# The birth of CIMMYT

Pioneering the idea and ideals of international agricultural research

CIMMYT MR
International Maize and Wheat Improvement Center

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**Abstract:** The birth of the International Maize and Wheat Improvement Center (CIMMYT) in Mexico was an experiment in applying the idea of international agricultural research for development and the ideals for designing international research programs. This paper traces the development and application of these concepts through the common lineage of CIMMYT and the International Rice Research Institute (IRRI), beginning briefly before World War II and accelerating with the establishment of the Rockefeller Foundation Office of Special Studies (Oficina de Estudios Especiales, or OEE) in Mexico in 1943. Myriad regional and country programs supported by the Rockefeller Foundation and other agencies laid the groundwork and provided lessons for the launch of CGIAR and the rapid expansion of international agricultural research from 1970 onwards as well as, more recently, the creation of CGIAR Research Programs.

CIMMYT MR
International Maize and Wheat Improvement Center

CIMMYT – the International Maize and Wheat Improvement Center (www.cimmyt.org) – is the global leader in publicly-funded maize and wheat research and related farming systems. Headquartered near Mexico City, CIMMYT works with hundreds of partners throughout the developing world to sustainably increase the productivity of maize and wheat cropping systems, thus improving global food security and reducing poverty. CIMMYT is a member of CGIAR Consortium and leads the CGIAR Research Programs on Maize and Wheat. The Center receives support from national governments, foundations, development banks and other public and private agencies.

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# Acronyms

| | |
|---|---|
| CIANO | Centro de Investigación Agrícola del Noroeste, Sonora state, Mexico |
| CIAT | International Center for Tropical Agriculture |
| CIMMYT | International Maize and Wheat Improvement Center |
| CIP | International Potato Center |
| CNM | Comisión Nacional de Maíz |
| CP | Colegio de Postgraduados, Mexico |
| CRP | CGIAR Research Program |
| FAO | Food and Agriculture Organization of the United Nations |
| IARI | Indian Agricultural Research Institute |
| ICA | International Cooperation Administration |
| ICAR | Indian Council of Agricultural Research |
| IIA | Instituto de Investigaciones Agrícolas (Institute of Agricultural Investigation) |
| IICA | Inter-American Institute for Cooperation on Agriculture |
| IITA | International Institute of Tropical Agriculture |
| INIA | Instituto Nacional de Investigaciones Agrícolas, Mexico |
| IRRI | International Rice Research Institute |
| MAP | Rockefeller Foundation's Mexican Agricultural Program |
| OEE | Oficina de Estudios Especiales (Office of Special Studies) |
| OIE | Oficina de Investigaciones Especiales (Office of Special Investigations) |
| PCCMCA | Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos y Animales |
| R&D | Research and development |
| UAch | Universidad Autónoma Chapingo |
| UN | United Nations |
| USAID | United States Agency for International Development |
| USDA | United States Department of Agriculture |

Norman Borlaug conducts a training course for wheat breeders at the experiment station in Ciudad Obregón, Mexico, 1963.

# Foreword

## International agricultural research: A "new" concept

In great detail and drawing on a broader collection of primary and secondary sources than previously seen in writings about CIMMYT's origins, Byerlee outlines the historical context in which the idea of international agricultural research took shape, as well as its causes and the diverse national and international programs through which it was applied, defined and improved.

Describing key institutions and actors, Byerlee delivers a rich and nuanced analysis of the emergence of the 1940s Rockefeller Foundation-Mexico program and others that finally gave birth to CIMMYT in 1966.

## Home of hunger fighters

As Center archives show, the individuals who signed the agreement that launched CIMMYT as an international organization in 1966 concurred that the Center "… should become a focal point for joining the critical battle now underway to provide enough food for the rapidly increasing population of the world."

They clearly envisioned agriculture as a means to achieve development, particularly in nations and regions with many rural inhabitants and where urban dwellers rely on bountiful grain harvests to ensure affordable supplies of food. This vision was reaffirmed by the World Bank's 2008 World Development Report[1], led by Byerlee and which cited cross-country estimates showing that GDP growth originating in agriculture is at least twice as effective in reducing poverty as GDP growth originating outside agriculture.

It now seems natural to us that global, publicly-funded networks should join the talent and resources of scientists and institutions across borders to foster more productive, profitable maize and wheat agriculture, and thus help to improve food security and prosperity. But Byerlee's study reminds us that this vision was once remarkably innovative. The lessons and events he reveals furnish valuable guidance for CIMMYT, an organization whose work substantively helps to address the converging challenges of climate change, fragile global grain markets and resource scarcities.

## Carrying forward the ideals

Byerlee also describes how these lessons are carried through to CGIAR and, looking to the future, in the continuing evolution of international agricultural research through the unified, global CGIAR Research Programs (CRPs). CIMMYT is proud to be leading two major CRPs and contributing significantly to several others, as well as to a spirit of positive and effective collaboration that runs through Byerlee's narrative as a key ideal. The Center had also played a lead role in the CGIAR System's governance reform, successfully completed in July 2016 and which is already creating a new sense of unity and collaboration among centers, partners and donors.

On behalf of CIMMYT and its many friends and partners, as well as those who value well-researched and presented history, I would like to thank Derek for a remarkable study that draws wisdom for CIMMYT's future from its complex roots.

***Martin Kropff***
***Director General***
***CIMMYT***

[1] Byerlee, De Janvry, et al. 2007, p. 6.

# Preface

The 50th anniversary of the International Maize and Wheat Improvement Center (CIMMYT), headquartered near Mexico City, provides an opportunity to celebrate the story of one of the world's most successful agricultural research institutes, which has made a difference in the lives of billions, and also the development of the idea and ideals of international agricultural research to benefit human welfare.

CIMMYT and the International Rice Research Institute (IRRI) were the pioneering international agricultural research centers, with common roots in the Rockefeller Foundation's Mexican Agricultural Program (MAP). The first director general of IRRI and his deputy had worked in the Mexican program in the 1940-50s, alongside the scientists who would later serve as CIMMYT's first director general and deputy. In fact, three of these four directors were maize breeders in the Mexican program. Together with other Rockefeller Foundation-funded leaders, they instituted the idea of research collaboration across countries, providing the rationale for establishing the international agricultural research system in the 1960s and 1970s.

My first objective of this paper is to describe the historical background leading to the founding of CIMMYT. The center's origins are closely linked to MAP, but the Mexican program was the mother ship to a range of Rockefeller-supported country and regional maize and wheat programs, as well as programs supported by other donors, especially the Ford Foundation, which were eventually merged into CIMMYT. These programs already had decades of experience refining the concepts of regional and global collaboration in agricultural research and assistance to build capacity in national programs. Though based on common principles, international research advanced differently in wheat and maize due to differences in crop characteristics, geographies, partnerships and the personalities involved.

My second objective is to trace the ideals of international agricultural research as they evolved in the decades preceding CIMMYT. Many basic principles were eventually enshrined in the creation of other centers and of the Consultative Group on International Agricultural Research (CGIAR) in 1971. They have of course changed considerably over the decades and some have been discarded, but many are still highly relevant.

My third objective is to relate the early experiences of establishing international agricultural research programs to the recent experience of building global CGIAR Research Programs, as part of the 2010 CGIAR reform agenda. The merger of several programs to create CIMMYT in 1966 offers many parallels and lessons.

All research builds on the shoulders of researchers who came before. I begin the story before World War II, when the building blocks for global awareness concerning the world food challenge and the potential of science to address it were put in place.

These trends accelerated dramatically during and after the war. At that time multiple factors – explosive population growth, the dismantling of colonial empires, the prospects of famine in Asia, and the rise of the development paradigm[2] and foreign aid as part of Cold War politics – generated a sense of urgency about the need to boost food production to solve world hunger. Few emerging countries were scientifically equipped to deal with these challenges, motivating investments by the Rockefeller Foundation and others.

The paper then describes the Foundation's Mexican program, which started in 1943, followed by three more country programs in Latin America, a program in India, and two in Sub-Saharan Africa, all of which prioritized maize and/or wheat research. Other actors later became involved, especially the Food and Agriculture Organization of the United Nations (FAO); the International Cooperation Administration (ICA), a predecessor to today's U.S. Agency for International Development (USAID); and the Ford Foundation.

The country programs featured elements of regional or even international cooperation

[2] The paradigm recognizes the responsibility of the state to foster rapid economic growth in poor countries in ways that reduce poverty and narrow the gap with more developed countries.

which over time were formalized into regional and international networks described in the next section. The Food and Agriculture Organization (FAO) of the United Nations and the U.S. Department of Agriculture (USDA) led their development and the Rockefeller Foundation, USAID, and European countries joined the effort. These programs eventually led to the creation of CIMMYT, in an evolutionary and somewhat messy process discussed later. The parallel development of IRRI to address rice, the most important crop in the developing world, also helped to create a model for CIMMYT. I end the story in 1971, when CIMMYT was consolidated programmatically, finally established its brand name, moved to a new campus in Central Mexico and joined CGIAR.

The final section fast forwards to today's challenges of creating or, as it turns out, recreating global crop and livestock/fish programs – the CRPs. It highlights lessons from experiences half a century ago relating to global crop programs, impact pathways, donor funding, and capacity development in national systems, all relevant to CGIAR reforms today.

This historical perspective on CIMMYT and international agricultural research is based largely on secondary sources, interspersed with key primary sources. It should not be seen as a comprehensive history of the creation of CIMMYT. Several hundred if not thousands of books, theses and articles have been written on the Rockefeller program in Mexico and the wheat revolution that was taking off when CIMMYT was created.[3] The focus here is on the institutional innovations for public research collaboration across countries, the development of the research culture that was embraced in CIMMYT and international research more generally and how these were initially formulated and tested.[4] These institutions are of course the result of the efforts of hundreds of dedicated people; some key players have been identified, with due apologies for omissions.[5] Nationalities are noted, except in the case of Rockefeller Foundation staff, who were almost all from the United States. Key dates and events in the story of CIMMYT and international research are included in Annex 1.

Many generous and caring individuals have contributed to the development of this document. Special thanks to Pedro Santamaria of the CIMMYT Archives, Karin Matchett, Marci Baranski, and the Rockefeller Archives for providing many original materials. Dana Dalrymple, Jesse Dubin, Greg Edmeades, Tony Fischer, Ken Fischer, Charlie Krull, Tom Payne, and Ernie Sprague provided valuable discussions and comments on the early evolution of CIMMYT. I appreciate the many comments and corrections received from those knowledgeable of the early years of CIMMYT, including Arnoldo Amaya, Jock Anderson, Carlos De Leon, Sanjaya Rajaram, Edgardo Moscardi, Don Winkelmann, Dagoberto Flores, Shawki Barghouti, Noel Vietmeyer, Gary Toenniessen and Alex McCalla. Mike Listman has provided invaluable guidance, encouragement, and editorial support throughout the process. Clyde Beaver is responsible for the clean design and Bianca Beks provided careful proofing. Finally, although I have tried to be accurate and objective, historical interpretation is subjective and any views expressed and remaining errors are mine and should not be attributed to CIMMYT.

***Derek Byerlee***

[3] The several biographies of Norman Borlaug also provide detailed historical accounts of the wheat program. The most comprehensive is the three volume work by Vietmeyer 2010.

[4] The review is limited to spring bread wheat and tropical and subtropical maize, although I recognize that the research programs of CIMMYT were broader, even when CIMMYT was established.

[5] Mainly I have included people who played leadership roles in CIMMYT and its predecessor organizations and those who have been internationally recognized such as winners of the World Food Prize.

The "El Horno" experiment station of the Universidad Autónoma Chapingo, Mexico, where Norman Borlaug began fieldwork as part of the Office of Special Studies in 1944.

Chapter 1

# Introduction

The birth of the International Maize and Wheat Improvement Center (CIMMYT) in Mexico was an experiment in applying the idea of international agricultural research for development and the ideals for designing international research programs. CIMMYT was created in 1966 by merging several regional and country research programs initiated by the Rockefeller Foundation and others to improve global food security. These programs had already amassed decades of experience in refining conceptual and practical aspects of regional and global agricultural research. Although the early CIMMYT wheat and maize programs were based on common core principles, they evolved differently due to their unique crop characteristics, geographies, partnerships, and the scientific personalities involved.

This paper traces the development of international agricultural research through the common lineage of CIMMYT and IRRI, beginning briefly before World War II and accelerating with the establishment of the Rockefeller Foundation Office of Special Studies (Oficina de Estudios Especiales, or OEE) in Mexico in 1943. After World War II, the world experienced explosive population growth and the dismantling of colonial empires, supplanted by the rise of the development paradigm and foreign aid as part of non-Soviet-bloc countries' efforts to stave off poverty and hunger in developing nations, lest they default to communism. These circumstances helped to generate a sense of urgency in boosting food production to solve world hunger. Accordingly, the Mexican program was followed by four more Rockefeller programs in Latin America, two in South and Southeast Asia, and two in Sub-Saharan Africa, all of which gave priority to maize and/or wheat research. Beginning in the 1950s, strong partnerships with the Food and Agriculture Organization of the United Nations (FAO), the Ford Foundation, the U.S. Agency for International Development (USAID) and the U.S. Department of Agriculture (USDA) extended the reach of the Rockefeller programs to West Asia and North Africa and throughout eastern and western Africa. The Foundation also supported basic research on maize and wheat at U.S. universities that was closely linked to the country-level and regional programs.

These programs were strongly results-oriented, aiming for increased food production and self-sufficiency, although the impact pathways to reducing hunger were poorly articulated. Together, they established many of the ideals of international agricultural research, especially the sharing and wide-scale testing of germplasm, germplasm collection and characterization, integration of several disciplines into coordinated crop programs, global scientific exchange and the sharing of scientific knowledge, sustained support over the long term for high-quality international scientists protected from political interference, and a commitment to building strong national systems through human and institutional capacity development.

The creation of CIMMYT was the logical result of a gradual merging of the Rockefeller and related programs. By 1960, the Mexican program had refocused as the maize and wheat research hubs for Latin America and, as of 1963, as global programs. By 1966, the wheat program was a fully integrated global program enjoying the early successes of the Green Revolution. The maize program was a looser-knit federation of programs that did not fully integrate until some years after CIMMYT was established; nonetheless the interlinked maize programs had already laid the basis for notable successes.

The experiences of CIMMYT and of IRRI (which became operational in 1962) laid the foundations for creating CGIAR, a global research partnership comprising 15 international or regional centers in collaboration with hundreds of partners, as well as for the rapid expansion of international agricultural research from 1970 onwards. These experiences are also relevant to the challenges of creating unified global programs (CGIAR Research Programs), subsequent to the fragmentation of post-war global programs and the decline of core funding support. Shortcomings in these early experiences remind us of the complexity even today of relating CGIAR's work to the global challenges of poverty and hunger, developing strategic partnerships for technology delivery and access to new science, and the long-term challenge of building strong national agricultural research systems.

