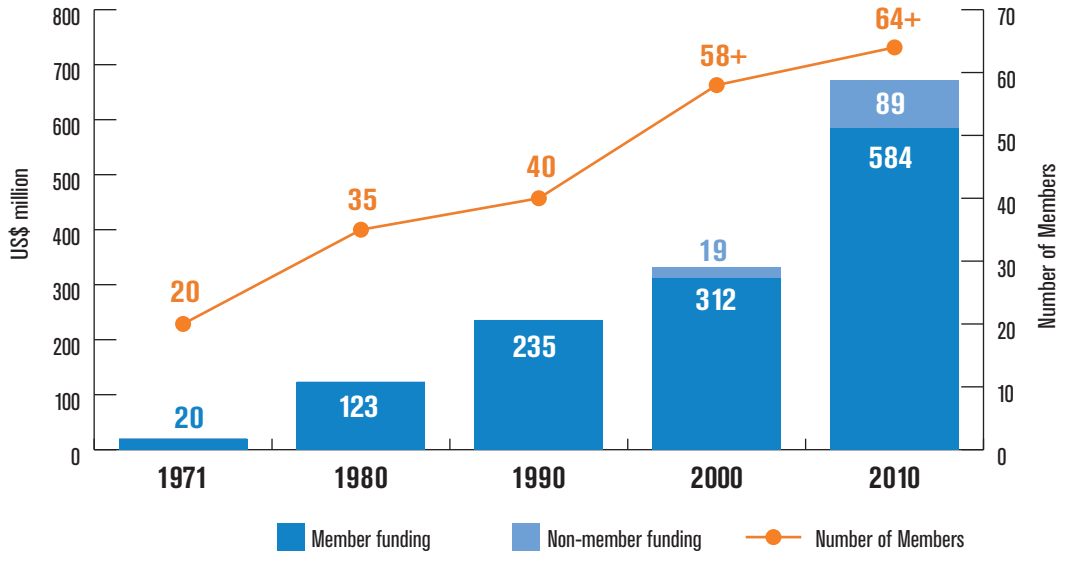
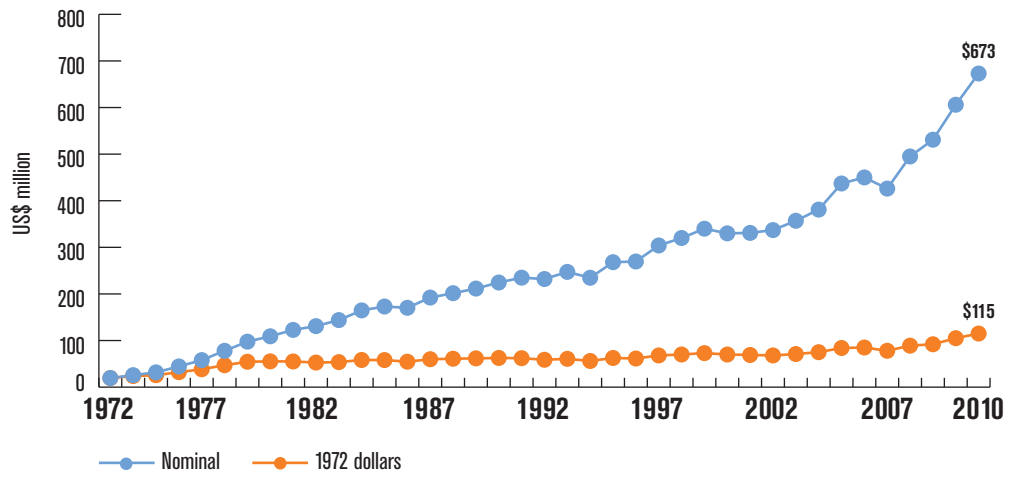


