

2013 Annual Report

Agricultural Research for Development to Improve Food and Nutritional Security.

About CIMMYT

Through research, development, training and capacity building, CIMMYT works with partners to sustainably increase the productivity of maize- and wheat-based cropping systems. Focused on improving food and nutritional security and improving livelihoods in the developing world, CIMMYT is a member of CGIAR and leads the MAIZE and WHEAT CGIAR Research Programs (CRPs).

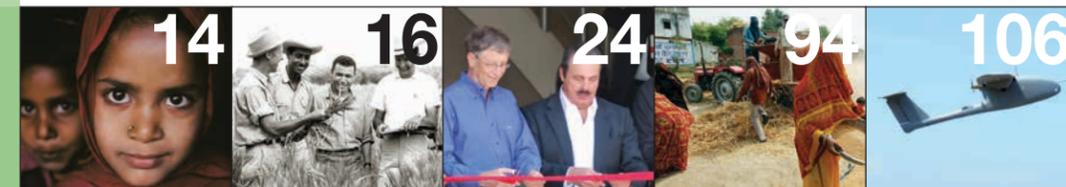


CGIAR is a global partnership that unites 15 research organizations dedicated to a food-secure future. CGIAR research is reducing rural poverty, increasing food security, improving human health and nutrition and ensuring more sustainable management of natural resources. This effort is carried out in collaboration with hundreds of partner organizations, national and regional research institutes, civil society organizations, academia and the private sector.

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* Expanded versions of these sections are available on the CIMMYT website (www.cimmyt.org).



The CIMMYT Mission

CIMMYT's mission is to "sustainably increase the productivity of maize and wheat systems to ensure global food security and reduce poverty."

CIMMYT's dedicated staff continued a tradition of excellence in agricultural research for development (AR4D) that stretches back to CIMMYT's predecessor organization (the Office of Special Studies) in the 1940s and to the founding of CIMMYT in 1966 – working to improve the food and nutritional security and livelihoods of those the Center serves.

This work is as important now as it has been for the past 70 years – perhaps more so as the world faces an ever-increasing population, climate fluctuations, less arable land and declining amounts of water for agricultural purposes. The critical work that CIMMYT does would not be possible without CIMMYT's partners and donors. Hundreds of partners work with CIMMYT to improve lives across the developing world, and CIMMYT's accomplishments are shared with them. The dedication of CIMMYT's donors to similar goals and their generous funding make CIMMYT's work possible, and all CIMMYT employees are proud and thankful for their support and assistance.

During 2013 CIMMYT's Board of Trustees, staff, partners and donors continued to work together to deliver on CIMMYT's mission. New projects began and

others continued to meet or exceed the goals set for them. CIMMYT staff members are working to improve all areas of operations across the world – to be ever more efficient and effective in reaching the Center's goals.

CIMMYT is having an impact across the world, but much more needs to be done – and will be through these collective efforts and partnerships.

The following are representative examples of CIMMYT's work to carry out its mission:

to sustainably increase the productivity of maize and wheat systems to ensure global food security and reduce poverty

- Recent estimates indicate that wheat varieties developed by CIMMYT and its partners are planted on more than 64 million hectares (ha) in developing countries, representing more than 75 percent of the area planted to modern wheat varieties in those countries.
- Maize varieties developed by CIMMYT and its partners are planted on nearly half of the area sown to improved varieties in non-temperate areas of the developing world.
- CIMMYT scientists who developed more nutritious maize varieties received the 2000 World Food Prize.

As reported in *Science* magazine, in the absence of CGIAR Centers such as CIMMYT, with their many partners in the developing world, crop yields in developing countries would have been 19.5 to 23.5 percent lower; prices for food crops would have been 35 to 66 percent higher; imports would be 27 to 30 percent higher; calorie intake would have been 13.3 to 14.4 percent lower; and 32 to 42 million more children would have been malnourished. The area planted to crops would be 4 percent higher for wheat and 2 percent for maize.



2013 Highlights

2013 grant income was \$166.4 million, compared with \$122.4 million in 2012.

2013 marked the 70th anniversary of the Office of Special Studies (see page 18).

A new biosciences complex opened at CIMMYT's headquarters.

Over 3 million farmers benefited from 63 new maize varieties released in partnership with commercial seed companies across target countries in Africa, Asia and Latin America.

The participation of women in capacity building events (formal courses, meetings, workshops, field days and study tours) increased:

- MAIZE events were held in 27 countries – 30 percent of the 48,958 participants were women.
- WHEAT events were held in 20 countries – 38 percent of the 1,047 participants were women.

\$5.7 million in competitive grants were awarded to non-CGIAR partners by MAIZE and WHEAT.

New office facilities opened in India and Zimbabwe.

MAIZE and WHEAT successfully completed gender audits.

Science Week 2013 helped CIMMYT plan for 2014 and beyond.

RustTracker systems now cover wheat-growing areas in 38 countries.

Africa

The CIMMYT-Kenya Agricultural Research Institute (KARI) Maize Lethal Necrosis Screening Facility and CIMMYT-KARI Doubled Haploid Facility opened in Kenya (see page 28).

Improved drought-tolerant maize varieties and hybrids resulted in yield increases as high as 30 percent in some areas.

Nearly 10,000 farming households in Zambia adopted Provitamin A maize.

21 maize varieties were released in eastern and southern Africa.

Asia

Approximately 200,000 farmers were trained in sustainable intensification technologies.

As part of a trial, six zinc-enriched wheat varieties were commercialized to more than 1,000 farmers in India's Eastern Gangetic Plains.

CIMMYT co-sponsored the 50th Pact Conference in India, celebrating the 50th anniversary of Dr. Norman Borlaug's first trip to South Asia with improved wheat seeds (see page 32).

Latin America

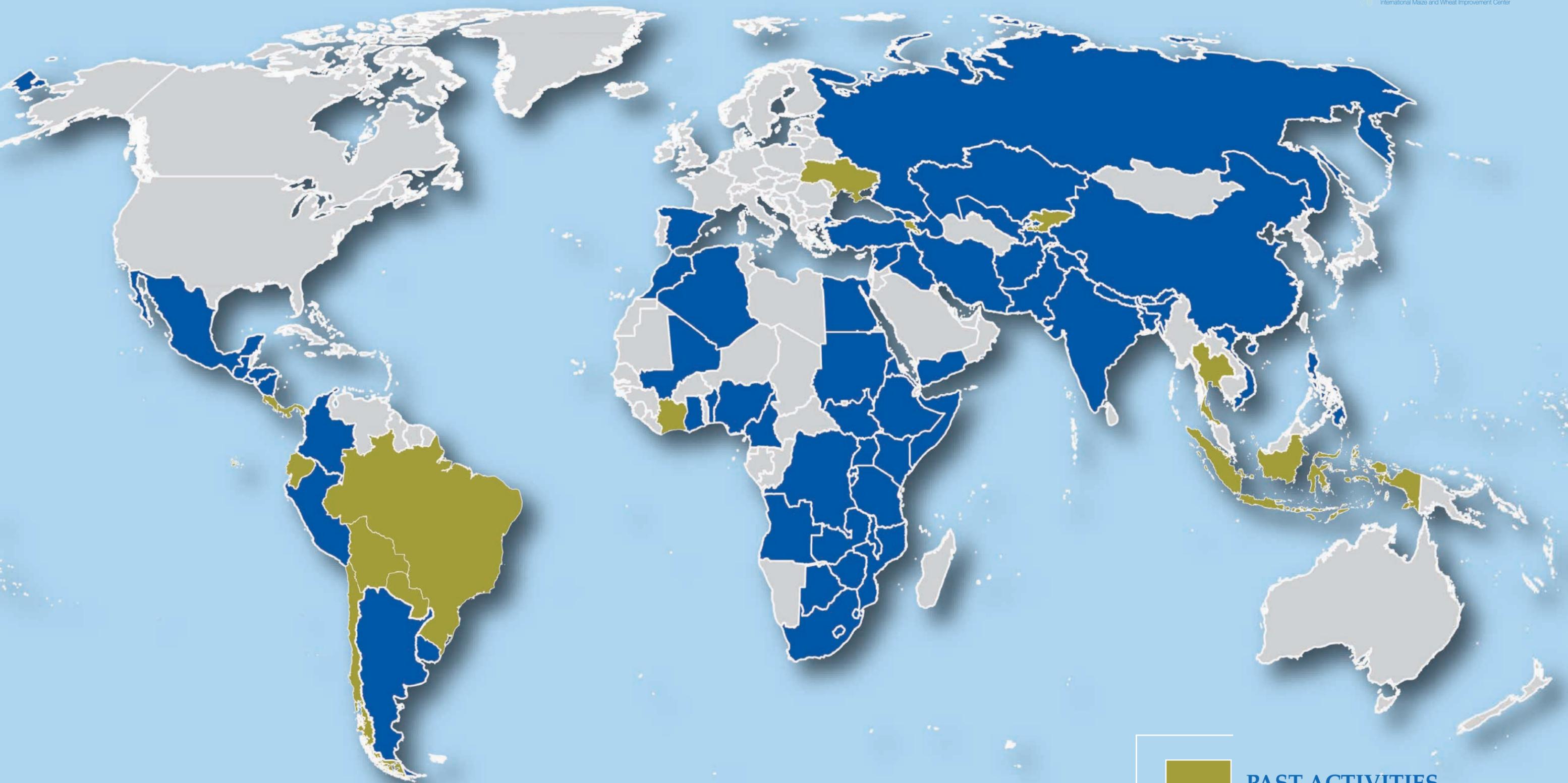
27.4 tons of pre-commercial seed of 26 hybrids and two varieties of maize were distributed to members of MasAgro's network of Mexican seed companies.

MasAgro Móvil launched a general agricultural information line with over 2,500 weekly subscribers.

11 cultivars were released in Latin America.

Remote sensing workshops were held in Colombia, Mexico and Peru.





CIMMYT Around The World



PAST ACTIVITIES



CURRENT ACTIVITIES

AT A GLANCE: MAIZE and

WHEAT Around the World

THE WORLD OF MAIZE

Staple food for 900 million people living on less than \$2 a day

Maize, rice and wheat provide **30%** of calories for 4.5 billion people in 94 developing countries

LATIN AMERICA

ANNUAL PRODUCTION INCREASE (2002-2012)
+4.5%
AREA HARVESTED (2012)
37.3m hectares
CONSUMPTION PER CAPITA (2009)
47.6 kg/year

SUB-SAHARAN AFRICA

ANNUAL PRODUCTION INCREASE (2002-2012)
+4.9%
AREA HARVESTED (2012)
32.5m hectares
CONSUMPTION PER CAPITA (2009)
39.7 kg/year

ASIA

ANNUAL PRODUCTION INCREASE (2002-2012)
+5.7%
AREA HARVESTED (2012)
57.6m hectares
CONSUMPTION PER CAPITA (2009)
9.3 kg/year

FAOSTAT 2013

1 2 3 4 Importance of maize as a source of calories where MAIZE CRP works

MAIZE TARGETS

WITH

TO HELP

275 million maize dependent poor smallholders in stress-prone areas and lacking market access

367 million smallholders held back by lack of access to technology

- New varieties
- Improved technologies
- Information services
- Market opportunities

Poor maize consumers vulnerable to price changes

Maize yields need to increase by **60% by 2050** to meet demand.

90% of poor maize farmers live in tropical climates most vulnerable to climate change.

Growing use as a livestock feed: **440 million tons** produced in 2014.

Biofuels: 1 ton of maize = 370 liters of ethanol.

New disease in Kenya: loss of **56,730 tons**, or **US \$23.5 million** in 2012 due to maize lethal necrosis virus.

GENDER IN MAIZE

MAIZE values the role of gender for farm households and for developing, testing and promoting technologies

MAIZE works with partners to integrate gender in all projects

Women's empowerment and better household decision making

13% of MAIZE budget is allocated to gender

A gender audit of MAIZE has been completed to assess gender targeting within the CRP

30% of participants in capacity-building activities in 2013 were female

MAIZE participates in a joint cross-CRP study exploring gender in agricultural innovation in 60 villages around the world

WHEAT: The Vital Grain of Civilization and Food Security

Wheat Matters – Today and Tomorrow



Wheat is the grain at the center of (Indo-European) civilization.

– Rachel Laudan renowned author on the history of food

215 million hectares – the area on which wheat is grown each year, worldwide.

- Equivalent to Greenland.
- Sown from Scandinavia to the Southern Cone of South America – more regions than any other staple crop.

215 million hectares



Nearly **US \$50 billion-worth** of wheat is traded globally each year.

2.5 billion people in 89 countries = Wheat consumers worldwide



Wheat is first among the three major staple crops as a source of protein in developing countries.

North Africa and West and Central Asia

Wheat is the dominant staple crop and provides as much as half of all calories consumed in these regions.

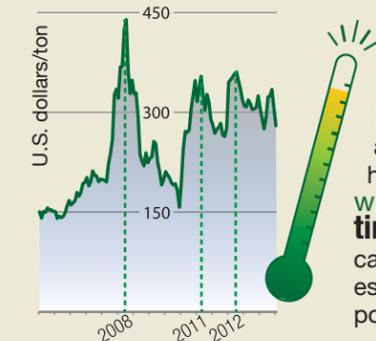
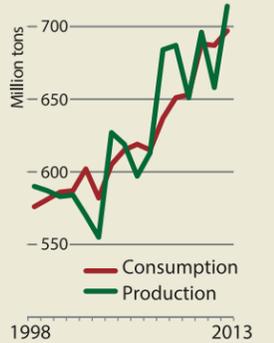


60% MORE WHEAT THAN TODAY...

The amount the world will need to grow to meet consumer demand by 2050.

Wheat and Food Security Rise and Fall with Grain Markets

Wheat Consumption: In 8 of the last 15 years, world wheat production has fallen short of demand.



Extreme weather events and trade dynamics have destabilized wheat markets **three times since 2000**, causing price spikes that especially harm resource-poor consumers.

80% HIGHER THAN IN 2005 = \$ The Price of Wheat Today

This affects poor consumers – including smallholder farm households – who spend most of their income on food.

As much as **30 percent** the reduction in South Asia's wheat yields forecast by climate change experts, if farmers continue to use current varieties and practices.

30% reduction in wheat

WE CAN GROW MORE WHEAT RESPONSIBLY TO MEET RISING DEMAND:

- Improved varieties and more effective agricultural practices generated remarkable **wheat production increases** that have fed expanding populations since the 1960s.
- The yield gains from those technologies have added US \$500 million-worth of grain to wheat harvests each year and **kept wheat grain prices at historically low levels** until 2005, benefiting farmers and poor consumers.
- New **technology and better policies** can power wheat-based farming to meet the crop's accelerating global demand, which is driven by emerging and developing countries.

2013 Overview

from the Chair of the CIMMYT Board of Trustees

CIMMYT is an exciting organization! In February, CIMMYT hosted Bill Gates, Carlos Slim and Mexico's Agriculture Minister Enrique Martínez y Martínez to celebrate the opening of the new biotechnology laboratories and office rejuvenation. I was lucky enough to travel to India where CIMMYT's new initiative, the Borlaug Institute for South Asia (BISA) is germinating. In Kenya, I saw CIMMYT's research strategy in both offensive mode (rolling out doubled haploid services to African maize breeders) and defensive mode (providing solutions for the devastating diseases in wheat – Ug99 stem rust, and in maize – maize lethal necrosis). In Mexico, CIMMYT has formed partnerships with a broad array of government, university and private sector organizations to really deliver the promise of the MasAgro program to Mexican farmers. At year-end, John Snape and I were privileged to attend Science Week and see the entire scientific staff of CIMMYT presenting their new ideas and planning for the future together.

I also write to report the activities of the CIMMYT Board of Trustees in 2013. The Board conducts two face-to-face meetings and two major teleconferences each year. In 2013, the board meetings were held in El Batán, Mexico, and Nairobi, Kenya.

The meeting in Mexico was chaired by Dr. Sara Boettiger who completed her six-year term. Many thanks go to Sara for her outstanding all-round input to CIMMYT, but particularly in the challenging areas of intellectual property matters and public-private partnerships (PPPs). The spring meeting concentrates on the audited financials and CIMMYT again achieved a clear (positive) audit report. The April meeting set 10 short-term objectives for the following six months, and this process was repeated in October. These 10 short-term objectives are listed below:

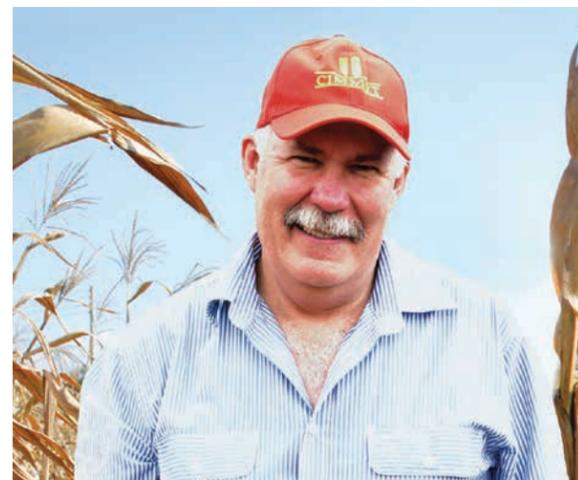
1. To single-mindedly pursue its mission of sustainably increasing the productivity of maize and wheat systems to contribute to global food security and reduce poverty.

2. To monitor and manage CIMMYT's growth.
3. To improve our management of the CGIAR Research Programs and delivery of outputs.
4. To work with the Mexican government and partners to deliver MasAgro.
5. BISA: To develop and implement the business plan, raise funds, gain government approvals, build facilities and employ staff.
6. To ensure major non-CRP projects are managed at a high standard.
7. To support the CIMMYT Communications Department's development and implementation of new strategies.
8. To improve corporate governance.
9. To continue the development of a new Strategic Plan.
10. To carefully choose new initiatives for Management Committee and Board review.

Of course, CIMMYT is much more than just what is reflected in this list; the list simply emphasizes some of the major areas where the Board and senior management need to work together to improve CIMMYT, while the staff delivers the full suite of CIMMYT's services and outputs.

The second board meeting was held in Nairobi. First, let me thank the staff of CIMMYT-Kenya, and our key partners at KARI, for organizing and conducting the meeting during a dark week in Kenya's history (the terrorist attack on Nairobi's Westgate Mall). Our thoughts are with the families and friends of those who were killed or injured in the siege.

Together with KARI, CIMMYT's staff in Kenya hosted two excellent field days prior to the meeting. The Board was proud and privileged to see the new DH facilities at Kiboko which will be crucial in efforts to speed the development of new maize varieties across Africa, and even further afield. We also saw the genetically modified organism (GMO) field trials at the same center, which are managed to the very high standards of agronomy and adhere to the regulatory guidelines that we expect. The following day the Board was able to inspect the new MLN screening nursery at Naivasha – built quickly to provide the glasshouse and field facilities to characterize maize genetic materials from all over Africa. The DH and MLN screening facilities are a



Andrew Barr in a maize field at the CIMMYT-KARI doubled haploid facility in Kiboko, Kenya.

complementary pair in the fight against this devastating disease. On behalf of the CIMMYT Board and staff, I would like to thank the Bill & Melinda Gates Foundation (BMGF) and the Syngenta Foundation for Sustainable Agriculture (SFSA) for their financial support in funding these critically important projects. This success gives the Board confidence that CIMMYT will mount a successful campaign on the MLN problem. Later, we visited Njoro to see where the world's wheat breeders send their materials for screening against not only Ug99 stem rust, but virulent races of stripe rust as well. The progress made in a short time is astonishing with new, well-adapted, high-yielding varieties of wheat released in many countries where Ug99 is present now, or may be in the near future.

CIMMYT worked hard in 2013 on a new strategic plan. The Management Committee engaged a respected consultant to facilitate the plan and engaged the staff strongly in the process. Indeed, during Science Week more than two days were spent garnering input from the staff about the plan. We are expecting sign-off and roll-out in 2014.

In the area of governance, CIMMYT's Board approved a new charter which clearly articulates the roles and functions of the Board. We welcomed Brenda Bautista as assistant to the Board of Trustees and one of her first tasks is to complete a comprehensive Board governance manual in 2014. At the management and Board level, CIMMYT has thought long and hard about the governance of our CRPs, designated WHEAT and MAIZE. These are large programs involving many partnerships – the two most significant of these are with the International Center for Agricultural Research in the Dry Areas (ICARDA) and the International Institute of Tropical Agriculture (IITA), respectively. The Board is determined to work more closely with these partners to achieve better governance and outcomes for the poor.

The CIMMYT Board and management have worked with the CGIAR Consortium in a range of electronic and personal forums to improve the governance of the entire CGIAR system. We have jointly debated the structure and goals of the second phase of the CRPs, for which initial proposals will be submitted in 2014.

CIMMYT welcomed three new trustees in 2013. Dr. Neal Gutterson is vice president of Agricultural Biotechnology at DuPont Pioneer and comes to CIMMYT with skills in research management, biotechnology and intellectual property management. Bob Semple joined, having just retired as a partner at PricewaterhouseCoopers in Ireland. Bob is an accountant, auditor and governance advisor whose skills will combine with those of our third new trustee, Nicole Birrell, to greatly improve our financial, audit and governance areas. Nicole has served with distinction on the boards and especially audit committees, of agribusinesses and research organizations, including Australia's Grains Research and Development Corporation.

The CIMMYT Board bid farewell to two valued trustees in October – Tom McKay (Canada) and Dr. Matsuo Iwamoto (Japan). Tom made very strong contributions to the financial, audit and risk functions of the Board while Matsuo was especially valuable for his perspectives on Asian issues and the impact of CIMMYT research on food quality for the poor.

The Trustees understand that CIMMYT's rapid expansion has created organizational strains and stresses. We are working hard with senior management to put into place the policies and procedures that will make CIMMYT a more efficient and effective organization. Members of the Board's Audit and Management committees have worked together to develop and populate a "growth dashboard," comprising a series of metrics which will allow CIMMYT to better monitor its growth and health.

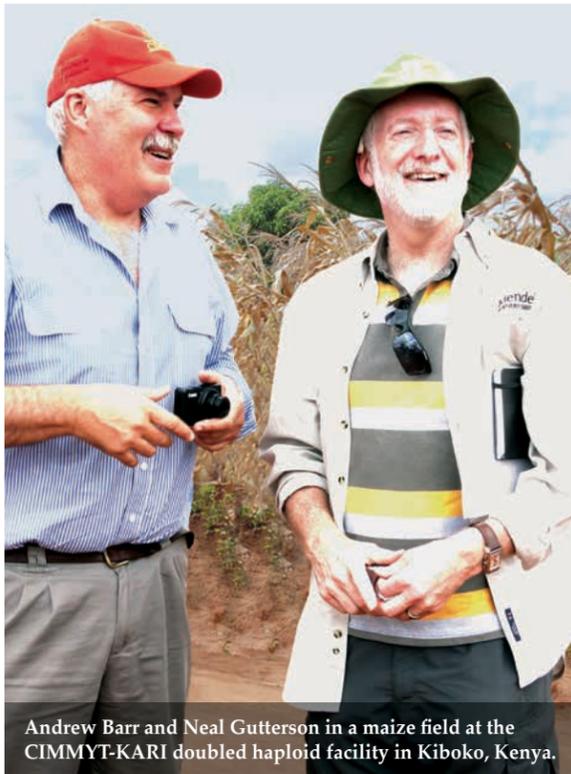
Financial indicators for CIMMYT reflect sound financial management, with an expanding income, a clean audit and adequate reserves, in excess of CGIAR financial guidelines. The number of staff increased to 1,187 at the end of 2013.

On behalf of the Board of Trustees, I would like to thank CIMMYT's donors, investors, collaborators and partners around the world, within and beyond CGIAR. I also extend my appreciation to the management team and staff at CIMMYT for their dedication to our mission. Finally, may I conclude by acknowledging that it is a rare and humbling privilege to serve CIMMYT. Thank you to all my fellow Board members and to the staff of CIMMYT for making it such a pleasure to do so.

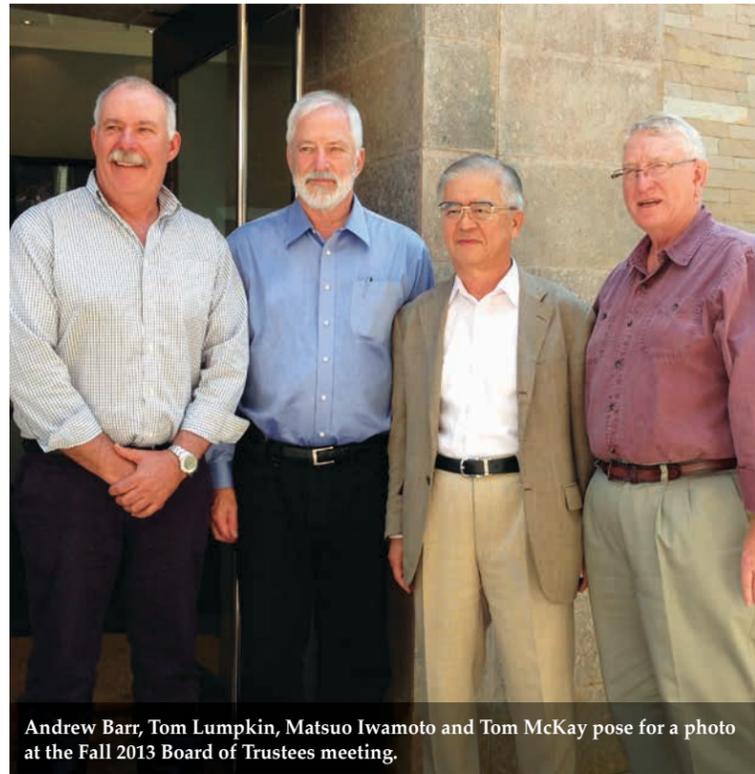
Andrew R. Barr

Andrew R. Barr
2013 Chair, Board of Trustees
(Served March 2013 through March 2014.)

CIMMYT Board of Trustees



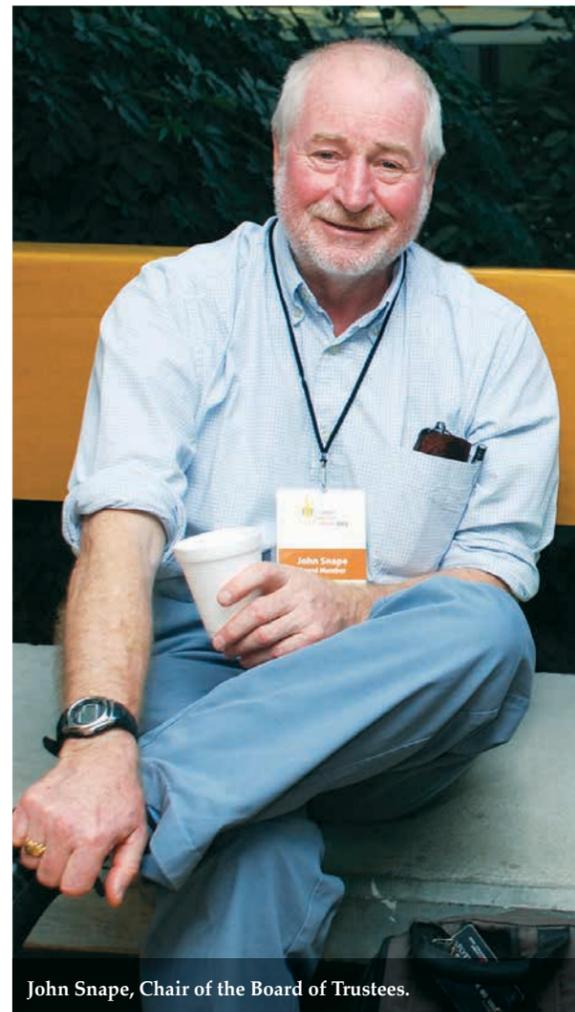
Andrew Barr and Neal Gutterson in a maize field at the CIMMYT-KARI doubled haploid facility in Kiboko, Kenya.



Andrew Barr, Tom Lumpkin, Matsuo Iwamoto and Tom McKay pose for a photo at the Fall 2013 Board of Trustees meeting.



Andrew Barr and Tom McKay.



John Snape, Chair of the Board of Trustees.