Near the cradle of wheat, Ethiopia benefitted in the 1950s from improved varieties developed in Mexico and spread through USDA nurseries.

# Chapter 2 Growing concerns about food and hunger on the world stage

## Early foundations prior to World War II

The world food problem has been an ongoing debate at least since Thomas Malthus' book, *An Essay on the Principles of Population*, brought the issue to the fore in 1798, suggesting that population growth inevitably led to famine. At the dawn of the 20th century, there was much equally-gloomy discussion of the issue starting with the 1898 book, *The Wheat Problem*, by distinguished British scientist Sir William Crookes. The Food Research Institute of Stanford University launched an authoritative series of world wheat studies in 1921. Edward East, Harvard University professor and one of the developers of hybrid maize, weighed in with his book, *Mankind at the Crossroads*, in 1923. Wheat was the major theme in all these books, reflecting the interests of Europeans and Americans, whose food staple was bread.

The debate changed in the 1930s, when depression severely curtailed demand and led to a global grain glut. At the same time, there was growing awareness that much of the world lacked sufficient food. The budding science of nutrition then showed that even Europe's populace suffered from protein and micronutrient deficiencies. A seminal paper presented at the League of Nations in 1935 by Frank McDougall, Australian farmer and self-trained economist, and Stanley Bruce, ex-prime minister of Australia, argued for the marriage of agriculture and health by increasing agricultural production to meet the world's nutritional needs.[6] This was further developed by the first League committee on agriculture, but the nascent efforts ended with the outbreak of World War II. Still, the groundwork had been laid for future discourse on world food problems beginning during the war.

In Washington for a world wheat conference in 1942, McDougall worked through U.S. Vice President Henry Wallace[7] to arrange meetings with President Franklin Roosevelt and his wife, Eleanor. McDougall argued that Roosevelt should define freedom to include "freedom from want of food" – perhaps the first recognition of the human "right to food."[8] This meeting was the spark that led Roosevelt to request the first UN conference on world food issues in 1943 in Hot Springs, Virginia, which called for an end to world hunger and set the stage for post-World War II efforts on world food security, including the establishment of FAO.[9]

## World food security gains prominence after World War II

Acute post-war food shortages in China, Europe, Japan, and other war-torn countries following World War II brought world food and hunger issues to humanity's attention, as did the general shortage in world markets that lasted through the mid-1950s. Concern also grew about developing countries' food problems, especially those of Asia. This awareness stemmed from concern regarding rapid population growth in the region and Cold War politics that set in motion a big push for development aid, technical assistance and food aid from

[6] Way 2013; League of Nations 1937.

[7] Wallace had recently returned from Mexico, where he set the foundations for the Mexican Agricultural Program described ahead.

[8] Way 2013.

[9] Staples and Sayward 2006; FAO 2015.

about 1950.[10] The status at that time of the U.S. as the world's bread basket and food reserve, in part thanks to its investments in science and technology, helped to create a sense of urgency about investing similarly to address global food problems, a trend that was led initially by the Rockefeller Foundation.

## *The population monster*[11]

Dominating discussions of world food security was the sharp rise in population growth in the developing world during 1940-60, driven in part by the war's end and better health, sanitation and control of disease epidemics. This period witnessed the largest world population bubble in human history, with decadal increases jumping from about 0.2 billion in the 1930s-40s to 0.5 billion in the 1950s and peaking at 0.8 billion in the 1980s (Figure 1). From the perspective of 1963 projections, the challenge of feeding the additional people seemed particularly acute for Asia, where population was expected to triple to nearly 4 billion people by 2000 (only a small overestimate; Figure 2).

The numbers must have appeared truly scary to the period's analysts and world leaders, who were nurtured in the Malthusian views of the early 20th century. There was no historical precedent for dealing with such large increases, especially in the land-scarce countries of Asia. It is not surprising that many popular books, including Paul Ehrlich's, *Population Bomb*, Georg Borgstrom's, *The Hungry Planet: the Modern World at the Edge of Famine* and the Paddock brothers' *Famine 1975!*, all published in the 1960s, echoed a deep Malthusian pessimism about looming world famines.

## *Cold War politics and the beginning of foreign aid*

Population monster fears fed into emerging Cold War politics immediately after World War II. From 1947, South and southeast Asian countries gained independence, followed by many African colonial nations as of the late 1950s. The newly-independent countries often had fragile governments and, with a re-assertion of nationalism in Latin America, provided the fuel for intensive Cold War rivalry.[12]

Foreign assistance to cash-strapped governments became one of the main weapons for the United States and its allies in the Cold War.[13] Already during the 1940s the United States had a variety of technical assistance programs in Latin America, in part to win friends during the war and also to supply commodities for the war effort. Foreign assistance to fight communism and develop U.S. export markets became official U.S. policy with President Truman's "Point Four Program" (1949). Given the food-population race, assistance for food and agriculture was a major focus of these programs, which rapidly reached most non-communist developing nations by the early 1960s.[14] The Rockefeller Foundation was already out in front with MAP initiated in 1943, enthusiastically embracing both the enormous challenge of accelerating food production to meet population growth and the strategic role of technical assistance for agriculture in fighting communism.

## Development debates

The newly independent states of Asia and Africa and the spirit of nationalism in Latin America strongly endorsed a development paradigm in which the government was

[10] Food aid for Europe dates from World War I but was institutionalized in the United States in 1954, with a focus on Asia.

[11] This term was frequently used by Norman Borlaug and may have been coined by him.

[12] Perkins 1997.

[13] Perkins 1997.

[14] Perkins 1997; Mosher 1957.

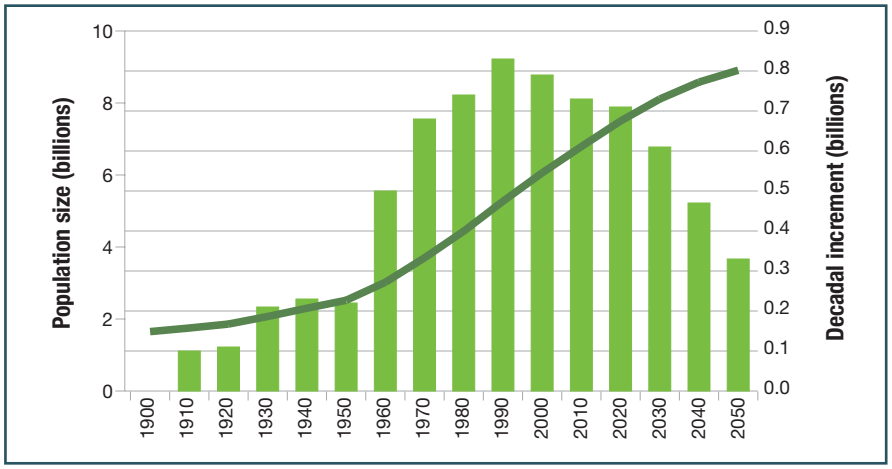



**Figure 1. World population (left axis solid line) and the decadal increment in population (right axis bars).** Source: Byerlee et al. 2017.

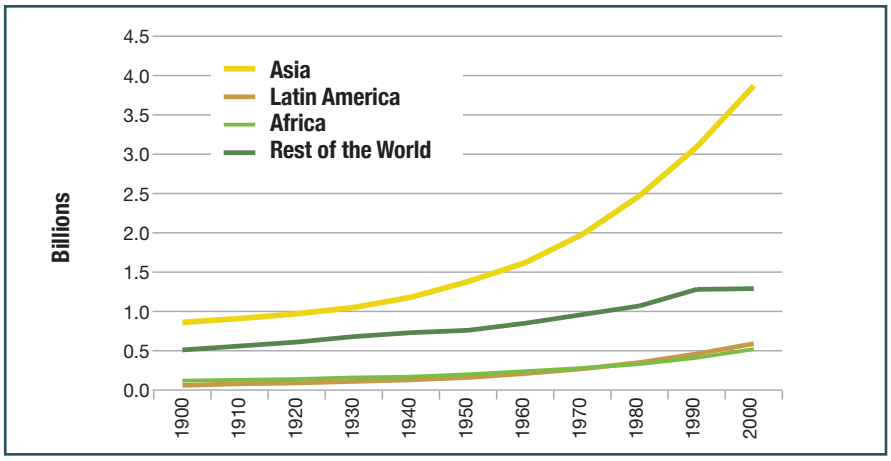



**Figure 2. Population by region. Data after 1960 were projections made in the early 1960s.** Source: Brown 1963.

responsible for fostering rapid economic growth through allocation of public and private investment. In 1961, the UN resolved that the 1960s would be the "Decade of Development" and planning ministries were set up in almost every developing country.

Although general consensus afforded the state an important role in development, there was no agreement on how this should be accomplished. The major debate germane to this paper related to the role of small-scale farmers in promoting development. Most early development economists, led by Arthur Lewis of the West Indies, believed that resource use in the agricultural sector was inefficient and surplus labor in agriculture could be harnessed for rapid industrialization.[15] Others emphasized the traditionalism or "cultural inertia" of smallholders regarding the uptake of modern technologies such as improved varieties or fertilizer. In his encyclopedic *Asian Drama*, the influential Swedish economist, Gunnar Myrdal, held like Lewis that it was possible to extract much higher yields from available land through more efficient use of farm resources but despaired that "cultivators are so many and so tradition bound."[16] Most technical assistance donors followed this line, especially the ICA/USAID and the Ford Foundation. In the 1950s, both invested heavily in India's extension and community development programs to promote the transfer of best farmers' practices. These programs met with some success but were not able to reverse a declining per capita production of food staples.[17]

Through the publication of his "poor but efficient" hypothesis, Theodore (Ted) Schultz of the University of Chicago began to change the conversation.[18] Based on field work by his students in the 1950s (including David Hopper, a Canadian and future Chair of CGIAR), he argued that smallholders were already using their resources efficiently and would adopt new, profitable technologies developed through investments in research to shift the "production frontier." This provided a strong rationale for investment in science and technology and helped to justify the Rockefeller Foundation approaches for technical assistance in Latin America and, later, Asia. The position was eventually embraced by the Ford Foundation, USAID and other donors but, as seen later, the "cultural inertia" position of Myrdal and others regarding smallholders was not discredited until the Green Revolution in the late 1960s.

All three economists in this debate went on to win Nobel Prizes in economics; Myrdal in 1974 and Lewis and Schultz together in 1979 – a testament to the versatility of the economics profession and the pragmatism of the Nobel selection committee.

## Mobilizing to eliminate hunger

Once established in 1945, one of FAO's first tasks was to improve the quality of statistics on food and agriculture, especially estimates of the number of undernourished. By the 3rd World Food Survey in 1963, FAO was converging on the estimate that about half the people in the world suffered from hunger or malnutrition.[19] Moreover, the food situation in developing countries was deteriorating. In the 20th century prior to World War II, yields were growing at about the same rate as the world population: about 1.2 percent annually. In the 1930s, Africa, Asia and Latin America exported 4 percent of their grain and, except for Africa, their yields were comparable to those in developed regions (Table 1). After World War II, growth in grain yields in developing countries fell well behind population growth and, alarmingly, per capita production fell in Asia and Latin America (Table 1). There were big differences among countries in Asia, with India and Pakistan showing the most serious decline while countries such as Thailand forged ahead.[20]

These emerging if imperfect statistics on the world food situation joined with mounting evidence of population growth and consciousness of social injustices that left up to half of developing world inhabitants without sufficient food calories or other nutrients. One outcome was global calls to end hunger that echo those of recent years.

Under the leadership of John Boyd Orr, a British nutritionist and winner of the 1949 Nobel Peace Prize, the newly-created FAO took an activist stance on improving food security and eliminating hunger. Facing opposition to his view of the centrality of FAO in world food security, he famously said "hungry people of the world want bread and they are to be given statistics."[21] FAO did take leadership in agricultural research in its early years, launching a world seed campaign in 1957 and regional crop research networks, including a major network of wheat researchers.

When B.R. Sen, former relief commissioner for the 1943 Bengal famine in India, took over as FAO's first director general from the developing world in 1956, he stepped up the dialogue on world hunger. With strong support from Eleanor Roosevelt, who had served as the first U.S. ambassador

**Table 1. Summary of food production statistics by region, 1930s and 1950s.**

| | | Asia | Latin America | Africa | Western Europe | North America |
|---|---|---|---|---|---|---|
| Grain yields (tons per hectare) | 1934-38 | 1.25 | 1.14 | 0.65 | 1.58 | 1.09 |
| | 1957-59 | 1.33 | 1.19 | 0.78 | 2.06 | 2.07 |
| Percent change, 1930s-1950s | | 5.9 | 4.1 | 19.2 | 30.6 | 89.4 |
| Per capita grain production (kilograms) | 1934-38 | 231 | 254 | 158 | 247 | 768 |
| | 1957-59 | 221 | 213 | 167 | 284 | 1,107 |
| Percent change, 1936-58 | | -4.3 | -16.1 | 5.7 | 15.0 | 44.1 |
| Net grain imports (million tons) | 1934-38 | -2.2 | -9.1 | -0.7 | 23.7 | -5.3 |
| | 1957-59 | 10.1 | -1.1 | 1.2 | 22.4 | -31.6 |

Source: Calculated from Brown 1963.

[15] Lewis 1954.
[16] Myrdal 1968.
[17] Perkins 1997.
[18] Schultz 1956; Schultz 1965.
[19] Spengler 1968.
[20] Myrdal 1968.
[21] Staples and Sayward 2006.

to the UN, Sen launched his Freedom from Hunger Campaign in 1959 and gave priority to technical assistance. FAO organized its first world food congress in 1963, where President Kennedy of the United States declared "we have the capacity to eliminate hunger in our lifetime, we only need the will." The same year, the Rockefeller Foundation launched its Conquest of Hunger program as the umbrella for its investments in agricultural science. Finally, in 1966, U.S. President Johnson announced a War on Hunger to be implemented through USAID.

There was a parallel flurry of activity in many developing countries, notably India. The Ford Foundation produced *India's Food Crisis: Steps to Meeting It* in 1959, while the World Bank in one of its first forays into agriculture sponsored a team to review Indian agriculture in 1964, led by John Crawford, an Australian economist, who would become a key player in the formation of CGIAR. Both reports endorsed major investments in agricultural science and technology representing a move away from the community development approaches of the 1950s.

Lab training at a Chapingo experiment station, 1964.

Scientists in the field at La Platina experimental station in Chile, 1963.

A scientist studies a double-cross hybrid maize crop at La Rinconada experimental station in Maipu, Chile, 1963.

CIMMYT maize breeder Elmer Johnson led early work to develop short stature versions of tropical maize and helped lay the foundations for effective drought tolerance breeding.

(left to right, foreground) E. J. Wellhausen, John D. Rockefeller III and George Harrar tour the OSS facilities.