FIGURE 2

CGIAR Total Funding Trends

Nominal and in 1972 dollars



Getting a grip on the financial crisis

The CGIAR took a number of steps to address the deepening financial crisis. For the first time, a standing committee on finance was established with the remit to examine the role of the World Bank's balancing grants (which had been in effect since the 1980s) and the mechanism for resource allocation, as well as to formulate a strategy for mobilizing resources. In a continuing effort to rationalize research, bring about operational efficiencies and save money, two task forces recommended, and the CGIAR agreed, to merge the International Livestock Center for Africa and the International Laboratory for Research on Animal Diseases to create the International Livestock Research Center and to fold the International Network for the Improvement of Banana and Plantain into the administrative and governance ambit of the International Plant Genetic Resources Research Institute (since renamed Bioversity International), thus reducing the number of Centers to 16. (A decade later, the International Service for National Agricultural Research was folded into the International Food Policy Research Institute, further reducing the number of Centers to 15.) Figure 3 illustrates the evolution of Centers.

A ministerial-level meeting held in Lucerne, Switzerland, in early 1995 focused on ways to increase funding through increased membership. Members from the South were targeted. The new CGIAR leadership succeeded in convincing the World Bank to provide a one-time special grant of $20 million paid over 2 years, to be matched 2 for 1 by new funding from other donors. The expected new funding materialized, and the $10 million World Bank grant for each year was fully matched. The result of these efforts was the full funding of the $270 million 1995 budget and the $305 million 1996 budget. Optimism about finances started to return to the CGIAR, as evidenced by the launching of new systemwide and ecoregional programs.

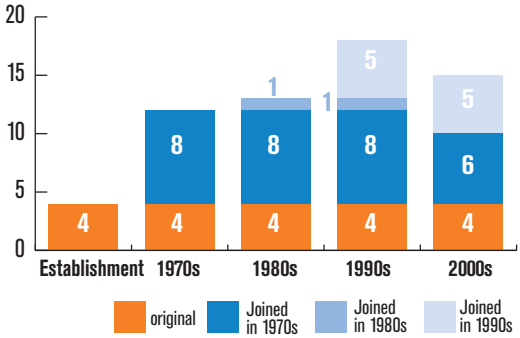
Stubborn financial issues

This optimism turned out to be short-lived because, despite concerted efforts in the mid-1990s, the underlying financial challenges remained at the close of the decade. The decline of core funding as a percentage of total funding appeared to be accelerating, as unrestricted funding seemed to reach a plateau at $200 million and tied funding from non-members increased rapidly, straining Centers'

cost structures and constraining financial flexibility. Membership expansion did not necessarily translate into a commensurate increase in high-quality funding, as several Members in the South were challenged to pay even the required minimum annual contribution of $0.5 million. In 2000, the CGIAR reached a dubious milestone, as the amount of restricted funding matched the amount of unrestricted funding, subsequently exceeding it (Figure 4). Although not readily apparent, the stagnation of funding in real terms experienced earlier in the 1990s was still very much a constraint. Finally, many Centers saw their purchasing power drastically curtailed by inflation and destabilized by wide swings in foreign exchange values. A direct result of this was that the central CGIAR Stabilization Fund, which had been set up using resources from the World Bank and other donors, was completely depleted by 1992.