- John Snape**, Chair (United Kingdom)
- Pedro Brajcich Gallegos**, Vice Chair (Mexico) (ex-officio)
- Nicole Birrell** (Australia)
- Cornelius F. Broekhuijse** (Netherlands/USA)
- Alfonso Cebreros Murillo** (Mexico)
- Neal Gutterson** (USA)
- Thomas A. Lumpkin** (USA) (ex-officio)
- Enrique Martínez y Martínez** (Mexico) (ex-officio)
- Rita Mumm** (USA)¹
- Matin Qaim** (Germany)²
- Bob Semple** (Ireland)
- Lindiwe M. Sibanda** (Zimbabwe)
- Manuel Villa Issa** (Mexico) (ex-officio)

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- Pedro Brajcich Gallegos
- Cornelius F. Broekhuijse
- Neal Gutterson
- Thomas A. Lumpkin

Audit Committee

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- Nicole Birrell
- Alfonso Cebreros Murillo
- Thomas A. Lumpkin
- Bob Semple

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- Neal Gutterson
- Thomas A. Lumpkin
- John Snape

Program Committee

- Neal Gutterson, Chair
- Pedro Brajcich Gallegos
- Cornelius F. Broekhuijse
- Thomas A. Lumpkin
- Rita Mumm
- Lindiwe M. Sibanda
- John Snape

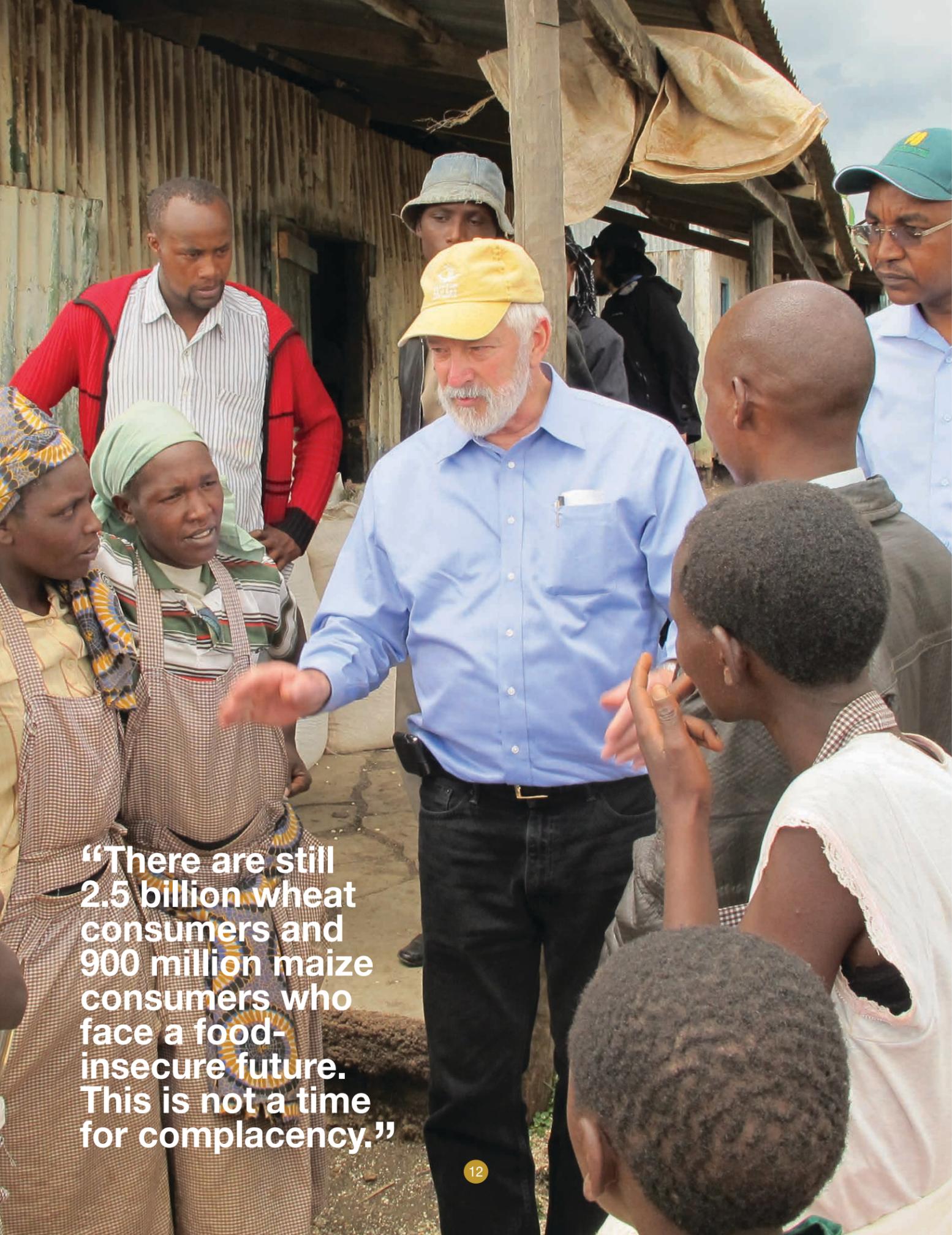
¹Joins Board in September 2014.

²Completes Board service in September 2014.



(Left to right): Alfonso Cebreros Murillo, John Snape, Lindiwe Sibanda, Matin Qaim, Andrew Barr, Salvador Fernández Rivera, Tom Lumpkin, Matsuo Iwamoto, Neal Gutterson and Tom McKay. Photo taken in Nairobi, Kenya, in September 2013.

Message *from the* Director General



“There are still 2.5 billion wheat consumers and 900 million maize consumers who face a food-insecure future. This is not a time for complacency.”

The global agriculture environment has been changing before our eyes. Climate change, natural resource degradation and micronutrient deficiencies pose enormous challenges to food production and human health; markets and food prices are becoming increasingly volatile; and the world's population is set to exceed 9.6 billion by 2050. To meet these challenges we must be responding now.

Improved crop varieties are among the vital components needed to meet current and future food security challenges, and advances in genetics and plant breeding offer exciting potential. With the MLN screening facility and the DH facility that opened in Kenya in 2013 we can significantly shorten the breeding process, simplify logistics, enhance genetic gains in maize breeding programs and develop cultivars with resistance to diseases like MLN or abiotic stresses like drought.

CIMMYT continues to work with a multitude of partners to achieve other advances in plant science. In 2013, the Wheat Yield Consortium (which became the International Wheat Yield Partnership, or IWYP, in 2014) was coordinating global research efforts in wheat. With 20 percent of all calories consumed by humankind coming from wheat, improvements in its yield are critical. CIMMYT is working with partners to grow more wheat on the same amount of land or less, while also using less water and fertilizer. In addition, CIMMYT is working with HarvestPlus and others on efforts to biofortify wheat with needed micronutrients. The impacts that these efforts will have on farmers' fields, the environment and human health are tremendous.

It is clear that tomorrow's seed needs to be more effective and efficient. We need new climate change-adapted seed that provides people with affordable and more nutritious food while simultaneously safeguarding valuable natural resources.

As a result, the scope of CIMMYT's work is expanding. In recent years agronomy has become a major research area. Farmers are playing a central role in this transformation. CIMMYT works with farmers across the developing world, as well as national and regional farmers' groups and

researchers to promote location-specific technologies and agricultural know-how on agronomic management, including improved water and soil conservation practices and post-harvest management. In 2013, approximately 200,000 farmers in South Asia were trained in sustainable intensification technologies, and 24,000 farmers in Mexico participated in conservation agriculture field days.

Our vision is to bring the information age to farmers. New technological innovations have the potential to revolutionize the lives of resource-poor farmers and consumers. CIMMYT is finding effective ways to adapt and apply existing technologies to the needs of smallholder farmers. Examples including geographic information system (GIS)-adjusted direct seeding and fertilizing implements, aerial mapping of fields to better utilize water and nutrients and information and communications technology (ICT)-based services are already showing tremendous impact.

It has been inspiring and gratifying to see the amazing work that the 'new' CIMMYT accomplished during 2013. Our achievements bode well for future successes, but the job is not yet done. There are still 2.5 billion wheat consumers and 900 million maize consumers who face a food-insecure future. This is not a time for complacency. The challenges ahead are daunting, and it is clear that we must maintain our innovative research efforts and partner with the best institutions around the world. More than simply showcasing our work in 2013, this annual report is a tribute and testament to the passion and values of CIMMYT's staff, partners and donors.



Thomas A. Lumpkin

Thomas A. Lumpkin
Director General, CIMMYT



Faces

of beneficiaries around the world

CIMMYT works with hundreds of partners in 45 countries to improve agricultural production and livelihoods. Each year, CIMMYT's varieties bring benefits worth US \$660 million to farmers across the developing world, improving the livelihoods of smallholder farmers and their families.



The 70th Anniversary of the Office of Special Studies

Adapted from a document written in 1978 by Norman Borlaug, R.D. Osler, G. Martínez, A. Amaya
"and other colleagues and contemporaries with good recall from that time."

1943: A joint program of the Government of Mexico and the Rockefeller Foundation, the Office of Special Studies was established to improve Mexican staple food crops – wheat, maize, potatoes and beans. Over the next 20 years, staff member Dr. Norman Borlaug developed high-yielding and disease-resistant semi-dwarf wheat that helped Mexico achieve self-sufficiency in that crop.

While many people know the story of Norman Borlaug's work to develop high-yielding, semi-dwarf wheat during his tenure in Mexico with the Office of Special Studies (OSS), most don't know about the overall work of the OSS. This article details its history and chronicles many of its accomplishments. The OSS was the precursor to CIMMYT; as the OSS mission was ending, CIMMYT was established.

The Cooperative Agricultural Program of the Mexican Ministry of Agriculture and the Rockefeller Foundation

When General Manuel Ávila Camacho became the President of Mexico on December 1, 1940, Henry Wallace, the Vice President of the United States of America, was the official representative of the U.S. at the inauguration. One member of President Ávila Camacho's Cabinet was distinguished Mexican agronomist Marte R. Gómez, who served as the Secretary of Agriculture and Livestock (SAG).

Gómez invited Vice President Wallace to tour various farming regions of Mexico, observe production problems first-hand and comment upon the strategies planned to increase production. Prior to being elected Vice President, Wallace had been U.S. Secretary of Agriculture, as well as founder and chairman of Pioneer Hi-Bred Seed and owner/editor of a well-known farming magazine. Gómez and Wallace spent quite some time traveling and observing research and production problems. Other SAG officials, such as Alfonso González Gallardo, then Undersecretary of Agriculture, also took part in their discussions.

Strengthening research and the training of Mexican agricultural scientists were among the projects espoused by Gómez. Through Gómez, the Government of Mexico asked Vice President Wallace for technical assistance from the U.S. to initiate these projects.

Wallace invited Dr. Raymond B. Fosdick, chairman of the Rockefeller Foundation, to Washington, D.C. to discuss Mexico's request for technical assistance. Wallace said that the Rockefeller Foundation, thanks to its years of work helping many countries develop public health programs, had valuable experience in cooperative programs. He also pointed out that the Foundation was an apolitical entity, which would be an advantage when providing technical assistance to Mexico (instead of setting up a bilateral agreement between the Mexican and U.S. governments).



Dr. Norman Borlaug stands in an OSS field, circa 1945.

He then suggested that the Foundation send a team of outstanding agricultural scientists to Mexico to explore the possibility of agreeing to the Mexican government's request.

In July 1941, the Rockefeller Foundation called together a group of agricultural scientists that included: Dr. E.C. Stakman, a wheat pathologist from the University of Minnesota; Dr. P.C. Mangelsdorf, a botanist and maize geneticist from Harvard University; and Dr. R. Bradfield, an agronomist and soil specialist from Cornell University. Dr. R. Schultes, a botanist who had recently completed his Ph.D. at Harvard after doing his thesis work in Mexico, also joined the group, which was to study the feasibility of establishing a technical assistance program.

The group traveled large portions of Mexico interviewing farmers, researchers, technicians and agriculture officials and, in the autumn of 1941, completed a report for the Rockefeller Foundation. The report recommended accepting Gómez's invitation and sending a team of well-qualified scientists to Mexico to cooperate with SAG on:

- **Developing improved maize, wheat and bean varieties.**
- **Developing improved cropping and production practices.**
- **Developing improved plant health practices.**
- **Aiding in the development of animal husbandry practices.**
- **Training Mexican agricultural scientists.**

After reaching the relevant agreements with Gómez and his staff, the Office of Special Studies was established in February 1943 as an agency of the Mexican Ministry of Agriculture and Livestock, with the involvement of the Rockefeller Foundation. Dr. J. George Harrar, the first director of the OSS, came to Mexico in February 1943.



The establishment of a maize germplasm bank was a highly significant achievement; it contained many landrace materials from Mexico and other Latin American countries. Collection of these materials started in 1943 and continues today.

Dr. Edwin Wellhausen arrived in October of that same year, and Dr. William Colwell and Dr. Norman Borlaug arrived in the autumn of 1944.

Starting in 1943, maize, wheat and bean improvement programs were established. Other improvement programs on crops such as barley, sorghum, forage crops, potatoes and vegetables were also begun. At the same time, a network of trials on farmers' fields was established in important rainfed and irrigated farming regions (El Bajío, Highland Valleys, Central Highlands, Northwest Region), to screen new materials and develop local technology packages. This methodology served as the blueprint for setting up extension services in Mexico and later in many other developing countries.

The establishment of a maize germplasm bank was a highly significant achievement; it contained many landrace materials from Mexico and other Latin American countries. Collection of these materials started in 1943 and continues today. The original gene bank from which CIMMYT's and INIA's (now INIFAP) current maize germplasm banks evolved, had as its objective to preserve the crop's valuable genetic diversity and build a base from which to develop commercial hybrids and improved open-pollinated or composite varieties.

The research conducted yielded important results for Mexican agriculture, such as:

- Development of high-yielding wheat varieties that were rust-resistant and day-length insensitive and that helped make Mexico self-sufficient in wheat by 1956. When the program began, Edmundo Taboada already had some materials and information. The OSS introduced many other materials and the first improved wheat varieties were re-selections of those introductions; in 1947, Kenya Rojo, Supremo 211 and Frontera 209 were released. In 1948, the first wheat varieties developed from crosses made in Mexico starting in 1945 were released – Kentana 48, Chapingo 48, Yaqui 48 and Nazas 48. Wheat breeding continued and in the 1950s, crosses and selection produced the first semi-dwarf varieties that were commercially released in Mexico starting in 1962 and some years later, in many other countries all over the world.
- Development of maize open-pollinated or composite varieties and hybrids for different regions of Mexico. Beginning in 1943-44, landrace varieties were tested and the best were selected for distribution to farmers. Before that, Eduardo Limón and Edmundo Taboada had already done some of the research and had information on valuable materials.
- The first improved open-pollinated varieties (OPVs) for highland valleys were released in 1947 (Rocamex V-7, Rocamex V-21, Rocamex US-10), and by 1948-49, hybrids for highland valleys (H-1, H-2, H-101, H-123)



Above (left to right): Dr. E. J. Wellhausen, John D. Rockefeller III, Dr. J. George Harrar, Dr. Robert D. Osler and engineer José Rodríguez Vallejo, coordinator of the Chapingo Plan, tour the OSS facilities. Below (left to right): engineer Ricardo Rodríguez Ramos, Dr. Aristeo Acosta Carreon, Dr. Norman E. Borlaug, Dr. Jacobo Ortega, Dr. Evangelina Villegas Moreno (2000 World Food Prize co-recipient), engineer Federico Castilla Chacón and Dr. Manuel Navarro Franco meet in the *Campo El Horno* greenhouse.





and for El Bajío and certain regions of the states of Jalisco, Michoacán and Querétaro (H-215, H-301, H-305, H-307, H-309, H-310) were developed. OPVs such as Celaya and Celita were also developed for these regions. In those first years varieties such as V-520 also were developed for tropical zones. Many hybrids and varieties were developed after this. The establishment of the National Maize Commission by the Government of Mexico provided impetus for the multiplication and distribution of improved maize. Outstanding agronomists such as Norberto Aguirre Palancares and Ricardo Acosta Velasco collaborated with Gabriel Ramos Millán, the Commission's first director.

- Development of improved potato varieties with good quality traits and resistance to late blight, such as Eréndira, Anita, Bertita and Conchita, were released beginning in 1956-57. These new varieties saved the country foreign currency by not having to buy seed abroad.
- Development of different types of improved bean varieties with disease resistance for different regions of the country. Beginning in 1943, landraces were selected and after 1944 selections were made. The first outstanding varieties from these selections were tested in 1945 and 1946 – Hidalgo 38-A, Guanajuato 10-A, Hidalgo 14-A, Mexico 38-A and Zacatecas 4-A. Later,

breeding work produced improved varieties such as Canario 101, Negro Mecentral, Canocel and Jamapa.

- Research on forage crops started in 1955 with studies on native and introduced grasses in northern Mexico (1958), development of improved alfalfa varieties (such as Tanverde in 1958), a mixture of grasses and legumes (from 1955 onwards) and initial work on alfalfa seed production (1957). In addition, tropical grasses as well as adaptive agronomic and management research began in 1955 (Pangola, Alemán, Merkerón, Jaragua and African Star).
- Development of improved varieties of commercial vegetables (for example, tomato variety Cotaxtla-1, released in 1957), introduction and testing of exogenous varieties and seed production schemes (1957).
- Development of improved crop management practices such as:
 - Fertilizer use: determining levels and dates of application.
 - Planting dates and density.
 - Chemical and mechanical weed control.
 - Moisture and irrigation water use and conservation practices.
 - Pest and disease control, doses and schedule for applying chemicals.

- Research on post-harvest product management began in 1952; pest and disease control of storage grains.
- Research on cereal chemistry (wheat industrial quality) began in 1957.
- Research on the benefit/cost ratio of the use of new agricultural practices started in 1957, marketing studies in 1958 and the first studies on the distribution and adoption of new technologies in 1958.
- Animal science research programs began in 1955 (nutrition, management and pathology, with special emphasis on poultry) and, later, the establishment (through a special agreement with SAG) of the National Livestock Research Center, which is now part of the National Livestock Research Institute. The first studies on poultry breeding were conducted in *Campo El Horno* at Chapingo and in *Campo Santa Elena* in the Toluca Valley; later, starting in 1957, they were also established in Cotaxtla, Veracruz.

level based on excellence. After a period of field work, the young people who were chosen were sent to universities that had post-graduate programs to pursue studies in accordance with the country's research needs. After finishing their master's degrees, these scientists continued to work in Mexico and after a certain period of time they were offered the opportunity to pursue Ph.D. studies in the best universities for their chosen field.

By the time the OSS was disbanded in 1961, 750 Mexican technicians had received in-service training, 400 had obtained a master's degree and 75 had earned a Ph.D.

During that time, the OSS also trained around 100 scientists from other Latin American countries and, in 1949 and 1950 the first Latin American agricultural science meetings took place in Mexico. These meetings were the foundation for the establishment of the Latin American Agricultural Science Association (ALCA); hundreds of Latin American scientists now belong to ALCA.

These training efforts were important drivers of progress for Mexican agriculture in the 1940s and 1950s. Not only was a cadre of leaders created who would later head or join different agencies of Mexico's agriculture sector, but a plan for training human resources was also created which was later used by the Banco de México, CONACYT and other Mexican institutions.

Training Mexican Scientists

OSS selected young Mexican scientists who had recently graduated from agriculture schools to give them in-service training so they could later continue post-graduate work. The program systematically selected the students at every





Contributions to Extension

As good research results were obtained, the OSS began intense extension work among farmers and technicians. Besides the activities described above, field days at experiment stations began (the first at *Campo El Horno*, in 1949) and a regular series of publications that INIA/INIFAP continued to produce – technical brochures (1947), extension booklets (1948), miscellaneous pamphlets (1949), the magazine *Agricultura Técnica en México* (Technical Agriculture in Mexico) (1955), *Novedades Hortícolas* (Horticultural News) (1955) and *Circulares Regionales* (Regional Circulars) (1958). It also began producing educational films on key agricultural topics (1957).

When Don Gilberto Flores Muñoz was SAG director, an Emergency Plan was launched (late 1952/early 1953) to accelerate the modernization of Mexico's agricultural extension service. The OSS contributed 38 technicians who became the core group of supervisors and state and regional delegates. Several joint training and technology transfer projects were initiated.

Middle left (left to right): Rodolfo Chena, Dr. Oscar Brauer, Dr. Norman E. Borlaug, engineer Ricardo Acosta and Dr. J. George Harrar talk during a tour of *Campo El Horno*.

Bottom and bottom left: Wheat breeders are trained in Obregón.

Top right: Dr. J. George Harrar signs documents that establish CIMMYT as Mexican officials look on.

Expanding Mexico's Experiment Station System

The OSS helped to expand and develop a network of experiment stations in Mexico by establishing some of the regional research centers that are currently among the most important nationwide:

- *Campo El Horno*, near Chapingo, established in 1944.
- *La Cal Grande*, near La Piedad, Michoacán, established in 1952.
- *Campo del Valle del Yaqui*, near Ciudad Obregón, established in 1955.
- *Cotaxtla*, near Veracruz, established in 1955.
- *El Cayal*, near Campeche, established in 1957.
- *La Campana*, near Chihuahua, established in 1958.

In addition, the OSS operated the Santa Elena I Experiment Station, established in 1952 in cooperation with the State of Mexico. It also worked on other SAG experiment stations, such as the *Campo del Yaqui*, Sonora; León, Guanajuato; Xalostoc, Morelos; and El Mexe, Hidalgo.

Agricultural Library

The Office of Special Studies created an agricultural library that contained 40,000 volumes. In November 1966, it was donated to INIA and physically transferred to Chapingo, where it became part of the National Agricultural Library.

Post-Graduate College, Chapingo

In 1959, the OSS helped to establish the Post-Graduate College in Chapingo, the first post-graduate agricultural school in Latin America. At first, it only offered a master's in science; now it also offers Ph.D. degrees. The Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food's (SAGARPA) Post-Graduate College in Chapingo is without doubt the best of its kind in Latin America.



The End... and the Beginning

As the OSS mission wound down, it was determined that its work needed to continue in a new organization. This led to the establishment of CIMMYT in 1963. CIMMYT became an international agricultural research for development institution in 1966.



Key Events of 2013

CIMMYT and members of its staff were involved in a wide range of events across the globe in 2013. The following articles represent some of the most significant events that took place during the year.

New CIMMYT Headquarters Facilities Opened

On February 13 the grand opening of CIMMYT's new \$25 million advanced bioscience research facilities included more than 100 invited guests.

Among those guests were Bill Gates, Carlos Slim, Minister of Agriculture, Livestock, Rural Development, Fisheries and Food Lic. Enrique Martínez y Martínez and Dr. Eruviel Ávila Villegas, Governor of the State of Mexico.

The new biosciences complex will allow researchers to speed the development of valuable seeds, through a more precise characterization of their genetic traits, such as heat and drought tolerance, disease and pest resistance and seed health, as well as the nutritional and industrial quality of the grain. CIMMYT was the cradle of the Green Revolution 50 years ago. By providing cutting-edge facilities and an enhanced research capacity, these new facilities will significantly improve productivity for smallholder farmers in the developing world.

"We are enthusiastic about this alliance," said Bill Gates, co-chair and trustee of the Bill & Melinda Gates Foundation. "Bringing together the collective experience of our respective organizations, we can promote innovation to transform the lives of farmers in Mexico and around the world. Investing in agricultural development is one of the most effective investments we can make. It allows farming communities to become self-sufficient and prosperous by growing and selling more of what they produce."



"When you ask where the best work is done for poor farmers, the answer is here, at CIMMYT."

– Bill Gates
Co-Chair and Trustee
Bill & Melinda Gates Foundation

Ribbon-cutting ceremony: Sara Boettiger, Chair, CIMMYT Board of Trustees; Eruviel Ávila, Governor of the State of Mexico; Bill Gates, Co-Chair and Trustee of the Bill & Melinda Gates Foundation; Lic. Enrique Martínez y Martínez, Secretary of SAGARPA; Carlos Slim, President of the Carlos Slim Foundation; and Thomas Lumpkin, CIMMYT Director General.

Carlos Slim added, “This alliance to promote research and development by CIMMYT, with the collaboration of national and international scientists dedicated to improved seed and generating more efficient techniques, is a step toward making this knowledge available to farmers everywhere, particularly small- and intermediate-scale farmers. Economic growth, employment, food self-sufficiency and exports will also be improved.”

The new buildings were the result of the Carlos Slim Foundation’s investment in CIMMYT. The BMGF partners with CIMMYT across the developing world in projects to build food security and improve livelihoods. The impact of the commitment made by both foundations will be felt worldwide.

“These investments will help introduce modern and more sustainable farming practices in CIMMYT’s target geographies,” said CIMMYT Director General Thomas A. Lumpkin. “These practices include precision and conservation agriculture, backed by intelligent ICT services in farmers’ fields. New tools in laboratories will open our access to the full genetic diversity of maize and wheat to benefit the world’s poorest farming communities.”



(Above): Dr. Thomas Lumpkin points out a detail of the Dr. Norman E. Borlaug Award to Carlos Slim, which was presented to Slim for his contributions to CIMMYT and his work to improve lives of those in need. Bill Gates (center) looks on.

During the ribbon-cutting ceremony, Gates spoke of the importance of CIMMYT’s role in agricultural research and development: “When you ask where the best work is done for poor farmers, the answer is here, at CIMMYT.”

New State-of-the-Art Greenhouses

After a year of planning and construction, CIMMYT and French manufacturing company CMF dedicated two new state-of-the-art greenhouses at El Batán on June 13. The facilities were funded by CIMMYT and the Carlos Slim Foundation, and are part of a new laboratory complex opened earlier in the year by Carlos Slim, Bill Gates and other distinguished guests.

French Ambassador to Mexico, Elisabeth Beton Delègue, attended the dedication. “This is a great adventure,” said Beton Delègue. “It is the first time I have seen buildings of this type, with multiple possibilities, allowing a dialogue between researchers and manufacturers and I am proud of our French technology. I am very happy to participate in the inauguration of the greenhouses and to visit CIMMYT,” she said. “I hope to collaborate with CIMMYT in the future because we have many overlapping interests.”

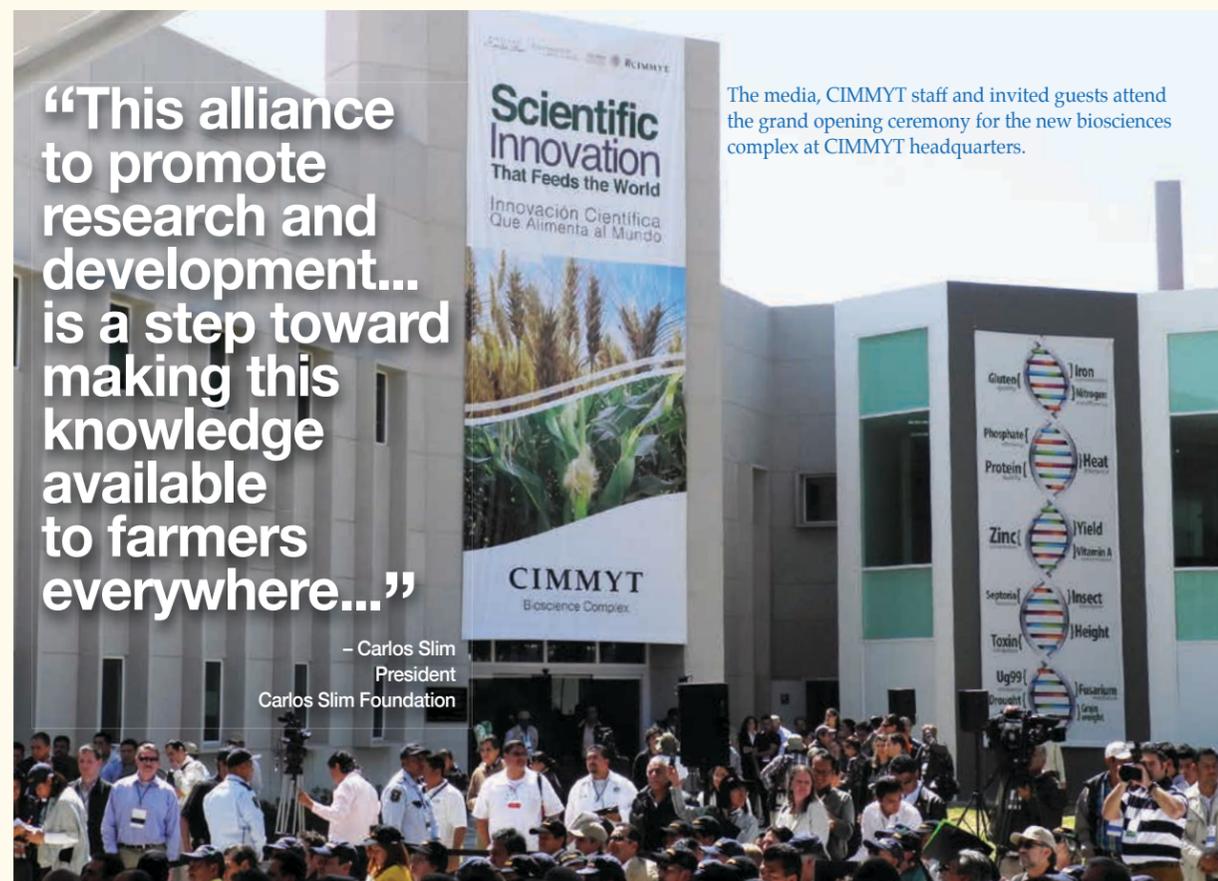
Working to CIMMYT specifications, CMF designed a 1,577-square meter greenhouse consisting of 21 cells that can reproduce different climates. It has its own weather station too. “We worked closely with CIMMYT researchers to define what their research needs were,” explained Renaud Josse, CMF project director. “One cell can reproduce a desert-like climate; another has a tropical climate. We worked on features such as temperature gaps and humidity fluctuations among other things.” Precise control of climatic parameters will assist CIMMYT’s research on climate change.



CMF also built a smaller greenhouse of 400 square meters which consists of five sealed cells for biosafety (rated at biosafety level 2). No exchange between indoor and outdoor air will be possible.

For Ravi Singh, CIMMYT distinguished scientist, “the new greenhouses are like a new car. The good control will help to improve efficiency and obtain better results.”

(Above): Kevin Pixley, director of the CIMMYT Genetic Resources Program, discusses crop diversity with Elisabeth Beton Delègue, the French ambassador to Mexico.



“This alliance to promote research and development... is a step toward making this knowledge available to farmers everywhere...”

— Carlos Slim
President
Carlos Slim Foundation

The media, CIMMYT staff and invited guests attend the grand opening ceremony for the new biosciences complex at CIMMYT headquarters.



A night-time view of the new greenhouses built by CMF and financed by the Carlos Slim Foundation and CIMMYT.

New Facilities in Kenya Aid Agriculture in East Africa and the World

CIMMYT, in partnership with the Kenya Agricultural Research Institute, opened two major maize facilities in Kenya in late September. The Maize Doubled Haploid Facility for Africa at KARI-Kiboko will accelerate the development of stress-resilient and nutritionally improved maize varieties while the Maize Lethal Necrosis Screening Facility at KARI-Naiwashua will focus on combating the deadly maize lethal necrosis disease.