# Chapter 3 The Rockefeller-supported country programs from the1940s

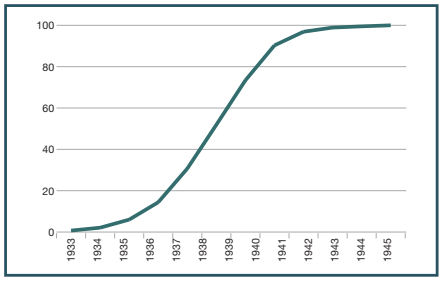
A growing global interest in eliminating hunger and the daunting prospect of feeding a rapidly growing population: these factors defined the context in which the Rockefeller Foundation and others stepped up their investments in agricultural science. MAP, a cooperative arrangement between the Rockefeller Foundation and the government of Mexico launched in 1943, was not the first venture by the Rockefeller Foundation into international agriculture. The Foundation had been supporting agricultural research and education in China and from 1941 even supported a hybrid maize program in Venezuela.[22] However, it was the first agricultural program in which the Rockefeller Foundation hired staff and posted them in-country to build long-term research capacity. MAP was to be the forerunner of many other country programs that were important building blocks in CIMMYT's foundation.

MAP itself built on decades of investment in crop research, especially in the United States, and sporadic efforts in maize and wheat research in developing countries prior to World War II. In the following section I describe these early research efforts and then the Mexican program and its sister programs, noting basic principles established by these first initiatives that would later be incorporated into the international centers of the 1960s-70s.

## Initiation of national research systems

It is convenient to begin the story of modern crop science from around 1900, with the rediscovery of Mendel's laws and the formalization of agricultural research systems in many of today's high-income countries,[23] but a substantial legacy of research pre-dates this, especially on soil chemistry and even plant breeding. Australia's William Farrer has been described as a "one-man international center;" he exchanged germplasm worldwide and in 1901 released "Federation," a rust resistant variety[24] that made him a legend in the wheat world.[25] The development of hybrid maize in the early 1900s and its rapid adoption in the 1930s created much excitement about the potential of genetics to revolutionize agriculture. There is little doubt that this influenced the launching of MAP in 1943 (Figure 3).

**Figure 3. Adoption of hybrid maize, Iowa, United States (percent area).**




Source: USDA, Agricultural Statistics (various years).

Early in the 20th century there were also notable successes in maize and wheat research in developing countries. Albert and Gabrielle Howard and Abdur Rahman Khan started the first major wheat germplasm collection, selection and breeding program at the Pusa Institute in India, opened in Bihar in 1905.[26] Their extensive work on wheat until 1924, emphasizing quality and rust resistance, was accelerated by a pioneering "shuttle breeding" program that included a summer

[22] Vessuri 1994.

[23] For example, the Hatch Act of 1887 to fund experiment stations in the United States, and the introduction of systematic state funding for agricultural research in the United Kingdom in 1909 (Perkins 1997).

[24] Caused by fungal pathogens, the three rust diseases of wheat have been a scourge of the crop since biblical times.

[25] Evans 1980.

[26] Howard 1953; Howard and Howard 1909; Pray 1984; Pal 1966.

cycle in the Baluchistan highlands. They released many varieties adopted in total on over 1 million hectares in northern India and Gabrielle Howard became the first female economic botanist in the British Empire. Soon after, the Imperial (now Indian) Council of Agricultural Research (ICAR) was created (1929). One of its early recruits in 1933 was B.P. Pal who made major contributions to breeding for rust resistance in wheat and who would play an important leadership role in the Green Revolution of the 1960s.[27]

Another early success in wheat was a private effort led by Enrique Klein in Argentina starting in 1919, with the founding of what is today Criadero Klein. An immigrant from Germany, his varieties came to dominate wheat production in Argentina, occupying an estimated 70 percent of the wheat area in the 1950s. They were also used extensively by MAP and CIMMYT.

In Africa, wheat research programs were established largely to meet the needs of European settler farmers in Kenya (a British colony), South Africa, and the French colonies of North Africa (Algeria, Morocco and Tunisia). The Kenya program dates to 1910 and went on to play an outsized role for selecting rust resistant materials after World War II, especially in the early Rockefeller Foundation and CIMMYT programs.

In maize, the direct transfer of temperate hybrid seed to the subtropics and tropics was not possible due to tropical diseases and big differences in preferences for grain type and color among countries. A handful of programs did succeed in developing their own subtropical and tropical hybrids. In Africa, Zimbabwe (then Rhodesia) became the first country after the United States to start hybrid maize research for its settler farmers in 1932 that later resulted in the release of the first single-cross hybrid in the world.[28] In Latin America, both Cuba and Brazil initiated hybrid maize programs in the 1930s that laid the foundation for post-World War II successes.[29] In Mexico, a start was made on collecting and describing local races of maize and carrying out genetic studies of maize.[30]

All of these programs were supported from national budgets and were necessarily small. Most were limited in their effectiveness by disciplinary fragmentation and lack of national coordination. However, there was already a considerable exchange of germplasm and knowledge between countries, especially for wheat. International scientific congresses were a regular occurrence and created the personal contacts that fostered cooperation across national and colonial borders. The India wheat varieties from Pusa, for example, were used extensively in Australia, Brazil and Egypt.[31]

Despite these sporadic and under-resourced efforts, most countries of Asia, Africa and Latin America, even significant producers of maize and wheat, lacked any research programs in these crops prior to World War II. In contrast many of these same countries supported extensive research programs on cash crops destined for export markets (e.g., cotton, cocoa, rubber, tea).[32] The depression years of the 1930s also greatly constrained investments in research more generally. Finally, there were almost no systematic efforts at regional or international cooperation.[33]

## The Mexican Agricultural Program from 1943

The Rockefeller Foundation had operated a health program in Mexico since the 1920s[34] and staff of that program as well as the U.S. ambassador to Mexico had pushed hard in the 1930s for the Rockefeller Foundation to open an agricultural program, recognizing that improving the quantity and quality of food was important to better nutrition. However, it was not until 1941 that three factors came together to lead the Rockefeller Foundation to seriously consider an agricultural program in Mexico. First, the election of President Manuel Avila Camacho in 1940 provided an environment that was more open to foreign investment and technical assistance from the United States.[35] Second, Roosevelt sent his Vice President Henry Wallace to the Mexican presidential inauguration in December, 1940. During the trip, Wallace, a founder of Pioneer Hi-Bred maize seed company in Iowa, made an extensive tour of farming regions of Mexico with a particular interest in maize. Third, the Rockefeller Foundation programs in Europe and China were closed by the outbreak of World War II, leaving it with resources to invest in Latin America.[36]

Wallace saw the opportunity for improving maize production, but due to the war the U.S. government lacked resources to invest in Mexico or any organized foreign assistance program, so Wallace approached the Rockefeller Foundation. The Foundation responded by arranging for a team of three well-known agricultural scientists to tour Mexico's farm regions in 1941, in what was called the Agricultural Survey Commission. The team members were Elvin Stakman, a plant pathologist from the University of Minnesota who had been monitoring wheat rust in Mexico since 1917; Richard Bradfield, a soil scientist from Cornell; and Paul Mangelsdorf, a maize geneticist from Harvard.[37] All three would continue for decades in an advisory role to MAP and to the Rockefeller Foundation program in agricultural sciences.

The Survey Commission recommended a team of four scientists be posted to Mexico.[38] The Mexican Secretary of Agriculture, Marte R. Gómez, strongly endorsed the proposal and was to play a leading role in its initial success. Interestingly in light of today's emphasis on performance metrics, Gómez also set a specific target for the program: to erase Mexico's 20-percent deficit in maize, wheat, and bean production that was being supplied by imports.[39]

The Rockefeller Foundation chose 37-year-old J. George Harrar, a student of

[27] Swaminathan 1996.

[28] Smale and Jayne 2003.

[29] del Valle 1949.

[30] Ruiz Erdozian 1916. See Matchett (2002) for a detailed review of early research on maize in Mexico.

[31] Pal 1966.

[32] Pardey et al. 1991.

[33] There were some early efforts to coordinate research within the colonial empires. In the British Empire, the Empire Marketing Board provided research grants for collaborative research on problems of common interest within the empire and the United Kingdom. The Colonial Development Act in 1940 provided similar grants for research in the tropics. The Imperial Agricultural Bureaux was formed in 1930 with branches related to abstracting of scientific literature, entomology and mycology within the empire. It later became the Commonwealth Agricultural Bureaux and today CAB International.

[34] Cueto 1994.

[35] The previous administration of Lázaro Cárdenas had undertaken a major land reform program but also expropriated foreign-owned oil companies including Standard Oil, which was owned by the Rockefeller family.

[36] Harrar et al. 1956; Waterhouse 2013.

[37] The team also included Richard Evans Schultes, who was to become the father of modern ethnobotany. Schultes was already familiar with Mexico and acted also as a guide and translator.

[38] Rockefeller Foundation 1941.

[39] Wellhausen 1990.

Stakman, as the leader of the team and he established the Oficina de Estudios Especiales (Office of Special Studies; OEE) in 1943. Harrar was regarded as an excellent administrator and was to be a visionary on the role of international research and cooperation for global food security. In a first nod to gender sensitivity, he at least recognized the wives (and all the spouses were wives) as an integral part of the success of the Rockefeller Foundation country teams.[40]

In the recommendations of the Survey Commission, maize was naturally the priority crop because of its overriding importance in Mexican diets and culture. The very recent spectacular adoption of hybrid maize and rapidly-rising yields in the United States also inspired confidence that the team would succeed with this crop (Figure 4; p. 27).[41]

Edwin (Ed) Wellhausen, a maize geneticist trained at Iowa State University, was recruited to lead the maize program and remained in that position until 1952, when he became the director of MAP and eventually the first director general of CIMMYT. Advised by Mangelsdorf, Wellhausen faced formidable challenges given the huge diversity of Mexican maize-growing environments and maize types, as well as the challenge of reaching Mexico's more than two million small-scale farmers. The Mexican Departamento de Campos Experimentales (later renamed the Instituto de Investigaciones Agrícolas, or IIA), had already started a hybrid maize breeding program under the leadership of Edmundo Taboado.[42] The early discussions by Wellhausen with Taboado assumed that the Rockefeller Foundation would collaborate closely with the existing Mexican program, but in practice they went their separate ways until they were finally merged into the Instituto Nacional de Investigaciones Agrícolas (INIA), created in 1961.[43]

Given the unsuitability of U.S. hybrids for Mexico's consumer tastes and growing conditions, along with its failure to cooperate with the IIA program, the Rockefeller Foundation maize program started from scratch. Wellhausen and colleagues invested considerable time and resources in collecting and classifying Mexican maize races, resulting in the landmark publication, *Razas de Maíz en México*, in 1952.[44] Mexican scientist and later renowned ethno-botanist Efraín Hernández Xolocotzi was a key partner in this effort.[45] The Rockefeller Foundation team also established breeding programs at four stations representing different Mexican agro-environments. Their work also focused on open pollinated varieties, given Wellhausen and Mangelsdorf's shared belief that smallholders would not adopt hybrid maize because it required annual seed purchases.[46]

Seed production was also a challenge, and the Mexican government established the Comisión Nacional del Maíz (CNM) in 1947 as a monopoly seed producer. The CNM strongly favored hybrid seed and this was a major factor in the shift of the OEE toward hybrids.[47] There was ongoing tension between the Rockefeller Foundation scientists and the CNM on the quantity and quality of seed produced, as well as its distribution. Looking back, Elmer Johnson, long-time tropical maize breeder under MAP as of 1957 and later CIMMYT, bluntly noted that there were "all kinds of screw ups" in CNM.[48]

Wheat did not get a lot of attention in the Agricultural Survey Commission except for wheat rusts, then the major scourge of wheat production and Stakman's specialty. In fact, wheat was listed under

Edwin Wellhausen (1907-2001) arrived in Mexico in 1943 to lead the maize work. He became director of MAP in 1952, director of the Inter-American Food Crop program in 1959, and CIMMYT's founding director general 1966-71. His legacy was both the elements of a global maize program and CIMMYT itself.

Norman Borlaug (1914-2009) arrived in Mexico in 1944 and led the wheat program under MAP, 1945-60, the Inter-American Wheat Improvement Program, 1960-66, and CIMMYT's wheat improvement program, 1966-79. His legacy includes a global wheat research program and the title "father of the Green Revolution."

George Harrar (1906-1982) established and led MAP 1943-51, was deputy director and director for agriculture in the Rockefeller Foundation headquarters, 1955-59, Vice President of the Rockefeller Foundation, 1959-61 and President of the Rockefeller Foundation from 1961-72. His legacy was the idea and many of the ideals of international agricultural research.

[40] Stakman et al. 1967.
[41] Griliches 1957.
[42] Matchett 2002; Cotter 1994.
[43] Rockefeller Foundation 1966. Wellhausen, Oral history.
[44] Wellhausen et al. 1952.
[45] Casas et al. 2012.
[46] Wellhausen and Roberts 1949; Matchett 2002.
[47] Matchett 2002.
[48] Matchett interview with Johnson, 2002.

"other crops." However, given that the MAP team leader, Harrar, and Norman (Norm) Borlaug, who arrived in 1944, were plant pathologists (both studied under Stakman), and strong interest from the Mexican government in developing irrigated agriculture in the northwest, it was natural that wheat should be included as the second major crop in the program (beans were the third). After initially working on maize, Borlaug took charge of the wheat program in 1945 and continued in that role until his retirement as Director of the CIMMYT Wheat Program in 1979.

The work on wheat drew upon an extensive germplasm collection assembled by the USDA Cereal Rust Laboratory under Stakman. However, finding and then maintaining resistance to stem rust proved a daunting task, one that relied heavily on a handful of materials, notably varieties from Kenya, a minor wheat producer but a hotspot for rust (see Box below). Several other factors contributed to success on the rust front:

- The implementation of "shuttle breeding," whereby breeding lines were selected in the winter at a lowland, irrigated desert location in northwest Mexico, and in the central highlands in the summer, to provide two cycles per year.
- Development of a large and efficient crossing system.
- Extensive testing of materials through the USDA International Spring Wheat Rust Nursery (described below) and, as of 1950, close cooperation with the Rockefeller Foundation Colombian Agricultural Program.

Wheat area in Mexico was concentrated in Mexico's mid-altitude central region known as El Bajío and the developing irrigation districts of northwest Mexico. Mexican agricultural policy during the 1940s-50s strongly favored irrigated agriculture in the northwest. As much as 90 percent of public resources for agriculture in that period was invested in irrigation and associated services.[49] That heavy investment provided a tail-wind for wheat researchers, as the center of gravity of wheat production quickly shifted to the northwest. Further, the wheat program did not have to deal with a parastatal seed monopoly such as CNM and was able to work out innovative arrangements for seed production and distribution through commercial farmers and their associations.