FIGURE 3

Evolution of Centers

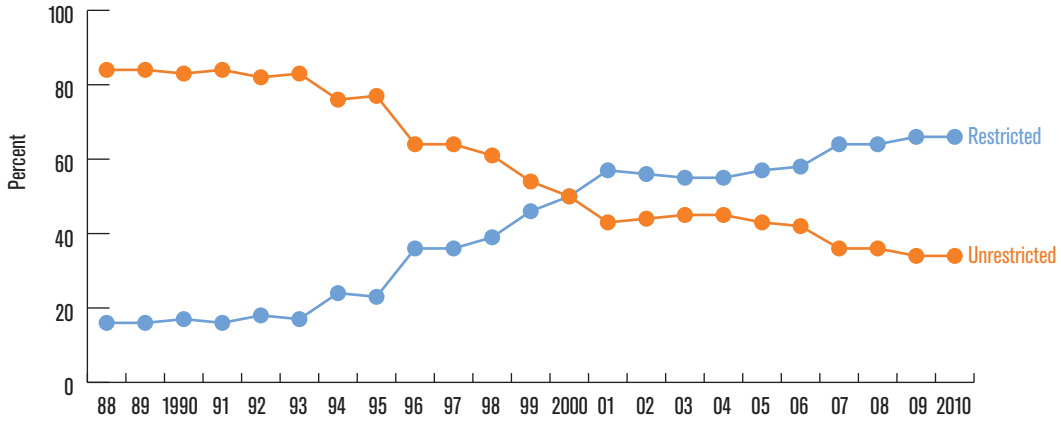


The fourth decade: reforms to address continuing financial stress

In addition to the financial issues that persisted after the end of the 1990s — declining agricultural ODA, funding stagnation in real terms, and Centers' constrained financial flexibility — the new millennium opened with the spreading realization that the research agenda itself was challenged by exogenous issues that the CGIAR needed to play a role in addressing. The issues of climate change and HIV/AIDS, for example — along with the crosscutting issues of the 1990s, such as biotechnology, gender, and the many problems and opportunities addressed by systemwide and ecoregional programs — only confirmed that CGIAR research had become more complex and would become even more so in the coming years. The United Nations had just adopted the Millennium Development Goals in 2000, with enormous implications for the work of the CGIAR. Clearly, the annual funding envelope of $330-340 million would not suffice.

FIGURE 4

Composition of CGIAR Funding



The CGIAR felt that a new set of reforms was needed to address its external and internal challenges. Of the package of reforms that was adopted in 2001, the introduction of Challenge Programs had the most far-reaching financial impact. The World Bank's contribution was used to provide catalytic funds for them, leveraging substantial amounts from other Members and non-members beginning in 2003. An internal analysis showed that Challenge Programs did not diminish unrestricted funding and that the new funds that they generated helped boost funding for the CGIAR overall. Challenge Program funding grew from $8 million in 2003 to $65 million by 2010.

Another pillar of the 2001 reform was the establishment of the Science Council, which replaced the Technical Advisory Committee. The Science Council budget averaged $2.5-3.0 million, but the formula for funding it did not significantly differ from the one for funding the Technical Advisory Committee until 2005, when a stopgap measure was adopted to provide funding mainly from the World Bank's CGIAR contribution, topped by discretionary support from individual Members. In 2007 a permanent formula that included a levy of up to 1% of Centers' funding went into effect.

Governance and fiduciary management in the 21st century

Perhaps the most important pillar of the 2001 reform was the establishment of the Executive Council (ExCo) as a stakeholder committee that had as one of its main responsibilities overseeing CGIAR finances, though oversight remained formally vested in the CGIAR through its Annual General Meeting. The impact of ExCo's oversight was keenly felt across the Centers as their annual financial performance was reported to ExCo, which required corrective action whenever warranted. When the first report was made to ExCo in 2002, more than half a dozen Centers had red flags on one or more of the agreed financial benchmarks. By 2009, the only Center remaining in this category was on a positive trajectory to reverse that status.

Financial policy development and financial reporting made significant progress during the decade. The Financial Guidelines Series was regularly updated and expanded to take into account both internal and external developments that affected accountancy and related disciplines and to promote best fiduciary practice. These guidelines, developed to provide the framework for fiduciary policies and procedures in Centers and programs, were approved by the CGIAR, through ExCo, before taking effect. Financial reporting had come a long way from the integrative reports of the 1970s and 1980s. A comprehensive, standalone financial report was produced annually beginning in 2000. In 2004, a peer review system was instituted, bringing in peers from Centers selected by rotation to review the audited financial statements submitted by Centers for compliance with CGIAR fiduciary guidelines and to vouch for the analysis underpinning the CGIAR financial report. This and the collaborative arrangement for drafting the annual financial report helped to instill a sense of collective ownership of the various financial products.