The Doubled Haploid Facility, established with funding support from the BMGF, was dedicated on September 25 by Felix K. Koskei, Kenya's Secretary of Agriculture, Livestock and Fisheries. Representatives from the ministry and county government, the CIMMYT Board of Trustees and Management Committee and the KARI Director and Board of Management attended the inauguration.

"Just as agriculture is the driver of economic growth, so is agricultural research the engine of agriculture," Koskei said. "I take this opportunity to congratulate maize research scientists for their tireless efforts in conducting cutting-edge agricultural research directed at solving the constraints that hinder agricultural growth."

The centralized facility will be able to produce at least 100,000 DH lines per year by 2016, thus strengthening maize breeding programs in Africa and improving breeding efficiency. The DH technology reduces the cost and time for breeding work as it enables rapid development of homozygous maize lines and fast-tracking development and release of elite maize varieties. The facility will improve and refine DH technology in collaboration with the University of Hohenheim, Germany.

"Just as agriculture is the driver of economic growth, so is agricultural research the engine of agriculture."

– Felix Koskei
Kenya Cabinet Secretary of
Agriculture, Livestock and Fisheries

The facility will serve African agriculture for years to come, said CIMMYT Director General Thomas Lumpkin. "The Maize DH Facility will speed up the delivery of drought-tolerant, disease- and insect-resistant and nutritionally enriched maize varieties for the benefit of Kenyan and African farmers."

(Below): B.M. Prasanna shows Koskei and other guests samples of maize diversity.



(Above): A technician prepares maize kernels for examination.

(Below): Felix Koskei and others walk through demonstration fields and exhibits prior to the DH facility dedication. Tsedek Abate, leader of the Drought Tolerant Maize for Africa project, is at the far left.



Felix Koskei, Kenya's Cabinet Secretary for Agriculture, unveils the plaque of the Doubled Haploid Facility in Kiboko, Makeni County. Looking on is Bodduppali Prasanna, director of CIMMYT's Global Maize Program (left), Thomas Lumpkin, Director General of CIMMYT and Ruth Kyatha, Makeni County Secretary of Agriculture.



The DH facility will also serve as a training hub for scientists and technical personnel from national programs and small- and medium-sized seed companies that may not have advanced breeding facilities. “This is a technology that the seed sector in Africa has been waiting for,” said Willy Bett, managing director of the Kenya Seed Company. “Faster breeding of improved maize varieties is quite important to effectively manage problems such as the MLN disease,” said Evans Sikinyi, executive officer of the Seed Trade Association of Kenya. The facility will enhance CIMMYT’s capacity to generate DH lines for effective use in Africa-based breeding programs such as the Drought Tolerant Maize in Africa (DTMA), Water Efficient Maize for Africa (WEMA) and Improved Maize for African Soils (IMAS) projects, as well as the HarvestPlus efforts focused on maize in Africa.

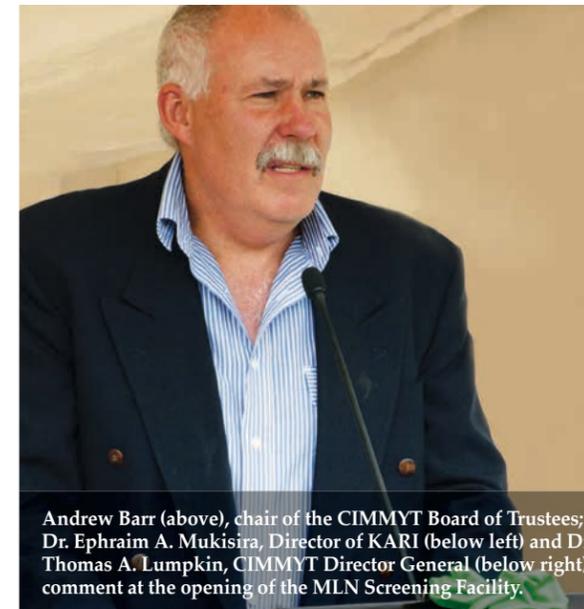
MLN Screening Facility

The MLN Screening Facility was officially opened on September 26. While maize is Africa’s most important food crop, the 2011 drought in East Africa – combined with the emergence of MLN in the same area in 2012 – resulted in significant crop losses and severe food shortages across the region. The accelerated development and delivery



Sicily Kariuki, Principal Secretary in Kenya’s Ministry of Agriculture, comments on the importance of the MLN Screening Facility during its dedication. Dr. Thomas Lumpkin, CIMMYT Director General, is at left.

of MLN-resistant maize varieties with other important adaptive traits is an urgent priority for CIMMYT and its partners in the region. The MLN Screening Facility is central to achieving this goal and was made possible with funding support from the BMGF and SFSA.



Andrew Barr (above), chair of the CIMMYT Board of Trustees; Dr. Ephraim A. Mukisira, Director of KARI (below left) and Dr. Thomas A. Lumpkin, CIMMYT Director General (below right), comment at the opening of the MLN Screening Facility.

Inaugurating the facility, Kenya’s Principal Secretary to the Ministry of Agriculture Sicily Kariuki, commended CIMMYT and KARI for their rapid response to MLN and for establishing a screening facility that will benefit the entire region. Prasanna emphasized that the facility “will serve not only CIMMYT and KARI, but other interested public and private sector institutions that are engaged in developing and delivering improved maize varieties to farmers in Africa.”

The new facility provides MLN phenotyping services and effectively manages the risk of MLN to maize production by screening and identifying MLN-resistant maize germplasm. The facility will help public and private sector research partners in Africa contribute to food security and to the livelihoods of farming communities in eastern Africa.

Through the KARI-CIMMYT partnership, several promising maize inbred lines and hybrids with resistance to MLN have already been identified and are being further validated and used in breeding strategies to develop MLN-resistant maize hybrids.

...the facility “will serve not only CIMMYT and KARI, but other interested public and private sector institutions that are engaged in developing and delivering improved maize varieties to farmers in Africa.”

– B.M. Prasanna
Director, CIMMYT Global Maize Program



The dedication plaque for the MLN Screening Facility.

The 50 Pact Conference: Renewing Dr. Borlaug's Mission to Increase Food Security in South Asia

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Dr Norman E Borlaug
(1914-2009)

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Collaborating for Greater Food Security in South Asia

The agriculture sector in South Asia faces multiple challenges now and over the coming decades that require coordinated responses at the regional level.

The threat of climate change and the need to meet the demand for more (and more nutritious) food for the growing population with dwindling land and water resources are critical.

To help meet these challenges, CIMMYT, BISA and the Indian Council of Agricultural Research (ICAR), organized the 50 Pact Conference. The international conference, which took place in Delhi, India, on August 16-17, commemorated the 50th anniversary of the late Dr. Norman E. Borlaug's first visit to India. The title of the conference refers to a pact to focus efforts on creating a second Green Revolution in South Asia.

The 50 Pact Conference focused on various aspects of the first Green Revolution, the current status and future of agriculture, science and technology for sustainable agriculture, expected impacts of climate change on agriculture, the role of the private sector and relevant technologies for small farmers. Attendees developed a roadmap to increase food productivity and attain food and nutritional security in South Asia.

A key point made by many at the conference was that a global redefinition of agricultural and development priorities is needed to deal with the impact of agriculture on the environment and the threat of climate change.

More than 200 participants from agricultural institutions, government, think tanks, industry and civil society in Afghanistan, Bangladesh, Belgium, Germany, India, Malaysia, Mexico, Nepal, Sri Lanka and the United States attended the meeting.

"This workshop comes at a crucial time; a time to build a successful partnership between the Indian national agriculture research system, the ICAR institutes and CIMMYT," said S. Ayyappan, ICAR Director General in his welcoming speech. He paid tribute to Borlaug as "the Nobel Laureate with a heart for the poor." Ayyappan reiterated the need for urgency to maintain the momentum and explained BISA's role in this critical effort.

South Asia is the most populous region in the world and several models predict that this region is going to be dramatically impacted by climate change. "We must



M.S. Swaminathan is honored with CIMMYT's Dr. Norman E. Borlaug Award by Borlaug's daughter, Jeanie Borlaug Laube.

devise new ways to feed more people with less land, less water and under more difficult climatic conditions," said Thomas A. Lumpkin, CIMMYT Director General, highlighting significant challenges that require critical innovations, collaborations and commitments. "Solving food insecurity and strengthening agriculture in South Asia will only occur if the countries develop regional solutions," he stated.

This sentiment was echoed by the speakers in the opening session of the conference including: Ayyappan; R.S. Paroda, President of the Trust for Advancement of Agricultural Sciences; R.B. Singh, President of the National Academy of Agricultural Sciences; Swapan Datta, Deputy Director General, Crop Sciences, ICAR; and Marianne Bänziger, CIMMYT's Deputy Director General for Research and Partnerships.

M.S. Swaminathan, a legendary figure in Indian agriculture, paid tribute to Dr. Borlaug for his immense contribution to agriculture. "From Bengal famine to India's Right to Food Act, it has been a historic transition and Dr. Borlaug played a very important role in this transition through his work," Swaminathan said. He spoke about the food crisis at the time of India's independence and how after 66 years – in spite of the advancements in research and development (R&D) and the Green Revolution – India still has a long way to go. The population has grown tremendously, but the problems of malnutrition, anemia and stunted growth still remain a problem especially among women and children. Swaminathan explained how a life cycle approach has been adapted in the National Food Security Bill and

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acknowledged its “special attention to the first 1,000 days in a child’s life, an enlarged food basket and for considering the woman as head of the household with regard to food entitlements.”

Jeanie Borlaug Laube, chair of the Borlaug Global Rust Initiative (BGRI) and the daughter of Dr. Borlaug, presented Swaminathan with CIMMYT’s Dr. Norman E. Borlaug Award for his contributions to agriculture and food security in India. Laube also urged attendees and their institutions to work together to alleviate human suffering and to provide people with the tools they need to achieve dignity for themselves and their families. She concluded by reminding participants of the principles Borlaug stood for – hands-on work, faith in the ingenuity of young people, belief in doing the impossible, collaboration and the ability to focus on the real problems of farmers and not on ourselves.

Key Roles for Technology and Innovations

Dr. P.K. Agarwal of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), highlighted threats to the region due to the changing climate. On an optimistic note he discussed opportunities that may result from climate change. Dr. Peter Kenmore of FAO spoke about the key elements necessary for zero hunger/zero-stunting due to year-round access to adequate food, sustainability of food systems, doubling the production of smallholder farmers and their incomes, and most importantly, reducing food waste to zero from the current level of 30 percent.

The role of micro-irrigation, drip irrigation and sprinkler systems for successful water management of major crops was discussed by Dr. Sangeeta Ladha of Jains Irrigation. The increasingly positive role of private companies in the seed sector and their contribution to agriculture was discussed by Dr. Arvind Kapoor of Rasi Seeds and Dr. Rajvir Rathi of Bayer Crop Sciences. Dr. Animesh Srivastava of the World Bank spoke about the role of agriculture in enhancing growth and shared prosperity in South Asia.

Representatives from Bangladesh, India, Nepal and Sri Lanka talked about the potential for post-Green Revolution agricultural development, as well as emerging challenges and opportunities. They acknowledged that

their countries must work together to find regional solutions to food insecurity. Highlighting the role of BISA to improve international and regional cooperation, the group recognized that there is a strong need for international linkages, enhanced research and policy and development work that would strengthen farmer organizations and systems.

Another session highlighted issues of falling water tables, poor soil quality and fragmented land holdings, which have led to problems in productivity. Genetically modified (GM) crops and the need for policy interventions were discussed by Paroda. He also emphasized the need to increase awareness among donor agencies investing in agricultural research about the urgency of conserving resources in South Asia, emphasizing their vulnerability and the impact of their loss or degradation.

Farmers need to be more involved in developing and refining agricultural technology. Speakers during a session on this topic pushed for greater farmer involvement at every step of new technology development. The session also highlighted the need to utilize all technologies, including molecular breeding, biotechnology, precision agronomy and mobile-based decision-making. Ravi Singh, CIMMYT wheat breeder and distinguished scientist, advocated for increased political will and a better policy environment to support the adoption of new technologies. He said, “We need to have scientific solutions, political support and the support of farmers to accept the technology – otherwise we will fail.” Chengal Reddy of the Farmers Forum advocated for a convergence of the field and lab and the need to place biotechnology on the priority agenda of the government.

– Dr. Thomas Lumpkin
CIMMYT Director General

“The National Agricultural Science Complex, where Norm spent a lot of his time in India, is a fitting place for this statue, and hopefully will inspire a new generation of scientists to conquer the great new challenges facing the country and the region.”

Greater Regional Synergy

In the closing session, Arvind Kaushal, Additional Secretary, Department of Agricultural Research and Education and ICAR Secretary, talked about regional and international cooperation in agriculture. He said, “India has been a strong supporter of regional and international cooperation to address challenges facing agriculture. India is playing a lead role in agriculture in the South Asian Association for Regional Cooperation and is also actively involved in

the G20 in shaping the agenda for agriculture, including research and development.” He also highlighted that natural resources are shrinking due to overexploitation and India would like to have technologies and practices that help in producing more output per unit of land, water and fertilizer.

In his closing remarks, Lumpkin reviewed the key recommendations that were generated at the conference:

- Continue the momentum of the 50 Pact Conference with a working session to develop a road map for BISA’s research priorities.
- Ensure access to cutting-edge research and technologies that are currently not available in the region.
- Governments and other donors commit to serious investments in agricultural research.
- Develop a new generation of scientists working with new technologies through training programs that will keep young scientists in South Asia and keep them interested in agriculture and fieldwork.
- Strengthen cutting-edge research that validates and tests new technologies to significantly increase crop yield.
- Build a forum with partners from all sectors who share a common mandate to transform farmers’ lives and improve food security in the region.
- Develop a policy environment that embraces new technologies and invests in agricultural research.
- Use BISA as a regional platform that focuses agricultural research across South Asia.

Borlaug Statue Unveiled

The Honorable Shri Sharad Pawar, India’s Minister of Agriculture, and Jeanie Borlaug Laube unveiled a statue of Dr. Borlaug at the National Agricultural Science Complex in Delhi on August 19. Borlaug developed semi-dwarf, disease-resistant wheat varieties and led the introduction of these high-yielding varieties combined with modern agricultural production techniques in Mexico, India and Pakistan. As a result, Mexico became a net exporter of wheat by 1963. Between 1965 and 1970, wheat yields nearly doubled in India and Pakistan, greatly improving food security in those nations.

The CIMMYT-commissioned statue was donated to the people and scientists of India as a gift to mark 50 years of partnership (Dr. Borlaug introduced his new wheat varieties in India in 1963). The statue is a permanent reminder of Dr. Borlaug’s achievements and a legacy for the future.

The statue was handmade by artist Katharine McDevitt, professor of sculpture at *Universidad Autónoma Chapingo* (Chapingo Autonomous University [UACH]) in the Mexican

Sarad Pawar, Union Minister of Agriculture, Government of India, places flowers at the base of the statue of Dr. Norman Borlaug at the National Agricultural Science Complex in Delhi.

city of Texcoco. Chapingo is the oldest agricultural university in the Americas and is also where Dr. Borlaug started his research in Mexico in 1944, sleeping on the floor of a university barn. The Borlaug statue holds a book inscribed with the names of some of the leading visionaries who worked with him during the Green Revolution – M.S. Swaminathan, C. Subramaniam, B. Sivaraman, A.B. Joshi, S.P. Kohli, Glenn Anderson, M.V. Rao and V.S. Mathur. It also contains a list in Latin and Hindi script of the original Mexican wheat varieties that were so productive in India.

Speaking at the event, Lumpkin said, “In his vigorous support for an agricultural revolution in South Asia and his passion for understanding their circumstances, Norm won the hearts of Indian farmers and helped deliver 50 years of food security to the region. The National Agricultural Science Complex, where Norm spent a lot of his time in India, is a fitting place for this statue, and hopefully will inspire a new generation of scientists to conquer the great new challenges facing the country and the region.”



2013 News Briefs

OSU Students Assist CIMMYT Researchers

Nine Oklahoma State University (OSU) graduate students traveled to Ciudad Obregón to work on the refinement of a hand planter for developing country farmers with CIMMYT agronomist Ivan Ortiz-Monasterio. From January 21-25 the students also collected Normalized Difference Vegetative Index (NDVI) data using the GreenSeeker™ 2 sensor and a pocket sensor developed for farmers in developing countries.



Since 1991, over 100 OSU graduate students have worked on short- (one week) or long-term (one year) CIMMYT projects in Mexico with Ortiz-Monasterio, Ken Sayre and Matthew Reynolds. As a result, CIMMYT has been one of the key players in vetting and testing the GreenSeeker™ sensors. Furthermore, OSU and CIMMYT have developed a new hand planter for those who farm maize on marginal landscapes. These hand planters, which deliver one seed per strike, enable seed singulation (16-20 centimeters [cm] apart) that allows for more homogeneous plant stands, improved soil conservation and increased grain yields when compared with the conventional system in which two to three seeds are planted 30-35 cm apart.



Global Maize Program Meeting

Applying advanced technologies and reconciling dramatic growth in funding, staffing and complex partnerships with the need to speed farmers' access to options for better food security and incomes were discussion topics among more than 60 specialists in maize breeding, agronomy, socio-economics and related disciplines who met in late January in Kathmandu, Nepal.

Participants representing more than 20 nationalities heard presentations on and debated improvements in: phenotyping; breeding efficiency and genetic gains; seed production and delivery; use of doubled haploids; genomic selection; cropping systems and CA; the Generation Challenge Programme's Integrated Breeding Platform, breeding informatics and database management; gender; and interfaces with the MAIZE and CCAFS CRPs.

Nepal was an apt setting for deliberations on maize and the valued role of national partners. The crop is crucial for farmers in remote hill areas who struggle to advance amid changing climates, poor infrastructure and market access and worsening labor shortages. These and other issues were highlighted in a presentation by Dr. K.B. Koirala, coordinator of the National Maize Research Program (NMRP) of the Nepal Agricultural Research Council (NARC), at its Khumaltar research station on January 30. "The average land holding in the hills is one-half hectare, and households typically spend 75 percent of their income on food," said Koirala, who also made reference to the country's long-standing partnership with CIMMYT, celebrated on its 25th anniversary in 2010.

Through CIMMYT's partnership with NMRP, maize productivity has increased more than 36 percent in the last three decades, based partly on the release of 24 improved varieties and hybrids, including the quality protein maize *Poshilo Makai-1* ("nutritious maize" in the local language).

Participants also received an update on the Hill Maize Research Project (HMRP), which began in 1999 with funding

from the Swiss Agency for Development and Cooperation (SDC) and (beginning in 2010) the United States Agency for International Development (USAID). HMRP has worked with national research and extension partners, non-governmental organizations (NGOs) and farmers to develop, test and disseminate high-yielding maize varieties, support seed production and marketing and test and promote resource-conserving farming practices. "Because we target women and disadvantaged groups, more farmers have adopted improved varieties and practices and benefited," said Guillermo Ortiz-Ferrara, CIMMYT maize breeder and HMRP leader. "To date we've reached nearly 50,000 households in the 20 hill districts."

Excellence Through Stewardship

To help upgrade its management of transgenic research, CIMMYT has joined Excellence Through Stewardship (ETS), the first biotechnology industry-coordinated

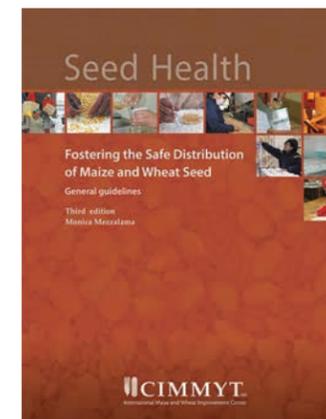


initiative to promote the global adoption of stewardship programs and quality management systems for the full life cycle of biotechnology-derived

plant products. ETS will assist CIMMYT in developing procedures of the highest standards for the Center's laboratory, contained and confined field trial (CFT) research, and will provide capacity building in areas pertinent to projects with a transgenics component, such as WEMA. ETS will also conduct audits at CIMMYT to monitor compliance with standard operating procedures and to help improve the Center's stewardship of transgenic research.

Revamped CIMMYT Seed Health Manual

A new edition of "Seed Health: Fostering the Safe Distribution of Wheat and Maize Seed" is now available. The manual contains scientific information on seed-borne



pathogens of wheat and maize and their geographic distribution and on pathogens in countries where CIMMYT distributes maize and wheat germplasm. The online version will be updated periodically as new phytosanitary regulations are announced by countries collaborating with CIMMYT.

GWP's Visitors Week 2013 in Obregón

Wheat researchers from around the world have an annual opportunity to visit the *Centro Experimental Norman E. Borlaug* (CENEB) and see wheat experiments in Ciudad Obregón, Mexico. Over 150 visitors representing 37 countries participated in the GWP's Visitors Week (March 19-22). They experienced field visits and presentations by the physiology group, durum breeding, cropping systems management, wide crosses units, the Bread Wheat Improvement Program and Seeds of Discovery. Other units within GWP, as well as all GWP regional offices, presented their research and answered questions.

As part of Visitors Week, the GWP Physiology Program inaugurated a new building – CIMMYT's first purposely planned and built facility for wheat physiology research – which was dedicated in a special ceremony to honor Dr. Tony Fischer, hired by Dr. Norman Borlaug as CIMMYT's first physiologist.



During the ceremony, CIMMYT wheat physiologist Matthew Reynolds noted Fischer's enormous legacy in wheat physiology, with outputs such as a new generation of stress-adapted germplasm that has been included in mainstream international breeding nurseries; equipping national agricultural research system (NARS) breeders worldwide with infrared thermometers and other field screening instruments used for breeding; a fully equipped airborne phenotyping platform capable of measuring thousands of yield plots for traits like canopy temperature and water index; over 70,000 germplasm bank accessions screened for heat and drought tolerance; identification of quantitative trait loci for a range of adaptive traits based on yield trials throughout Africa, Asia and Mexico; the Wheat Yield Consortium, connecting some of the best crop scientists worldwide, with a \$1.1 million annual contribution from SAGARPA; and GWP breeding programs dedicated to physiological breeding. "Dr. Fischer is a great source of inspiration for the physiology group," Reynolds concluded.



Women in Triticum Visit CIMMYT

During March, CIMMYT-Obregón hosted six recipients of the Jeanie Borlaug Laube Women in Triticum (WIT) Early Career Award. The award, established in 2010 by the Borlaug Global Rust Initiative, provides professional development opportunities for women working in wheat during the early stages of their careers. In 2013, CIMMYT provided its facilities to support Kaori Ando (Japan), Samia Berraies (Tunisia), Lida Derevnina (Australia), Sandra M. Dunckel (Switzerland), Maria Newcomb (USA) and Naruoka Yukiko (Japan). By supporting WIT, CIMMYT seeks to increase scientific knowledge and collaborative research to improve agricultural productivity. The participants attended GWP's Visitors Week, benefited from daily interactions with scientists from around the world and worked with CIMMYT scientists and trainees from 16 countries.

The WIT award is named after Laube, a mentor to many and the daughter of Nobel Laureate Dr. Norman E. Borlaug. She has served as BGRI Chair since 2009.

Ando, a post-doctoral fellow at Washington State University, reflected on her experience: "I would like to thank all of the staff who made my visit possible. Visiting CIMMYT was one of my life-long dreams; words cannot

(Above): Recipients of the Jeanie Borlaug Laube Women in Triticum Early Career Award are shown examining wheat in CIMMYT/PIAES fields in Obregón.

(Below): Winners of the WIT Early Career Award pose with others in Ciudad Obregón during the CIMMYT Global Wheat Program's 2013 Visitors Week.

research and to deepen my knowledge of wheat breeding. The visit reminded me that there are so many things I can learn and improve, and it provided me with an opportunity to refocus my research. The most significant aspect of my visit was that I met and made many new friends with whom I can share my passion for wheat breeding. I am newly focused and will strive to accomplish great things worthy of a WIT scientist."

Successful Partners' Day: CIMMYT-Harare

The value of CIMMYT's maize research is enhanced through partnerships supporting the development and dissemination of new production technologies. To encourage this collaboration, CIMMYT's southern Africa regional office in Harare, Zimbabwe, holds an annual event during which stakeholders from the Ministry of Agriculture (MoA), academic institutions, seed companies and donor

representatives tour field trials and get acquainted with the station's research outputs.

On April 5, Australian Ambassador Matthew Neuhaus and donor representatives from the European Union, Australian Agency for International Development (AusAid) and SDC joined stakeholders from the Democratic Republic of Congo (DRC), Lesotho, Mozambique,

South Africa, Swaziland and Zimbabwe. Over 200 visitors explored CIMMYT fields, observed various trials on drought tolerance, nitrogen use efficiency and CA demonstrations. Visitors also learned about small-scale farm mechanization for CA and management of post-harvest losses through the use of metal silos.



describe how ecstatic I was to be here. Our first week coincided with Visitors Week, so we could see each group's expertise and get acquainted with their programs. We were given opportunities to interact with scientists from around the world and were given an overview of CIMMYT's work. My visit was very fruitful; I was able to see CIMMYT's latest



During the field tour, participants also saw how legumes are incorporated into maize production systems. This includes using legumes for cover crops (contributing to nitrogen fixation, which improves soil fertility) as well as grain legumes to improve diversity in farming households' nutrition. "CIMMYT wants farmers to gain more yield per unit area instead of having them increase the acreage under maize," explained Mulugetta Mekuria, regional liaison officer for southern Africa. "When the maize yield is increased on a small portion of land, a family can then use the rest of the land to grow high-value crops such as pigeon peas that are successfully being exported to India from Mozambique and Tanzania."

Nutrition was another Partners' Day topic. Many farmers across Africa prefer white maize, but when diets are predominantly based on maize, nutritional deficiencies may arise (especially with weaned infants). Two exciting options for overcoming such nutritional deficiencies are quality protein maize (QPM) and vitamin A maize (also called orange maize). QPM varieties have increased amounts of the essential amino acids lysine and tryptophan, thereby enhancing their protein quality and contributing to the reduction of malnutrition in children under five years of age who are commonly weaned on maize porridge. "Mothers may not be able to ensure their children's nutritional needs with the food they currently have," said seed systems specialist John MacRobert as he explained the benefits of QPM varieties. Orange maize has improved levels of provitamin A and may help in alleviating Vitamin A deficiency. Two varieties have been released in Zambia, and two are in pre-release in Zimbabwe. During the tour, seed company

representatives were also encouraged to identify pre-release materials of interest.

Participants engaged the scientists in discussions, asked questions and commented on the benefits of new technologies. Kgotso Madisa, an extension officer from Botswana's MoA, highlighted the value of nitrogen use-efficient maize for farmers who cannot afford to apply the recommended fertilizer doses. "Most of our smallholder farmers are resource-poor; these varieties can benefit them," said Madisa with reference to the hybrids developed under the IMAS project.

Arsenio Mutatisse of Mozambique's Higher Polytechnic Institute confessed that he had been skeptical about CA before the event. However, after hearing agronomist Christian Thierfelder explain how to implement CA successfully and observing the trial, Mutatisse said he was convinced about its benefits. "This

event was really helpful for us to see how the varieties perform in trials as we work closely with CIMMYT to ensure they get to the farmers," said Helene Dinova Nsolani, leader of a group of community seed producers in the DRC.

The field day was followed by a feedback session and a technical seminar on MLN. Danisile Hikwa, principal director of Zimbabwe's Department of Agriculture Research Services, expressed her appreciation to CIMMYT for its efforts to develop MLN-resistant varieties.

CIMMYT Promotes Wheat Improvement Collaboration Between China and Australia

The Chinese Academy of Agricultural Sciences (CAAS) and Murdoch University, Australia, with financial support from the Chinese Ministry of Science and Technology and the Australian government, officially opened the Australia-China Joint Center for Wheat Improvement in Beijing on April 9. The center is one of six approved jointly by the two governments. It was opened in the presence of the Prime Minister of Australia, the Honorable Julia Gillard; CAAS President Jiayang Li; Rudi Appels of Murdoch University; and CIMMYT distinguished scientist and liaison officer for China Zhonghu He. Establishing the Center builds upon more than 10 years of successful wheat quality improvement collaboration between the CAAS-CIMMYT wheat program and Murdoch University.

From April 15-17 more than 50 participants from Murdoch and eight Chinese institutes attended a workshop at the new Center. They focused on discovery of new genes,



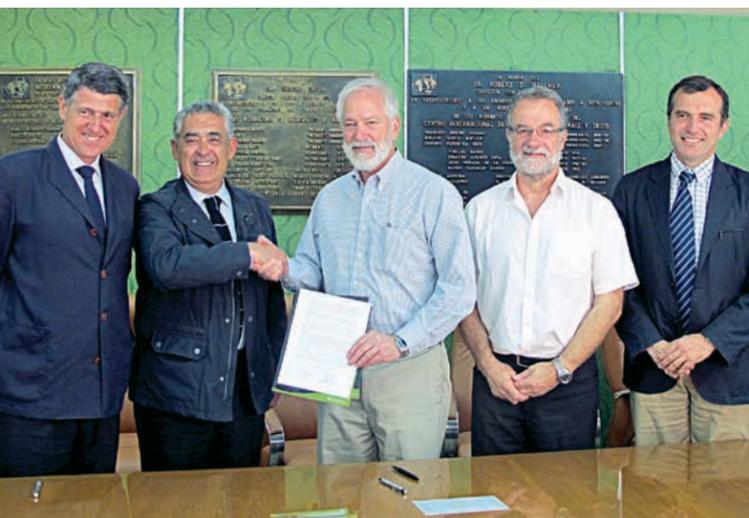
development of elite germplasm and development of gene-specific markers by genomic approach for important traits such as yield, drought resistance and quality. As part of the collaboration, Murdoch University offers year-long scholarships for 10 Chinese post-graduate students.