The Survey Commission had recommended research on agronomy and soils as a top priority for MAP to confront an overriding problem of poor soil fertility. There was an agronomist among the original Rockefeller Foundation scientists who arrived in 1943, but staffing turnover was high until Reginald (Reggie) Laird came in 1952. He quickly integrated his work with the maize and wheat programs. Given that fertilizer prices were declining steadily and availability increasing in the post-World War II period, a major part of the agronomic work focused on increasing fertilizer use, which was minimal in Mexico at the time. Borlaug himself became almost obsessive about promoting the role of fertilizer in increasing wheat production. In Sonora the portion of fertilized wheat area

[49] World Bank 1982; Hewitt de Alcántara 1976.

## A Columbian exchange on cereal rust resistance genes

The early Rockefeller programs in Mexico benefited greatly from the international exchange of germplasm as well as making important contributions to other regions. The examples of the wheat rusts (stem rust, leaf rust and stripe rust) and southern corn rust show how this exchange worked both ways.

In the case of wheat, Kenyan varieties contributed enormously to the use of rust resistance genes in many countries. Kenya was and still is a hotspot for both stem and stripe rust. Despite the fact that wheat is a relatively minor crop in Kenya, it has had a continuous breeding program from 1910, first under private auspices before being taken over by the colonial government in 1927.[50] When Borlaug started work on wheat in Mexico, stem rust represented his most important challenge. He used two Kenyan varieties obtained from the USDA Cereal Rust Laboratory as parents, resulting in one of his first successful varieties, Kentana, released in 1948.[51] Kenyan germplasm and screening of materials in Kenya continued to be important in the Mexican program and throughout the history of CIMMYT. The Rockefeller Foundation supported the Kenyan program through travel grants starting in 1956 and a large strengthening grant in 1961. In the 1960s the Kenyan program began to rely heavily on materials from the Rockefeller Foundation programs in Mexico and Colombia.[52]

In the case of maize, Africa was hit by a devastating attack of maize rust (*Puccinia polysora*) that reached West Africa from the Americas in 1949 and quickly spread across Africa during the 1950s. Local varieties carried little resistance and the rust caused yields losses of 50 percent or more[53]. There was very little maize breeding work at the time outside of southern Africa but many countries established programs to combat the disease – including Ghana, Kenya and Nigeria, all in the mid-1950s.[54] In Nigeria, a West African Maize Rust Research Unit was set up in 1952 at Ibadan.[55] Through informal contacts, these programs turned to the new subtropical and tropical maize germplasm collections of the Rockefeller programs in Mexico and Colombia and quickly found effective sources of resistance. By the time varieties were ready for release, it seems that farmer selection of the survivors within the local materials had brought the epidemic under control. However, a lasting benefit was investment for the first time by African colonial governments in maize research and the recognition of the value of germplasm from the Americas for these programs.[56]

[50] Makau 1984.

[51] Dubin and Brennan 2009.
[52] Guthrie and Pinto 1970.
[53] Hooker 1985.

[54] McCann 2001.
[55] Stanton 1996.
[56] van Eijnatten 1965.

jumped from 9 percent in 1953-54 to 64 percent in 1955-56, causing lodging to become a major problem.[57] After rust was brought under control, Borlaug logically started work on producing shorter varieties to resist lodging, which from the mid-1950s included the work to incorporate dwarfing genes.

From the beginning MAP had two major objectives: applied research to increase food production, and training of young scientists to staff the national agricultural research system. The in-service practical training, in which participants worked for 6-12 months alongside experienced scientists in the field, was a unique contribution of MAP and is estimated to have trained over 700 Mexican scientists during 1943-63.[58] In the same period, some 245 Mexicans received fellowships for advanced degree studies – 160 for master's degrees and 85 for doctorates; in the latter case nearly all in the United States.[59] Many of these scientists comprised the core staff for CIMMYT in 1966.[60] Graduate training shifted to Mexico when the Colegio de Postgraduados opened in 1959, with support from both the Rockefeller Foundation and the Ford Foundation.

Behind the scenes, Dorothy Parker, the only female member of the team, made a major contribution to the success of the program.[61] With a doctorate in botany, she was appointed in 1945 to set up a library but also contributed informally as editor of OEE publications and in handling a "continuous demand for reports" from headquarters. Before coming to Mexico she spent time in Washington to assemble a truck load of duplicate books and journals from various libraries that were shipped to Mexico. The OEE library became the best agricultural science library in Latin America and Parker helped set up libraries in several other countries of the region, before moving to India in 1959 to help upgrade the central library of the India Agricultural Research Institute (IARI). At the time, developing country researchers' lack of access to scientific literature was a major constraint on their keeping abreast of global science.

Another contribution of Parker was to employ a fresh Mexican graduate, Evangelina (Eva) Villegas, as an assistant librarian. Villegas went on to obtain a doctorate in cereal quality. Milling and baking quality were key components of the wheat program. In addition, the maize program's focus on quality protein maize in the 1960s required good laboratory support. Villegas played a central role in both activities and in 2000 shared the World Food Prize with CIMMYT maize breeder Surinder (Sam) K. Vasal for the development of quality protein maize.

Finally, although maize and wheat were top priorities and work on those crops led to MAP's and Rockefeller Foundation's international fame, it should be noted that the OEE conducted research on other crops and livestock and in disciplines besides breeding and agronomy. The 1958-59 MAP annual report, for example, lists a total of 15 Rockefeller Foundation staff and over 100 Mexican staff working on barley, beans, forage and other specialty crops, poultry, rice, sorghum and soybeans, as well as in economics, horticulture, information science, entomology, pathology, seed production and soil science, in addition to maize and wheat.

An agricultural economist (Donald Freebairn) was appointed in 1957. He worked on maize and wheat but his research was conducted largely independently of the crop programs. Information services was added in 1956 with the arrival of Delbert Myren, who later led CIMMYT's first communications team and also turned out to be MAP's best social scientist, providing balanced reviews of its accomplishments.[62]

## Expansion of the Rockefeller Foundation country programs

The second country program established by the Rockefeller Foundation was the Colombian Agricultural Program in 1950. Known as the Oficina de Investigaciones Especiales (OIE), it was modeled on MAP and grew to be almost as large as MAP. Like MAP, OIE gave priority to maize and wheat research but also included many other crops and livestock, and drew heavily on the experience and technologies from MAP. MAP scientists, notably Joseph (Joe) Rupert, transferred from Mexico to Colombia to lead the maize and wheat work. Although wheat was a much smaller crop in Colombia than in Mexico, Colombian sites proved to be excellent to screen Mexican breeding materials for disease resistance. As in Mexico, the maize program started by collecting local varieties and launching a breeding program for both open pollinated varieties and hybrids. In 1967, the Colombian program, headed by Ulysses J. (Jerry) Grant, who had started as a maize breeder in the program, became the basis for the International Center for Tropical Agriculture (CIAT), the third international agricultural research center, with Grant as director general.

In 1956, wheat in Ecuador was added to the Colombian program and a Rockefeller Foundation wheat scientist from Colombia, John Gibler, moved there in 1965. In 1955, the Rockefeller Foundation opened a country program in Chile where wheat was the priority crop and Rupert who had worked in both the Mexican and Colombian programs was transferred to head Chile's OEE. Rockefeller Foundation grants also supported maize and wheat programs in several other Latin American countries, notably Argentina, Brazil and Peru, although it did not post staff to those programs.[63] In addition, it began the regional programs discussed in the next section.

The Rockefeller Foundation had recognized early on that South and southeast Asia, with a very large and rapidly-growing population and shrinking per capita land base, was the highest priority in combating global hunger and poverty. Accordingly, Rockefeller Foundation teams visited Asia starting in 1952, including Bradfield, Mangelsdorf and Harrar, who had played a large role in founding MAP. The Rockefeller Foundation focused particularly on the largest "free" country, India, and negotiations proceeded over several years. Wellhausen and Grant visited India in 1954 to review maize research. Finally, after almost five years of negotiation, the Rockefeller Foundation Indian Agricultural Program was established in 1956. Maize was the primary crop at first and Grant

[57] Rockefeller Foundation (MAP Annual Report 1955-56).
[58] Ardito-Barletta 1970.
[59] Ardito-Barletta 1970.
[60] Among others, Arnoldo Amaya and Eva Villegas in cereal quality; Alejandro Ortega and Carlos de Leon in maize; Marco Quiñones, Maximino Alcalá, Ricardo Rodríguez and Gregorio Vásquez in wheat; and Gregorio Martínez in communications.
[61] Rockefeller Foundation 1967.
[62] Myren 1969.
[63] See, for example, Shepherd 2005.

moved from Colombia to New Delhi in 1957 as the Coordinator for the All India Coordinated Maize Improvement Program. The choice of maize was a compromise – it was the fifth most important cereal, accounting for about 5 percent of cereal production in India. However, the opportunity to tap hybrid maize technology and India's position that it already had strong research programs on the two major cereals, rice and wheat, carried the day. Unlike the Latin American programs, the Indian program built on existing maize research programs and focused on integrating the maize research activities of 13 stations into a single, well-coordinated national program. The Rockefeller Foundation maize program also helped build the Indian public and private seed industry and infrastructure that would subsequently support rapid diffusion of semi-dwarf wheat and rice varieties.[64] Grant was replaced by Ernest (Ernie) Sprague in 1959, who would direct the CIMMYT maize program in the 1970s.

The Rockefeller Foundation wheat program in India did not start until after Borlaug's 1963 visit at the invitation of M.S. Swaminathan, Head of the Botany Division of IARI, to discuss the potential of semi-dwarf wheat varieties. Swaminathan would go on to many high honors in international food and agriculture, including receiving the first World Food Prize in 1987. A subsequent visit by Borlaug in 1964 led to a Rockefeller Foundation/ICAR agreement to appoint Glenn Anderson as joint coordinator of the wheat program, with S.P. Kohli as coordinator. A Canadian wheat breeder destined to be director of CIMMYT's wheat program in 1979, Anderson was already familiar with the Mexican program and a personal friend of Borlaug from regular visits to his winter nurseries in Mexico.[65] The major purpose of the Rockefeller Foundation wheat program in India was the testing, adaptation and large-scale multiplication of the newly-developed semi-dwarf varieties and the institutional restructuring of wheat research into a national coordinated program following the maize model. As in MAP, the Rockefeller Foundation also invested heavily in graduate training, including support for post-graduate degree education at IARI.

The India program and Swaminathan's students also figured prominently in CIMMYT staffing and fame. As of the 1990s-early 2000s, maize scientists Ripusudan (Rip) Paliwal became director of the maize program and Sam Vasal won the 2000 World Food Prize; wheat specialists George Varughese served as associate director of the wheat program and Sanjaya Rajaram as director, also winning the 2014 World Food Prize.

The Rockefeller Foundation paid little attention to Africa until after the beginning of independence around 1960, when the annual report by the Foundation's new president, George Harrar, of MAP fame, highlighted the need to support agricultural development in the newly-independent countries. As we have seen, the Kenyan wheat program was especially important for international rust screening and the Rockefeller Foundation provided a number of grants to the program. The Rockefeller Foundation also supported a visit by the maize breeder in Kenya, Michael Harrison, to the Mexican and Colombian programs in 1959, where he collected Latin American germplasm that was used to develop a highly successful set of hybrids.[66] When Kenya became independent in 1963, the Rockefeller Foundation and British aid supported the maize program at Kitale. Harrison joined CIMMYT in 1967 and moved in 1970 to the International Institute of Tropical Agriculture (IITA), launching its maize program. The Foundation also posted scientists to Ibadan, Nigeria, as of 1963, including a maize breeder in 1964. Finally, the Rockefeller Foundation supported maize research in Egypt and posted a full-time maize breeder there in 1965, in partnership with FAO.

The maize and wheat components of all of these programs were inherited by CIMMYT.

## Other bilateral country programs

The Rockefeller Foundation country programs were not the only technical assistance programs for the agricultural sciences. An early rival in maize was the Tropical Research Center in Guatemala, established by Iowa State University in 1945 with funding from a seed company to work on hybrid maize for the tropics and facilitate access to tropical germplasm by U.S. companies.[67] Varieties from this program played an important role in Thailand's maize takeoff a decade later (Chapter 6).

FAO experts were assigned to several maize and wheat programs, in addition to its regional programs described in the next section. The United States' ICA expanded very rapidly after the Point Four program was announced in 1949, including a number of hybrid maize programs in Asia.[68] France also maintained a food crop research institute, Institut de Recherches Agronomiques Tropicales, focused on its colonies or ex-colonies and whose work included maize. In an inventory of technical experts in wheat research in 11 countries of West Asia and North Africa around 1960, FAO counted 32, mainly from FAO, USAID and France. The Ford Foundation was a latecomer to supporting agricultural research, but Haldore Hansen, the Foundation's representative in Pakistan, played a critical role in the wheat program by supporting the appointment of Mexico's chief wheat scientist, Ignacio (Nacho) Narvaez, to Pakistan in 1965 (Hansen later became the second director general of CIMMYT).

## Legacy of the bilateral country programs

The Rockefeller Foundation programs introduced a set of core values that were to influence crop research in the international centers for decades. First, they established a strong results orientation, aiming for increased food production and self-sufficiency, although the impact pathway to reducing hunger and poverty was poorly articulated. They also focused on getting quick results through applied field-based research on specific problems and strong links to delivery mechanisms.

Second, the programs integrated several natural science disciplines, especially crop protection and breeding and, over time, agronomy and cereal quality. However, social science perspectives were not encouraged in the early years.

Third, over time, the programs developed the concept of national coordinated crop programs linking together all crop research within a country through coordinated planning, testing and information exchange.

[64] Barwale 2000.
[65] Borlaug 1992.
[66] Rockefeller Foundation Annual Report 1959.
[67] Melhus and May 1949.
[68] See Borlaug 1960 for a discussion of the Pakistan hybrid maize program.

This greatly increased the efficiency of research on specific crops, although with some costs in terms of broader farming systems perspectives.[69]

Fourth, they integrated practical in-service training by recruiting young scientists for informal instruction and practical work in the field, combined over time with formal classroom instruction. Support for graduate education was also central to all programs; the Mexican and Indian programs included the development of national postgraduate programs.

Fifth, the country programs established many of the ideals of international cooperation in agricultural research. The Latin American Rockefeller Foundation programs in particular regularly exchanged germplasm and information with each other and began to organize regional testing of their materials as well as accepting trainees from other countries in the region. Rockefeller Foundation and national scientists in Latin America regularly visited each other's programs and, especially for wheat, a pattern developed of transferring experienced staff from Mexico to new programs as they opened.