Trouble spots in system

From 2003, externally generated crises and other financial failures jolted the CGIAR. A civil war in Côte d'Ivoire, the host country of the Africa Rice Center, required its staff to be evacuated to temporary headquarters outside the country. In 2003, the CGIAR decided to request the board of the International Service for National Agricultural Research to dissolve the Center, at a cost of $4.0 million. During the second half of the decade the International Maize and Wheat Improvement Center required a substantial transfusion of $3.0 million to restructure itself, followed by International Center for Tropical Agriculture, which required $2.3 million. In all of these cases the CGIAR leadership decided to use some of the World Bank's contribution under the rubric of "emergencies and restructuring" to provide resources to address these challenges, in addition to any other financial assistance from individual Members. These allocations were typically endorsed by ExCo and reported internally within the World Bank.

CGIAR investment by region: focus on Africa

Out of concern that the Green Revolution had essentially bypassed sub-Saharan Africa, the CGIAR began to channel more funding into research for this region. In 1992, it began monitoring and recording its

investments by region. Figure 5 illustrates the shift of investment to sub-Saharan Africa, whose share rose from 39% in 1992 to 50% in 2010.

A newly favorable climate

As the first decade of the 21st century drew to a close, there were signs that agriculture was staging a comeback on the international development agenda. The *World Development Report 2008* of the World Bank called attention to expanding demand for food, feed and biofuels; the consequences of climate change; rising energy prices; and other issues related to agriculture. World Bank lending for agriculture picked up from $1.4 billion in fiscal year 2001 to $2.1 billion in fiscal year 2005, and the 2008 and 2009 summits of the Group of Eight Industrialized Nations in Hokkaido and L'Aquila featured food security on their agendas. At the Rome World Food Summit in June 2008, World Bank President Robert B. Zoellick presented a 10-point plan to achieve food security that called for doubling funding for the CGIAR between 2008 and 2013. Augmenting stepped up efforts by traditional ODA donors, the CGIAR's funding base expanded to include more non-members, whose combined contributions swelled from $19 million (6% of total funding) in 2000 to $89 million (13%) in 2010 (Figure 1). The Bill & Melinda Gates Foundation became the most prominent such donor. Total funding reached $673 million in 2010, placing the CGIAR within striking distance of its target of $1 billion by 2013. Table 1 highlights the top-10 donors at the end of each decade.

In this positive climate, the CGIAR recognized that maintaining its relevance to global challenges required it to deepen its reforms. This realization prompted the CGIAR to launch in 2008 its Change Management Initiative, which culminated in the latest set of reforms. The most salient financial aspects of these reforms are (i) the shift from Member-centered fiduciary oversight by ExCo and the Annual General Meeting to Consortium-driven oversight with the Center boards and (ii) a centralized funding pool to finance large CGIAR Research Programs, with donors entrusting a substantial portion of their traditional sovereignty in resource allocation to the Fund Council.