Agrovegetal and CIMMYT Renew Alliance

On April 12, CIMMYT Director General Thomas Lumpkin and José Ortega Cabello, chairman of the *Campo de Tejada* cooperative in Spain, signed a five-year extension of a collaborative agreement between Agrovegetal S.A.

(Left to right): Rafael Sánchez de Puerta, José Ortega Cabello, Thomas Lumpkin, Hans Braun and Ignacio Solís Martel pose following the signing ceremony to renew the alliance between CIMMYT and Agrovegetal.

and CIMMYT that dates back to 1998. The collaboration's objective is to develop improved durum wheat, bread wheat and triticale varieties. Agrovegetal is an association of several farmer cooperatives and other entities that offers quality seed to farmers in the Andalucía



region of Spain. To that end, it channels resources and efforts towards strategic R&D priorities and activities aimed at developing improved varieties.

Ortega Cabello, Ignacio Solís Martel (Agrovegetal's technical director) and Rafael Sánchez de Puerta Díaz of the Andalusian Federation of Agricultural Cooperatives met with GWP Director Hans Braun to define the specific research activities to develop high-yielding, high-quality, drought-tolerant and disease-resistant varieties.

Among the alliance's successes are the development of materials with high-yield stability and resistance to downy mildew and leaf rust, as well as durum wheat varieties with excellent pasta-making quality and bread wheats with good baking quality and yellow rust resistance. The alliance has also produced triticales with high protein content, high specific grain weight and resistance to foliar diseases (downy mildew, rusts and septoria).

CIMMYT Supports Wheat Initiative

On May 16 the Wheat Initiative issued a vision document paving the way for its future actions. Created following a meeting of the G20 Agriculture Ministers in Paris in June 2011, the Wheat Initiative was established to coordinate global wheat research to achieve – through international collaborative efforts – the progress needed to increase



wheat production, quality and sustainability, thereby contributing to the global efforts to improve food security and safety under changing climatic conditions. Although wheat is a staple crop worldwide, its production has not reached demand in 10 of the 15 past years.

Secretary of Agriculture Links MasAgro to National Crusade Against Hunger

Mexico's Secretary of Agriculture, Enrique Martínez y Martínez, visited CIMMYT on May 25 to reiterate the Mexican government's commitment to applied research and technological development aimed at increasing smallholder farmer productivity.

Martínez y Martínez acknowledged the partnership between SAGARPA and CIMMYT, and said he hoped both institutions will strengthen the Sustainable Modernization of Traditional Agriculture (MasAgro) initiative so that its objectives and advances can be incorporated into Mexico's National Crusade Against Hunger. When describing MasAgro, the Secretary said that it is an integrated initiative to increase the sustainability and productivity of maize



(Left to right): Ricardo Aguilar Castillo, Enrique Martínez y Martínez, Thomas Lumpkin and Jesús Aguilar Padilla.

and wheat, two crops of strategic importance for Mexico. The initiative will make it possible to strengthen food security and eliminate subsidies that create market distortions and do not contribute to capacity building.

He also stated that the SAGARPA-CIMMYT partnership can build on MasAgro's results to expand its presence among the poorest communities, which do not have adequate land to produce enough maize and wheat and are priority areas for the National Crusade.

The visit included a tour of CIMMYT's germplasm bank, experimental plots and new laboratories. The Secretary was accompanied by: Jesús Aguilar Padilla, Subsecretary of Agriculture; Ricardo Aguilar Castillo, Subsecretary of Food and Competitiveness; Mireille Roccati Velázquez, General Counsel of the Agriculture Secretariat; Héctor René García Quiñones, General Coordinator of Sector Linkages; and Belisario Domínguez Méndez, Director General of Technological Productivity and Development.

Nebraska Declaration on CA Signed

After months of discussions and debates on the scientific evidence regarding CA for small-scale, resource-poor farmers in SSA and South Asia, a group of 40 scientists reached a consensus on the goals of CA and the research necessary to reach these goals. The discussions leading to the signing of the Nebraska Declaration on Conservation Agriculture on June 5 began during a scientific workshop on "Conservation agriculture: What role in meeting CGIAR system-level outcomes?" organized by the CGIAR Independent Science and Partnership Council at the University of Nebraska in October 2012. Several CIMMYT scientists contributed to the workshop and the subsequent draft of the convention. "Not every participant agreed to

sign. It went too far for some CA purists and not far enough for others. This is usually the case when a consensus between 50 scientists and experts is sought," said Bruno Gerard, director of CIMMYT's Global Conservation Agriculture Program (GCAP).

According to the Declaration, most efforts to date in developing countries have promoted CA as a package of three practices – minimum disturbance of soil, retention of sufficient crop residue and diversified cropping patterns. However, circumstances on the ground limit this strict definition, as there is little evidence of the wide adoption of CA in SSA and South Asia, but there is evidence of the adoption of one or two of the components. To play a significant role in low-productivity, resource-poor agricultural systems, broader efforts going beyond a focus on the package of the three main practices are necessary. Emphasis needs to be placed on diagnostic agronomy and participatory on-farm research to identify the constraints faced by farmers and to guide farmers in finding solutions to them. There are a range of sound agronomic, economic and/or social reasons for choosing not to adopt the three-component CA package; therefore the Declaration stresses that it is necessary to systematically assess the suitability and viability of management options and practices while considering farmers' objectives and constraints.



Bruno Gerard, director of CIMMYT's Global Conservation Agriculture Program (GCAP).

Rigorous and coordinated research is needed to assess and better understand the CA adoption process. Unless farmers' reasons for choosing to adopt or not to adopt a certain practice are known, wider adoption of CA practices is unlikely. "I think the Declaration is useful, because CA principles should be seen as a path to sustainable intensification and not an end by itself," commented Gerard. "The Declaration fits well with

the present efforts of GCAP and the Socio-economics Program to put CA in a broader context, and to better understand constraints to adoptability and adoption, which are agro-ecology-, site- and farm-specific. Furthermore, it stretches the importance of systems research to integrate field-level agronomy work within a multi-scale and multi-disciplinary framework."

Nutrient Expert® DSTs Launched

Nutrient Expert®, a set of decision support tools (DSTs) for maize and wheat crops, was officially launched for public use on June 20 at the National Agricultural Science Centre Complex in Delhi, India, during a meeting jointly organized by the International Plant Nutrition Institute (IPNI) and CIMMYT.

Beginning in 2009 under the Cereal System Initiative in South Asia (CSISA) project and later the MAIZE, WHEAT and CCAFS CRPs, the tools were developed through a joint effort of IPNI, CIMMYT and several NARS to help Indian farmers achieve higher yields and profits. These easy-to-use, interactive, computer-based tools capture spatial and temporal variability to provide precise nutrient recommendations to smallholder farmers in the wheat and maize systems of India. Nutrient Expert® was developed in collaboration with target users and local stakeholders from public and private sectors through a series of dialogues and consultations, using site-specific nutrient management principles. As a result, the tools reflect smallholder farmers' resource constraints, lack of access to soil testing and the absence of tillage-specific nutrient management strategies in India.



In a three-year validation process assessing their efficacy under contrasting management scenarios, conducted across a large number of locations in collaboration with ICAR, state agricultural universities, state agriculture departments and fertilizer and seed industries, the DSTs have shown improved productivity, profitability, efficiency and reduced environmental footprints over existing fertilizer management practices. According to Bruno Gerard, GCAP director, "these excellent tools are outputs of the IPNI-CIMMYT partnership and will benefit not only South Asia but also other regions." IPNI vice president Adrian M. Johnston praised the unique ability of Nutrient Expert® to link databases for output.

India faces many challenges to feed its growing population as food habits change, and CIMMYT Director General Tom Lumpkin emphasized the need for new DSTs. "We need to fully apply precision agriculture; we need tools like the Nutrient Expert® and remote-sensing technology to be able to do so."

During panel discussions following the launch, ICAR Sciences Duputy Director General Swapan Datta said, "The challenges currently faced by South Asia should be used as an opportunity to create impact. Enabling farmers to apply fertilizer nutrients correctly and in a more precise way is one such opportunity." The Nutrient Expert® tools will also help reduce the knowledge gap between extension workers and farmers, he added. Concerned about the degradation of natural resources, Datta stressed that "excessive and imbalanced use of chemicals significantly contributes to non-point source pollution. A precise, site-specific nutrient management approach is a welcome solution."

Wheat for Africa Gains Momentum

Wheat has not been a traditional staple in much of SSA, but urbanization, a growing middle class and changing lifestyles are driving a rapid increase in demand for the crop and the products that are made from it. The urban and rural poor in Africa eat wheat, as do more prosperous consumers, and demand is burgeoning with rising populations. But leading wheat-producing countries in SSA grow enough to meet only about 40 percent of demand, so SSA imports more than \$12 billion of wheat annually. However, a key study was released in late 2012 at the groundbreaking "Wheat for Food Security in Africa" conference in Addis Ababa, Ethiopia. Shortly after that conference, agriculture ministers of African Union (AU) member countries endorsed wheat as a strategic crop for Africa. At a subsequent AU meeting a few months later, their Heads of State also endorsed the crop as essential to the African continent.

Efforts to put wheat on Africa's food and trade agenda continued at the Forum for Agricultural Research in Africa meeting in Accra, Ghana, July 15-20, when senior research, development and policy experts met with representatives of WHEAT to develop a strategy for promoting African wheat production. "The idea is to connect the entire value chain – growers, millers, processors, legislators and regulators and those representing demand and markets," said Victor Kommerell, WHEAT manager. "Initially the strategy should focus on gathering more evidence of production and market potential, particularly regarding smallholder farmers' chances to grow wheat as a cash crop, and then looking at future consumption and regional trade." The 2012



study focused on rain-fed wheat, according to Kommerell. Irrigated wheat also has great potential – and unique challenges – in Africa.

"As a rough estimate, most countries are fulfilling less than one-quarter of their wheat production potential," said CIMMYT socio-economist Bekele Shiferaw, a key author of the wheat study. "There are many opportunities, both to expand the area devoted to wheat and to increase yields



from existing acreage." According to Shiferaw, this will require a fundamental change in the way participants view the entire wheat value chain – from farm to market and from government office to donor boardroom. More research is needed on potential constraints to improved wheat production, including issues related to markets, land, labor and how food aid is distributed.

Challenges affecting farming at different scales in different country contexts also must be carefully considered – from small farms' lack of mechanization, labor and access to markets, to problems that have undermined previous large-scale wheat farming projects in Africa. The goal is to ensure the best mix of small, medium and large farms, as well as fitting options to the differing conditions of high and low population density nations and current highland wheat-growing areas.

U.S. Borlaug Fellows in Global Food Security Train at CIMMYT



"The U.S. Borlaug Fellows in Global Food Security graduate research grant program supports exceptional graduate students interested in developing a component of their graduate research in a developing country and in collaboration with a mentor from an international agricultural research center (IARC), or a qualifying national agricultural research system unit. We anticipate the fellowship program will lay a foundation for launching long-term international research collaborations for the students and their affiliated faculty advisors and IARC/NARS mentors."

– Center for Global Food Security, Purdue University

Funded by USAID, the Borlaug Fellowship provides graduate students the opportunity to collaborate with agricultural scientists in developing nations. The program fosters connections between scientists internationally, while furthering research and developing community around important agricultural themes, such as production, natural resource conservation and development. With a focus on interdisciplinary and cross-cultural experiences, students benefit from practicing their science on the ground in an international setting, preparing them to become members of the global scientific community. Doctoral candidates Ariel N. Rivers (below) of Pennsylvania State University (PSU) and Sean M. Thompson (bottom) of Texas A&M University were given the opportunity to "go to the field" during 2013 in partnership with CIMMYT.



Enrolled in a dual program (entomology and international agriculture and development) at PSU, Rivers is mid-way through her six-month tenure at CIMMYT's El Batán station. By studying the three key CA practices – crop rotation, minimal soil disturbance and retention of crop residues on the soil surface – Rivers hopes to better understand which of these practices augment beneficial insect communities

and how. In high enough numbers, beneficial insects can contribute to pest control, nutrient cycling and soil aeration, all of which are essential to agricultural production in low-input developing countries.

Thompson, of the Department of Soil and Crop Sciences at Texas A&M, is working with ground penetrating radar (GPR) to assess wheat root biomass. This technology could allow for rapid, non-destructive assessment of populations and selection for traits undetectable by traditional methods. The primary objective of this research is to define the capability of GPR to phenotype below-ground crop biomass, in the context of higher yield and quality stability in wheat during drought stress. GPR is one of the many field-based high-throughput phenotyping technologies being tested in CIMMYT's Wheat Physiology program.

Both Rivers and Thompson plan international careers after they complete their doctoral studies. "We have benefited from the opportunity to practice our skills at CIMMYT," they both agreed. "Thanks to the example set by Dr. Borlaug, we are better prepared to take our science 'to the field.'"

CIMMYT and Syngenta México Partner to Benefit Mexican Agriculture

CIMMYT and leading agribusiness company Syngenta México signed an agreement to work together in efforts to sustainably increase crop production in Mexico while protecting the environment and contributing to food security.

Syngenta and CIMMYT will collaborate on CA research in four experimental platforms. The new project follows the same goals as MasAgro, which CIMMYT implements in coordination with Mexico's SAGARPA. MasAgro is working with small-scale farmers to encourage the adoption of sustainable farming practices and technologies that may help increase maize and wheat output, in line with Mexico's recently announced National Crusade Against Hunger. The three-year agreement will focus on improving maize productivity, generating more income for farmers, protecting natural resources and combining Syngenta's expertise with local knowledge to work directly with farmers. Syngenta and CIMMYT will also develop joint research protocols and offer courses in crop protection and proper use of agro-chemicals.

Soil conservation and protecting the biodiversity of undergrowth, small animals and beneficial insects will be

another focus of the agreement. Both organizations have also expressed their interest in increasing ICT use in the agriculture sector. Representatives from Syngenta and SAGARPA visited CIMMYT's headquarters to see CA trial plots and the gene bank before signing the agreement on August 14. Javier Valdés, Director General of Syngenta México, said during the ceremony that the agreement illustrates the company's commitment to food security and sustainability. "We will continue to promote the formation of important public-private partnerships like the one we're celebrating today to increase the productivity of maize and wheat, which will help with economic, social and environmental development in the country's rural communities."

CIMMYT has previously worked on projects with Syngenta. This new collaboration is an example of cooperation between an IARC and a private company.

Scientific collaboration is essential to make maize production in Mexico sustainable and profitable for resource-constrained farmers, said Bram Govaerts, GCAP Deputy Director.

Belisario Domínguez, SAGARPA Director General of productivity and technological development, said the vision of MasAgro is essential to the government's fight against hunger. Domínguez congratulated the organizations for forming the alliance and said that similar projects will promote the growth of the Mexican agriculture sector.



(Left to right): Belisario Domínguez Méndez, SAGARPA Director General of productivity and technological development; Tom Short, CIMMYT Deputy Director General - corporate services; and Javier Valdés, Director General of Syngenta México, pose after the signing of the CIMMYT-Syngenta México partnership agreement.

Scaling Up Nutritious Wheat Research Partnerships in South Asia

A group of stakeholders from South Asia's public and private sectors is working to breed wheat with increased nutritional value. The Wheat Biofortification Research Group, which includes partners from India, Nepal and Pakistan, met in Delhi August 23-24 to review progress and plan future activities prior to the All India Coordinated Wheat and Barley Improvement Workshop. CIMMYT's Hans Braun, Ravi Singh, Govindan Velu, Arun Joshi and Julio Huerta were among those who attended the meeting.

The Group's goal is to reach more than 100,000 households in South Asia with biofortified wheat by 2018, said Wolfgang Pfeiffer, deputy director of HarvestPlus-CIAT, during an overview of the status of R&D. This target can be achieved by increasing interest among small- and medium-sized private seed companies to become partners to test and promote CIMMYT-derived high-zinc wheat lines in India. Indu Sharma, project director for ICAR's Directorate of Wheat Research (DWR), highlighted the importance of high-zinc wheat, especially for resource-poor people who rely on a wheat-based diet in India. Braun emphasized the global goal to make staple crops more nutritious, rather than just a calorie source.

Similar to the rice biofortification trial in India, a separate wheat biofortification trial is also being proposed. This new trial system may lead to the fast-track identification and release of high-zinc wheat for inclusion in the Government of India's Nutri-Farm pilot program, which seeks to reduce malnutrition problems through the introduction of nutrient-rich crops. These group meetings have led to a greater integration of research activities among CIMMYT, HarvestPlus, ICAR, private sector seed companies and farmers in germplasm sharing and dissemination. Potential partners have also been identified in Bangladesh and Nepal to test and promote zinc-rich wheat lines (see related article on page 78).

CIMMYT and FAO Partner in Mexico

Representatives of FAO and the Strategic Project for Food Security (PESA) visited CIMMYT's headquarters to discuss collaborative opportunities and tour the gene bank and CA trial plots on September 12.

Thomas A. Lumpkin, CIMMYT Director General, and representatives of the MasAgro program met with Nuria Urquía, FAO representative in Mexico, and Julio César

Rosette Castro, Director General of PESA. The leaders shared information on their work in Mexico and expressed an interest in making concerted efforts to contribute to Mexico's National Crusade Against Hunger (a partnership that will help guarantee food security and better nutrition for 7.4 million Mexicans who live in conditions of extreme poverty). This cooperation can strengthen synergies among the institutions and increase the productivity of subsistence farmers in Mexico.

Urquía welcomed the meeting as an opportunity "to increase the collaboration between CIMMYT and FAO and to form future partnerships that will strengthen the work for farmers in marginalized areas."



Víctor López (center) demonstrates the use of CIMMYT's low-cost seed planters for Julio César Rosette Castro and Nuria Urquía.

According to Lumpkin, "CIMMYT, FAO and PESA are working towards a collective goal of increasing agricultural production and reducing hunger and extreme poverty in Mexico. Working together as part of the National Crusade Against Hunger will lead to a greater exchange of technologies and information that will benefit Mexican farmers."

CIMMYT's gene bank maintains one of the largest wheat and maize collections in the world, with 28,000 accessions of maize and more than 140,000 accessions of wheat. Funded by the Japanese government, the state-of-the-art center has a storage capacity of more 450,000 seed samples and is one of only three germplasm banks globally to achieve ISO certification. MasAgro is financially supported by Mexico's SAGARPA.



CIMMYT Hosts International Diplomats

“Mexico is pleased with CIMMYT’s role in national agricultural development and with the synergies that have arisen through the MasAgro initiative,” said Belisario Domínguez Méndez, Director General for productivity and technological development of Mexico’s SAGARPA. “The government is very proud that MasAgro is not only part of Mexico but is now sharing results with other countries,” Domínguez said, opening the 2013 Ambassadors Day event at CIMMYT headquarters in El Batán on October 10 on behalf of Mexican Secretary of Agriculture Enrique Martínez y Martínez. “The partnership with CIMMYT is a fundamental strategy for our country.”

Ambassadors Day participants included Mexico-based members of the diplomatic corps of 20 nations – including countries where CIMMYT works and donor nations – as well as representatives of the United Nations Educational, Scientific and Cultural Organization, the Inter-American Institute for Cooperation in Agriculture, SAGARPA, the Technical and Scientific Cooperation Division of Mexico’s Foreign Affairs Secretariat (*Secretaría de Relaciones Exteriores*) and CIMMYT staff. The program featured briefings on CIMMYT activities and outputs, such as maize

and wheat genetic resources, wheat disease resistance breeding, bread wheat quality, maize breeding and biofortification. CIMMYT staff members from the countries of the visiting dignitaries were on hand to answer questions and offer hospitality. At a luncheon in honor of the guests a new video on CIMMYT aired to many favorable comments.

In his address to the visitors, Lumpkin emphasized that an expanding population, changing diets, limited natural resources, demand for bio-fuels and increasingly variable climates are all putting extraordinary pressure on the global food system. “In summary, we will have a huge demand for food crops coupled with worsening conditions for crop production,” he said. “This highlights the need for improved technology.”

The representative of the Embassy of Venezuela, Alba Mendez, expressed interest in working with the country’s ambassador to propose collaboration with CIMMYT to strengthen agricultural research in Venezuela. She also said she is interested in a training program for smallholder farmers.

(Left to right): Thomas Lumpkin, Elizabeth Amarillas, Ravi Singh, Jalal Kalantari, Luis A. Fourzan, Ashleigh McArthur, Malkhaz Mikeladze, Irena Valkyova and Hristo Georgiev Gudjev tour CIMMYT.



Collaboration to Combat Climate Change

More than 70 experts on maize, millet, rice, sorghum and wheat identified cross-cutting priorities and goals to address climate change, one of the most pressing issues for food security, at a recent meeting in India.

“Maintaining cereal productivity under climate change through international collaboration” took place November 18-20 at the National Agriculture Science Centre (NASC) in Delhi. CIMMYT organized the meeting, co-sponsored by USAID and the BMGF. “We learn a great deal by comparing notes among crops,” said Matthew Reynolds, CIMMYT wheat physiologist and organizer of the meeting’s scientific program. “It can help provide new inspirations as well as avoid reinventing the wheel.”

Following remarks from Etienne Duveiller, CIMMYT director for South Asia, USAID’s Saharah Moon Chapotin and Srivalli Krishnan, BMGF’s Tony Cavalieri and ICAR’s Swapan Datta, a diverse panel summarized the challenges climate change poses to cereal production.

Mark Rosegrant, director of the Environment and Production Technology Division at the International Food Policy Research Institute (IFPRI), highlighted the numerous effects climate change is predicted to have on cereal production and prices. Maize prices are predicted to increase by more than 50 percent and the prices of other crops by 25 to 50 percent by 2050. “This is without accounting for effects of climate change,” he said. “Climate change is a threat multiplier, and significant new expenditures are required to reduce its adverse impacts.”

Other presentations included information on temperature thresholds in different crops, efficient phenotyping and breeding approaches and how crop modeling might facilitate the design of climate-ready crops.

Leading scientists focusing on each of the five crops gave presentations on recent genetic gains and research

achievements in their field, which enabled participants to see the similarities between the crops and learn about discoveries applicable to their own research. Donor representatives emphasized the importance of collaboration and cross-cutting research to improve yield gains in the face of climate change. “With all the expertise we have in this room, and with all the partners you have across the globe, I really think we can make a difference in this area,” Chapotin said.

Participants split into multi-disciplinary working groups to identify priorities and potential areas for cross-crop collaboration in the following areas: data management and sharing; genotyping platforms; heat- and drought-adaptive traits; phenotyping in a breeding context; and the minimum dataset required to define target environments.

K.C. Bansal, director of India’s National Bureau for Plant Genetic Resources, questioned whether the most is being made of plant genetic resources in the face of climate change during his session “Biodiversity Act and Germplasm Access in India.” Many participants highlighted their own difficulties in getting germplasm out of India and Bansal outlined a procedure to simplify the process.

Collecting data requires funding. Scott Chapman, crop adaptation scientist for Australia’s Commonwealth Scientific and Industrial Research Organization, estimated his nation spends several million dollars annually to collect the data from its national trials.

Participants agreed that more accessible, synchronous and searchable data sharing will be essential for future collaborations. Data sharing will soon become mandatory for all USAID projects, and participants emphasized the need for a common system. Most participants expressed interest in establishing a working group to continue these fruitful, cross-crop interactions. A web portal to facilitate such dialogue will be established as soon as possible.

New Projects

Because of the cyclical nature of projects, CIMMYT both completes and begins projects each year. A number of innovative projects began in 2013. Among them are the following:



Heat Stress Tolerant Maize for Asia

South Asian farmland has increasingly experienced climate change-related weather extremes. A 2009 report from the Asian Development Bank warned that if the current trends

persist until 2050, major crop yields and food production capacity in South Asia will significantly decrease – by 17 percent for maize, 12 percent for wheat and 10 percent for rice – due to climate change-induced heat and water stress. In response to this situation, USAID's Feed the Future (FTF) initiative is providing financial support to the "Heat stress resilient maize for South Asia through a public-private partnership" project, also known as Heat Tolerant Maize for Asia (HTMA), to develop heat-resilient maize for South Asia.

HTMA is a public-private CIMMYT-led alliance that includes Purdue University, DuPont Pioneer, seed companies and South Asian public sector maize programs. It targets resource-poor south Asian farmers who rely on maize for subsistence or income in rain-fed conditions, and whose welfare is directly dependent on maize yields and negatively affected by crop failures. To develop and deploy heat stress-resilient, high-yielding maize hybrids for vulnerable regions in South Asia, HTMA is building upon CIMMYT's elite abiotic stress-tolerant maize germplasm base; the technical expertise of the key resource partners; the maize breeding and phenotyping locations and strengths of the NARS of Bangladesh, India, Nepal and Pakistan; and the seed production capacity, strong links with farming communities and market reach of private sector partners (DuPont Pioneer, Vibha AgriTech, Ajeet Seeds and Kaveri Seeds).

A project launch meeting took place in late January in Hyderabad, India, where 44 scientists gathered to discuss various aspects of the project, including genomic selection (GS), which is proposed to be one of its major approaches. CIMMYT's Jose Crossa, Paulino Perez and Raman Babu discussed the GS concept, its application in breeding programs and data analysis and management for fast-track breeding progress and product development. The meeting included a presentation on the FTF initiative by

USAID's Larry Beach, who explained the role of HTMA in achieving FTF goals in South Asia. GMP director B.M. Prasanna discussed the climate change scenario in South Asia, its potential impact on the farming community and the importance of HTMA in addressing these challenges. CIMMYT maize physiologist and HTMA coordinator P.H. Zaidi then provided an overview of HTMA's scope, objectives, outputs and outcomes, which was followed by presentations from participating countries on the current status of heat-tolerant maize and on the suitability of HTMA for country and institutional priorities.

Further discussions on work plans, activities and intended outputs and outcomes (including breeding strategies, trial sites, resources, bottlenecks and potential solutions) took place. The group then agreed on an implementation strategy for each of the planned activities and decided that a project management committee would hold bi-monthly, web-based meetings to review implementation of activities, perform monitoring visits and receive updates on activities during the crop season at each site. A project steering committee also met to discuss the project structure and execution plan.

For more information, contact P.H. Zaidi (phzaidi@cgiar.org).

Australia-CIMMYT Partnership Supports Afghan Research on Wheat and Maize

Although Afghanistan has made significant gains in wheat productivity and production over the last decade, the gains are insufficient to meet domestic demands. Afghans rank among the world's top wheat consumers with a consumption rate of 180 kg/capita/year. In 2011-12 wheat and maize accounted for over 80 percent of Afghanistan's cereal acreage and production. CIMMYT, with support from AusAid and the Australian Centre for International Agricultural Research (ACIAR), has been working towards sustainable growth in wheat and maize production and productivity in the country to address the gap between production and demand. This cooperation has led to the release of wheat and maize varieties during the last decade, which contributed to the growth of PPPs within the seed industry. The new partnerships are poised to cover up to 12 percent of the country's wheat seed demand in 2013, ultimately leading to sustainable gains in wheat production and productivity.

ACIAR is supporting a new phase of CIMMYT's work in Afghanistan – the Sustainable Wheat & Maize Production in Afghanistan project – which will build upon the R&D and capacity building activities of the previous phase, begin zone-specific yield evaluation trials and cultural condition-

specific crop management and create informal information management hubs in Balkh, Herat, Kabul and Nangarhar provinces for stakeholders and partners. The hubs will also undertake baseline and subsequent annual surveys to assess technology adoption levels and study the factors affecting them, including the role of women and children in wheat- and maize-based cropping systems. Additionally, project staff will engage in technology assessment, demonstration and dissemination. The project will involve all in-country partners including, but not limited to, ICARDA, FAO projects, the French Embassy's agricultural staff, Japan International Cooperation Agency (JICA) and several NGOs, seed organizations, progressive farmers and private sector representatives to ensure that the gains achieved are sustainable.

An inception meeting to ensure clear understanding of roles and linkages and to utilize the collective wisdom of partners to bridge potential work plan gaps was organized at the Afghan Ministry of Agriculture, Irrigation and Livestock (MAIL). The meeting was attended by 40 participants representing MAIL, the Agricultural Research Institute of Afghanistan (ARIA), FAO, ICARDA, USAID, AusAID, CIMMYT-Iran, NGOs and representatives of Private Seed Enterprises (PSE). The meeting was opened by Akbar Waziri, MAIL Directorate of Cereal Development director, followed by several presentations covering the importance of annual crop workshops, germplasm introduction and seed production, wheat disease management and

utilization of feedback from farmer field demonstrations to further refine technologies. Saidajan Abdiani, PSE president, said that he plans a higher level of collaboration with CIMMYT in the development of maize hybrids and varietal demonstrations. Yaseen Ayobi, AusAID-Afghanistan senior manager, highlighted the Australian contribution to Afghan agricultural development, particularly in wheat and maize. Kateb Shams, Directorate of Agriculture, Irrigation and Livestock director in Balkh, spoke on behalf of the provincial staff and requested CIMMYT's permanent presence in the provinces. Participants then discussed the incidence of Karnal bunt (KB) in Nangarhar province and emphasized the necessity of further work to develop a KB management plan.

For additional information, contact Rajiv Kumar Sharma (rk.sharma@cgiar.org).

Farm Mechanization & Conservation Agriculture for Sustainable Intensification

If asked "What is the factor that most limits cereal production in Sub-Saharan Africa," a majority of agronomists would say water, nitrogen or phosphorus. Could farm power also be on this list? From March 25-30, a multidisciplinary group of 40 agronomists, agricultural engineers, economists, anthropologists and private sector representatives from Australia, India, Kenya and Tanzania



A participant in the launch of the FACASI project tests a 2-wheel tractor in Arusha, Tanzania.

attended a meeting in Arusha, Tanzania, to launch the Farm Mechanization & Conservation Agriculture for Sustainable Intensification (FACASI) project, supported by the Australian International Food Security Centre (AIFSC) and managed by ACIAR. The meeting focused largely on planning activities that will take place in Kenya and Tanzania, but the project will eventually explore opportunities to accelerate the delivery and adoption of two-wheel tractor (2WT)-based CA and other 2WT-based technologies (transport, shelling, threshing) by smallholders in Ethiopia, Kenya, Tanzania and Zimbabwe. FACASI will be implemented over the next four years by CIMMYT and its partners.