Sixth, one of the enduring international public goods created by the country programs in maize was the collection and classification of 15,000 local varieties of maize in 7 Latin American countries.[70] After the Mexican collection, this work was supported by the National Research Council of the U.S. National Academy of Sciences in collaboration with Mangelsdorf. Germplasm was quickly shared not only within the region, but globally. On completing the Colombian collection in 1956, for example, samples were shipped throughout the Americas as well as to India, Indonesia, and the Philippines in Asia and to Kenya, Rhodesia (Zimbabwe) and Somalia in Africa.[71]

Last but not least, the Rockefeller Foundation programs established a tradition of sheltering scientists from bureaucratic and political interference. The work in Latin America was undertaken under specially-created offices that reported to agricultural ministries at a high level but not for day-to-day operations. Experienced administrators such as Harrar in Mexico and Ralph Cummings Sr. in India skillfully played this role. These special offices evolved into the semi-autonomous national agricultural research institutes such as the Mexico's Instituto Nacional de Investigaciones Agrícolas (INIA) in the 1960s. Even stronger ideals of independence from political interference were adopted by the international centers created in the 1960s.

[69] See, for example, Byerlee et al. 1987; Byerlee et al. 1989.

[70] Rockefeller Foundation Annual Report 1964.

[71] Roberts et al. 1957.

Experiments at the Quinta Normal experimental station in Santiago, Chile, 1963.

Attendees of the 1956 International Wheat Rust Conference at Chapingo.

# Chapter 4 The development of regional cooperation in the 1950s

By the mid-1950s, the country programs had established the value of informal regional exchanges and cooperation. It was also clear that the Rockefeller Foundation and others could not provide assistance to the growing number of countries requesting it, especially small countries with limited scientific resources. In the 1950s, several important regional initiatives developed formal cooperative agreements with regional groupings of countries. FAO and USDA pioneered these efforts but were soon joined by USAID and the Rockefeller Foundation.

## USDA and the world's first international nursery

A major institutional innovation at the time was the USDA-sponsored International Spring Wheat Rust Nursery, conceived as a regional program for the Americas, although it quickly evolved into the first truly international nursery and one that was to have major global impacts. Through Stakman at USDA's Cereal Rust Laboratory at the University of Minnesota, USDA had run a uniform rust nursery for U.S. and Canadian cooperators since 1919.[72] It appears that Borlaug in Mexico regularly received this nursery in the 1940s. In 1950, with the threat of yet another virulent strain of stem rust (race 15B), Stakman organized the first International Wheat Rust Conference, where a decision was made to transform the nursery into a regional cooperative nursery. At first the emphasis was on extending coverage to South America, but after USDA participated in the first meeting of the FAO Near East Wheat and Barley project in 1952 (described next), the nursery soon became global, covering all major spring bread wheat producing countries, which by 1963 numbered 40.[73] With over 1,000 entries, the nursery was the main vehicle for the global sharing of spring wheat germplasm, as well as providing valuable information on rust incidence and resistant lines. Associated with the nursery, participants met at triennial international rust conferences. The third conference in 1956 was hosted by MAP in Mexico City.

The USDA nursery greatly expanded the genetic base of the Mexican program through incoming materials. By the late 1950s, MAP nurseries included 50,000 entries.[74] At this time, U.S. and Canadian wheat programs began to plant off-season nurseries in Mexico to speed breeding, thereby adding to germplasm exchange and networking. The research station in the Yaqui Valley, in Sonora state

[72] Loegering and Borlaug 1963.

[73] Loegering and Borlaug 1963.

[74] Byerlee and Dubin 2009.

of northwestern Mexico, known as the Centro de Investigación Agrícola del Noroeste (CIANO), became a hub of ad-hoc international germplasm exchange and information in spring wheat.

## FAO regional programs in the 1950s

FAO played an active role in maize and wheat research on several fronts.[75] One of its flagship programs was the FAO Near East Wheat and Barley Improvement and Production Project, begun in 1952. Initially led from Rome, it involved 11 countries from Libya to Pakistan. The program got a big impetus with the appointment of James (Jim) Harrington in 1955, former chair of the Department of Plant Breeding, University of Saskatchewan, Canada, and a professor to Glenn Anderson. The project included all the elements of a strong regional network – rust nurseries in over 30 locations, mentoring through twice-yearly visits to each country, disease monitoring, provision of equipment, annual meetings and in-service training and graduate fellowships.[76] The FAO network was also among the first anywhere to establish regional uniform yield trials that went to 85 locations. Another scientist, Abdul Hafiz, a highly-regarded wheat pathologist and Deputy Director of Research, West Pakistan, took over as coordinator in 1962 and, with additional support from the government of the Netherlands, remained to 1982, based in Cairo, Egypt.

The FAO wheat program was not explicitly linked to the Mexican program until 1960. However, through the USDA rust nursery, Mexican germplasm became widely available in the region well before the semi-dwarfs appeared. For example, in 1956, shortly after initiating its first-ever research activities, Ethiopia released two Mexican-bred wheat varieties.[77] Mexican-bred tall varieties were also released in Israel, Jordan, Kenya, and Libya by 1960.[78]

## The Central American Maize Improvement Program

In 1954, the Rockefeller Foundation took a major step toward developing an international approach to research when it created the Proyecto Cooperativo para el Mejoramiento del Maíz Centroamericano (Cooperative Central American Maize Improvement Program), involving research organizations and scientists of five countries.[79] The network pioneered regional yield testing and organized germplasm exchange, agronomic trials and annual meetings to review results and coordinate work plans. The program was coordinated by a maize scientist based at El Instituto Interamericano de Cooperación para la Agricultura (IICA),[80] Costa Rica, and advised technically by a scientist from the Mexican program (initially Sterling Wortman, who was MAP maize breeder during 1950-55). A breeding hub for tropical maize was established in Cotaxtla, Mexico, that received trainees from the region.[81]

The Central American program was a departure from the Rockefeller Foundation Mexican and Colombian programs, in that it worked to strengthen existing national institutions rather than create new ones. The network gradually expanded to other crops and disciplines and countries and is now known as the Programa Cooperativo Centroamericano para el Mejoramiento de Cultivos y Animales (PCCMCA). It must surely be rated as one of the most sustainable research networks anywhere, holding its 61st annual meeting in Costa Rica in 2016.

## Other regional programs and their legacy

The Central American regional maize program was the model for many future regional programs. One of the most important was the Inter-Asian Corn Improvement Program that grew out of maize activities of the Rockefeller Foundation Indian Agricultural Program and of Ernie Sprague, Foundation maize scientist in New Delhi, who began around 1960 to travel to other countries of South and Southeast Asia. The program was formalized in 1963 and moved to Bangkok in 1966 where it had several staff working on various aspects of maize improvement, including disease resistance and agronomy. Thailand became a center for maize breeding and training for the region.[82]

Other regional maize networks were established through other donors. The African Major Cereals project, funded by USAID and managed by USDA, was initiated in 1963 building on the Rockefeller Foundation supported maize programs in Kitale, Kenya, and Ibadan, Nigeria. It established regional networks in East and West Africa, the latter for the first time bringing Francophone and Anglophone countries together for cooperative research.

Most of the regional cooperative programs also included training. Probably in response to a two-month tour of 13 Latin American research and university systems by Stakman in 1947, MAP took a decision to expand in-service training to other countries in the region beginning in 1948. Confined to a handful of trainees each year, it was nonetheless regarded as key support to countries lacking resident Rockefeller Foundation staff.

All these initiatives built evidence on the benefits of international collaboration. They enabled the systematic and widespread sharing of germplasm and knowledge and, through this and related meetings, generated social capital for stronger cooperation. The information provided from testing across diverse sites also saved time and money for country programs. They also showed the value of a strong regional hub to gain economies of scale in research programs. In retrospect, they pioneered institutional innovations that provided the foundation of today's international research system.

[75] FAO also established the Hybrid Maize Program for Europe and the Mediterranean in 1947 that successfully transferred U.S. hybrid technology and germplasm to the region. Afghanistan, Egypt, Lebanon and Syria participated in this network (Sprague 1975).

[76] FAO 1960.

[77] Gebre-Mariam et al. 1991.

[78] Rockefeller Foundation Agricultural Sciences Annual Report 1959-60.

[79] Costa Rica, El Salvador, Honduras, Nicaragua and Panama. Guatemala was not included initially possibly because it had the Iowa State University Tropical Research Center that specialized in maize.

[80] IICA had been established in 1942, with U.S. Vice President Wallace again playing a leading role.

[81] Maize scientists from the Central America Program also participated actively in the Central American network.

[82] Sprague 1964; Dowswell et al. 1996.

(left to right) Aristeo Acosta Carreon, Norman Borlaug, Jacobo Ortega, Evangelina Villegas Moreno (2000 World Food Prize co-recipient), Federico Castilla Chacón and Manuel Navarro Franco meet at Chapingo, 1963.

# Chapter 5 The establishment of international maize and wheat programs in the 1960s

## The birth of the idea of an international research center

By the 1950s, the Rockefeller Foundation and other programs on maize and wheat in Latin America had increasingly demonstrated the benefits of focused multidisciplinary research on those crops and of regional and international collaboration across countries on problems common to the crops. At the same time, within the context of rapid population growth, the Rockefeller Foundation and others recognized the overwhelming importance of rice for Asian food security. As we have seen, Foundation teams had been visiting Asia since the early 1950s and by 1957 had initiated a program in India, but it was limited to maize, sorghum and millet. How to address the "rice problem" was still under debate.

Harrar was the most important originator of the idea of a center for international research. Even before leaving Mexico in 1951 he was promoting the idea of Mexico as a hub for agricultural research in Latin America.

"The experience gained in Mexico can and should serve for other operations elsewhere and eventually result in an international integrated program of agricultural sciences with free exchange of material, information and personnel... toward the goals of greater food production and subsequent social benefits.[83]

In 1953, a year after transferring from Mexico to New York, he noted that "If agriculture is to be improved throughout the world, then agricultural science will have to be placed on a truly international basis."[84]

In 1954, with Warren Weaver, Director of the Natural Sciences division of the Rockefeller Foundation, Harrar prepared a paper "Research on rice" for discussion with the Rockefeller Foundation Board and which articulated an option to create an international center for rice research in Asia. The paper drew on the Rockefeller Foundation experiences in Latin America and recognized not only the value of international cooperation but the benefits of having a centralized research facility for all aspects of rice research, training and knowledge management. The center would not only offer cost savings over establishing individual country programs, but countries might actually finance the operating costs. However, in the end, they proposed the country-by-country approach used in Latin America as the way forward for rice in Asia, deeming the start-up costs and the risks (such as an underwhelming reaction to financial contributions from Asian countries) too high.[85]

This digression on rice shows that by the mid-1950s the idea of an international research center was already under active discussion. By the late 1950s, concrete steps were underway to create both CIMMYT and IRRI but by very different pathways. IRRI was essentially a greenfield project that received the go ahead when the Ford Foundation, in a major departure from its investments in community development, agreed to contribute capital costs for IRRI, while the Rockefeller Foundation would contribute staff and money for operations. Robert Chandler, who had joined the Rockefeller Foundation in New York in 1956 to work on Asian issues, transferred to the Philippines as interim director of IRRI. He negotiated an international agreement with the government of the Philippines (1960) and began acquiring land, designing and constructing the campus, and hiring staff. He was joined by Sterling Wortman in 1960 as his deputy and IRRI effectively began research operations in 1962. It is significant that both Chandler and Wortman had gained their early experience with international agriculture in MAP – Chandler as a soil scientist, 1946-47, and Wortman as a maize breeder and then leader of the maize program, 1950-55.[86]

[83] Harrar 1951, p. 6.

[84] Harrar 1953. Meeting Hunger Needs through Agriculture. Reproduced in Harrar 1963, p. 12.

[85] Weaver and Harrar 1954.

[86] For the history of IRRI, see Chandler 1982 and Anderson 1991.

## Steps toward the creation of CIMMYT

The first steps to create CIMMYT were precipitated by the plans to establish INIA in Mexico, effective January 1961, which would take over MAP programs in operation for 16 years, as well as the parallel research organization, IIA. This started a long and sometimes difficult process to establish CIMMYT as a legal civil society organization under Mexican law in 1966, eventually gaining international status in 1988. Along the way, CIMMYT integrated and consolidated a legacy of many maize and wheat programs inherited from around the world, unlike the zero-based approach to create IRRI.

The transformation toward CIMMYT started with the creation in 1959 of the Inter-American Maize Improvement Program, led by Wellhausen, and of the Inter-American Wheat Improvement Program in 1960, led by Borlaug. These programs aimed to refocus the work of Rockefeller Foundation scientists in Mexico to become the hub for networks of maize and wheat scientists in Latin America (see Box below), although Rockefeller Foundation staff continued in an advisory capacity to INIA. The programs were further re-oriented as international programs when CIMMYT was created as a cooperative agreement between the Rockefeller Foundation and three Mexican

## CIMMYT's difficult birth as an international center

The creation of CIMMYT was drawn out over about six years. From 1960, the Inter-American Wheat Improvement Program, the Inter-American Maize Improvement Program and a related program on potatoes (later merged with the International Potato Center, CIP) were collectively referred to by the Rockefeller Foundation as the Inter-American Food Crop Improvement Program. Wellhausen was the director of this program, although the three crop programs operated more or less independently under their respective leaders. In 1962, after a visit to IRRI's shiny new facility in the Philippines, Mexican President Adolfo López Mateos made a request to the Rockefeller Foundation for a similar facility in Mexico, building on the Inter-American food crop programs. This led to the signing of the first agreement creating CIMMYT in 1963 as a cooperative agreement between INIA, the Colegio de Postgraduados, the Escuela Nacional de Agricultura (now Universidad Autónoma Chapingo, UACh) and the Rockefeller Foundation. The agreement envisaged cooperation of these institutions around a Chapingo campus with each party contributing staff and resources to make the campus an international hub for maize and wheat research, and INIA contributing the use of its experiment stations for international research and training. The Rockefeller Foundation would support international costs and facilitate links with other Rockefeller Foundation country and regional programs.

The first "version" of CIMMYT had a staff of 12, including 4 regional programs for maize in Central America, the Andes, Asia and West Africa, and 2 regional programs for wheat in the Andes and Asia (mainly India). CIMMYT also had extensive collaboration with most Latin American countries and with North American universities. The wheat program in addition had extensive collaboration in the Near East and Asia through the FAO wheat and barley program (see Box on p. 21).[87]

Wellhausen was named "Executive Coordinator" of this entity, which had no legal basis, no funding beyond the Rockefeller Foundation, no experimental facilities of its own nor a clear vision of the benefits to the Mexican partners from their international participation. Even the translation of CIMMYT into English was not settled. The Rockefeller Foundation annual reports referred to it as the International Center for Corn and Wheat Improvement, and CIMMYT in its first Research Report in 1965 called itself the International Center for Maize and Wheat Improvement.