FIGURE 5

CGIAR Investment by Region

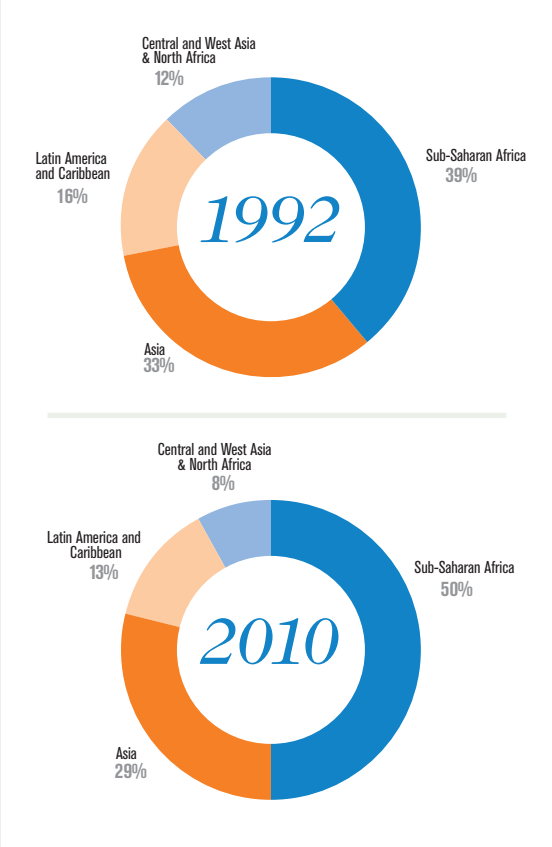


TABLE 1

Top Donors by Decade

US$ million

1971-1979		1980-1989		1990-1999		2000-2010	
United States	105.7	United States	412.7	World Bank	426.8	United States	650.4
World Bank	42.9	World Bank	236.0	United States	392.3	World Bank	539.9
Canada	39.3	Japan	127.9	Japan	321.9	United Kingdom	389.4
Germany	33.9	Canada	103.0	European Commission	159.3	European Commission	337.5
Inter-American Development Bank	29.2	Inter-American Development Bank	88.8	Switzerland	149.7	Canada	298.2
United Kingdom	23.7	Germany	87.5	Germany	146.7	Bill & Melinda Gates Foundation*	218.6
Rockefeller Foundation	21.2	United Kingdom	78.1	Canada	143.6	Switzerland	198.5
Ford Foundation	20.3	United Nations Development Programme	72.1	Netherlands	110.3	Netherlands	185.6
United Nations Development Programme	19.3	European Commission	67.3	United Kingdom	109.7	Japan	184.0
Sweden	15.3	Switzerland	58.5	Denmark	102.8	Germany	170.6
		Italy	58.5				

* Began contributing in 2004

Improved forage technologies provide more and better quality fodder for cattle.

A 2008 study of potato improvement found varieties originating in the CGIAR sown on more than 1 million hectares, double the area documented just 5 years before.

THE CGIAR IN 2010

CGIAR FUND COUNCIL COMPOSITION

Chair: Inger Andersen
Executive Secretary: Ren Wang

DONOR COUNTRIES

Europe: European Commission (Marc Debois), Norway (Ruth Haug), Sweden (Philip Chiverton), United Kingdom (Jonathan Wadsworth)
North America: Canada (Catherine Coleman), USA (Robert Bertram)
Asia: Japan (Keiichi Sugita)
Pacific: Australia (Nick Austin)

DEVELOPING COUNTRIES AND REGIONAL ORGANIZATIONS

Sub-Saharan Africa: Kenya (Romano Kiome), Nigeria (B.Y. Abubakar)
Asia: China (Huajun Tang), India (S. Ayyappan)
Pacific: Papua New Guinea (Raghunath Ghodake)
Central and West Asia and North Africa: Iran (Jahangir Porhemmat)
Latin America and the Caribbean: Brazil (Luciano Nass)
Regional Fora: Fondo Regional de Tecnologia Agropecuaria (Mario Allegri)

MULTILATERAL AND GLOBAL ORGANIZATIONS

World Bank: Juergen Voegele
International Fund for Agricultural Development: Rodney Cooke
Food and Agriculture Organization of the United Nations: Anton Mangstl
Global Forum on Agricultural Research: Monty Jones

FOUNDATIONS

Bill and Melinda Gates Foundation: Prabhu Pingali
International Development Research Centre: Jean Lebel