Why do these issues matter? In many countries, the number of tractors has declined in the past 20 years, as has the number of draft animals (due to biomass shortage, droughts, diseases, etc.). As a result, African agriculture increasingly relies on human labor. This problem is compounded by labor shortages arising from an aging population, rural-urban migration and the effects of HIV/AIDS. Even in areas where the rural population is increasing faster than the cultivated area, labor may be in short supply during critical field operations due to opportunities in construction and mining. One consequence of low farm mechanization is high labor drudgery, which disproportionately affects women, as they play a predominant role in weeding, threshing, shelling and transport by head-loading, and which makes farming unattractive to youth. Sustainable intensification in SSA appears unlikely if inadequate and declining farm power is not addressed. Power supply could be increased through appropriate and equitable mechanization, while power demand could be reduced through power-saving technologies such as CA. Synergies can be exploited between these two avenues – for example, the elimination of soil inversion in CA systems reduces power requirements (typically by a factor of two), making the use of lower-powered and more affordable 2WTs a viable option. 2WTs are already present in eastern and southern Africa, albeit in low numbers and seldom used for CA in most countries. Several CA planters adapted for 2WTs have also been developed recently and are now commercially available. These are manufactured outside the region (Brazil, China, India, etc.) and in the region (in Kenya and Tanzania).

The project's first activities will identify likely farmer demand by defining the primary sources of unmet power demand and labor drudgery. This will help determine the choice of technologies – from the 2WT-based technologies available for CA (seed drilling, strip tillage, ripping, etc.) and non-CA operations (transport, threshing, shelling) – to evaluate on-station and on-farm, with the participation of farmers and other stakeholders involved in technology transfer.

The second set of activities will identify and test site-specific unsubsidized business models – utilizing private sector service providers to support market systems – that will enable efficient and equitable delivery of the most

promising 2WT-based technologies to smallholders; technologies affordable to resource-poor and female-headed households (FHHs). The project will also examine institutional and policy constraints and opportunities that may affect the adoption of 2WT-based technologies in the four countries. Finally, it will create awareness of 2WT-based technologies in the sub-region and share information with other regions, thanks to the establishment of a permanent information platform hosted by the African Conservation Tillage Network.

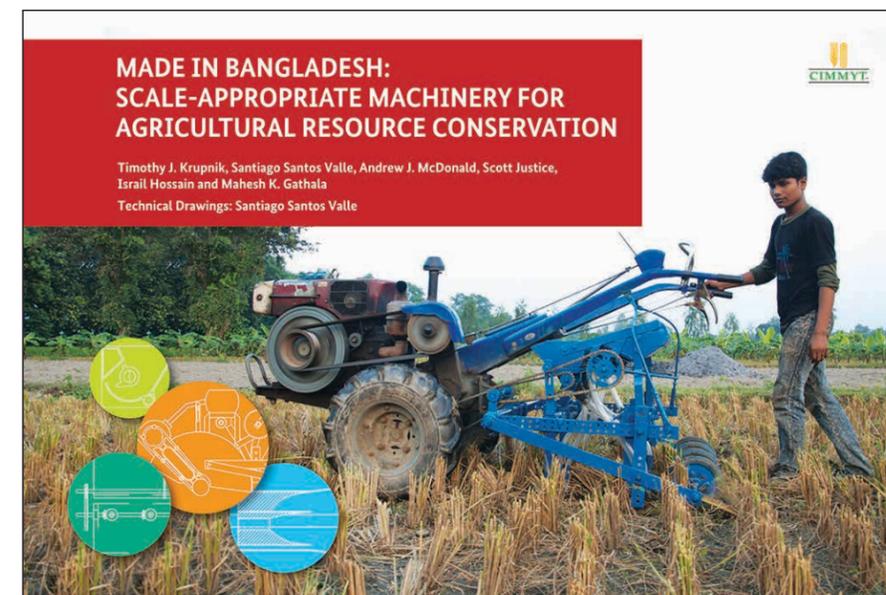
For more information about FACASI, contact Frédéric Baudron (f.baudron@cgiar.org).

Cereal Systems Initiatives for South Asia-Mechanization and Irrigation Project Launched in Bangladesh

Southwestern Bangladesh has the world's largest delta with plentiful fresh surface water, but more than 600,000 hectares of land lie fallow in the dry season. In response, CIMMYT and International Development Enterprises (IDE) have initiated the Cereal Systems Initiative for South Asia-Mechanization and Irrigation (CSISA-MI) project



to sustainably intensify cropping on fallow and low-productivity lands. The five-year project, supported by the FTF Initiative and administered by the USAID mission in Bangladesh, was launched on July 1. CSISA-MI is an initiative under CSISA in Bangladesh, connecting CIMMYT, IRRI and WorldFish. The MI initiative will unlock agricultural productivity by conducting research and market development to increase the availability and adoption of resource-conserving irrigation equipment, and to scale farm machines to respond to rural labor scarcity and high costs, while also encouraging CA-based crop management practices.



(Above): A new book by members of the CSISA staff and others provides information to fabricate small-scale machinery. (Below): A 2-wheel tractor powers an axial flow pump in Bangladesh.

Southern Bangladesh is constrained by numerous factors, including farmers' inability to invest in resource-conserving and productivity-enhancing machinery, the high cost to pump irrigation water and lack of awareness about the potential for dry season crops like wheat, maize, sunflowers and legumes. CSISA-MI is responding to these problems by developing smart business models to link farmers with agricultural service providers, and service providers with machinery and irrigation equipment dealers, to boost the use of irrigation and machinery for CA. CSISA-MI will also bridge the gap between the public and private sectors by facilitating partnerships with the Government of Bangladesh and private sector partners engaged in irrigation, agricultural mechanization and extension.

CSISA-MI will create broad access to low-cost surface water irrigation, agricultural machinery and other services to enable farmers to optimize water, labor, time, seed and fertilizer use in their fields during the dry season. Research topics will focus on the improvement of irrigation water use efficiency and agricultural water management as well as enhancement of the use of fuel-saving axial flow pumps (AFPs) and other equipment for surface water irrigation. Further research and the development of value chains will focus on machinery compatible with 2WTs such as strip tillers, bed planters, multi-crop reapers and rice transplanters used to reduce turn-around time between crops. Machines and cropping practices will be fine-tuned to the diverse agro-ecological conditions of the region through on-farm action research and experimentation in farmers' fields. CSISA-MI harnesses



At the launch of the Agricultural Innovation Program, CIMMYT and Pakistani scientists gather to inspect a demonstration field. Dr. Thomas Lumpkin, CIMMYT Director General, is center left (dark coat) and Hans Braun, director of the CIMMYT Global Wheat Program, is center right (white shirt).

the power of the market to align incentives toward large-scale, smart-technology adoption. The initiative has already made significant progress – memoranda of understanding with leading firms, including RFLPran Group and ACI Agribusiness, have been signed to accelerate the commercial availability of AFPs, bed planters and seed-fertilizer drills.

For additional information, contact Timothy Krupnik (t.krupnik@cgiar.org).

Agricultural Innovation in Pakistan

Pakistan ushered in a new era of agricultural research when the Ministry of Food Security and Research, CIMMYT, USAID, the Pakistan Agricultural Research Council (PARC) and key agricultural leaders from throughout Pakistan gathered in Islamabad on March 8 to announce the Pakistan Agricultural Innovation Program (AIP). This project seeks to revitalize the contribution of science-supported innovation to the economic growth of Pakistan's agricultural sector by more effectively utilizing AR4D.

"Pakistan's agricultural productivity has fallen behind comparable countries with similar agro-ecologies," said Thomas Lumpkin, CIMMYT Director General. "There is a tremendous potential for growth, but we must act now." Under AIP, commissioned projects and competitive grants will address key objectives to increase productivity within the cereals/cereal systems, livestock and horticulture sectors. While CIMMYT will manage and take responsibility for the overall AIP portfolio and the cereals/cereal systems component, the program will also draw on the expertise

of the International Livestock Research Institute (ILRI), IRRI, World Vegetable Center (AVRDC) and University of California, Davis (UC Davis). UC Davis will also assist in linking Pakistani research systems to agriculture science and innovation in the USA via the human resources development component of AIP, which will make a particular effort to engage women scientists in Pakistan. PARC is the hosting partner and will also oversee the competitive grants portfolio and ensure that AIP is led and executed by national partners.

AIP hopes to foster a demand-driven, results-oriented science research community and enhance linkages between Pakistan's agricultural research and innovation communities, the wider global community of agricultural scientists and the private and civil society sectors. Research is a key contributor to increased food security and economic growth; by creating a dynamic, responsive and competitive system of science and innovation partnerships, AIP seeks to rapidly boost agricultural production, productivity and value.

AIP Planning Continues

On May 27-28, representatives from CIMMYT, USAID, PARC, ILRI, IRRI, AVRDC and UC Davis met with colleagues from several Pakistan universities, agricultural secretaries of the provinces, development sector organizations, private sector representatives and farmer organizations to plan the next stage of AIP.

In his opening address, Randy Chester, USAID's deputy office chief for agriculture, stated that "AIP represents a unique and unprecedented collaboration, in that it brings

"AIP represents a unique and unprecedented collaboration, in that it brings together the expertise and resources of all of these organizations, including USAID, to increase the income of farmers across Pakistan."

– Randy Chester
USAID Deputy Office Chief for Agriculture

together the expertise and resources of all of these organizations, including USAID, to increase the income of farmers across Pakistan." By using the Global Conference on Agricultural Research for Development approach of AR4D, AIP "will foster a demand-driven, results-oriented, science research community and enhance linkages between Pakistan's agricultural research and innovation communities, the wider global community of agricultural scientists and the private and civil society sectors," he concluded.

While AIP draws on the expertise and resources of five international partners, many Pakistani partners will be brought on as the program develops. PARC Chairman Iftikhar Ahmad highlighted the role that Pakistan organizations must play – "We need a new kind of collaboration. It must be a two-way process in that Pakistan must also contribute to international science. Pakistani scientists must play a crucial role in paying back what we get from the outside. Other economies can benefit from Pakistani science as well," he stated.

As part of AIP, international and Pakistani scientists are expanding efforts to accelerate access to climate-resilient maize and rust-resistant wheat varieties in Pakistan, as well as improving farmers' access to quality seeds.

Farmers throughout the world face similar problems from increasing production costs, fluctuating market prices, water and soil degradation and potential implications of climate change, said Ken Sayre, a CIMMYT CA consultant. Sayre also described the benefits of CA crop management technologies and their main principles. These include seeding systems that allow major reductions in tillage, retaining adequate levels of crop residues on the soil surface and using diversified crop rotations.

There are many challenges AIP can address. Maize yields in Khyber Pakhtunkhwa Province are low due to a lack of technology. Most maize farmers in Pakistan use manual sowing, which is not cost- or time-effective and farmers need more confidence in hybrid seeds before they will pay a premium for them.

Priorities for the maize work plan include introducing climate-resilient maize hybrids, developing biofortified maize, developing cultivars with resistance to biotic stresses and strengthening the seed sector. CIMMYT maize experts and national partners joined to refine the plan.

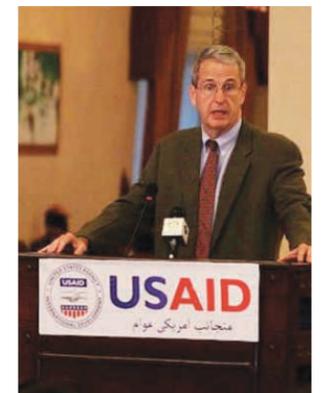
Participants also discussed options for commissioned projects in wheat, including rapid diffusion of high-yielding, rust-resistant wheat; climate-resilient wheat; the cultivation of durum wheat in Balochistan Province; introducing standardized fungicides to combat yield losses; and generating a durum wheat value chain in

Pakistan. Kay Simmons of the USDA-Agricultural Research Service and Ian C. Winborne, plant health advisor for the USDA Animal and Plant Health Inspection Service at the U.S. Embassy in Islamabad, also attended the meeting to discuss enhancing wheat productivity.

In rice, top priorities include developing tolerance to submergence and heat in locally adapted varieties, in addition to bacterial leaf blight resistance and superior grain quality.

AIP will focus on adapting and up-scaling existing technologies present elsewhere in the region, such as Greenseeker™ sensors for improved nutrient management. Closing the meeting, Jonathan Conly, USAID Mission Director in Pakistan, praised group members for their collaboration to revolutionize Pakistan's agriculture sector. "If we care about driving economic growth, it has to be done by increasing farm productivity, by increasing adoption of technologies and human capacity building. I believe that AIP will lead to the desperately needed increases in agricultural productivity in this country."

For additional information, contact AIP project leader and CIMMYT Pakistan Country Liaison Officer Muhammad Imtiaz (m.imtiaz@cgiar.org).



Randy Chester, USAID Deputy Office Chief for Agriculture, addresses attendees at an AIP planning meeting.

Ongoing Projects

During 2013 CIMMYT managed nearly 120 projects and grants across the developing world. The following are highlights of selected projects from the Center's portfolio.

Partnerships Seed Hope for Smallholders

To achieve food security, smallholder farmers in southern Africa require access to improved seed and inputs for higher yields. "Seed is one of the key movers in agricultural development," said John MacRobert, New Seed Initiative for Maize in Southern Africa (NSIMA) leader, indicating the importance of going beyond developing improved seed

Workers unload bags of seed in Lusaka, Zambia.



varieties to encompass their dissemination, promotion and adoption when developing strategies around seed development. These issues, together with NSIMA's progress to-date (the project is in its third phase) and strategies for the next phase, were discussed August 7-9 in Lusaka, Zambia. About 50 participants from collaborating institutions led by CIMMYT and funded by the SDC were present; among them were representatives from national agricultural research institutes, seed companies and institutions of higher learning from Angola, Botswana, DRC, Lesotho, Malawi, Mozambique, Swaziland, South Africa, Zambia and Zimbabwe.

"Some challenges to maize crops can be addressed by research," said Moses Mwale, director of the Zambia Agricultural Research Institute (ZARI). "The rest can be addressed by other players in the maize sector," he added,

emphasizing the importance of collaboration within the maize seed value chain. Challenges such as variable rainfall, low soil fertility and heat and drought stress can be addressed by improved varieties from CIMMYT-led projects including Drought Tolerant Maize for Africa and Improved Maize for African Soils. Other climate change-related issues in small-scale farming can be confronted using CA technologies such as cover crops and crop residue left on the soil help to retain moisture and mitigate the impact of droughts.

But smallholder farmers often do not have access to the new seeds, technologies and information. "Integrating stress-tolerant maize and legumes, such as pigeon peas, beans and cowpeas, leads to sustainable production systems. We need effective seed 'road maps' to enhance access and availability of improved maize and legume seeds," said Mulugetta Mekuria, CIMMYT regional director for southern Africa.

Seed companies and community-based organizations (CBOs) producing seed play a significant role in solving these issues. Nelson Munyaka of the SDC Seeds and Markets project spoke of the success of Zaka Superseeds, a nascent seed company that began as a community seed enterprise. MacRobert agreed: "In Benin and DRC, where we do not have seed companies, the community seed producers could learn from Zaka and grow into full-fledged seed businesses." DTMA project leader Tsegede Abate added that including drought-tolerant maize varieties in seed enterprises' product portfolios could have a significant impact.

Policy-makers in the seed value chain must be engaged as well. "Many do not seem to believe in smallholder abilities," said consultant Michael Jenrich. "The private sector steers away from smallholders, viewing them as high-risk because of their poor infrastructure, lack of credit and land tenure, while governments may not view them as a viable investment." Zaka Superseeds proves them wrong; cooperating with smallholders can be beneficial for seed companies, as they can work more closely with the community consuming their seed.

The policies that govern the seed trade vary among the Southern African Development Community (SADC) countries. An SDC-funded initiative to implement harmonized seed laws in all SADC countries to facilitate easier intra-regional seed movement is currently under way. To date, 10 countries have signed the memorandum of

understanding. Such laws would enhance seed trade and contribute to food security by ensuring farmers' access to improved seed.

For more information about NSIMA, contact James Gethi (j.gethi@cgiar.org).

Drought-Tolerant Maize for Africa Project (or DTMA) Addresses Farmers' Needs

A multi-national team visited DTMA trial and demonstration plots in Malawi, Mozambique, Zambia and Zimbabwe from April 21-30 in a traveling workshop that combined peer learning and project monitoring with evaluation. The 17 team members were breeders from national programs, DTMA scientists and DTMA Advisory Board Chair Dave Westphal. Participants had the opportunity to compare notes, gain new knowledge based on the experiences of colleagues in other countries and measure themselves against their peers based on practical, real-life results.

"DTMA addresses a real need in the region; drought is part of our farming systems," said Zamseed breeder Verma Bhoola when he hosted the team at the company's farm. "Over 90 percent of maize grown in Zambia is rain-fed, so it is prone to drought," he said, emphasizing the importance of breeding for drought tolerance not only in Zambia but also in the rest of Africa, where most maize

farming depends on rain patterns that are increasingly unpredictable as a result of climate change. "About 25 percent of maize production in Africa is threatened by frequent drought, while 40 percent is affected by occasional drought," said DTMA project leader Tsegede Abate.

The project is making significant strides. "We are on track in terms of overall production of drought-tolerant maize seed," said Abate. More than 100 varieties have been released in 13 countries. "Zimbabwe is leading in seed production, with over 7,000 metric tons of drought-tolerant seeds produced by the end of 2012," he said. DTMA plans to produce and market 70,000 tons of seed annually by 2016.

Partnerships Deliver Drought-Tolerant Maize to African Farmers

Partners from 13 countries working with the DTMA project said they benefited from the help of its staff during the 2012-13 crop season. DTMA trained maize breeders and technicians, rehabilitated seed storage facilities, supported seed companies and research institutes to release varieties and produce breeder seed and began hybrid seed production in places where seed companies did not exist.

Partners from across Africa met September 23-27 in Nairobi, Kenya, for DTMA's annual meeting. They discussed progress in developing and deploying drought-tolerant maize varieties to benefit smallholder farmers in Africa.

A Tanzanian farmer grows a drought-tolerant maize variety from the DTMA project.



Maize varieties that respond to climate change challenges – such as drought and infrequent or unevenly distributed rainfall – are critically important in helping those who depend primarily on rain-fed agriculture. Officials who opened the meeting included: Thomas Lumpkin, Director General of CIMMYT; Ylva Hillbur, Deputy Director General of IITA; Ephraim Mukisira, director of KARI; and Joseph De Vries, director of the Alliance for a Green Revolution in Africa (AGRA) Program for Africa's Seed Systems (PASS).

DTMA has released 140 drought-tolerant maize varieties since 2007, including 81 hybrids and 59 OPVs. These varieties perform well under drought stress as well as adequate rainfall.

“Over the last seven years, DTMA has made significant progress in developing and delivering improved technologies,” Lumpkin said. “Farmers have also benefited from [drought-tolerant] varieties that possess other desirable traits such as resistance to major diseases like maize streak virus and gray leaf spot,” he added. Lumpkin thanked DTMA donors, especially the Bill & Melinda Gates Foundation, for supporting DTMA as well as for the new maize DH and MLN screening facilities (see article on page 28); the latter is co-funded by the Syngenta Foundation for Sustainable Agriculture.

The national agricultural research systems and small- to medium-sized seed companies working with CIMMYT maize projects such as DTMA will be key beneficiaries of these facilities. Mukisira recognized the role seed companies play in deploying drought-tolerant seed for market and making it accessible to smallholder farmers. “We encourage you to continue investing in the marketing and promotion of improved drought-tolerant maize

varieties,” he said. Mukisira also highlighted the partnership between CIMMYT and KARI. KARI centers in Embu, Kakamega and Kiboko are part of the drought screening network and its socio-economics team is working with DTMA on household surveys across Kenya.

Hillbur said the strong partnerships DTMA has built with NARS and seed companies as well as the “top quality science approach involving the breeders, economists, social scientists and seed systems specialists” are two of the project's distinguishing factors. Project leader Tsedeke Abate said DTMA is moving toward its goal of reaching more than 30 million farmers with drought-tolerant maize varieties by the end of 2016. The NARS are key in breeding and disseminating improved varieties, he added.

Moving forward, DTMA will continue to mainstream drought-tolerant varieties, enhance seed systems partnerships with AGRA-PASS, build the capacity of the NARS to produce breeder seed, mainstream gender and build on socio-economic research to provide evidence for policy advocacy.

For further information about DTMA, contact Tsedeke Abate (t.abate@cgiar.org).

Curbing Maize Post-Harvest Losses

CIMMYT's Effective Grain Storage for Sustainable Livelihoods of African Farmers (EGSP) Phase II (2012-2016) builds on the previous phase (2008-2011) to reduce post-harvest losses, enhance food security, improve incomes and reduce the vulnerability of resource-poor farmers – particularly women – in eastern and southern Africa through the dissemination of effective grain storage technology.

The project's next phase is funded by the Swiss Agency for Development and Cooperation and will help farmers through the acquisition of more than 16,000 metal silos, which reduce grain losses from storage pests.

The metal silo technology promoted by EGSP for maize storage has been hailed as the ultimate solution to high post-harvest losses caused by the maize weevil and larger grain borer, two destructive insects that can cause losses up to 30 percent of stored maize and damage as high as 80 percent to stored maize in SSA. Real losses are even larger when their environmental impact, subsequent losses in nutritional value, industrial input, market opportunities and the possible adverse effects on health of populations consuming poor-quality products are considered. Therefore, the need for interventions becomes even more apparent and pressing.

For example, Kenya has experienced tremendous improvements in maize productivity, increasing from 1.53 million metric tons (mmt) in 2002 to 3.42 mmt in 2011. However, post-harvest losses of up to 40 percent of the harvested grain pose great challenges to attaining food security, because about 80 percent of Kenyans live in rural areas and derive their livelihoods primarily from agricultural activities. Maize is the main staple crop and agriculture is the cornerstone of Kenya's economy (accounting for 27 percent of GDP and producing over 75 percent of industrial raw materials). Therefore, post-harvest losses pose a challenge to the country's ongoing economic development.

“It is pointless to invest heavily in good agricultural practices, attain high yields and then lose 40 percent of the production. Feeding the nation not only requires increased production but also a safeguard of all that is produced,” stated Leonard Ochieng', Nakuru County director of agriculture. According to Nakuru County crops protection officer Hannah Oduor, there is usually a surplus of maize in the Rift Valley counties known as “the granaries of Kenya,” but the country still imports maize. “We cannot afford to continue importing maize; it is expensive and unsustainable. Money for development is used to import food that we could have safeguarded with appropriate technologies like metal silos,” Ochieng' said. Oduor added, “We need technologies like the metal silos for effective storage of this surplus to prepare for periods of scarcity and for redistribution to other parts of the country where production is below consumption.” According to Grace Kirui, the county's deputy director of agriculture in charge of extension and training, “EGSP tracks the Ministry of Agriculture's renewed efforts to intensify training and dissemination of appropriate pre- and post-harvest technologies to reduce both quantitative and qualitative losses. The technologies that reduce post-harvest losses will improve food security, create employment, increase farm incomes, save on foreign exchange and alleviate poverty.”



Maize kernels are collected from the release valve of a metal storage silo.

According to Tadele Tefera, CIMMYT entomologist and EGSP coordinator, creating awareness of post-harvest management is a critical project component. EGSP held workshops in 2013 to help government policy-makers, extension staff, media and potential users from the region to learn about different factors affecting post-harvest management.

Ivor Mukuka, EGSP national coordinator for Zambia and chief agricultural research officer at ZARI, stated that effective grain storage helps smallholder farmers safely keep their grains longer so that they can sell when prices are higher. CIMMYT economist Hugo De Groote noted that metal silos have a major impact on farmers' livelihoods. Those who have not adopted the technology sell most of their maize at harvest (when prices are at their lowest because supply is at its peak) while adopters sell much of their grain in the fifth month at higher prices. Adopters stored their maize for two months longer than non-adopters and were food-secure for one month longer.

“In Zambia, reducing post-harvest losses will increase food security, because it is not only important to increase domestic food production but also to protect what is produced by minimizing losses,” said Bert Mushala, Permanent Secretary of Provincial Administration, Eastern Province Office of the President, in a speech at the opening of the ‘Improved Post-Harvest Management Training Workshop for Extension and Media Personnel’ held May 27-28 in Chipata. The Ministry of Agriculture and Livestock, supporting organizations and donors have devoted resources to improve agricultural production. “The resulting improved yield gains, especially in maize, have largely been



Participants at the 2013 DTMA planning meeting pose for a group photograph on the steps of the World Agroforestry Centre in Nairobi.



wasted because of post-harvest losses,” noted Mushala, adding that “EGSP is therefore unique and important to Zambia as it focuses on the comparatively neglected storage aspects. It is the first of its kind and could not have come at a better time.” Agricultural extension staffers were challenged by Mushala to be first adopters of metal silos to help promote the technology for effective grain storage.

(Above): A farmer from Mbeere District, Kenya, stands by her two metal silos. The silos allow her to store grain for use by her family and to sell.

Eastern Province agriculture coordinator Obvious Kabinda called for commitment: “You must have confidence and belief in the technology if you are to successfully promote it to others.” Michelo Lubinda, a producer with Zambia News and Information Services, said, “I have gained important information about the technology and, like others, will be using it to ensure that farmers are aware of post-harvest storage and have access to it.”

While Kenya, Malawi, Zambia and Zimbabwe are EGSP II’s target countries, representatives of other countries also took part in EGSP meetings and workshops to learn more about storage technologies. Because other forms of storage – traditional granaries and sisal and gunny bags – have proven ineffective, and chemical control is unsuccessful (only half of Kenyan maize farmers use storage pesticides, for example), Burundi, Kenya, Rwanda, Tanzania and Uganda are working together to develop technologies and policies to reduce post-harvest losses.

The incorrect use of pesticides was also recently reported in a Kenya MoA survey. According to Ngari Nyaga, Crop Post-Harvest Division head at the MoA, metal silos will

“lead to lower rates of storage pesticide use, thereby resulting in better health and less illegal use of restricted pesticides by farmers.”

Embu County (eastern Kenya) farmer Gladys Nthiga recently acquired two metal silos with a capacity of 450 kg each. “Despite treating my grains with pesticides, I was still losing nearly half a ton of maize every year,” said Nthiga. “If what I have been told about the technology is true, then my problems with these pests are over.”

Officials from the Malawian and Zambian ministries of agriculture, Malawi’s Chitedze Research Station, ZARI and silo artisans from the two EGSP countries visited sites in Kenya, October 7-12, that had high levels of silo adoption. They were accompanied by implementing counterparts in Kenya from the Catholic Dioceses of Embu and Nakuru counties and KARI.

Maize is a major part of the food served in Kenyan schools. Jane Obwocha, deputy principal of Uhuru High School in Nakuru, noted the school avoided purchasing maize in bulk due to heavy losses during storage, which she attributed to poor storage facilities. “The metal silo is a timely and critical intervention in maize storage as most schools lack effective storage,” she said. Peter Njiiru, principal of Kierie Secondary School in Embu County, said he purchased a metal silo for maize storage and planned to add three more.

At Baraka Agricultural College, the delegation saw a new metal silo prototype that facilitates removing the stored grain. The college has also started creating awareness about the technology and promotes it to farmers from Kenya and across eastern Africa.

The delegation also met with members of BOLESA, a women’s group of HIV/AIDS victims and former commercial sex workers. BOLESA is using a 900 kg-capacity metal silo acquired last year to store its members’ maize.

EGSP stakeholders have reported several challenges to wider adoption of silos, including an inadequate number of skilled artisans with entrepreneurial skills; lack of fabrication materials; expensive materials; low awareness of the technology; and inadequate extension services. To overcome these challenges, project staff and stakeholders agreed to boost awareness through promotional events, engage in capacity building for collaborators and strengthen the artisan network.

For further information about EGSP, contact Tadale Tefera (t.tefera@cgiar.org).

SIMLESA Prepares for Phase II

Over 200 researchers, policy-makers, donors and representatives of seed companies and NGOs from Africa and Australia gathered in Chimoio, Mozambique, from March 17-23 for the third Sustainable Intensification of Maize-Legume Systems for Food Security in Eastern and Southern Africa (SIMLESA) annual regional planning and review meeting to discuss the project’s progress and achievements, share lessons learned over the past three years and develop better ways to design and implement future activities in the SIMLESA target countries (Ethiopia, Kenya, Malawi, Mozambique and Tanzania) and spillover countries (Botswana, South Sudan, Uganda and Zambia).

SIMLESA is a collaboration between the NARS of the target countries, CIMMYT, the International Center for Research in the Semi-Arid Tropics (ICRISAT), the Association for Strengthening Agricultural Research in Eastern and Central

Africa (ASARECA), the Agricultural Research Council of South Africa, the Queensland Alliance for Agriculture and Food Innovation – University of Queensland, Murdoch University and the Government of Australia through the Australian Centre for International Agricultural Research.

“SIMLESA has attained a ‘steady flight path’ and is on track to deliver significant impacts,” noted Derek Byerlee, Program Steering Committee (PSC) co-chair, and the mid-term review (MTR) conducted in 2012 supports his words: “The MTR Team has reviewed progress by objectives and the overall execution of the Program, and finds that in general it has made very good progress in its first two years.” Bekele Shiferaw, Program Management Committee chair, then highlighted MTR recommendations including: SIMLESA should take concrete steps to overcome current socio-economic research capacity constraints in national agricultural research systems and in the areas of value chains, informal analyses, business management, participatory agronomy and breeding research; focus on ‘smart’ sequences for testing conservation agriculture technologies with farmers resulting in step-wise adoption; and create representative and effective innovation platforms with clear roles, structures and functions.”