It was soon clear that this arrangement was unworkable and that other elements of the "Chapingo project," such as the integration of research, education and extension, were unravelling.[88] The Colegio Postgraduados, for example, was planning a move to a new campus away from Chapingo.[89] Wortman, by now director-designate of the agricultural sciences program in the Rockefeller Foundation in New York, visited CIMMYT in 1965 and, undoubtedly influenced by his experience setting up IRRI, recommended setting up CIMMYT as an autonomous international center.[90] This was partly accomplished when CIMMYT was constituted as a civil society organization under Mexican law on 12th April, 1966, giving the Center the means to hire staff and raise funds independently of the Rockefeller Foundation. With additional funding from the Ford Foundation, plans were made to establish a new campus at El Batán that opened in 1971. However, the chair of the Board of Trustees was still the Mexican Secretary of Agriculture and the President of the Rockefeller Foundation was the vice-chair, both persons with multiple job responsibilities and very busy schedules. Further amendments were made to the statutes in 1971 to make these positions elective. However, equipment imports and visas were still handled under the existing Rockefeller Foundation agreement until, finally, in April 1988, CIMMYT gained full international status under Mexican law nearly three decades after IRRI had achieved that status.

The Board of Trustees in the early years reflected CIMMYT's historical legacy, with representatives of Mexico (three including the chair), the Rockefeller Foundation (vice-chair), the Ford Foundation, four appointees from Latin America and three from Asia. From Latin America, Galo Plaze had previously served as president of Ecuador and left the Board to be President of the Organization of American States in 1968. The first elected chair of the Board in 1971 was Virgilio Barco, who would later become president of Colombia. Only in 1972 did the Board diversify to include a member from Europe and one from North Africa.[91]

[87] Roberts 1965.
[88] See, for example, Casas et al. 2012.
[89] Matchett 2002.
[90] Baum and LeJeune 1986.
[91] CIMMYT annual reports.

research and teaching institutions at Chapingo (see Box on p. 20). Both the maize and wheat programs embraced the idea and ideals of international research but in different ways, in part due to differences in the crops and in their institutional legacies. By 1966, when CIMMYT became operational as a legal entity, the wheat program was already a fully-integrated global program enjoying the early successes of the Green Revolution. The maize program was a looser-knit federation of programs that did not fully integrate until some years after CIMMYT was established; nonetheless the interlinked maize programs had already laid the basis for remarkable successes.

## Wheat

In the case of wheat, there were already Rockefeller Foundation-supported wheat programs in Chile, Colombia, Ecuador, and Mexico, and Rockefeller Foundation wheat scientists regularly supported work in Argentina and Brazil, which had relatively strong national programs.[92] After discussions at the Latin American conference of agricultural scientists in Santiago in 1958, Borlaug set about establishing the Inter-American Wheat Yield Nursery to measure yield performance across locations for a uniform set of elite cultivars, to assess wide adaptability and challenging the prevailing paradigm of crop varieties being adapted only to specific locations.

It is also clear that Borlaug sought bigger challenges. In 1961, he mused that there were only three important wheat producers in Latin America – Argentina, Chile and Mexico – and that maize was twice as important in the region's diets as wheat. At the same time, Asia encompassed five times more wheat area than all of Latin America, and wheat was five times as important as maize in diets there.[93] These observations no doubt arose from his first trip to the Near East and South Asia to evaluate the FAO Near East Wheat and Barley Project in early 1960 (see Box on p. 21), following on the heels of a long trip to the wheat programs of Latin America at the end of 1959.[94] As of 1959 and the early 1960s, he generally referred to his program as the "International wheat improvement program,"[95] although the Rockefeller Foundation officially referred to it as the Inter-American Wheat Improvement Program in all their reports. Indeed, the wheat program was already operating globally in 1960 when Borlaug sent the first Inter-American Wheat Yield Nursery to countries outside of the Americas, including Australia, Egypt, Kenya and Pakistan.

The Near East/South Asia trip not only opened Borlaug's eyes to the enormity of the challenge in that region, but also to the excellent performance of the pre-semi-dwarf wheat varieties from the Mexican and other Rockefeller Foundation Latin American programs in a wide range of settings (see Box on p. 21). Accordingly, he devised a two-pronged strategy for expanding the reach of the Mexican program. First, he proposed an in-service training program for the FAO project, with FAO selecting the trainees, the Rockefeller program supporting costs for five years, and the newly-created INIA providing the facilities. All parties quickly agreed to this program, and the first set of trainees arrived in early 1961 for an eight-month stay.

The second prong was closely tied to the training program. While in Mexico, trainees prepared a nursery set for a Cooperative Near East American Spring Wheat Yield Nursery, to be planted in their 10 countries of origin upon their return home in the 1961/62 season. The objective was to test the adaptability and performance of the best wheat varieties and advanced lines from diverse origins under a wide range of soil, climatological and biological conditions, as well as facilitate germplasm exchange. Notably, an explicit objective was to forge linkages among wheat scientists and programs in the Near and Middle East, Northern Africa, and the Americas (Colombia and Mexico).[96]

The nursery dramatically increased the flow of germplasm from the Mexican and Colombian programs to the Near East, including for the first time the as-yet unreleased semi-dwarf lines. The nursery data also demonstrated the wide adaptability of the Mexican wheats, which consistently gained the top places in yield performance. In 1964, the Inter-American Wheat Yield Nursery was merged with that for the Near East to create the 1st

[92] Borlaug made many trips to Argentina in the 1950s, sometimes for several weeks initially, to interact with Criadora Klein, and to support young scientists in the newly-established Instituto Nacional de Tecnología Agropecuaria.

[93] Borlaug 1961.

[94] Borlaug 1960.

[95] Borlaug 1959.

[96] Krull 1968; Borlaug et al. 1964.

## Borlaug visits the wider wheat world in 1960

Most biographies of Norman Borlaug have not appreciated the critical role of his trip to the Middle East and South Asia in early 1960. Already 46 years old and with his semi-dwarf varieties just entering advanced testing in Mexico, it was Borlaug's first trip outside of the Americas. He and Jose Villega, Instituto de Fitotecnia, Argentina, were requested by FAO to evaluate the Near East Wheat and Barley Improvement and Production Project. They traveled with the project coordinator, Harrington, for two months to 12 countries. Three weeks were spent in Pakistan and Afghanistan and they made a quick stop in New Delhi to visit the Rockefeller Foundation India program, so Borlaug got a good exposure to South Asia. At the end of the trip, the team prepared a 45-page program of work for 1961-65 and, despite Borlaug's well-known aversion to office work, he penned a detailed 198-page trip report.

In Pakistan in particular, he was struck by the agro-climatic similarity to the Yaqui Valley in northwest Mexico. As many of the Mexican and Colombian tall materials had been distributed since 1957 to countries of the region through the USDA International Wheat Rust Nursery and the FAO nurseries, he was able to observe them at many stops, and frequently commented on their good performance both in yield and rust resistance – observations confirmed by Pakistan yield testing data. Toward the end of the trip, he writes "I am about convinced that the breadth of adaptation that has been incorporated into the wheat breeding programs of the Rockefeller Foundation in Mexico, Colombia, and Chile is adequate to cover a good share of the areas of the world where severe winter hardiness is not required. I have no doubt that the materials produced...if sent to other countries…will result in the rapid development of important commercial varieties."[97] In Pakistan too, Hafiz proposed a program for Mexico-based in-service training that was to closely link the Rockefeller Foundation and FAO programs.

[97] Borlaug 1960, p. 131.

International Spring Wheat Yield Nursery, distributed to 23 major spring wheat growing regions, including India, Australia, southern Europe, and North America. It was the combination of these nurseries, the in-service training and the strong partnership with FAO and key national systems such as Argentina, India and Pakistan that cemented the global wheat program into an integrated whole.

## Maize

The Inter-American maize program focused on the Americas, which produced about half the maize in the subtropics and tropics. It was based on two pillars. The first was to continue the successful Central American model of cooperative maize research. The original intent was to have additional networks in the Andean region and the Southern Cone. The Andean regional network did get established, based out of the Colombian Agricultural Program, and operated independently until CIAT took charge around 1970.[98] In Mexico INIA took over the MAP maize program as of 1961, although with significant continuing input from Rockefeller Foundation maize staff.[99]

The second major pillar of the Inter-American maize program was basic research to evaluate the large maize germplasm collections, including studies on heterotic patterns, the cytology of chromosome morphology and breeding methods. The work was carried out collaboratively with the newly-established Colegio de Postgraduados (CP) and several U.S. universities, through additional Rockefeller Foundation grants. One partner was John Lonnquist of the University of Nebraska, who would become the second director of the CIMMYT maize program. As part of a move to build up the Chapingo complex into a world class center for basic research and teaching on maize, several professors from the United States taught courses in the CP. It was during this period too that Barbara McClintock, of the Carnegie Institute of Washington and future Nobel Prize winner for work on maize genetics, was associated with the Inter-American Maize program and CIMMYT.

The country and regional maize programs in Africa and Asia continued through this period relatively independently of the Inter-American program and of each other.[100] Their breeding programs were highly decentralized, although germplasm was often exchanged with the Inter-American program. There is no evidence of more systematic international testing of maize lines across regions, although it was an objective of the Inter-American program.[101] None of the maize staff in the programs outside of Mexico had worked in Mexico, while all out-posted staff in wheat had worked closely with Borlaug in Mexico, so likely there was less social capital in the maize program.[102]

Wellhausen did not have the authority to be a global coordinator of the various Rockefeller Foundation maize programs and did not seek it. Even so, the maize program was also thinking in terms of a more international program and Wellhausen made a number of visits to Africa, Asia and Europe, while Mexico received visitors from other regions. Likely influenced by the wheat experience, maize program scientists began to think their improved germplasm might travel well outside the region. After Wellhausen made his first visit to East and West Africa in 1962, the Foundation optimistically reported:

"It was evident that maize production in tropical Africa could be revolutionized with very little effort through the introduction and screening of varieties from the Americas."[103]

These experiences did move the Mexico-based programs toward establishing international programs. The first attempt to create CIMMYT as a cooperative agreement was very much "learning by doing." In 1964-65 the Rockefeller Foundation (presumably Wellhausen) after listing the various country and regional programs to be included in CIMMYT, wrote:

"…though they [the various country and regional programs] may be administered separately, they are conceptually part of the Center in Mexico, and the Center is constantly evolving in form and function..."

However, by 1966 it was clear that the co-operative arrangement around a Chapingo hub was inadequate for the functions of an international research center, and the next step was to create CIMMYT as a legal entity (see Box on p. 21).[104]

## The early CIMMYT years, 1966-71

By 1965-66, the IRRI experience with its own campus, the freedom to operate independently, and its international status had established another ideal of international agricultural research: the value of bringing to one place diverse scientific skills from different nationalities to create a world center of excellence around a specific crop and thereby reap economies of scale in producing technologies and scientific knowledge with wide potential spillovers. The international wheat program operating out of CIANO had some of these dimensions but still depended on the hospitality of INIA and the support of one donor, the Rockefeller Foundation. The logical next step was for CIMMYT to model itself along the lines of IRRI. Although it did not have the international status enjoyed by IRRI, the new legal status achieved in 1966 allowed the Ford Foundation to be a full partner in constructing a new campus and recruiting staff on an international basis. By 1969, USAID had also joined in providing core support to CIMMYT.

With oversight from the newly-appointed Board of Trustees, Wellhausen became "general director," Borlaug continued as director of the wheat program and Robert (Bob) Osler, previously head of the MAP maize program in the 1950s, returned to lead the maize program. The first edition of the CIMMYT News in July 1966 lists 16 international staff (Annex 2), with half based outside of Mexico in 8 separate regional and country programs. Of the country and regional programs, six were inherited from the Rockefeller Foundation and two from the Ford Foundation (Table 2). However, the reach of CIMMYT was already much larger than these 16 people through key partnerships already noted, including FAO in the Near East, PCCMCA

[98] There is no evidence that the Southern Cone maize network was actually established.

[99] In fact, contrary to most reviews of the Rockefeller Foundation program, MAP continued to be a large and active program until 1964 as well as serving as the center for trainees from abroad.

[100] Indeed, even after CIMMYT was legally established each regional program continued to report to the Rockefeller Foundation New York office rather than to Mexico (E. Sprague, pers. comm).

[101] The Colombian program did set up international observation of its germplasm collection in India, Kenya and Thailand in the late 1950s but results seem not to have been published. See Baranski 2015 and the annual reports of the Colombian Program.

[102] The two senior wheat breeders out posted in Latin America, Rupert and Gibler, both started in MAP. Likewise in Asia, Glenn Anderson had made frequent visits to his winter nursery in Mexico before joining the Rockefeller Foundation and Ignacio Narvaez was a long-term staff member of MAP.

[103] Rockefeller Foundation, Program in the Agricultural Sciences: Annual Report, 1962-63, p. 235.

[104] Osler et al. 1978.

in Central America and the USAID/USDA Major Cereals Project in West and East Africa. Staff numbers increased rapidly and became more international through recruitment from among Mexican MAP fellows, the India program and others, often as post-doctoral fellows for two years before long-term employment was offered.[105] By the first annual report for 1966-67, there were 24 international staff and this number increased to 50 by 1971.

Although CIMMYT had been over 20 years in the making and had already been operating regionally and internationally for years, the early days as a formally established international center entailed great excitement. This was heightened by the fact that 1966-67 were the first years of wide adoption of semi-dwarf wheat varieties in South Asia. The first CIMMYT annual report devotes 62 pages to wheat, almost double that for maize. Under Borlaug's continued leadership the program rapidly scaled up its nursery program in number of locations and nursery types, with emphasis on broad adaptation.[106] Breeding in Mexico expanded to emphasize to new sources of diversity (e.g., spring x winter wheat crosses), hybrid wheat and triticale (a wheat x rye hybrid) as a new crop. Physiology and agronomy were strengthened in 1970 under R. A. (Tony) Fischer from Australia, later to become wheat program director. In outreach, the major new addition was in the Magreb countries in North Africa (Morocco, Algeria and Tunisia) with Ford Foundation and USAID support and a strong partnership with the Ford Foundation in Beirut led by Robert (Bob) Havener, who would become CIMMYT's third director general, and with the Rockefeller Foundation and Oregon State University in Turkey. Recognizing that crop management was the key to improving rainfed crop production, agronomy was a major discipline in these programs, with notable successes in Turkey.[107] In short, the wheat program was already on a "high," when Borlaug won the Nobel Peace Prize in 1970.

The maize program had more challenges in transforming itself into an integrated international program. The first maize director, Osler, became deputy director general in 1967, and Lonnquist was recruited for the position. He had already been involved in the Inter-American Maize Improvement Program and understandably continued to support that part of the program. The regional programs in Asia, Central America, the Andean Zone, and Africa also became part of CIMMYT but continued to be quite decentralized, each with their own regional testing networks and the Asian program had its own training program as well. The first international testing was organized in 1970 as the International Maize Adaptation Nursery sent to 26 countries.[108] Training was also becoming international, with some 25 trainees from 15 countries in 1971, the first year with a comprehensive maize training program.[109] Important new initiatives in this period were the incorporation of the quality protein trait into tropical and subtropical maize germplasm, novel selection of tropical maize for lower plant height and screening of germplasm for insect resistance.