CGIAR FUND OFFICE

Executive Secretary of the Fund Council and Head of the Fund Office: Ren Wang

CGIAR TRUSTEE

Ulrich Hess

INDEPENDENT SCIENCE AND PARTNERSHIP COUNCIL

Chair: Roelof (Rudy) Rabbinge
Members: Derek Byerlee, Ken Fischer, Hans Herren, Jeffrey Sayer, Beatriz da Silveira Pinheiro
Executive Director: Peter Gardiner

CONSORTIUM OF INTERNATIONAL AGRICULTURAL RESEARCH CENTERS

CONSORTIUM BOARD COMPOSITION:

Carlos Pérez del Castillo, *Chair*
Carl Hausmann, *Vice Chair*
Tom Arnold
Mohammed Ait-Kadi
Ganesan Balachander
Gebisa Ejeta
Ian Goldin
Lynn Haight
Lloyd Le Page, *ex-officio board member*

CONSORTIUM OFFICE

Lloyd Le Page, *Chief Executive Officer*

RESEARCH CENTERS

Africa Rice Center
Getachew Engida, *Board Chair*
Papa Abdoulaye Seck, *Director General*

Bioversity International
Paul Zuckerman, *Board Chair*
Emile Frison, *Director General*

International Center for Tropical Agriculture
Juan Lucas Restrepo, *Board Chair*
Ruben Echeverria, *Director General*

Center for International Forestry Research
Andrew Bennett, *Board Chair*
Frances Seymour, *Director General*

International Maize and Wheat Improvement Center
Julio Berdegué, *Board Chair*
Thomas Lumpkin, *Director General*

International Potato Center
Peter VanderZaag, *Board Chair*
Pamela Anderson, *Director General*

International Center for Agricultural Research in the Dry Areas
Henri Carsalade, *Board Chair*
Mahmoud Solh, *Director General*

International Crops Research Institute for the Semi-Arid Tropics
Nigel Poole, *Board Chair*
William Dar, *Director General*

International Food Policy Research Institute
Fawzi Al-Sultan, *Board Chair*
Shenggen Fan, *Director General*

International Institute of Tropical Agriculture
Bryan Harvey, *Board Chair*
P. Hartmann, *Director General*

International Livestock Research Institute
Knut Hove, *Board Chair*
Carlos Seré, *Director General*

International Rice Research Institute
Elizabeth Woods, *Board Chair*
Robert Zeigler, *Director General*

International Water Management Institute
John Skerritt, *Board Chair*
Colin Chartres, *Director General*

World Agroforestry Centre
Eric Tollens, *Board Chair*
Dennis Garrity, *Director General*

WorldFish Center
Remo Gautschi, *Board Chair*
Stephen Hall, *Director General*

CGIAR MEMBERS 2009*

African Development Bank
Arab Fund for Economic and Social Development
Asian Development Bank
Australia
Austria
Bangladesh
Belgium
Brazil
Canada
China
Colombia
Commission of the European Community
Côte d'Ivoire
Denmark
Arab Republic of Egypt
Finland
Food and Agriculture Organization of the United Nations
Ford Foundation
France
Germany
Gulf Cooperation Council
India
Indonesia
Inter-American Development Bank
International Development Research Centre
International Fund for Agricultural Development
Islamic Republic of Iran
Ireland
Israel
Italy
Japan
Kellogg Foundation
Kenya
Republic of Korea
Luxembourg
Malaysia
Mexico
Morocco
Netherlands
New Zealand
Nigeria
Norway
Opec Fund for International Development
Pakistan
Peru
Philippines
Portugal
Rockefeller Foundation
Romania
Russian Federation
South Africa
Spain
Sweden
Switzerland
Syngenta Foundation for Sustainable Agriculture
Syrian Arab Republic
Thailand
Turkey
Uganda
United Kingdom
United Nations Development Programme
United Nations Environment Programme
United States of America
World Bank

* CGIAR membership as of December 2009. With reform, former CGIAR Members and others are welcomed as donors to the CGIAR Fund.