SIMLESA Phase I ends in 2014; participants brainstormed on key issues anticipated in Phase II, concluding that the overall approach should be holistic, flexible in dealing with complex systems and should devise effective ways to target different groups of farmers. Furthermore, it was noted that Phase II should focus on changing the mindset of farmers. “The real work is to deal with the psychological, social, cultural and environmental factors of the farmer that will determine the adoption of introduced technologies,” noted one of the

(Below): Participants in a SIMLESA planning meeting listen attentively during a field tour near Chimoio, Mozambique.



Participants in a SIMLESA planning meeting listen attentively during a field tour near Chimoio, Mozambique.



participants. Following the discussion on Phase II, Byerlee shared the PSC's vision – apply a broader approach to system intensification (CA elements, soil fertility, integrated pest management and diversification); be more country-specific; create empowering, location-specific and sustainable innovation platforms; and pay more attention to institutions and policies vis-à-vis technology.

According to Inacio Maposse, PSC member and Director General of the Agricultural Research Institute of Mozambique (IIAM), Phase II is not necessary only because Phase I is ending but also “because we want to add another dimension to the program, and perhaps a different philosophy, one that will lead us to success. We need Phase II because we have yet to produce significant adoption and impact on the farming communities.”

John Dixon, senior advisor for cropping systems and economics and ACIAR principal regional coordinator for Africa and South Asia, added, “Where resources are limited, sustainable intensification is the only option to feed the extra two billion people by 2050.”

Melissa Wood, AIFSC director, then explained some of the reasons behind the close cooperation between Australia

and Africa – “Australia and Africa share many common agricultural challenges, including limiting soils, highly variable climates, pests and diseases.” Consequently, AIFSC aims to accelerate adoption; bridge the gap between research and development; find new ways to support African agricultural growth through adoption, policy, scale-out, improved market access, diversification and nutrition.

Marianne Bänziger, CIMMYT Deputy Director General for Research and Partnerships, said SIMLESA should provide farmers in the five target countries with diverse opportunities to improve their livelihoods. “Farmers should be able to get incomes not only from maize and legumes but also from other farm enterprises.”

For more information about SIMLESA, contact Mulugetta Mekuria (m.mekuria@cgiar.org).

Resource-Conserving Practices for African Smallholder Farmers

“Today Embu farmers are reaping benefits associated with conservation agriculture,” said Charles Wanjau, district agricultural officer in Kenya's Embu East District. “We hope that through CASFESA, the benefits that accrued from the SIMLESA project will spread to many more farmers in Embu and beyond for improved food security.”

Wanjau was referring to the Conservation Agriculture and Smallholder Farmers in Eastern and Southern Africa (CASFESA) project that began in June 2012 in Ethiopia and January 2013 in Kenya, with funding from the European Union (EU) and the International Fund for Agricultural Development (IFAD). The 2.5-year CASFESA project is leveraging institutional innovations and policies for sustainable intensification and food security in Ethiopia, Kenya and Malawi, and demonstrating CA as a sustainable and profitable farming practice in randomly selected villages. The effort is also assessing the effects of markets and institutions on adoption and impacts, through

baseline and impact studies in both treatment and control villages. In Kenya, activities are under way in 15 villages to establish researcher/farmer-managed demonstration plots on the farms of two volunteer farmers per village. The demonstration plots are planted with farmers' preferred maize and bean varieties using locally recommended seed rates and fertility inputs.

The first CASFESA stakeholder workshop in Kenya was held on February 22 and attended by 30 farmers hosting demonstration plots, 16 extension agents from the MoA, and scientists from CIMMYT and KARI. Other participants included representatives from Kenya Equity Bank, Kilimo Salama and Organic Africa, providing farm credit, insurance and inputs, respectively. The workshop included updates on project objectives and work plans.

CIMMYT agronomist Fred Kanampiu presented CA information, followed by KARI-Embu agronomist Alfred Micheni, who shared KARI-SIMLESA experiences and key points of the CASFESA work plan. CIMMYT socio-economist Moti Jaleta gave an in-depth talk on project objectives, methodologies, selected sites and plans.

Subsequent workshop discussions centered on demonstration planting details and observations were drawn from farmers and the extension agents' experiences. Also discussed were MoA recommendations, which encourage tillage, and when to inter-crop maize and beans. The varied labor roles of women and men was discussed; women typically do the bulk of planting, weeding and harvesting. There was an on-station demonstration of CA practices – particularly ridge planting for maize – under the supervision of Kanampiu and Micheni. This was important because the farmers and extension agents needed to see a successful case before embarking on establishment of proposed demonstrations based on furrows and conservation tillage practices.

For more information about CASFESA, contact Moti Jaleta (m.jaleta@cgiar.org).

Hill Maize Research Project

In August, the fourth phase of HMRP began working with the Seed Entrepreneurs Association of Nepal and district agriculture development offices to facilitate contracts between 51 community-based seed production (CBSP) groups and 25 seed buyers/traders for 201 tons of improved maize seed. Of the total contracted seed, seed companies account for 55 percent; agro-vets, 20 percent; community seed banks, 13 percent; and cooperatives, 12 percent.

Launched in 1999, HMRP improves the food security and income of resource-poor farm households in the hills of Nepal by raising the productivity, sustainability and profitability of maize-based cropping systems. Work now

covers 20 hill districts of Nepal and is jointly funded by SDC and USAID. CIMMYT implements the project in partnership with public and private sector institutions. Principal partners include the National Maize Research Program of the Nepal Agricultural Research Council, the Crop Development Directorate of the Department of Agriculture (DoA), the Seed Quality Control Centre and the National Seed Board under the Ministry of Agriculture Development (MoAD). Other partners include community-based organizations, CBSPs, farmer groups, NGOs, private entrepreneurs, seed companies and universities.

The project began multiplying seed of improved maize varieties through CBSP groups in 2000. That year, about 14 tons of improved maize seed were produced by seven CBSP groups. By 2011, more than 1,140 tons of improved maize seed were produced by 195 CBSP groups and, in 2012, 207 groups produced 1,036 tons. Of the total marketable surplus seed produced in 2011, about 75 percent was marketed or exchanged; that percentage increased to 83.3 percent in 2012. The seed was marketed mainly across the 20 hill districts of the HMRP project area.



HMRP partners visiting CBSP groups in the hill district of Palpa, Nepal.

Seed production through CBSP groups has been a successful model and has contributed to the increased adoption of improved maize varieties and technologies. The CBSP model helps ensure the on-time availability of improved maize seed in remote hill areas at lower prices.

Maize seed marketing is one of HMRP's major challenges. Until 2012, CBSP groups did not consider the supply and demand in markets, resulting in surplus seed in some areas and deficits in others. The 2013 project phase initiated pre-sowing seed contracts for improved maize varieties, assisting and guiding CBSP groups and seed buyers/traders (agro-vets, community seed bank cooperatives and seed companies) to sign formal agreements.

For more information about HMRP, contact Guillermo Ortiz-Ferrara (g.ortiz-ferrara@cgiar.org).



A Malawian farmer stands in his conservation agriculture field.

SIMLEZA Field Tour in Zambia

In rural areas surrounding Chipata in eastern Zambia, tobacco, cotton and maize dominate the agricultural landscape. Smaller plots are used to grow groundnuts, cowpeas, soybeans and sunflowers. In this smallholder farming area – with an average annual rainfall of more than 1,000 millimeters – it is neither easy to stay ahead of the weeds on all fields nor to buy enough fertilizer for a healthy crop.

The Sustainable Intensification of Maize-Legume Systems in the Eastern Province of Zambia (SIMLEZA) project, funded by USAID and implemented by CIMMYT and its partners, seeks to address production and sustainability constraints through on-farm testing and demonstration of improved maize and legume varieties (soybeans and cowpeas) and agronomic practices that build on CA principles. CA addresses the high labor demand of local agriculture. It can drastically reduce smallholder farmers' workload at the beginning of the season, replacing hand-made ridges-and-furrows with direct seeding on flat ground with a pointed stick and herbicide use for weed control. As a SIMLEZA demonstration farmer who had been given the tool and herbicides for testing exclaimed, "Up until now I have been punishing myself!"

The second major issue – the need for higher fertilizer inputs – is more difficult to resolve. Zambia's fertilizer subsidy program has increased fertilizer access for poor rural households, but it provides only two bags at reduced prices and is insufficient to cover farmers' total land area. SIMLEZA's focus on improving intercropping and crop rotation with legumes seeks to decrease farmers' reliance on expensive fertilizers. Nitrogen provided by legumes benefits the following year's crop on a plot and reduces the need for mineral fertilizers. But farmers will have to increase the land area

Participants in a SIMLEZA field tour listen attentively near Chipata, Zambia.



Participants in a SIMLEZA field tour engage in a lively debate while using an umbrella and a hat to shade themselves from the sun near Chipata, Zambia.

dedicated to legumes if this is to work at farm-scale. A short group discussion in the Khokwe community revealed farmers' interest in doing just that.

When asked what the best cash crops are, cotton and tobacco appeared to be the least popular. The simple explanation for the apparent contradiction between the large area dedicated to tobacco and farmers' dislike of it was: "One cannot eat tobacco!" While legumes such as groundnuts, common beans and soybeans topped the list of favorite cash crops, the volumes traded are small and do not reach the urban market of Chipata. Farmers complain that buyers in Chipata are few and prices low, despite the export demand for legumes. Thus, dedicating land to tobacco is the result of late payments and decreasing prices for legumes in past years. Increasing smallholder farmers' legume production and simultaneously linking them to profitable markets is a major challenge.

In nearby Malawi, this shift towards increased legume production is happening. There is far less tobacco than before; legumes such as soybeans and groundnuts are increasingly replacing it. Dwindling prices for tobacco and free seeds from the government have undoubtedly stimulated farmers' planting of legumes and boosted volumes traded. Together with its partners, Total Land Care, the Ministry of Agriculture and Livestock, IITA and ZARI, SIMLEZA seeks to contribute to a similar productivity-enhancing change in the agricultural landscape of Zambia.

For more information about SIMLEZA, contact Christian Thierfelder (c.thierfelder@cgiar.org) or Peter Setimela (p.setimela@cgiar.org).

High Expectations Among Stakeholders as WEMA Phase II Begins

From February 4-8, stakeholders of the Water Efficient Maize for Africa project gathered in Nairobi, Kenya, for the Fifth Review and Planning Meeting to discuss achievements and challenges of the recently concluded WEMA Phase I (2008-2013) and to plan for the second phase of the project (2013-2017). Over the past four years, WEMA had several key achievements, including the successful application and approval of permits to conduct CFTs for transgenic varieties in Kenya, South Africa and Uganda.

Kenya and Uganda are in their third year of CFTs; South Africa is in its fourth. WEMA also submitted conventional drought-tolerant maize hybrids for national performance trials in Kenya. "It is expected that farmers will have these WEMA conventional maize seeds by 2014," said Denis Kyetere, executive director of the African Agricultural Technology Foundation (AATF). CKH110078, one of the hybrids developed from DTMA materials, is in its final stage of approval in Kenya.

Emily Twinamasiko, Uganda's National Agricultural Research Organization Director General and WEMA Executive Advisory Board chair, was pleased with the project's achievements and commended all teams and the operations committee for their efforts. Natalie Rosenbloom, Monsanto vice president for Sustainable Agriculture Partnerships, commented on the indicators of success: "The project will never be successful until the farmer has a product to plant and options to choose from." Getting seed to the farmers was stressed also by Ephraim Mukisira, KARI director, who called for rapid deployment of the varieties.

"KARI wants to see the product with the farmer. Scientists must work hard so that impact can be seen today."

B.M. Prasanna, GMP director, thanked Monsanto for donating drought-tolerant and Bt genes. "This is a tremendous opportunity to address some of the biggest challenges to African smallholder farmers [drought and stem borer infestation]. MON810 presents yet another great opportunity for WEMA to tap into products from the Insect Resistant Maize for Africa [IRMA] project to develop a product that addresses many of the insect-related constraints." He added that new challenges were posed by MLN, but the WEMA team assured partners that the materials being produced are resistant to the disease. During a visit to trials at KARI-Kiboko, stakeholders observed WEMA varieties, many of which have outperformed some of the best local hybrids on the market. They also visited the confined field trials for Bt MON810 and drought-tolerant MON87460 that are in their first and fourth seasons of trials, respectively.

Shifting attention from successes to challenges, Stephen Mugo, CIMMYT principal scientist and co-chair of the WEMA product development team, spoke of the lessons learned in Phase I that are crucial for the success of the second phase – continuous training in trial modernization and modern breeding techniques, as well as an effective quality assurance program for the exchange of germplasm between the private and public sectors to minimize the risk of inappropriate germplasm exchange.

Lawrence Kent of the BMGF noted that "with great privilege comes lots of responsibilities. We therefore expect great success from WEMA." This sentiment was shared by other



Participants in a WEMA Phase II planning session inspect maize at the KARI research station in Kiboko, Kenya.



Participants in a WEMA Phase II planning session listen to information provided about a maize trial in a demonstration plot at the KARI research station in Kiboko, Kenya.

stakeholders, who were impressed by the achievements of Phase I and have high expectations for Phase II. “WEMA continues to be a success because of the combined and dedicated efforts within the partnership – the NARS, CIMMYT, Monsanto and AATF. These partners have continued to work together, celebrating project gains and resolving any challenges together for the good of the larger goal – the promise of food security and better livelihoods for smallholder farmers,” stated Kyetere. “A food-secure continent is the greatest inheritance and legacy we can leave to our children and our children’s children.”

For more information about WEMA, contact Stephen Mugo (s.mugo@cgiar.org).

Study Tour Empowers African Farmers

From April 29 to May 10, 16 agricultural engineers, agronomists, machinery importers and machinery manufacturers from Ethiopia, Kenya, Tanzania and Zimbabwe took part in a study tour in India organized by CIMMYT, ICAR, ACIAR and AIFSC. The tour was organized as part of the FACASI project to identify opportunities for the exchange of technologies and expertise between India and Africa and to strengthen South-South collaborations in the area of farm mechanization. The project is funded by AIFSC and managed by ACIAR.

India is the world’s largest producer of pulses, and the second-largest producer of wheat, rice, potatoes and groundnuts. But would India’s agricultural performance be that high if the number of tractors in the country was divided by six and the number of draft animals by three? Such a reduction in farm power would bring Indian agriculture close to the current situation in Kenya and Tanzania. In India, most agricultural operations are mechanized, including planting, harvesting, threshing, shelling and transportation to the market; in Africa, these are generally accomplished manually. Bringing African agriculture closer to India’s model is a FACASI goal. The tour was the first step in the construction of an enduring trilateral partnership among Africa, India and Australia,

coordinated by CIMMYT, to facilitate exchange of R&D results in farm mechanization.

The study tour began with remarks by S. Ayyapan, ICAR Director General, who stressed the importance of farm mechanization for agricultural intensification. He pointed out the commonalities between Indian and African smallholders and invited the group to develop concrete, country-specific proposals regarding possible partnerships with India. The participants then spent five days at the Central Institute of Agricultural Engineering in Bhopal, Madhya Pradesh state, where they were exposed to various low-cost, gender-friendly technologies for post-harvest operations and weeding; sowing, fertilizing, spraying and harvesting adapted to animal traction; two-wheel and four-wheel tractors; as well as CA-based technologies. Through calibration exercises and other field activities, participants gained hands-on experience with these machines.

The second part of the study tour took place in the states of Punjab and Haryana, where the group interacted with scientists from Punjab Agricultural University and BISA. Participants were shown various Indian innovations including laser land levelers operated by 2WTs, relay direct seeders, multi-crop planters, crop threshers and rotary weeders. They also participated in a discussion with a farmer cooperative society at Noorpur-Bet focused on innovations encouraging farmer access to mechanization, and interacted with Indian agribusinesses such as National Agro-Industry, Dashmesh Mechanical Engineering, Amar Agro Industries and All India Machinery Manufacturers Association.

The study tour concluded in Karnal with visits to the Central Soil and Salinity Research Institute to observe how CA is helping to reclaim degraded land, and DWR.

The knowledge acquired in India will be put into practice through the FACASI project. The study tour generated several ideas for the development of new machines by

Testing a 2-wheel tractor during a study tour in India.



African engineers and created contacts between Indian manufacturers and African machinery importers that may create business opportunities for both.

For more information about FACASI, contact Frédéric Baudron (f.baudron@cgiar.org).

Trees Improve Productivity of Ethiopian Wheat Systems

Researchers with CIMMYT’s GCAP in Ethiopia have found that agroforestry systems involving an indigenous tree could mitigate climate change effects in Ethiopian smallholder wheat systems. Specifically, their study showed that maximum temperatures under the canopy of *Faidherbia albida*, a nitrogen-fixing, acacia-like species found throughout African savannas, were constantly 4-5°C lower than temperatures outside the canopy.

By 2050, the maximum daily temperature in wheat-growing areas of Ethiopia is predicted to rise by 2-3°C. This could significantly reduce wheat yields, a crop that accounts for one-fifth of Ethiopia’s cereal production. The crop is critical to the food security and incomes of smallholder farmers who grow it.

CIMMYT researchers are studying the effect of trees that are currently common in farmers’ fields. Keeping trees in fields for the production of firewood and fencing materials is extremely common in Ethiopia. “But these trees have other functions and may positively affect the productivity of crops underneath them,” said Frédéric Baudron, a CIMMYT cropping systems agronomist based in Ethiopia.

In addition to more wheat-friendly temperatures, there are other benefits of *F. albida* in wheat systems, according to Baudron. “Soil moisture increases significantly under the canopy, resulting in a greener wheat crop for a longer time. The tree’s presence also fosters longer wheat leaf blades, a greater number of tillers per plant, longer spikes and a higher number of seeds per spike – translating into higher stover and grain yields.” Moreover, the incidence of wheat diseases diminishes under the tree canopy.

As part of the World Agroforestry Centre (ICRAF)-led Trees4Food project, funded by AIFSC and managed by ACIAR, GCAP-Ethiopia studies interactions between food crops and various indigenous trees in wheat- and maize-based systems.

In the case of *F. albida*, there are no trade-offs between the provision of tree products and the crop yield underneath. The research seeks management practices – such as proper fertilization rates, genotypes of crops, pruning management and tillage practices – that maximize the existing synergy. With other tree species commonly found in Ethiopian fields (such as *Acacia tortilis*, *Cordia africana* or *Croton macrostachyus*), these trade-offs are



Wheat grows under the canopy of *F. albida* around mid-October in the Mojo area of Ethiopia.



This photo, taken the same day, shows wheat a few meters outside the canopy of *F. albida*. It is not as green and healthy as the wheat in the photo above.

often substantial. In that case, the research is focused in management practices that minimize competition. The project is being implemented in Ethiopia and Rwanda.

For more information, contact Frédéric Baudron (f.baudron@cgiar.org).

CIMMYT and USDA Support Wheat Improvement in Pakistan

The annual planning meeting of the Wheat Productivity Enhancement Program (WPEP) September 17-18 at the Pakistani National Agriculture Research Center (NARC) in Islamabad highlighted efforts of PARC and CIMMYT to improve the country’s wheat crop. The meeting reviewed progress during the last three years under the United States Department of Agriculture (USDA)-funded WPEP and refined work plans for 2014. The program is focused on developing wheat varieties that resist Ug99 stem rust as well as fostering seed multiplication and distribution, improved agronomic practices and human resource development in the agriculture sector to ensure food security.



Wheat Productivity Enhancement Program (WPEP) Farm Machinery Shed at the Wheat Research Institute, Faisalabad.

USDA Agriculture Counselor Clay Hamilton noted that the USA and Pakistan have a long history of agricultural collaboration. The U.S. will continue to provide support for wheat productivity in Pakistan, he said. Shahid Masood, a scientist in PARC's Plant Sciences Division, highlighted PARC's role in strengthening the national and provincial agricultural research system in coordination with national and international collaborators and research partners.

Muhammad Imtiaz, CIMMYT country liaison officer for Pakistan, briefed the participants about WPEP's achievements during the last three years and its impact on the national wheat research system in rust surveillance, breeding, pre-breeding and capacity building, which led to the release of Ug99-resistant wheat varieties like NARC-2011. National partners from all provinces presented their achievements and 2014 work plans. They acknowledged the role of USDA, CIMMYT and PARC in supporting wheat productivity enhancement in Pakistan.

For more information about WPEP, contact Muhammad Imtiaz (m.imtiaz@cgiar.org).

Mexico's Sustainable Modernization of Traditional Agriculture

The MasAgro project had a decisive year in 2013. The project began in late 2010; 2011 and 2012 were fundamental to reach agreements on research priorities, to seek and establish partnerships and to lay the foundations for a 10-year project to increase Mexico's annual maize production in rain-fed areas by 85 percent, and its wheat production by 10 percent by 2020. MasAgro, a collaboration between CIMMYT and SAGARPA, became CIMMYT's largest AR4D project in its third year. Moreover, MasAgro is the most important partnership that CIMMYT has had with its host country since the years of the Green Revolution.

For CIMMYT, 2013 also brought the challenge and the opportunity to adapt MasAgro to the priorities of Mexico's new government. MasAgro's leadership team aligned project objectives to Mexico's 2012-2018 Development Plan, its National Crusade against Hunger and its agriculture and rural development plans. In the process, CIMMYT showed MasAgro's impact in Mexican farmers' fields as well as encouraging results from its world-class research in laboratories and trial plots.

In 2013, the MasAgro model that had been endorsed by such international stakeholders as the G20 Agriculture Vice-Ministers Group, the World Economic Forum, the Inter-American Development Bank and the BMGF, was in full implementation. MasAgro and its four components – Seeds of Discovery (SeeD), International Maize Improvement Consortium (IMIC), Wheat Yield Consortium (WYC) and Take it to the Farmer (TTF) – delivered tangible results in data, improved seeds and extension services that effectively reduced the costs and increased the income and productivity of a sample of 835 farmers participating in the program, as verified by an independent SAGARPA consultant.

Seeds of Discovery/MasAgro Biodiversity

In 2013, SeeD analyzed more than 30,000 DNA samples of maize and wheat landraces and wild relatives to generate high-density genetic profiles that breeders will use to develop more resilient and productive seeds of both grains. Some of these high-throughput analyses were performed for the first time by the Genetic Analysis Service for Agriculture (SAGA), which MasAgro successfully established at Mexico's Genetic Resources Center. MasAgro made cutting-edge genotyping-by-sequencing



(GBS) platforms available to agricultural research in Mexico and the region. By the end of 2013, SeeD had generated 42,000 high-density genetic profiles of wheat and 20,000 of maize. These will be used to build "molecular atlases," enabling breeders and researchers to navigate the native genetic diversity of the crops.

In addition, Mexico's Laboratory of Genomics for Biodiversity sequenced the complete genome of 18 maize landraces to provide MasAgro with a wider reference framework to compare the thousands of genetic profiles SeeD generates from CIMMYT gene bank accessions. MasAgro also continued the most comprehensive genome-wide association study (GWAS) in the history of

maize research by starting to establish the relationship between genome-wide genetic 'fingerprints' and important agronomic traits, such as drought tolerance and disease resistance, in a group of 4,000 landraces.

SeeD conducted field trials to evaluate adaptation capacity, heat and drought tolerance and grain-quality characteristics of more than 20,000 wheat accessions. SeeD has processed more than 70,000 wheat accessions since MasAgro began. In addition, the project has studied resistance to key diseases in more than 7,500 accessions of wheat; over 4,500 were evaluated in 2013. MasAgro multiplied seed of 800 selected maize landraces in order to conduct drought trials in 2014. SeeD also multiplied 350 varieties of blue maize to measure the physical and chemical characteristics that determine grain quality for culinary uses.

To make the genetic information and field data generated by SeeD available to maize and wheat breeders, web developers at the James Hutton Institute improved the search and data visualization capabilities of the SeeD web portal. SeeD also finished a draft Proactive Intellectual Property Strategy to set a legal framework in which SeeD-generated information and seeds can be safely exchanged in a pre-competitive commercial environment. Finally, SeeD contributed to the development of Mexico's research capacities by organizing a hands-on workshop in GBS analysis for scientists from partner institutions who were able to process their own maize and wheat DNA samples at SAGA. To date, SeeD has trained more than 100 national researchers on genetic and computer skills for breeding.

For more information about SeeD, contact Peter Wenzl (p.wenzl@cgiar.org).

International Maize Improvement Consortium/MasAgro Maize Network

The MasAgro breeding program delivered 6.6 tons of basic seed to 19 small and medium-sized companies and to Mexican research institutions in 2013. Companies that participate in MasAgro's network have received 8 tons of seed of 16 maize hybrids adapted to Mexico's rain-fed growing regions. As a result, the companies can multiply and commercialize enough hybrid seed to sow 1 million hectares in 2014 (one-eighth of the total land used to grow maize in Mexico). These hybrids have the potential to yield 60 percent more than Mexican farmers' average yield.

In areas served by local seed companies and with higher productivity potential, MasAgro will help increase the use of improved seed by almost 50 percent. Although it normally takes five years to develop one or two commercial hybrids from more than 10,000 crosses per year, MasAgro benefited from the advanced hybrids that CIMMYT began to develop in 2011. As a result, small farmers will have access to maize hybrids specifically adapted to their fields.



IMIC also distributed 27.7 tons of pre-commercial seed of 16 maize hybrids to 18 companies and two public research centers in 2013. In sum, MasAgro has distributed 31 tons of pre-commercial seed to the companies that participate in its germplasm evaluation and exchange networks.

Breeders and managers of participating seed companies also received training in seed improvement and multiplication techniques, management and marketing practices. MasAgro offered four workshops on these subjects, including seed certification training for 22 technicians of Mexico's Seed Inspection and Certification Service, and a workshop on DH technology for seed improvement for technicians from 19 companies. In three years, MasAgro has offered 23 workshops to IMIC partners.

Breeding efforts were fruitful in 2013; IMIC identified nine high-yielding hybrids developed by CIMMYT and Mexico's National Institute of Forestry, Agricultural and Livestock Research (INIFAP). The yields achieved in tests of these hybrids were similar to or even higher than yields obtained from the best commercial seed available to growers.

In addition, IMIC developed 15,313 DH lines in 2013 that will maintain the desirable agronomic traits of the donor lines and accelerate the breeding process. After matching GBS analyses with phenotypic information collected, IMIC breeders were also able to use GWAS to identify maize varieties that are resistant to corn stunt.

The MasAgro socio-economics team concluded five surveys of seed producers and growers to identify priority intervention zones, and to estimate the potential growth of improved seed markets. The findings show that 740,000 ha in southeast Mexico and 372,000 ha in the High Valleys have the highest productivity potential. Both zones combine high yield gaps with high potential use of improved seed. Seed companies in MasAgro networks

could see their sales double by 2018 if these markets reach their full potential. Another study conducted by INIFAP confirmed that 54, 68 and over 90 percent of smallholder farmers in the states of Mexico, Oaxaca and Veracruz, respectively, want to use hybrid seeds.

For more information about IMIC, contact Arturo Silva (a.silva@cgiar.org).

Wheat Yield Consortium/MasAgro Wheat

The WYC successfully concluded the third annual evaluation of 30 advanced wheat lines from the CIMMYT Core Germplasm (CIMCOG) panel. The trials studied how genetic variability can contribute to improvement of traits related to wheat yield potential. The traits of interest to WYC researchers were spike and leaf photosynthesis, grain partitioning and lodging resistance. Field evaluation results showed that spike photosynthesis was responsible for up to 40 percent of grain weight in elite wheat lines. These findings were presented at the 16th International Congress on Photosynthesis in St. Louis, Missouri, in 2013.

Similarly, the outcome of the trials that measured partitioning to grain efficiency in the CIMCOG subset were presented at the 7th Conference of the European Plant Science Organization in Greece, and at the 2nd Conference of Cereal Biotechnology and Breeding in Hungary. Measurements of spike fertility and phenological range of the CIMCOG elite lines were also presented at the 12th International Wheat Genetics Symposium in Japan. It is important to note that the presentations were given by Mexican Ph.D. students who conducted WYC research at Mexico's Phenotyping Platform (MEXPLAT).

The MEXPLAT research station, located in Ciudad Obregón, Sonora, hosted the Third Technical Workshop of the WYC in March 2013 with 91 scientists from 26 countries participating. The MEXPLAT research station was also



where the seven WYC Ph.D. students established the field experiments that fed their doctoral research at prestigious international universities. MEXPLAT is one of the most important wheat phenotyping stations in the world.

To standardize measurement procedures in the field and reduce inconsistencies attributable to human error, WYC published phenotyping manuals in English and Spanish. These protocols make measurements gathered at MEXPLAT comparable to readings taken from other global evaluation sites. The CIMCOG panel was sent to MasAgro partners and tested at 15 international sites to evaluate its adaptation potential to different wheat-producing regions.

The results of multi-location yield trials in Mexico and around the world (25 sites) provided first proof of concept that wheat yield potential can be increased through strategic physiological crossing. The new lines of the first and second WYC yield trials – generated by crossing materials of increased photosynthetic capacity with materials of high spike fertility – were evaluated during the 2013 spring wheat cycle. The evaluations confirmed that the best new lines from the WYC international nurseries were especially promising in increased biomass and radiation use efficiency.

For more information about WYC, contact Matthew Reynolds (m.reynolds@cgiar.org).

Take It to the Farmer/MasAgro Farmers

MasAgro's extension strategy grew rapidly in 2013. The MasAgro hubs that connect farmers with extension agents in demonstration plots and with scientists in research platforms grew to 10 regions covering 20 Mexican states. TTF exceeded its 2013 infrastructure targets and by year-end had successfully established 55 research platforms and 225 demonstration modules in 10 hubs.