**Table 2. Regional and country programs inherited by CIMMYT, 1966-67.**

| | Maize | Wheat |
|---|---|---|
| Regional programs | Central American (Chapingo, Mexico)<br>Andean Zone (Bogota, Colombia)<br>Southeast Asia (Bangkok, Thailand )<br>East Africa (with USDA) (Kitale, Kenya)<br>West Africa (with USDA) (Ibadan, Nigeria) | Near East (FAO lead) (Cairo, Egypt)<br>Andean Zone (Quito, Ecuador) |
| Country programs | Mexico (Puebla Project)<br>Egypt (Ford Foundation) | Chile<br>India<br>Pakistan<br>(Ford Foundation) |

Except where noted, all are Rockefeller Foundation supported. CIMMYT/Rockefeller Foundation involvement in West African maize appears to have closed in 1966. The East African program was included from 1967. Home base of the regional program is given in parentheses. Sources: CIMMYT News Vol 1 No 1, July, 1966; CIMMYT Annual Report 1966-67; Rockefeller Foundation Annual Report 1966.

After Sprague took over as maize director in 1970, CIMMYT hosted an international maize conference in 1971 to take stock, followed in 1974 by an internal review by all CIMMYT maize staff.[110] These efforts led to the development of a global, systematic approach to evaluate and deliver improved maize germplasm, structuring breeding materials as 27 germplasm pools defined by ecology, maturity, color and grain type.

The regional program in the Andean region was transferred to CIAT by 1970. The USDA-supported regional programs in Africa were taken over by IITA in 1970, leaving only the Central American and Asian regional programs with CIMMYT.[111] However, new country programs were opened in Congo DR, Nepal and Pakistan. A major new country initiative at this time was Plan Puebla in Mexico, managed collaboratively with CP to reach small farmers in rainfed areas with new maize technology. Financed through a sizable Rockefeller Foundation grant, Plan Puebla addressed the Foundation's disappointment with MAP results in Mexico (discussed in the next section). However, at the very moment of initiating Plan Puebla, Rockefeller-CIMMYT programs in El Salvador, Kenya, and Thailand were showing rapid uptake of improved maize technology by millions of small-scale farmers in rainfed areas. In short, the CIMMYT maize program was already demonstrating remarkable successes in its early years, although it was slow to recognize this.

Unlike IRRI, CIMMYT did not include economists in its original staffing. With pressure from CIMMYT Trustee Lowell Hardin, Ford Foundation economist, in 1970 CIMMYT hired Donald (Don) Winkelmann, then working with the Ford Foundation at the CP, destined to serve as CIMMYT's fourth director general and who successfully negotiated CIMMYT's final status as an international center. His early work focused on introducing trainees to economics and conducting studies on the adoption of new maize and wheat technologies. However, it would take another decade for economics to become an integral part of CIMMYT research, especially through participatory approaches to on-farm testing of new technology.

[105] The maize program was the first to implement the post-doctoral system.

[106] Krull 1968; Baranski 2015.

[107] See CIMMYT annual reports for this period.

[108] CIMMYT Annual Report 1970-71.

[109] CIMMYT 1974.

[110] CIMMYT 1971; 1974.

[111] IITA did not take over the East African regional program but hired the CIMMYT regional maize scientist who was not replaced for several years.

In an official constitutive act in Mexico in 1963, George Harrar signs documents establishing the International Maize and Wheat Improvement Center.

# Chapter 6 Early impacts: A center born in the spotlight of success and controversy

By the time CIMMYT was born, MAP had been hugely successful in increasing Mexican grain production, building on the 23 years of investment in research prior to the creation of CIMMYT. However, that success immediately excited controversies that linger to this day. This is not the place to provide a comprehensive discussion of the debates but it would also be remiss in any history of the founding of CIMMYT to ignore them completely.

Undoubtedly the Mexico program succeeded well beyond expectations in achieving what it set out to do – to increase the production of maize and wheat and eliminate grain imports. By 1960, wheat and maize yields in Mexico had increased by 76 percent and 34 percent, respectively, since 1944 (Figure 5). By 1956, Mexico was a wheat exporter and by 1964, it had started exporting maize as well. The increased production paid high returns to the investment in MAP, for both wheat and maize, according to a doctoral thesis by Nicolas Ardito-Barletta (a future president of Panama) completed in 1970 under the supervision of Ted Schultz at the University of Chicago.

Furthermore, MAP was a major scientific success. For wheat, this success was evident in the development of stem rust resistance that endured for nearly half a century, the tenacious and successful effort to incorporate semi-dwarfing genes and the development of broad adaptability across major irrigated and many rainfed environments. In maize, scientific success included the first comprehensive collection and classification of tropical and subtropical maize races, the development of improved populations and hybrids for the tropics and subtropics from virtually a zero base and the refinement of breeding methods.

Why then the controversy? The very different characteristics of maize and wheat in Mexico tell most of the story as summarized by Myren, head of information services for MAP and later CIMMYT (Table 3).[112] At the time MAP started about three-quarters of the wheat was irrigated but only 2 percent of Mexican farmers grew wheat as a major crop, and these were overwhelmingly larger commercial farmers. Adoption of the new technology was rapid with almost universal coverage even before the semi-dwarfs were released. Maize was of course the major crop and food staple for over two million smallholder farmers.[113] Due to problems in producing and distributing seed through the parastatal CNM and weak extension, adoption was still only about 10 percent of the maize area by 1960 and mainly by larger farmers based mostly in irrigated or higher potential areas.[114] The heterogeneous maize growing conditions meant that available hybrids and open pollinated varieties (OPVs) were suited to only a portion of the total maize growing area. This was demonstrated in the Puebla Project when, after extensive testing, it was decided that no improved variety or hybrid could consistently outperform the local variety.[115] Even so, possibly as many as a third of the farmers were using second-generation seed or "criollized" varieties, developed through cross-pollination by the common practice of growing improved germplasm near plots of local varieties.[116]

Independent social scientists were highly critical of this unequal outcome, although with the prevailing distribution of farm holdings and the Mexican government's food and agricultural development strategy focused on irrigated agriculture, it is hard to see how the outcome could have been different.[117] There were of course ideological undercurrents to some of these assessments, but long-time chronicler of the adoption of high-yielding varieties, Dana Dalrymple of USAID, concluded that "the poor growers have largely been bypassed" and "the Mexican model is hardly a complete model for other less developed countries."[118] Even Rockefeller Foundation scientists were concerned. Reviewing in 1967 the history of the program they had conceived, Stakman, Bradfield and Mangelsdorf, concluded that:

[112] Myren 1969.
[113] Venezian and Gamble 1969.
[114] Myren 1969; Ardito-Barletta 1970; Dalrymple 1969.
[115] Winkelmann 1976.
[116] Wellhausen 1978. This process was later documented in Bellon and Risopoulos 2001.
[117] Hewitt de Alcantara 1976; Lewontin 1983; Jennings 1988; Freebairn 1969.
[118] Dalrymple 1969, pp. 26-27.

"The great majority of Mexico's small farmers have not yet gained much from the agricultural research because they have not yet applied it...Such data as are available in Mexico indicate that the increased wealth produced by the improvement of agriculture in the past 20 years has gone largely to the upper income groups."[119]

Wellhausen himself frequently agonized over the failure to reach small-scale farmers in Mexico and as CIMMYT director general passionately argued for the "urgency of accelerating production on small farms" by refocusing science on the needs of the bottom half of the world's farmers that had not yet been reached.[120]

In 1950 about two-thirds of the Mexican population was still in agriculture, so reaching the mass of small farmers was essential to address problems of poverty and hunger. Still Mexico was urbanizing rapidly and the increase in agricultural productivity may have translated to lower prices and more affordable food for the growing number of urban poor. This is particularly so for maize, which remained the major staple of the urban poor.[121]

Meanwhile, even as CIMMYT was being launched in 1966 the wheat revolution was taking off in South Asia. Indeed, it was South Asia with 10 times the wheat production of Mexico that put CIMMYT on the global map. Again irrigated areas dominated wheat production in the region, but this time the producers were tens of millions of very small farmers across the Indo-Gangetic Plains in a region that was chronically short of foreign exchange and far too large to depend on world markets for food. In India, the timely availability of the semi-dwarfs, excellent scientific leadership from Swaminathan, a bold push on fertilizers by agriculture minister C. Subramanian, strong support by Prime Minister Indira Ghandi and the onset of the worst drought of the century together led to bold action on seed imports and fertilizer production and distribution.[122] Similarly, in Pakistan the semi-dwarfs were tested and selected by ex-CIMMYT trainees under the FAO Near East program (notably Manzour Bajwa and Muhammed Nur), with strong support from national policymakers and the Ford Foundation. Aided by historically unprecedented imports of seed (from Mexico), adoption reached most farmers within 10 years and India and Pakistan spectacularly raised their respective wheat yields by 71 and 87 percent, from 1966 (Figure 6).

**Table 3. Summary of conditions for maize and wheat production in Mexico in 1940 and the adoption of improved varieties of maize and wheat by 1960.**

| | Maize | Wheat |
|---|---|---|
| Area 1940 (million hectares) | 3.34 | 0.60 |
| Percent irrigated, circa 1960 | 9 | 73 |
| Percent of farms with maize/wheat as major crop, circa 1960 | 55 | 2 |
| Average maize/wheat area per farm, where major crop (hectares), circa 1960 | 17 | 3 |
| Percent area under improved seed, 1960 | 8-14 | 95+ |
| National yield (tons per hectare) | | |
| 1940 | 0.63 | 0.76 |
| 1960 | 0.84 | 1.34 |
| Percent increase | 34 | 76 |

Note: Adoption of improved maize was based on seed sales. It is likely that a much higher share of farmers used varieties based on improved germplasm, especially open pollinated varieties.

Initially there were abundant critics of distributional outcomes in South Asia as well. Even Hopper, Schultz's former student and by then a Rockefeller Foundation economist in India, wrote to Wellhausen in 1969 about the introduction of the semi-dwarf varieties:

"The small farm problem has become an issue of major political importance in India. There is substantial evidence that the economic benefits of the …introduction of dwarf varieties…have accrued primarily to large landholders."[123]

However, the mass of evidence assembled by Michael Lipton a decade later in *New Seeds and Poor People* (and by many others[124]) showed that small farmers adopted the technology after a lag, and with similar yield and profitability gains. But long before these findings had become mainstream, and despite the initial reports from India, CIMMYT in its Annual Report for 1968-69 was claiming victory in no uncertain terms.

"Finally, the fears voiced by many critics on the non-receptivity of the traditional farmer to new varieties and new technology...have been quietly laid to rest in the ashes of the flaming success of the two past harvests." p. 64.

Lipton also highlighted that landless laborers, the poorest of the poor, benefited from the new technology through increased employment, migration opportunities and wages. Probably the largest impact came from the decline in the price of wheat, a major food staple of poor consumers, including the rural landless, that closely tracked productivity increases.[125] Nonetheless, there were also losers in India, especially farmers in rainfed regions who did not adopt the new technology and faced lower prices for their grain.

While the wheat revolution in irrigated areas, soon to be joined by rice and re-named the "Green Revolution," was stealing the headlines, several more localized but nonetheless major breakthroughs were quietly unfolding in maize, reaching masses of small-scale farmers in rainfed areas. Even as the Mexican program was debating the appropriateness of hybrid seed for smallholders, two other Rockefeller Foundation-supported programs paved the way for the first wide-scale adoption of hybrid maize technology and associated management technologies. In El Salvador self-taught maize breeder Jesús Merino Argueta "had only a high school education, a shoestring budget and an innate ability to selecting promising lines."[126] After training in MAP and accessing germplasm through the Central American regional program, he succeeded in developing the successful hybrid H-3 by 1963. He developed strategic partnerships with a private

[119] Stakman et al. 1967, p. 214.

[120] Wellhausen 1970.

[121] Wheat was a fully tradable commodity and the only impact on prices would have been the difference between export and import prices. Mexicans however have a strong preference for white maize which was hardly traded in the market at the time so price impacts of increased domestic supply could have been significant.

[122] This story has been well documented. See Perkins 1997 and Lewis 1995.

[123] Letter from Hopper to Wellhausen, 2 Dec 1969. http://rockefeller100.org/files/original/2fcb7f3ccf0571df5f182cb0d239cf48.pdf. Hopper wrote to request a copy of a CIMMYT Report on the Puebla Project.

[124] Notably, Ruttan 1977.

[125] Sidhu and Byerlee 1992; Evenson and Gollin 2003.

[126] Walker 1981.

seed company to produce and market the seed, a government extension effort to mount over 18,000 demonstrations, and collaborated with a Catholic priest to establish credit cooperatives.[127] Hybrid maize adoption took off rapidly from 1967, reaching 60 percent of the farmers in the country by 1974 and making El Salvador the highest adopter of improved maize in Latin America, outside of Argentina.

The Kenyan story is quite similar. Cooperation of the Kenyan maize program with the Mexican and Colombian programs led to the release of the hybrid H611 in 1964, based on a cross of local material with a collection from Ecuador (Ecuador 573).[128] H611 was rapidly and widely adopted by Kenyan smallholders. As in El Salvador, a (then) private seed company, the Kenyan Seed Company (with support from the Dutch government) and a large-scale extension effort supported by FAO's Campaigns against Hunger and backed by Rockefeller Foundation-supported agronomic research stimulated smallholder adoption on over half the maize area outside of the dry zone by 1976 (Figure 6). The adoption of hybrid maize in El Salvador and Kenya by smallholder farmers was almost as rapid as in Iowa three decades earlier and finally realized the vision of Henry Wallace when he visited Mexico in 1940.[129]

The Rockefeller Foundation-supported program in Thailand led to wide adoption of open pollinated varieties of maize and rapid area expansion in regions with extensive land available for cultivation. Thailand began using maize germplasm from the Americas in 1952, especially Tequisate Golden Yellow from the Iowa State University station in Guatemala.[130] Construction of roads led to opening of new land and rapid expansion of maize as a cash crop during the 1960s. Additional impetus was provided when the Rockefeller Foundation and USAID started supporting the national maize program in the late 1950s and when the Inter-Asian Corn Program was initiated in 1963. An outbreak of downy mildew stimulated a new generation of maize varieties that eventually resulted in the highly successful Suwan varieties of the early 1970s. Maize production in Thailand increased from about 0.5 million tons in 1960 to 3 million tons in 1975 and Thailand became the world's fourth largest maize exporter, based entirely on small- and intermediate-scale producers.