CGIAR 1971-2010

CGIAR FUND COUNCIL CHAIR, 2010-
Inger Andersen, 2010-

CGIAR CHAIRS, 1971-2010
Katherine Sierra, 2006-2010
Ian Johnson, 2000-2006
Ismail Serageldin, 1994-2000
V. Rajagopalan, 1991-1993
Wilfried Thalwitz, 1990-1991
W. David Hopper, 1987-1990
S. Shahid Hussain, 1984-1987
Warren Baum, 1974-1983
Richard H. Demuth, 1971-1974

EXECUTIVE SECRETARY OF THE CGIAR FUND COUNCIL AND HEAD OF THE FUND OFFICE, 2010
Ren Wang, 2010

CGIAR DIRECTORS, 2001-2010
Ren Wang, 2007-2010
Francisco J.B. Reifschneider, 2001-2007

CGIAR EXECUTIVE SECRETARIES, 1972-2001
Alexander von der Osten, 1989-2001
Curtis Farrar, 1982-1989
Michael Lejeune, 1975-1982
Harold Graves, 1972-1975

INDEPENDENT SCIENCE AND PARTNERSHIP COUNCIL CHAIR, 2010-
Roelof (Rudy) Rabbinge, 2010

INDEPENDENT SCIENCE AND PARTNERSHIP COUNCIL EXECUTIVE DIRECTOR, 2010-
Peter Gardiner, 2010-

SCIENCE COUNCIL CHAIRS, 2004-2009
Roelof (Rudy) Rabbinge, 2007-2009
Per Pinstrup-Andersen, 2004-2006

SCIENCE COUNCIL EXECUTIVE DIRECTOR, 2004-2009
Ruben Echeverria, 2004-2009

INTERIM SCIENCE COUNCIL CHAIR, 2002-2003
Emil Q. Javier, 2002-2003

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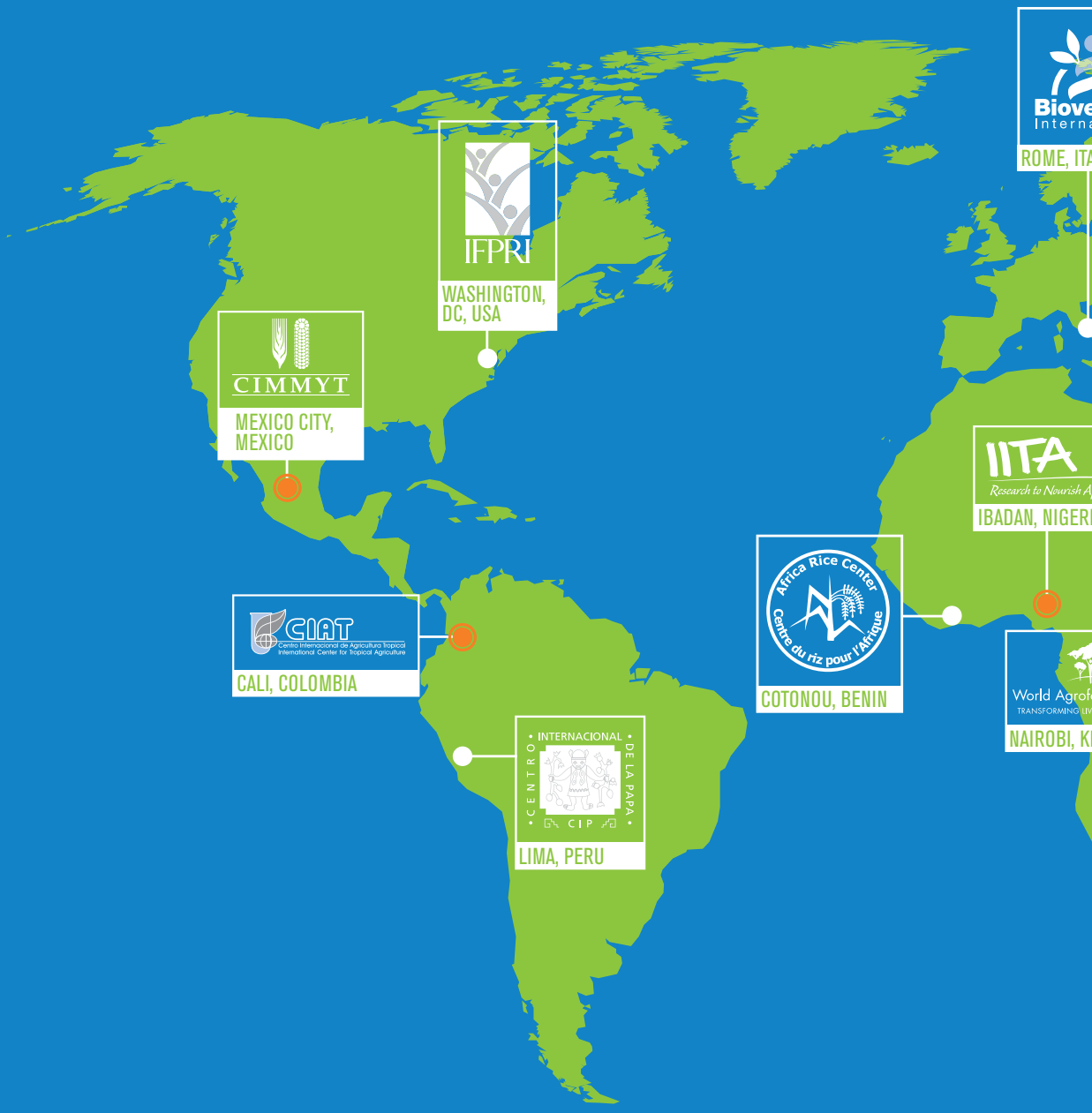
CONSORTIUM OF INTERNATIONAL AGRICULTURAL RESEARCH CENTERS