TTF's accelerated growth was due to 83 extension agents who achieved their Certificate in Conservation Agriculture in 2013. MasAgro has 181 extension workers who offer technical advice to farmers growing on 94,400 ha, although the program's area of influence is currently estimated to exceed 600,000 ha. MasAgro organized 203 field days for 10,277 participants, and trained 6,797 farmers in the use of sustainable farming technologies. In addition, TTF offered 44 trainings in CA, maize pathology, machinery and use of the GreenSeeker™ sensor to members of maize and wheat value chains in 10 hubs.

Efforts to transfer precision agriculture techniques to farmers included 59 experiments designed to calibrate the GreenSeeker™ for calculating optimal doses of nitrogen to fertilize maize and wheat fields. These experiments were established in eight hubs covering 19 states.

On a commercial scale, TTF finished testing the GreenSat service used to apply the exact amount of nitrogen fertilizer to grow wheat on 160,000 ha in the Yaqui and Mayo valleys of Sonora state. The GreenSat used images collected by the SPOT 6 satellite of Mexico's Information Service for Agriculture, Food and Fisheries. The nitrogen prediction service also studied yield gaps in Chiapas maize-bean farms of medium to high marginalization. Similarly, TTF concluded the pilot phase of MasAgro Móvil, a mobile information service that offered technical advice, grain price and weather information via text messages to more than 3,500 farmers in 2013.

By the end of the year, TTF conducted a study to determine what technologies had the highest adoption index among participant farmers. Data collected from 11,652 plots monitored with an Electronic Field Book system showed that 26 percent of farmers were using integrated fertilization systems; 25 percent had adopted improved maize, wheat and barley varieties; 14 percent were using CA practices; 11 percent had adopted post-harvest solutions; 5 percent were using tools for chemical analysis of soils; and 2 percent had access to new, diversified markets.

The study also found that the average yield of MasAgro farmers growing maize is more than 4 t/ha. Depending on water availability, yields may vary from 3.5 t/ha in rain-fed zones to 9.7 t/ha in irrigated fields. MasAgro farmers have already achieved average yields of 3.5 t/ha in rain-fed zones. To reduce post-harvest losses, TTF conducted 48 experiments and organized 41 field days to promote grain storage solutions adapted to local markets in seven hubs.

TTF also sought closer alignment to state-level programs by forming a group of 50 trainers who monitor and offer technical advice to local extension agents operating in 23 states. These trainers monitored 1,185 demonstration plots and 3,395 extension areas across the country in 2013.

For more information about MasAgro, contact Bram Govaerts (b.govaerts@cgiar.org).

CIMMYT's Work Across the Developing World

CIMMYT works on four continents across the world. The following are updates of activities in some of the countries that CIMMYT is conducting AR4D activities and projects.

AFGHANISTAN



Research and Development Needs

For more than 10 years CIMMYT has been working with Afghanistan's national agriculture research system to contribute to the country's sustainable agricultural growth and AR4D. The efforts have led to the release of 12 wheat, four maize and two barley varieties. Wheat and maize account for 84 percent of cereal acreage and production in Afghanistan. On March 5-7 CIMMYT Director General Thomas Lumpkin visited to observe CIMMYT activities and discuss further cooperation.

During a tour of ARIA's research station at Darulaman, station manager Gul Zaman told Lumpkin that 70 to 80 percent of field experiments at the station were ARIA-CIMMYT wheat trials. The station is in dire need of reconstruction, lacks proper infrastructure and farm machinery is kept outside. Lumpkin met with key ARIA staff to assess the station's needs on behalf of MAIL. Abdullahjan Ahmadzai, Director General of agricultural extension and development, updated Lumpkin on CIMMYT-Afghanistan's work in drafting a long-term agricultural AR4D strategy document. "CIMMYT could also bring in the latest technologies, such as conservation agriculture, precision agriculture and the use of

ICTs for extension services," commented Lumpkin. Other assistance needs include a gene bank, soil and pathology laboratories, technical support in basic research, capacity building and R&D for agricultural machinery, according to ARIA Director Qasem Obaidi.

Abdul Ghani Ghuriani, deputy minister for technical affairs at MAIL, suggested that CIMMYT establish a permanent facility to provide long-term AR4D support to the Afghan NARS and other stakeholders. Mir Dad Panjsheri, MAIL chief advisor, highlighted the sustainability of development agency interventions, acknowledged the need for CIMMYT's continued support and suggested new collaboration. "We would appreciate CIMMYT's assistance with diversification of the crops in farmers' fields, genetic resource conservation and support of home-grown breeding programs."

Lumpkin also met with USAID, USDA, AusAID and ACIAR officials. USAID and AusAID welcomed the idea of a BISA facility in Afghanistan, as it could serve as a platform for other CG centers, in-country partners and foreign universities to address Afghanistan's AR4D gaps in a programmatic and sustainable manner.



Staff members of CIMMYT and the Agricultural Research Institute of Afghanistan exchange information prior to a working lunch.

BANGLADESH



Secretary of Agriculture Backs CIMMYT Sustainable Crop Intensification Plan

The majority of Bangladesh's farmland is cultivated during each of the country's three distinct agricultural seasons, and farmers cultivate two and sometimes three crops on the same field. However, in impoverished southern Bangladesh, only 50 percent of farmers currently grow more than one rainy season rice crop per year. This is highly problematic for the world's most densely populated country, where agricultural land is shrinking by 1 percent per year as urbanization accelerates.

The primary limitations to increased cropping intensity are the lack of dry season irrigation, the high cost of agricultural labor and delays in rice harvesting that delay timely planting of subsequent dry season wheat, maize or legume crops. As population and future demand for cereals grows, overcoming these constraints is becoming increasingly critical. For these reasons, CIMMYT works closely with public and private sector partners, local agricultural service providers and farmers to encourage efficient agricultural mechanization, irrigation and CA.

To raise awareness of CIMMYT's work on sustainable crop intensification in southern Bangladesh, CIMMYT, in association with iDE, hosted a field day in Kramji Char, Barisal, on January 17. The visit showcased activities of the EU-funded Agriculture, Nutrition and Extension Project (ANEP), as well as the USAID-funded Cereal Systems Initiative for South Asia. Several high-level public and private sector dignitaries took part, including: Monzur Hossain, Secretary of the Ministry of Agriculture; Paul Sabatine, USAID-Bangladesh deputy mission director; Anar Khalilov, USAID-Bangladesh senior food security advisor; Nazmul Islam, chair of the Bangladesh Agricultural Development Corporation; Wais Kabir, executive chair of the Bangladesh Agricultural Research Council; Krishibid Mukul Chandra Roy, Director General of the Department of Agricultural Extension; and Ahsan Khan Chowdhury, PRAN-RFL Group deputy managing director.

CIMMYT's work in Kramji Char and much of southern Bangladesh focuses on the sustainable provision of low-cost, fuel-efficient surface water irrigation using AFP technologies, which can provide up to 46 percent more water per drop of fuel consumed. CIMMYT has also popularized the use of agricultural machinery such as seeder-fertilizer drills, bed planters and reapers that can be attached to 2WTs. These implements enable more efficient planting and irrigation water use, while reducing labor requirements and saving farmers money. Working with iDE, CIMMYT is developing business models for private sector and local machinery service provider partners to ensure farmers' access to low-cost CA services. As the field day



A diesel-powered axial flow pump transfers water from a retention pond in Bangladesh.

closed, Hossain stated that "the demonstration of these machines opens the door to increased crop productivity and farmers' income."

For more information about ANEP or CSISA, contact Andrew McDonald (a.mcdonald@cgiar.org).

Visits from Donors and Staff

Farmers in southern Bangladesh face increasing costs for agricultural labor and the negative effects of climate change. CIMMYT-Bangladesh partners with farmers and agricultural service providers throughout the region to improve farmers' livelihoods by developing affordable irrigation and efficient machinery. These efforts have drawn attention, and donors and distinguished guests visited the region to see CIMMYT-led initiatives.

On February 6, Saharah Moon Chapotin, USAID team leader for agricultural research, and Tony Cavalieri from the BMGF visited activities conducted under CSISA, funded by USAID's FTF initiative with support from BMGF. CSISA is a collaborative project of CIMMYT, IRRI and WorldFish to sustainably increase productivity of cereal-based farming systems by developing innovative agricultural technologies – including small-scale agricultural machinery and CA – and market linkages to raise household incomes. Accompanied by cropping system agronomists Timothy J. Krupnik and Samina Yasmin (CIMMYT-CSISA), GWP associate director and wheat pathologist Etienne Duveiller, regional agronomist Andrew McDonald and Timothy Russell, director of IRRI in Bangladesh, the team visited Patuakhali District, where preliminary results of rain-fed maize field trials showed both yield increase (1.5 t/ha) over

conventional management practices and reduced production costs. Farmers are increasingly growing maize to sell to tourists at premium prices in the nearby beach district. The guests also visited women's producer groups involved in maize cultivation, IRRI rice screening trials and WorldFish activities that are introducing micronutrient-dense fish species.

The following week, Dan Mozena, U.S. Ambassador to Bangladesh and USAID-Bangladesh Mission Director Richard Greene visited CSISA activities in Shatkira District. They learned about CIMMYT's efforts to test, refine and extend labor-saving and cost-reducing CA machinery to farmers through agricultural service networks, and through the study and promotion of 2WTs to power fuel-efficient, surface water axial flow irrigation pumps used for bed-planted maize fields. Mozena commented, "This project is funded by USAID and is working with the Government of Bangladesh to help increase food security. Wonderful things are happening right here. I saw a beautiful maize field grown with new technology. If you don't have this machinery and you are using only day labor, it is very hard to cultivate enough land. This machinery really works."

Two days later, a European Union delegation visited the EU-funded ANEP project in Barisal, a very poor region that is prone to tidal flooding and low annual crop productivity. ANEP is a partnership between CIMMYT, iDE, Save the Children, WorldFish, Community Development, CEAPRED and BES-Nepal. ANEP focuses on increasing cropping intensity in Barisal to enable farmers to grow two economically viable crops per year. The EU delegation included Philippe Jacques (head of EU cooperation in Bangladesh), João Anselmo (attaché to the EU delegation), Marion Michaud (ANEP-EU task force manager based in Nepal) and Roselyn Mullo (ECHO regional nutrition coordinator). They saw how small-scale machinery used for strip tillage and bed planting helps farmers plant dry season crops such as wheat, maize and legumes, while reducing costs and saving irrigation water. "Within ANEP, CIMMYT partners with iDE to develop seasonal crop production business plans tailored to specific villages and farmers' organizations. These production plans help farmers to make better decisions to assure timely



A farmer from Shovna village in southern Bangladesh harvests her crop in an on-farm, farmer-managed experiment observing optimal wheat varieties, planting dates and nitrogen levels.

harvesting, aggregation of grain and delivery of maize to the market to obtain premium prices," explained Krupnik.

For more information about CSISA or ANEP, contact Andrew McDonald (a.mcdonald@cgiar.org).

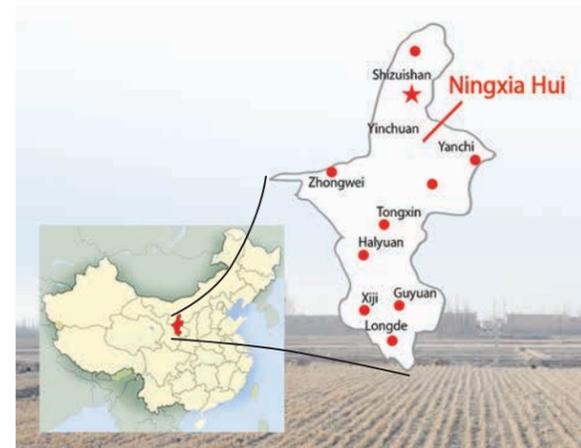
CHINA



Strengthening the Partnership with Ningxia Hui Autonomous Region

On February 21, Yuan Hanmin, vice president of the Ningxia Academy of Agriculture and Forestry Science (NAAFS), hosted Qu Dongyu, vice governor of Ningxia Hui Autonomous Region, CIMMYT cropping systems agronomist Jack McHugh, reporters, government officials, divisional chiefs and translators.

Dongyu expressed his familiarity and friendship with CIMMYT, CGIAR, ACIAR and a wide range of Sino-Australian activities with marketing potential. He believes zero tillage is a key technology to address the considerable water resource issues that Ningxia faces. The region is surrounded by deserts on three sides; the Yellow River



is the region's most significant source of water. However, because the limited amount of agricultural water is used on higher value crops (grapes, goji berries and vegetables), there is a significant concern regarding the loss of staple food (wheat and rice) cropping area.

After covering a range of topics, including Dongyu's association with CIMMYT's Director General Tom Lumpkin and his time at CGIAR and the Chinese Academy of Agricultural Sciences, McHugh noted that "the Vice Governor is very congenial and astute and we should be grateful to have him in our corner."

International Conservation Agriculture Forum Reinforces Partnerships

The International Conservation Agriculture Forum, held at NAAFS in late May, was attended by a number of provincial government officials and private sector representatives who discussed national and international partnerships in farming system intensification, mechanization, nutrient-use efficiency, precision agriculture and training; CA; joint needs, priorities and constraints to broad adoption of CA in China; and the Cropping Systems Intensification for North Asia (CSINA) project.

Key Chinese academic leaders briefed international participants including: Bruno Gerard, Ivan Ortiz-Monasterio, M.L. Jat, Scott Justice, Dan Jeffers and Garry Rosewarne



A Chinese seeder is displayed.

from CIMMYT; Wang Guanglin from ACIAR; and Rabi Raisaily, international liaison for Haofeng Machinery. Key constraints to CA adoption were covered, including a lack of financial, political and personal incentives; too few zero-till machines; inflexible irrigation water distribution; narrow approaches to

research, development and engineering without linkages to the larger issues of farming and cropping systems; and limited knowledge of rural socio-economic conditions. Participants defined priorities: a socio-economic study covering labor, gender, impacts of previous projects and adoption issues; and mechanization development and plant residue trade-offs and handling, especially of rice/wheat systems.

An important outcome was the establishment of new relationships with China Agricultural University, Nanjing Agricultural University, Sichuan Academy of Agricultural Sciences, Northwest Agricultural and Forestry University and others. Similarly, invigorating old ties with the Shandong Academy of Agricultural Sciences and Gansu Academy of Agricultural Sciences is expected to benefit future research platform development. Partnerships with machinery manufacturers are often crucial to drive CA adoption (by creating a push demand for CA machinery). Therefore, the presence of private sector representatives of the Henan Haofeng Machinery Manufacturing Company, Qingdao Peanut Machinery Company and Jingxin Agricultural Machinery was crucial.



The Crop Research Institute in Yinchuan, Ningxia Province, hires women from a nearby village to do a range of tasks associated with the wheat and maize breeding programs. In this photo, women manually plant early maturing maize into spring wheat stubble.

The importance of such partnerships has been proven; for example, the R&D activities of Qingdao Peanut Machinery Company have advanced the Chinese Turbo Happy Seeder, which has been downsized to suit tractors with less than 30 horsepower. Participants learned about preliminary discussions to prototype the 2WT Happy Seeder specifically for Africa and joint CIMMYT/ACIAR projects. "We are hopeful that one of the companies present will create demand for CA machinery for small landholders," said CIMMYT's Jack McHugh.

The forum, jointly organized by the Ningxia Provincial Government Foreign Experts Bureau, NAAFS and CIMMYT, was successful and advanced future CIMMYT funding requests. “We’ve had a good start toward the development of integrated research platforms in three distinct agro-ecological zones. The next step is to consolidate the outcomes from the forum and commence the iterative process of project development,” McHugh added.

For more information about the CSINA project, contact Jiakang Wang (j.k.wang@cgiar.org).

ETHIOPIA



Demonstration Sites Showcase CA

Farmers showcased conservation agriculture's benefits in retaining soil moisture, reducing erosion and improving organic matter during recent field demonstrations. The demonstrations were hosted by the CASFESA project in Jabitehnan and South Achefer districts.

CASFESA, which is funded by the EU and IFAD, shows that CA is sustainable and profitable through demonstrations in several African countries. Each CA demonstration plot in 28 villages was visited by neighboring farmers during the last two months, raising awareness.

The farmers' field days and end-of-season field evaluations were held November 9-10 for farmers' CA demonstrations, as well as extension and development agents in the demonstration villages and researchers from CIMMYT and the Amhara Regional Agricultural Research Institute (ARARI). Others attending included representatives of the Amhara Region Bureau of Agriculture, Amhara Seed Enterprise, Merkeb Multipurpose Marketing Cooperative Union, the district offices of agriculture in Jabitehnan and South Achefer districts and the West Gojjam Zone Administration and Agriculture Office.

Farmers hosting demonstration plots said they view CA as a productivity-enhancing, labor-saving technology. Maize planted on CA plots germinated three to four days earlier than that planted on conventional tillage plots. It was better anchored to the soil and resisted the wind without lodging.

Intercropping cowpeas as a forage crop with maize was introduced this season to reduce the use of maize residue as livestock feed. Apart from its feed value, the intercropping of cowpeas and maize suppressed weed germination and growth on both conventional and CA plots. Maize plants on both types of plots with cowpea intercropping were less dry than those on maize-only plots.

Though farmers pledged to expand CA technologies during the coming season, they voiced concerns about the challenges of crop residue retention due to the local practice of free communal grazing on post-harvest stubble.



Participants visit and evaluate conservation agriculture demonstration plots at Ato Hunegnaw's farm in the Care-Gurach village of South Achefer District, Ethiopia.

District and zonal administrators asked farmers to adopt community bylaws and enforcement mechanisms to restrict free grazing and livestock movements in post-harvest farm plots.

For more information about FACASI, contact Frédéric Baudron (f.baudron@cgiar.org).



Farmers discuss their experiences with conservation agriculture technologies.

Australian Ambassador Visits SIMLESA

The Australian Ambassador to Ethiopia paid her first visit to a CIMMYT project and commended efforts to improve livelihoods in resource-poor rural households.

On November 7, Ambassador Lisa Filipetto learned about activities of the SIMLESA project, which have been implemented in different areas of Ethiopia since 2010. She visited SIMLESA sites in northwest Ethiopia, where work is conducted by ARARI.

Maize-based farming in the region is characterized by unsustainable production systems, including mono-cropping, repeated tillage and residue removal. SIMLESA promotes new crop varieties and production practices such as intercropping, maize-legume rotations, reduced tillage and year-round residue coverage. Farmers who have traditionally mono-cropped maize appreciate the new practices, which help them increase harvests while replenishing soil fertility.

Filipetto was accompanied by scientists from CIMMYT-Ethiopia and the Ethiopian Institute of Agricultural Research, a SIMLESA partner. Dr. Biru Yitaferu, Director General of ARARI, highlighted ARARI's managerial structure, mandates, mission and resource capacities. Likawent Yeheyis, ARARI's director of livestock research, presented an overview of SIMLESA work in the region.

Presentations showcased SIMLESA's extensive AR4D activities including CA-based exploratory trials; farmer participatory variety selection (PVS) for maize, grain,

legumes and forage and fodder varieties; and technology implementation in South Achefer and Jabitenan districts, which is aided by ARARI researchers and district agricultural offices.

Filipetto visited a SIMLESA hub in South Achefer and saw intercropping as well as PVS trials with maize hybrids and OPVs and varieties of sweet lupine (a traditional Ethiopian



Scientists from CIMMYT and the Ethiopian Institute of Agricultural Research show a maize demonstration field to Lisa Filipetto, Australian Ambassador to Ethiopia.

multi-purpose legume). Four sweet lupine varieties in the trials are under the final stage of evaluation for future commercial release.

Yeheyis said Amhara's agriculture bureau will include CA, maize-legume intercropping and maize-fodder/forage relay cropping in its regular extension program. This will contribute to adoption of the technologies by more farming communities in the region, according to Yeheyis. At the end of her visit, Filipetto expressed great interest in partnering with CIMMYT to improve livelihoods in the region. SIMLESA is funded in Ethiopia by ACIAR and AusAID.

For more information about SIMLESA, contact Mulugetta Mekuria (m.mekuria@cgiar.org).

INDIA



Making Villages 'Climate-Smart'

“Climatic extremes and variability are becoming more frequent and resulting in farmer losses. This issue needs participation of all stakeholders, at all levels,” stated Clare Stirling, leader of CIMMYT's component of CCAFS, at a stakeholder consultation on ‘Climate-Smart Agricultural Technologies for Smallholder Farmers of Bihar’ held July 22.

The talks were organized by CIMMYT and BISA, under the aegis of CCAFS, and in collaboration with national research and extension partners such as ICAR, the Indian Agricultural Research Institute (IARI), Rajendra Agriculture

University, the State Department of Agriculture and the Government of Bihar; international centers Bioversity International, the International Water Management Institute and IFPRI; local NGOs and private sector partners; and farmer groups of the Climate-Smart Village (CSV) clusters of Bihar State's Vaishali District.

The discussions included almost 200 participants, including innovative CSV farmers from Bhatthadasi, Rajapakar and Mukundpur (Vaishali District); agriculture advisors from various villages; climate-smart farmer groups, research students and local service providers.

M.L. Jat, CIMMYT-CCAFS South Asia leader, explained the concept of CCAFS CSVs in South Asia, and the key climate-smart activities they are implementing for the benefit of smallholder farmers in Vaishali District. Participants visited demonstration plots where R.K. Jat, CIMMYT-BISA cropping systems agronomist, showed how mechanization and CA-based management practices are being implemented even on small, fragmented land holdings. By effectively 'pooling' their land for operational purposes, farmers have improved efficiency, reduced costs and established timely crop management – even with uncertain rainfall. He also explained the main advantages of key climate-smart interventions such as zero tillage (ZT), direct seeded rice (DSR), raised bed planting, residue management, crop diversification and nutrient management in managing climate risks and optimizing resources for higher profitability for the smallholders.

The active participation of about 80 women farmers allowed for a balanced and varied consultation. All the farmers

(Below): Members of the audience listen to a speaker during a climate-smart villages meeting in Bihar State, India.

expressed concerns regarding climate variability and how it is affecting their livelihoods. They shared their experiences of turning their villages into CSVs, and how the new practices have benefitted them; after planting

their wheat under ZT in the winter of 2012-13, farmers were initially skeptical of changes to age-old practices, but having reaped higher yields with lower input costs, all the farmers have committed to planting under ZT next season. DSR was recently introduced and farmers thought the technology seemed promising in that it would reduce cultivation costs and provide some security under increasing uncertainties of rainfall and labor shortages. The women farmers praised the introduction of ZT machinery by CIMMYT under CCAFS. With many men migrating to cities to find work, the women highlighted the reduced labor load with the increased availability of machinery and bed planting of maize and legumes.

I.S. Solanki, IARI regional station head, emphasized the need for farmers to work with scientists on resilient farm technologies and locally adapted seed. This was reiterated by Stirling, who said, "The concept of CSVs is just one example of synergies among different programs, investments, institutions and stakeholders, for adaptation, risk management and mitigation of climate change."

For more information about CIMMYT's work under CCAFS, contact Clare Stirling (c.stirling@cgiar.org).

CIMMYT Launches Mobile Telephone Voice Messaging for CSVs

A pilot program seeks to reach Indian farmers with information on weather, pests and climate change through their mobile telephones. CIMMYT launched the "Dissemination of climate-smart agro-advisories to farmers in CCAFS benchmark sites of India" project on August 15 in four villages in the Karnal District of Haryana State and four villages in the Vaishali District of Bihar State on September 1. The project is led by CIMMYT's Surabhi Mittal; IFFCO Kisan Sanchar Limited is the content partner and Kisan Sanchar is the dissemination and implementing agency.



(Above): Participants in a pilot project in India's Bihar and Haryana states to use mobile phones to transfer agricultural information listen to a speaker describe the project.

experts, responses are collected and the farmer is called back. The feedback is converted into a voice message if it is relevant to a wider group of farmers. Feedback is also filtered back by field scouts who interact with the farmers through frequent focus group discussions and a bi-weekly structured feedback form.

The project aims to help farmers clarify information about climate-smart technology; help them adopt technologies that could mitigate their climate change-related risks; and measure how receiving information on mobile phones affects farmers. The project covers 1,200 men and women farmers in the eight villages and will run for eight months.

Farmers whose mobile numbers are in the project database receive two voice messages every day along with detailed SMS messages (in Hindi when required). The messages give weather updates, information about pests and remedies, details of climate-smart technologies and general information about climate change to the CCAFS CSVs. Challenges to building the database included farmers whose telephones could not receive messages from unknown numbers. The project team worked with farmers to authorize the messages and get permission from the Telecom Regulatory Authority of India to unblock them.

Encouraging women to participate was another hurdle. Due to cultural barriers, men were not willing to share their wives' contact numbers. Awareness and focus group discussions held in Karnal on August 29-30 helped. Mittal met the *sarpanch* (elected head) of the villages as well as with women health workers known as *anganwadi*. The *sarpanch* of the four villages in Karnal are women, which helped to mobilize women farmers and women in households headed by men. In Bihar, a female scout is working closely with women farmers and has created women's groups for the project.

Customized feedback is built into the project. A helpline allows farmers to give feedback and ask questions. Some questions are answered instantly; others are diverted to

Efforts are underway to make the information more relevant, timely, customized and useful. The research and field teams have to work proactively to meet the farmers' diverse requests. Efforts to compile farmers' correct telephone numbers and to make them aware of the benefits of new technologies are great challenges. But the enthusiasm of farmers – shown through an increased listening rate to the voice messages and an increasing number of calls to the helpline – is a great motivation for the project team.

To learn more about this project, contact Surabhi Mittal (s.mittal@cgiar.org).

Investigating Maize's Hidden Half

A new root phenotyping facility at CIMMYT-Hyderabad allows researchers to assess and quantify key maize root traits and their dynamics under various growing conditions.

The facility uses the lysimetric system; scientists can directly assess and quantify root traits and their dynamics under various growing conditions. It also allows high-precision phenotyping of various root traits. The system revolutionizes the research, moving from a static



assessment of roots through time-consuming extraction and scanning to a real-time measurement of water uptake, water use and an assessment of variation in roots under different growing conditions in the rhizosphere. Recent advances in high-precision weighing systems and ICT tools have improved the system's efficiency and effectiveness.

The facility is specially designed for – but not restricted to – maize. It features 2,400 minirhizotron observation tubes placed in eight concrete pits. A wheeled stand is used to lift the rhizotrons for weighing. Each plant's weight is monitored, allowing researchers to estimate the amount of water used and transpired as well as the transpiration efficiency of different genotypes.

Roots are critically important to plants because they are the part first exposed to any soil-mediated stresses such as drought, waterlogging, salt stress or nutrient stress. Root traits govern the overall performance of plants; however, this important “hidden half” is often avoided due to the complexity of studying root structure and functions. In maize, the genotypic variation in root traits and variation under stresses can be carefully selected in targeted breeding for stress tolerance, which can contribute significantly to genetic gains. Root traits are often judged on the basis of related characteristics, which may not accurately explain the stress-responsive or stress-adaptive structural and functional changes in roots under sub-optimal or stressed conditions.

The facility is used in phenotyping root traits of mapping populations developed for various molecular breeding projects on drought and heat stress tolerance as well as traits usually observed in the field, including morphological traits and grain yield. It is located under a renovated shelter, protecting the trials from rain at the targeted crop stage and allowing for year-round use. CIMMYT is grateful to the Syngenta Foundation for Sustainable Agriculture for its financial support and ICRISAT for providing space and logistical support.

For more information, contact P.H. Zaidi (phzaidi@cgiar.org).

Zinc-Rich Wheat Reaches Eastern India

In a continuing effort to increase awareness of wheat biofortification and its use to improve health and quality of life in eastern India, Banaras Hindu University (BHU), the *Mahamana Krishak Samiti* farmers' cooperative, CIMMYT and HarvestPlus, with support from M/s Shyam Seed Company, organized a series of farmer-scientist interactions and field visits during February in about 20 villages in the Mirzapur and Chandouli districts of Uttar Pradesh state. The series focused on training and advocacy among women's groups, monitoring and data recording in PVS trials, monitoring of seed multiplication undertaken



A USAID representative is shown a maize root extracted from a minirhizotron.



Minirhizotrons with maize plants sit at the root phenotyping facility.

by the seed company, problem resolution by farmers, seed multiplication strategies, pre-release of mini-kit trials and varietal release. More than 70 farmers interested in HarvestPlus experiments participated at each location. “They were optimistic about zinc-enriched wheat varieties and keen to know when these varieties would be available for cultivation,” said CIMMYT wheat breeder Arun Joshi.

The HarvestPlus team introduced the importance of biofortified wheat. Topics included the roles of zinc and iron in human health and crop production, zinc distribution in different soil types and the importance of a well-planned strategy to maximize the gains from nutrient-rich varieties.

BHU scientists along with Chhavi Tiwari, HarvestPlus research associate, organized a session to educate women on the importance and role of micronutrient-enriched wheat in daily lives and its subsequent positive impact on society. Participants ranged from schoolgirls to working women, women farmers, housewives and elderly women, representing various educational, economic and social levels. They received a brochure on the importance of biofortified wheat in India, and discussed issues such as nutritious food, consequences of iron and zinc deficiency and their desire to work with BHU biofortification projects. Rekha, a Pidkhir village farmer said, “I did not know one type of wheat is different from another because it contains zinc. I did not know this nutrient is so important, or that I will be able to grow this wheat soon.” Most of the women agreed that the new wheat varieties will have a great impact by improving human health.

Participants attended a hands-on training on HarvestPlus trials to learn about plot area design, the number of lines

and the amount of seed to be sown. They discussed differences between conventional and ZT drills for planting; their experience with biofortified varieties and quality seed production; balanced use of nitrogen, phosphorus, potassium, zinc, sulfur and boron based on soil analysis; and the importance of maintaining the purity and quality of tested and multiplied seeds.