Similarly, investment in maize research in Ibadan, Nigeria, was initiated by the 1950s maize rust outbreak, backed by germplasm from the Rockefeller Foundation Latin American programs. The work was supported by the Foundation since 1963 with the posting of staff to Ibadan, by USAID under the USDA-led Major Cereals Project for Africa, and by the Ford Foundation, before being taken over by IITA when it started operating in 1970.[131] The Ford Foundation also began to support maize work at Zaria in the North in the early 1960s, including pioneering socioeconomics research on farming systems.[132] These programs developed Nigeria Composite A and B, which laid the foundation for IITA's successful development of the TZB maize variety widely adopted across the Nigerian savanna and in other countries of West Africa.[133] A major World Bank-funded extension effort in the 1970s and generous fertilizer subsidies were critical to this success.[134] As a result, maize production in Nigeria doubled in the 1970s.

[127] The El Salvador maize story is described extensively in Walker 1981 and Cutie 1975.
[128] Harrison 1970.
[129] The Kenyan hybrid maize story is reviewed most extensively in Gerhardt 1975. See also Johnson et al. 1979 and Dixon 1960.
[130] Dowswell et al. 1996.

[131] Goldsmith 1990. Eberhart and Sprague 1973.
[132] Norman et al. 1982.
[133] Fakorede et al. 1993.
[134] See Smith et al. 1994; Eberhard and Sprague 1973; IITA 1992.

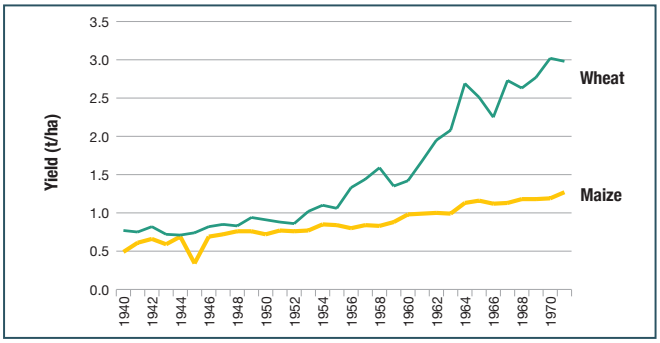



**Figure 4. National maize and wheat yields, Mexico, 1940-70.** Source: INEGI 2016.

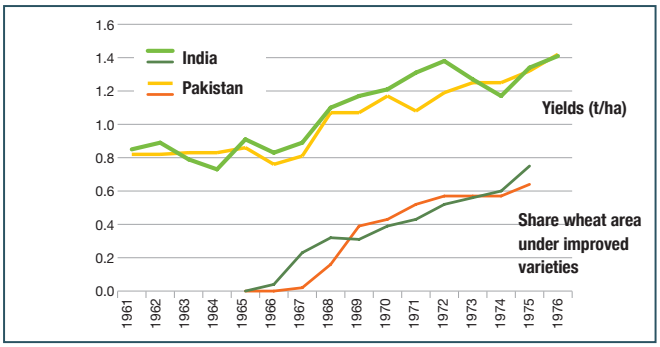



**Figure 5. Adoption of semi-dwarf wheat varieties and wheat yields in India and Pakistan.** Source: Dalrymple 1974 and FAOSTAT.

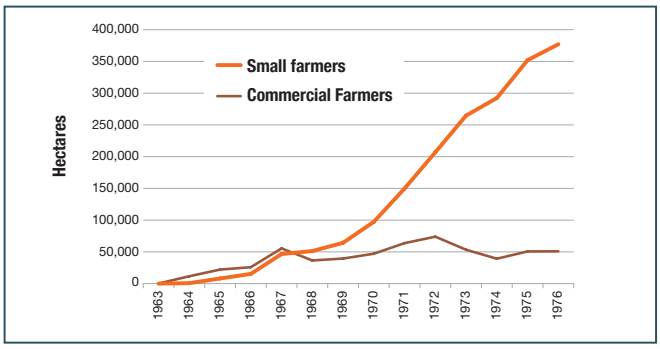



**Figure 6. Adoption of hybrid maize in Kenya.** Source: Johnson et al. 1979.

A view of the administrative building at CIMMYT in Mexico.

Chapter 7

# Fast forward to 2016: Re-affirming the role of international agricultural research and its challenges

The experiences of CIMMYT and IRRI laid the basis for the rapid expansion of international agricultural research, especially after CGIAR was founded in 1971. It is interesting to speculate on how CIMMYT's founders might view the Center and, more generally, CGIAR today. They would probably feel quite familiar with the spate of gloomy publications about world food supply, with the titles updated from *Six Billions to Feed*, as published by FAO in 1962, to the many variants of Feeding the Nine (or Ten) Billions published in recent years. They would no doubt remind us that, in partnership with national research systems, they were extraordinarily successful in supplying world food needs, particularly considering that the population explosion they faced was greater than that we face today – and they were not even anticipating the 150 million tons of grain that would go to ethanol or the even larger 250 million tons of grain used for feeding animals in Asia today.

Much of this success was due to investment in the genetic improvement of crops, the main focus of this study. Retrospective studies of CGIAR's impacts have cited 0.7-1.0 percent yield growth annually during 1965-2000 thanks to genetic gains, with about half of that attributable to CGIAR. Impacts were greatest for the three big crops – rice, wheat and maize – with well over half of developing country area for each crop sown to improved varieties and with

benefits amounting to tens of billions of dollars.[135] However, by 2000 there were notable successes for almost all cereals, roots and tubers and legumes, but only modest success in Sub-Saharan Africa, where the most recent estimates are that about one-third of the area is sown to improved varieties.[136] In aggregate, without genetic improvements of crops by CGIAR, it has been estimated that world food production by 2000 would have been 5 percent lower and food prices 18-21 percent higher.[137]

Our founders would likewise be familiar with the sustainable development goal of zero hunger – that had been the call at every world food summit since the first one in 1943. It was later enshrined in the FAO Freedom from Hunger campaign in 1959, the Rockefeller Foundation Conquest of Hunger program in 1963, and the U.S. War on Hunger in 1966, all established during the decade that CIMMYT was founded. Nonetheless, our founders would be disappointed at the slow progress over the past 50 years in meeting that challenge, with 800 million still hungry today, despite the enormous success on the food production front. Although Rockefeller Foundation scientists and their contemporaries set out to conquer hunger, they did not articulate well the impact pathway from food production to food security. Today as the world rapidly urbanizes, articulating this impact pathway remains a central challenge to CGIAR, especially getting the right balance between poor farmers and poor consumers. Theories of change[138] are helping articulate these pathways, but much more specificity is needed to identify how changes in productivity in particular regions, crop and livestock products, and types of farmers translate into reduced food insecurity.

Second, CIMMYT's founders would endorse the move toward CGIAR Research Programs as consistent with their vision of international research and urge patience in making them work. These CRPs respond to the fragmentation of the earlier global programs, as new international centers were created and core funding support to CGIAR system declined. This review has shown that CIMMYT's creation was in fact the merger of many programs into global maize and wheat programs, akin to today's CRPs. Especially for maize, it took a decade after CIMMYT was established to create a well-coordinated international maize program from the initial set of relatively independent country- and regional-programs. Even the acceptance of CIMMYT as a brand name was slow, with CIMMYT staff identifying themselves with their Foundation origins well into the 1970s – another lesson for today's nascent CRPs. Nonetheless, the Rockefeller Foundation did facilitate the process by quickly providing core support to CIMMYT and phasing out country- and region-specific grants. The lesson for donors today is that long-term core support to the CRPs is crucial for their success. Although such support should be tied to results on the ground, the results framework needs a light touch and a long-term perspective – after all, Borlaug did not anticipate that the wheat varieties he bred for Mexico would have far-reaching application in the wheat world until 16 years after he had initiated the work.

Our founders would note the slow progress toward building strong national research systems and be surprised by the large number of CGIAR staff, both local hire and international, based in country and regional programs, in many ways echoing the original offices of special studies of the Rockefeller Foundation. The Rockefeller Foundation saw their role as "working their way out of a job" at the country level and shifting to international and small regional hubs to provide what we now call international public goods and regional facilitation services. Although there is evidence of increased investment in agricultural research by some countries, overall investment continues to constitute a low share of agricultural budgets and only a fraction of that in developed countries. Related to this and other factors, many national programs have difficulty attracting and keeping qualified staff. The private sector has only partly filled this gap but, especially for maize, is now offering the opportunity to make up for lost decades of attempting seed delivery through largely ineffective parastatal seed sectors. After 50 years, this suggests that a renewed dialogue is badly needed on the role of the international centers in getting the right balance between facilitating the development of strong national systems (including private R&D) versus substituting for the lack of such development.

Of course much has changed beyond recognition over the past 50 years. The free sharing of germplasm, which may have accounted for half of breeding progress[139] and provided a major rationale for establishing international research, has been eroded by intellectual property and biodiversity rights and the dominance of large private R&D efforts for some crops, notably maize. There is also an unrealistic view in many countries regarding the value of their national biodiversity versus the benefits of international cooperation. At the same time, sharing of knowledge and databases through open-source publishing has greatly expanded and, along with the internet, is moving the balance of international cooperation from germplasm to knowledge, some of which could be managed by a virtual center. Sustainability concerns were not high on the agenda of early CGIAR efforts, although Borlaug (originally a forester) strongly argued with some justification that increasing crop yields was the best way to conserve forests and other natural areas.[140] Even so, the strong focus on single crop programs inherited from our founders did come at the cost of insufficient attention to broader farming system and ecological perspectives, only recently addressed in CGIAR.

What has not changed is the original idea that international collaboration in agricultural research will and must continue to be a central pillar of improving human welfare. The basic ideals of cooperation of global facilitation, production of international public goods, free exchange of scientific knowledge and products, long-term strategic partnerships to access the latest science and to deliver products to clients, sustained support over the long term for high-quality scientists protected from political interference, and integration of capacity development evolved over 50 years ago and remain equally valid today.

[135] Evenson and Gollin 2003.

[136] Walker et al. 2015.

[137] Evenson and Gollin 2003.

[138] Theories of change are methods of planning and evaluation that identify long-term goals and detailed preconditions to achieve them.

[139] Dubin and Brennan 2009.

[140] Byerlee et al. 2014.

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## Annex 1. Timeline of important events in maize and wheat research to 1966.

| | Rockefeller Foundation Mexican progam/CIMMYT | Other Rockefeller Foundation maize and wheat programs | Other partner programs in maize and wheat | World Food events |
|---|---|---|---|---|
| 1940 | US Vice President Henry Wallace visit to Mexico. | | | |
| 1941 | Richard Bradfield, Paul Mangelsdorf and Elvin Stakman Survey Commission in Mexico. | | | |
| 1943 | Mexican Agricultural Program (MAP) initiated under leadership of George Harrar and including maize breeder, Edwin Wellhausen. | | | United Nations Conference on Food and Agriculture, Hot Springs, USA. |
| 1944 | Norman Borlaug joins MAP and takes over wheat program in 1945. | | | |
| 1945 | | | | FAO created, based in Washington, USA. |
| 1948 | MAP begins training young scientists from Latin America. | | | |
| 1949 | | | | US launches 'Point Four' program of extensive foreign assistance to the 'free world.' |
| 1950 | Colombia Agricultural Program initiated. | | USDA establishment of International Spring Wheat Rust Nursery. | |
| 1952 | | | FAO Regional Near East Wheat and Barley Improvement program initiated. | |
| 1954 | | Central American Regional Maize program initiated. | | |
| 1955 | | Chile Agricultural Program Initiated. | | |
| 1957 | | India Agricultural Program initiated for maize. | | |
| 1959 | Inter-American Maize Improvement Program initiated, Colegio Postgraduados established. | | | FAO initiates Freedom from Hunger Campaign. |
| 1960 | Inter-American Wheat Improvement Program initiated. Borlaug makes extensive visit to 12 countries in Near East-Asia. | | | International Rice Research Institute legally established (operational in 1962). |
| 1961 | Mexico establishes INIA. | | First group of wheat trainees from Near East/Asia sent to Mexico in Mexico. First Near East Americas Spring Wheat Nursery. | |
| 1963 | CIMMYT established as a cooperative agreement between the Rockefeller Foundation and the Government of Mexico. | Inter-Asian Corn Program established. East African maize program supported (with USAID/USDA). Highly successful maize hybrid released in El Salvador. | | World Food Congress, Washington, USA. The Rockefeller Foundation launches the Conquest of Hunger program. |
| 1964 | | West African maize program initiated (with USAID/USDA). India Wheat program initiated. Highly successful maize hybrid released in Kenya. | | |
| 1965 | | | Ford Foundation initiates its Pakistan wheat program. | Beginning of worst drought in India for 20th century and large food aid shipments. |
| 1966 | CIMMYT legally established as a civil society organization. | India orders large seed shipment of semi-dwarf wheat varieties from Mexico. | Ford Foundation initiates its Egypt maize program. | US launches War on Hunger. |

## Annex 2. Initial list of CIMMYT international staff, July 1966.

| Administration | Maize | Wheat | Other |
|---|---|---|---|
| Edwin J. Wellhausen, General Director (1943) | Robert D. Osler, Head (1955) | Norman E. Borlaug, Head (1944) | Reggie J. Laird, Head, Soils (1952) |
| N. B. MacLellan, Administrative Assistant and Photographer (1952) | Elmer Johnson, Breeder (1958) | Charles F. Krull, Breeder (1960) | Delbert T. Myren, Head, Communications (1955) |
| | | | Gregorio Martinez V., Technical Editor (1957) |
| **Posted outside of Mexico** | | | |
| | Dale D. Harpstead, Breeder, Andean Zone, Bogota (1961) | John W. Gibler, Breeder, Andean Zone, Quito (1952) | |
| | Ernest W. Sprague, Breeder, Southeast Asia, Bangkok (1959) | Joseph Rupert, Breeder, Santiago (1948) | |
| | Marvin F. Lindsey, Breeder, Africa, Ibadan (1964) | R. Glenn Anderson, Breeder, New Delhi (1964) | |
| | Arthur E. Peterson, Production specialist, Cairo (1966) | Ignacio Narvaez, Breeder, Lahore (1964) | |

Note: The published list includes John S. Niederhauser, plant pathologist. All other sources indicate that he was working full time on potatoes and CIMMYT provided support. The list did not include Rupert but he is added here since all other sources confirm that Rupert who had already worked nearly 20 years with Rockefeller Foundation on wheat in Mexico, Colombia and Chile was part of CIMMYT from the beginning.

Year in parenthesis when staff member first hired by the Rockefeller Foundation or MAP usually according to the Rockefeller Foundation Annual Reports. Note that staff lists were not included in the 1949, 1950 and 1951 reports so staff listed as 1952 could have been hired earlier.

*Source: CIMMYT News Vol 1 No 1, July 1966 (CIMMYT Archives).*

1966-2016
CIMMYT

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CIMMYT MR

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