Placement markers are approximate and indicate city locations.

Original 4 Centers

ALEPPO, SYRIA

PATANCHERU, INDIA

PENANG, MALAYSIA

LOS BAÑOS, PHILIPPINES

BATTARAMULLA, SRI LANKA

BOGOR, INDONESIA

NAIROBI, KENYA

Original Centers at founding in 1971

CIAT

CIMMYT

IITA

IRRI

Joined the CGIAR in the 1970s

ICRISAT, 1972

CIP, 1973

ILRI (ILCA & ILRAD), 1973-1974

Bioversity, 1974

ICARDA, 1975

Africa Rice, 1975

IFPRI, 1979

Joined the CGIAR in the 1990s

IWMI, 1991

World Agroforestry, 1991

WorldFish, 1992

CIFOR, 1993

ABBREVIATIONS

AWARD	African Women in Agricultural Research and Development
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture), Colombia
CIFOR	Center for International Forestry Research, Indonesia
CIMMYT	Centro Internacional de Mejoramiento de Maiz y Trigo (International Maize and Wheat Improvement Center), Mexico
CIP	Centro Internacional de la Papa (International Potato Center), Peru
CRP	CGIAR Research Program
ExCo	Executive Council of the CGIAR
HIV/AIDS	human immunodeficiency virus/acquired immune deficiency syndrome
ICARDA	International Center for Agricultural Research in the Dry Areas, Syria
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics, India
IFPRI	International Food Policy Research Institute, USA
IITA	International Institute of Tropical Agriculture, Nigeria
ILRI	International Livestock Research Institute, Kenya
INIAP	Instituto Nacional Autónomo de Investigaciones Agropecuarias (National Institute for Agricultural Research), Ecuador
IRRI	International Rice Research Institute, Philippines
IWMI	International Water Management Institute, Sri Lanka
NERICA	New Rice for Africa
ODA	Official development assistance

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