Wolfgang Pfeiffer of HarvestPlus lauded the farmers and national research systems for promoting the nutrient-rich varieties and for contributing to the eradication of malnutrition in South Asia. “I encourage more women to participate. We are approaching the seed delivery phase and their views will be particularly important.”

Following the program, Ravi Prakash Singh, distinguished scientist and head of CIMMYT's Wheat Improvement Program, visited BHU on March 7. He reviewed the collaborative research and praised BHU for its work within HarvestPlus. “I hope that BHU will take the lead and will be the first center to release the first-ever biofortified wheat in South Asia,” Singh encouraged BHU's scientists.

For more information about wheat biofortification in India, contact Sukhwinder Singh (suk.singh@cgiar.org).



Women farmers in India's Uttar Pradesh state learn about zinc-rich wheat varieties.

IRAN



CIMMYT-Iran Collaboration Continues

CIMMYT and Iran have been successfully collaborating in research since 1967. CIMMYT has provided training for many Iranian wheat and maize breeders and researchers as well as providing the country with bread and durum wheat, triticale and maize germplasm. Furthermore, Iran has received more than 35 wheat cultivars released from CIMMYT germplasm and almost all of the bread wheat cultivars bred by national wheat breeding programs have at least one parent from CIMMYT. This cooperation was further strengthened on March 21 when Jahangir Porhemmat, Deputy Minister and Head of the Agricultural Research, Education and Extension Organization, and Naser Tavakkoli, Deputy Minister for Crop Production, Ministry of Jihad-e-Agriculture, visited CIMMYT in Mexico. During their visit, they met with CIMMYT Director General Thomas Lumpkin and employees from various departments and laboratories. Lumpkin and Porhemmat signed the “Amendment to the Agreement for Scientific and Technical Cooperation 2009-2013 for the period of 2013-2017” to strengthen and expand bilateral collaborations.

Iranian and CIMMYT Scientists Discuss Utilization of Wheat Genetic Resources

From August 12-14, GWP scientists Marc Ellis, Masahiro Kishii and David Bonnett visited Iran. Together with Jalal Kamali, CIMMYT principal scientist and representative in

Iran, the group met with Iranian scientists involved in wheat breeding and the collection, conservation and utilization of the rich diversity of wheat relatives found in Iran. Participants came from the Seed and Plant Improvement Institute (SPII), Dryland Agricultural Research Institute, Agricultural Biotechnology Research Institute, University of Tehran, Agricultural Research and Extension Organization (AREEO) and the Ministry of Jihad-e-Agriculture of Iran.

Iran is a country with a rich agricultural heritage and a diverse geography and climate. It is in the center of origin and a major producer of many important agricultural species such as carrots, dates, figs, grapes, melons, mulberries, peaches, pistachios, pomegranates, saffron, sesame and walnuts. SPII is active in breeding many of these species and conserving their genetic resources in its National Plant Gene Bank of Iran. New releases and genetic resources of many of these were featured in tours of SPII.

The meetings were opened by Niazali Sepahvand, SPII Director General, with additional comments by Mojtaba Rajab-Baigy, Director General of the International Scientific Relationship Office of AREEO. They expressed gratitude for past collaborations between CIMMYT and Iran and enthusiasm for a strengthened relationship.

Technical presentations outlined the wheat breeding research priorities in Iran’s different agro-ecological zones. Around 14 million tons of wheat are produced annually in Iran, from warm environments near the Caspian Sea to cold mountainous regions more than 2,000 meters above sea level. Yields are lower than their potential – only around 1.1 t/ha in rain-fed areas and 3.5 t/ha in irrigated areas – due in part to limited water allocations. Improved agronomy

and research into improving resistance or tolerance to a range of biotic and abiotic stresses such as yellow rust, drought and heat and improvements in genetic yield potential could raise production.

Iran is nearly self-sufficient in wheat production but is threatened by reductions in water availability and a growing population. The fragility of Iran’s wheat production and need to improve yields in diverse environments was highlighted by a severe drought in 2008, which caused Iran to import 6 million tons of wheat.

The genetic diversity of wheat and related wild and ancestral species was highlighted by Javed Mozafari, head of the national gene bank. It maintains and characterizes a collection of almost 20,000 accessions. CIMMYT scientists focused on the contribution of diversity from landraces and wild relatives to CIMMYT’s wheat improvement efforts. This included the contribution of synthetic wheats incorporating diversity from goat grass to improved resistance to diseases as well as drought and heat tolerance and emerging data on improvements to genetic yield potential. Wide crossing, genetic analysis of diversity, pre-breeding and conventional variety breeding were discussed.

CIMMYT and Iranian scientists became more familiar with each other’s research and breeding efforts. They identified areas where collaboration in the use of genetic diversity from wheat and its relatives could be strengthened.



(Above): Members of the CIMMYT Board of Trustees and others stand with Deputy President William Ruto of Kenya. (Left to right): John Snape, B.M. Prasanna, Sicily Kariuki, Ruto, Andrew Barr, Tom Lumpkin, Hans Braun and Salvador Fernández.

Kenyan government was also represented by Sicily Kariuki, the principal secretary for the Department of Agriculture in the Ministry of Agriculture, Livestock and Fisheries, and James Nyoro, senior advisor on food security to the Presidency.

In close collaboration with KARI, CIMMYT has worked in Kenya for almost 40 years, contributing to research on maize, wheat, CA and socio-economics in addition to building the capacity of local scientists in different fields.

The roles of the newly opened CIMMYT-KARI Maize DH Facility and the MLN Screening Facility in responding to the challenges posed by the disease were also highlighted.

Agriculture is the backbone of Kenya’s economy and the CIMMYT-KARI collaboration significantly contributes to more productive agriculture. The government has also demonstrated support for CIMMYT by donating land for research activities and participating in CIMMYT events.

KENYA



CIMMYT Leaders Visit Deputy President of Kenya

Members of CIMMYT’s Board of Trustees and management met with Kenya’s Deputy President William Ruto on September 27. Ruto was briefed on CIMMYT’s work in Kenya, which is enhancing food security and livelihoods, particularly for smallholder farmers. Policy issues such as the importance of wheat as a strategic crop for Africa and transgenic research were also discussed.

Board Chair Andrew Barr was accompanied by Director General Thomas Lumpkin and board members Tom McKay, John Snape and Salvador Fernández. B.M. Prasanna, the Nairobi-based director of the CIMMYT GMP; Hans Braun, GWP director; Wilfred Mwangi, regional liaison officer; and Ephraim Mukisira, director of KARI also attended. The



CIMMYT’s David Bonnet, Marc Ellis and M.R. Jalal Kamali look at a handful of Iranian wheat seeds on the campus of the Iranian National Seed and Plant Improvement Institute.

MEXICO



CIMMYT and Patronato Renew Partnership

To continue state-of-the-art breeding research aimed at improving wheat productivity in Sonora state, the Association for Agricultural Research and Experimentation of the State of Sonora (PIEAES, or Patronato) and CIMMYT renewed a 70-year-old collaboration agreement (that began with CIMMYT’s predecessor, the OSS; see article on page 18) allowing CIMMYT to continue its wheat improvement research on 240 ha owned by PIEAES, and authorizing Patronato to multiply the seed of high-yielding wheat varieties developed by CIMMYT for farmers in the state. In addition, the agreement includes training for PIEAES technicians and researchers, as well as financial and administrative support for AR4D activities conducted by



(Above): Dr. Thomas Lumpkin, CIMMYT Director General (right), and Antonio Gándara Astiazarán, PIEAES president (center), sign a collaboration agreement between the two organizations. Andrew Barr, chair of the CIMMYT Board of Trustees, looks on (left).

CIMMYT at CENEB. This initiative is supported by Mexico's National Institute of Forestry, Agricultural and Livestock Research which conducts research at CENEB with CIMMYT and PIEAES and also releases the resulting improved wheat varieties in the Sonoran and Mexican markets.

"This research-supporting agreement is a farmer initiative that

seeks to ensure the financial and professional viability of our farming activities, while safeguarding the long-term conservation of the environment," said Antonio Gándara Astiazarán, PIEAES president. He highlighted the results of seven decades of successful collaboration between the two organizations, particularly the average wheat yield of 7.2 t/ha produced by the farmers in the Yaqui and Mayo valleys during the 2011-12 cycle.

Hans Braun, GWP director, emphasized that the average bread wheat yield recorded in the Yaqui Valley between 2008 and 2010 is the second-highest in the world, surpassed only by the winter wheat yield in the United Kingdom. As a result, Yaqui Valley farmers rank second among growers of the world's top 20 wheat-producing countries. CIMMYT Director General Thomas Lumpkin expressed CIMMYT's gratitude for the support it has received from PIEAES farmers and congratulated them on having pioneered the establishment of PPPs in agricultural development. He added that research carried out by this partnership also contributes to the MasAgro program coordinated jointly by CIMMYT and SAGARPA, which works with wheat producers across the country. This work reaches far beyond the borders of Mexico, however, as researchers in Sonora work on drought-tolerant, disease-resistant, climate-resilient wheat varieties. "These are the kinds of dreams we have at CIMMYT, and we are trying to make those reality. The very center of those dreams is right here in the Yaqui Valley. Thank you for renewing that dream," Lumpkin added.

NEPAL



Seminar Highlights Project Progress

A three-day traveling seminar organized by HMRP and partners gave policy-makers a first-hand look at the status of maize varietal development, source seed production, agronomic interventions and seed multiplication and marketing in the project's 20 hill districts.

In close partnership with NARC and DoA, HRMP hosted its third annual seminar from August 27-30 for 25 officials representing donors SDC and USAID, as well as organizations including the National Planning Commission, MoAD, Ministry of Finance, NGOs, private companies and the media.

Participants visited the agriculture research station in Dailekh District, where they interacted with scientists and observed maize research activities and CA trials. In this area, HMRP is promoting the intercropping of white quality protein maize and off-season vegetables such as bitter melon, tomatoes and radishes. HIV/AIDS-infected women farmers in Rakam village were also invited to participate.

"Our main resource is land," said 30-year-old farmer Mana Sara Sijapati during a group discussion. "We must increase production from this land to have food security during the entire year." She asked participants for a program targeted toward farmers affected by HIV/AIDS. Ram Prasad Pulami, joint secretary at the MoAD, asked NARC and DoA representatives to respond to the request immediately.

The group then participated interactively with farmers, observed seed production activities and assessed on-farm trials and demonstration plots at the Basnatamala and Jeevanjyoti Women CBSP group.

(Below): Traveling seminar participants visit the NARC Agricultural Research Station, Dailekh District, Nepal.

Dr. Guillermo Ortiz-Ferrara, HMRP team leader, and Pulami jointly inaugurated an HMRP-funded seed storehouse that was built for the CBSP group. The team also



Dr. Thomas Lumpkin, CIMMYT Director General (kneeling, center), plants an olive tree sapling in the visitors' garden at BARI-Chakwal. Hans Braun, director of the CIMMYT Global Wheat Program, looks on (far right).

visited the Sambriddhi Agriculture Cooperative, Ltd., as well as a QPM village, where CA trials will soon begin.

Pulami said that HMRP's efforts and progress are greatly appreciated, particularly the partnerships between the project and its diverse stakeholders. He said the Government of Nepal is implementing a Mid-Hill Mega Maize Production Program focused on 40 hill districts and will utilize HMRP's experiences and research innovations.

For more information about HMRP, contact Guillermo Ortiz-Ferrara (g.ortiz-ferrara@cgiar.org).

PAKISTAN



CIMMYT Expands Pakistani Collaboration

The collaboration between CIMMYT and Pakistani national agricultural research institutes has played a vital role in food security for the country since the Green Revolution. Re-opening the CIMMYT office in Pakistan in November 2010 clearly demonstrated the Center's commitment to support the development of sustainable agricultural research in the country, as did a visit by Tom Lumpkin, CIMMYT Director General on March 7-11. During his visit, Lumpkin inspected a potential site for the construction of a new CIMMYT building at NARC in Islamabad, and with PARC chairman Iftikhar Ahmad, inaugurated a new wing in the crop sciences institute at NARC provided to CIMMYT.

PARC and the Pakistani government reaffirmed their commitment to establishing BISA in Pakistan. PARC

donated land on its Islamabad campus for a BISA-CIMMYT office, as well as land that will be an experimental farm. The Pakistani government also asked BISA to build an experimental farm in every province. BISA will provide Pakistani researchers with the opportunity to collaborate with South Asian counterparts to increase wheat yields and develop more nutritious and heat-resistant maize.

Lumpkin also met with Ahmed Bakhsh Lehri, Secretary of Agriculture at the Ministry of National Food Security and Research, and members of his staff to brief them on CIMMYT's contributions to Pakistan's agriculture sector and discuss what CIMMYT can offer in terms of technical knowledge and research capacity. The USAID-funded AIP project was also discussed, and Lumpkin explained how it will contribute to increased productivity and the production value of livestock and horticultural and cereal crops, and thus increased income for Pakistani farmers.

Lumpkin and Hans Braun, GWP director, visited Barani Agricultural Research Institute (BARI), a lead institute focusing on rain-fed agricultural research in the Punjab area, where they observed the use of various agronomic practices, such as ridge planting, and interacted with farmers to learn about their basic problems, especially the constraints limiting productivity. After the visit, Lumpkin and Braun planted olive trees in the visitors' garden at BARI-Chakwal to commemorate the contributions of CIMMYT varieties to rain-fed areas of Punjab.

Braun, Rick Ward (AIP interim project leader), and Muhammad Imtiaz (CIMMYT country liaison officer for Pakistan) also visited the upgraded rust disease facility at the Crop Diseases Research Institute in Murree. The



U.S. Ambassador to Pakistan Richard Olson (center) hands the keys of donated tractors to Iftikhar Ahmad, chair of the Pakistan Agricultural Research Council. Muhammad Imtiaz, CIMMYT country liaison officer (left in sunglasses) also attended the event.

facility was established with funding from CIMMYT's Wheat Productivity Enhancement Program for Pakistan, which is funded by USDA. It meets international standards and thus will strengthen the research capacity of Pakistani national programs in handling rust samples, sample storage, race identification and gene postulation.

U.S. Ambassador Visits NARC

On May 8, U.S. Ambassador Richard Olson reaffirmed the United States government's long-term support to farming communities in Pakistan during his visit to the NARC campus in Islamabad. The visit, organized by CIMMYT in collaboration with the U.S. embassy in Pakistan and PARC/NARC, was to recognize the success of WPEP, a USDA-funded program implemented by CIMMYT in collaboration with national and provincial research partners, and to inaugurate the harvesting ceremony for NARC 2011, a Ug99-resistant wheat variety. "Since the 1950s, the United States has been working to support agriculture in Pakistan," stated Olson. "Wheat accounts for approximately 60 percent of the daily caloric intake of the average Pakistani, so our joint efforts to combat this disease are critical."

Muhammad Imtiaz, CIMMYT country liaison officer and wheat breeder, briefed the ambassador on CIMMYT's mission to sustainably increase the productivity of wheat and maize systems to increase food security and reduce poverty. "CIMMYT collaboration on sustainable agricultural research with national and provincial research institutes in Pakistan began when Dr. Manzoor Bajwa and Dr. Norman Borlaug worked together to develop 'Mexi-Pak,' the wheat variety that started the Green Revolution in Pakistan and

helped to double Pakistan's wheat production between 1965 and 1970," Imtiaz told Olson. He also commented on the long-lasting importance of the partnership for Pakistani farmers; the work is not over as the need for disease-resistant wheat varieties continues. Experts estimate that Pakistan's annual wheat harvest could be reduced by as much as 50 percent if and when Ug99 arrives. "Agriculture comprises 21 percent of Pakistan's GDP and employs 45 percent of the labor force, making it one of the most significant economic drivers of Pakistan," Imtiaz explained. Pakistani farmers grew about 24 million tons of wheat on 8 million ha in 2012.

Abdul Basit Khan, Additional Secretary at the Ministry of National Food Security and Research, and Iftikhar Ahmed, PARC Chairman, praised CIMMYT's effective role in wheat improvement through technical support and the implementation of internationally funded projects, and reiterated CIMMYT's importance in enhancing the research efficiency and capacity of Pakistani national institutes.

For more information about CIMMYT's work in Pakistan, contact Muhammad Imtiaz (m.imtiaz@cgiar.org).

RUSSIAN FEDERATION



Strengthening CIMMYT-Russia Cooperation in Agricultural Research

GWP director Hans Braun and winter wheat breeder Alex Morgounov attended the G-20 meeting of Agricultural Chief Scientists in Moscow on July 24-25, where they

made a presentation on the CIMMYT-led WHEAT CRP and the cooperation between CIMMYT and Russia. The G-20 meeting adopted a declaration stating the importance of cooperation in agricultural research and defining future priority areas and directions for this cooperation. The meeting also emphasized the involvement of the Russian Federation in international agricultural research and development. In 2013, Russia supported WHEAT with \$1.1 million, part of which was allocated to the Kazakhstan-Siberian Network on Wheat Improvement (KASIB) for spring wheat improvement and part to strategic initiatives related



(Left to right): Vladimir Shamanin, Alex Morgounov, Sergey Petukhovskiy, Hans Braun and Nina Kazydub.

to biotic and abiotic stresses. The utilization of the funds and strengthening cooperation with Russian scientists were discussed with Sergey Kiselev, director of the Eurasian Center of Food

Security at Lomonosov Moscow State University, and Ivan Savchenko, vice president of the Russian Academy of Agricultural Sciences.

Following the meeting, Braun and Morgounov visited western Siberia to sign a sub-grant agreement between CIMMYT and Omsk State Agrarian University on technical coordination of KASIB activities; development of shuttle

breeding germplasm for cooperating institutions in Russia; expansion of training and visits between the university and CIMMYT; and attendance at regional and international conferences by Russian scientists.

The subsequent field visits to the university and the Siberian Agricultural Research Institute demonstrated the value of regional germplasm exchange and improved adaptation of the germplasm developed for the region in Mexico and Turkey. "The shuttle breeding program, initiated in the early 2000s to incorporate rust resistance into local material is working; several advanced lines have been identified and will be considered as variety candidates in the near future," said Morgounov. Northern Kazakhstan and western Siberia jointly cultivate almost 20 million ha of high latitude spring-planted wheat; this area plays a significant role in global wheat supply.

TURKEY



Turkey's Importance to Wheat

CIMMYT Director General Tom Lumpkin, GWP director Hans Braun and University of California-Davis professor Cal Qualset visited Turkey in late June to evaluate activities of the International Winter Wheat Improvement Program (IWWIP) and its partners. The group also met with Masum Burak, Director General of the Ministry of Food, Agriculture and Livestock's General Directorate of Agricultural Research and Policy, to discuss the ongoing partnership with CIMMYT and to identify new areas of cooperation, including conservation agriculture and the application of new biotechnological tools for breeding.

The group also visited the Haymana Station of the Central Field Crop Research Institute, the Transitional Zone Agricultural Research Institute in Eskisehir and Bahri Dagdas International Agricultural Research Institute in Konya. The visit covered winter wheat germplasm development activities, regional cooperation, suggestions



Participants at an International Winter Wheat Improvement Program meeting pose for a group photo in a Turkish wheat field. Dr. Thomas Lumpkin, CIMMYT Director General (center, wearing a light blue shirt and dark blue hat), and Hans Braun, director of the CIMMYT Global Wheat Program (center, wearing a red shirt), assisted in a program evaluation.

for future enhancement and ongoing IWWIP activities to collect, evaluate and improve wheat landraces currently grown in Turkey. The visitors also learned about soil-borne pathogen research conducted by CIMMYT in collaboration with Turkish partners and the CIMMYT Physiology Group's focus on winter wheat tolerance to drought and heat. Two farming communities that grow landraces in the provinces of Kutahya and Nevsehir, where IWWIP initiated its work in 2009, were also visited. Farmers in these communities have shown a significant understanding and experience regarding landrace utilization, and received support and recommendations to assure sustainability and diversity of the landraces in farmers' fields.

For more information about CIMMYT's work with IWWIP, contact [Beyhan Akin \(b.akin@cgiar.org\)](mailto:b.akin@cgiar.org).

UZBEKISTAN



Traveling Wheat Seminar in Uzbekistan

IWWIP held its biannual traveling seminar in Uzbekistan May 20-24, supported and organized by the Uzbek Research and Production Center of Agriculture, Turkish Ministry of Food, Agriculture and Livestock, CIMMYT, ICARDA and FAO. The seminar attracted 40 participants from 14 countries, who traveled to the Kashkadarya Research Institute of Breeding and Seed Production of Cereal Crops in Karshi and the Gallyaoral Research Institute of Cereal Crops and Uzbek Research Institute of Plant Industry in Tashkent. Seminar attendees assessed the status of wheat production and breeding in Uzbekistan, discussed regional cooperation with IWWIP and developed future plans.

Uzbekistan reached self-sufficiency in wheat production in 1991 by expanding its wheat-growing area and by applying modern varieties and technologies. The visiting group witnessed this progress, the level of local wheat breeding and research programs and exemplary experimental fields

with a high level of germplasm diversity, all a result of governmental support. Although wheat in Uzbekistan also faces some serious issues (widespread yellow and leaf rust epidemics), these are being attacked through research and cooperation; a number of resistant varieties and lines have been identified, including several originating from IWWIP. Participants developed recommendations to enhance IWWIP breeding efforts and intensify regional cooperation.

ZAMBIA



Provitamin A Biofortified Orange Maize

Zambia has a major public health problem – over 50 percent of Zambian children under five are deficient in vitamin A. This has resulted in several government intervention programs including vitamin A supplementation and sugar fortification, efforts which will soon be complemented by the release of three orange maize hybrids with higher levels of provitamin A carotenoids (compounds converted to vitamin A when consumed). The hybrids were developed by CIMMYT in collaboration with ZARI, with funding from HarvestPlus.

The release, dissemination and promotion plans for these new hybrids were discussed March 18-21 when the HarvestPlus maize project held its 10th planning and review meeting in Lusaka, Zambia. The meeting was co-organized by CIMMYT and HarvestPlus; nutritionists, biochemists, biologists, social scientists, public health specialists and crop development experts from Zambia and other countries in SSA attended. The meeting focused on information exchange, identification of gaps in the development and dissemination of provitamin A maize and lessons learned from the Zambian experience as the project expands to other countries in the region.

On March 20 participants visited a ZamSeed seed production site where one of the hybrids is being multiplied, an orange maize demonstration plot and a provitamin



Staff from CIMMYT, HarvestPlus and the Zambia Agricultural Research Institute see provitamin A maize crops during a field visit near Lusaka, Zambia.

A maize testing site at SeedCo Zambia. Later, they visited the Sibuyunji Agricultural Camp in the Sibuyunji District where farmers shared their thoughts on provitamin A orange maize.

"We are very happy to have orange maize as an option to avert vitamin A deficiency in our children," said a farmer growing one of the orange maize varieties.

For more information about biofortified maize in Zambia, contact [Peter Setimela \(p.setimela@cgiar.org\)](mailto:p.setimela@cgiar.org).

ZIMBABWE



ZimCLIFS Integrates Crop and Livestock Production Research in Zimbabwe

With funding from ACIAR, three CGIAR centers – ILRI, ICRISAT and CIMMYT – launched the Integrating Crops and Livestock for Improved Food Security and Livelihoods in Zimbabwe (ZimCLIFS) project in 2012. Its goal is to develop methods to increase agricultural production, improve household food security, alleviate poverty and reduce food-aid dependency in rural Zimbabwe through better integration of crop and livestock production and market participation.

Project objectives include: increase productivity of smallholder crop and livestock farming systems in four districts in two contrasting agro-ecological regions by identifying and adapting appropriate technologies and management practices; improve farmers' access to resources, technologies, information and markets by characterizing and strengthening value chains for crops (maize, sorghum and legumes) and livestock (goats and

cattle); and increase the knowledge and skills of research, extension and agribusiness staff, enabling the first two to design and implement integrated farming systems and value chain research, and the latter to apply knowledge generated by the project elsewhere in Zimbabwe.

Since its launch, the project has established field trials on 102 farm sites in the high-potential sub-humid Murehwa and Goromonzi districts of Mashonaland East Province, where CIMMYT leads the agronomic activities (including the CA and socio-economic components of the project). To support work on these trials, project partners including extension and NGO personnel convened on January 16 for a data collection training workshop facilitated by staff from ILRI and CIMMYT. The workshop sought to orient partners to the project's objectives, activities and operational framework; create awareness of the different types of agronomic experiments implemented in 2012; train participants on data collection tools and expectations for the different agronomic experiments; and review trial implementation progress. Presentations covered ethics in agricultural research and the various ZimCLIFS activities and their data collection needs.

On January 25-26, project manager John Dixon and George Mburathi of ACIAR visited ZimCLIFS staff at the CIMMYT office in Harare and project sites in Goromonzi to evaluate progress. They witnessed CA trials in which maize is grown along with livestock-palatable and unpalatable legumes, with the palatable species used to feed livestock and the unpalatable species used to generate biomass for soil cover, given that livestock graze communally in the area. For example, mucuna is used to feed livestock, while residues from fish-poison-bean or dry sunn hemp is used to provide soil cover as a new approach to managing residue cover provision in crop-livestock environments. They also visited a site where maize, soybeans, cowpeas and mucuna rotation and intercropping were being tested to intensify maize-legume production. Other agronomic trials established by the project address residue types and residue rates in CA systems where livestock competition exists. They also saw cowpea screening and forage production trials that seek to demonstrate hay and silage production from legume sources such as cowpeas and hyacinth beans. Dixon also visited a local abattoir and a goat market to better understand the livestock production value chain.

During its first season, ZimCLIFS established trials in high- and low-potential sites with 303 farmers (about 63 percent of the targeted 480 households); an impressive start according to Dixon. The project runs until July 2015. Dry season activities will focus on livestock feeding, value chain studies and the establishment of innovation platforms as vehicles for dissemination and increased productivity.

For more information about the ZimCLIFS project, contact [Mulugetta Mekuria \(m.mekuria@cgiar.org\)](mailto:m.mekuria@cgiar.org).



Participants in the Uzbekistan traveling wheat workshop pose for a group photo.

CGIAR Research Programs

CIMMYT is the lead Center on two CGIAR Research Programs – WHEAT and MAIZE – and participates in several others – Agriculture for Nutrition and Health (A4NH), Climate Change, Agriculture and Food Security (CAAFS), Policies, Institutions and Markets (PIM) and Managing and Sustaining Crop Collections (Genebanks).

Highlights of the CRPs' activities in 2013 include:

WHEAT CRP

Launched in 2012, the WHEAT CRP is led by CIMMYT with the International Center for Agricultural Research in the Dry Areas as its main CGIAR Consortium partner. WHEAT focuses on increasing wheat production for the 2.5 billion poor consumers for whom wheat is a staple



food. The program brings together over 200 research and development partners – top researchers within NARS, NGOs, advanced research institutes, civil society and farmer organizations and the private sector.

WHEAT is a key part of an international, collaborative effort to raise the productivity of wheat farming systems, address the global threat of wheat diseases and help farmers in developing countries grow wheat in warmer conditions with less water and fertilizer.

Through the efforts of CIMMYT, ICARDA and partner institutions, more than 1.6 million farmers benefited from the results of 140 projects under WHEAT in 2013. Millions more have benefited from input-saving agronomy and precision agriculture tools and other research results generated through past CGIAR funding for wheat research. Indeed, CGIAR-derived improved varieties are grown on over 50 percent of the entire area sown to wheat in the developing world, where two-thirds of global production originates.

At the core of WHEAT strategy are a number of interconnected research agendas. They cover comprehensive wheat improvement, agronomy, systems and precision



agriculture and frontier research on breaking the genetic yield barrier. Over the mid- to long-term, WHEAT research aims to: stabilize wheat prices; boost farm-level wheat productivity; fortify wheat's resistance to important diseases and pests; and enhance its adaptation to warmer climates. Challenges are immense – all of this must occur without using more land and as fertilizer, water and labor costs rise.

WHEAT works on two primary value streams – improved wheat germplasm and sustainable intensification of climate-smart wheat-based systems – contributing directly and indirectly to five CGIAR priorities (greater productivity increases, poverty reduction, food security, environmental sustainability and greater gender equity/empowerment). About 30 million poor farmers in the developing world rely on wheat system innovations to improve their incomes, the sustainability of their production and to adapt to climate change. WHEAT (and associated programs) has impacted 50 percent of them to date and plans to reach more with new technologies or know-how that can elevate their ability to increase income, become more food-secure and produce more sustainably.

The challenge for WHEAT is to maximize contributions to the expected annual wheat demand increase of 1.7 percent (up from the current 1.1 percent), which must be met in spite of: climate change; increased water, land, nutrient and labor scarcity or cost; and more aggressive pests and diseases. Because more than half of wheat production occurs in the developing world, most of this productivity increase will need to take place there, including Africa,

where at least eight countries have significant potential to profitably and sustainably increase wheat production. Wheat is grown in many male-dominated societies and creative avenues are needed to strengthen the role of women farmers and consumers.

Important 2013 outcomes and impacts included zero-till (ZT) scale-out and -up in Kazakhstan, large-scale adoption of CGIAR-derived varieties in Ethiopia (leading to greater production), West and South Asia (greater stress tolerance) and both systems- and germplasm-based increases in farmer incomes in Mexico. Impacts were also documented in China, while gender mainstreaming increased in a number of projects. Important collaborations include those with advanced research institutes and NARS with many developing and developed nations, and linkages with other CRPs (in particular A4NH, CCAFS, Dryland Systems, GRiSP, MAIZE and PIM).

The CRP invested approximately 12 percent of its resources to: strengthen capacities in Central, South and West Asia, Africa and Mexico, reaching approximately 17,500 professionals and farmers; associated with the International Wheat Improvement Network (IWIN); and the 45 multi-stakeholder innovation platforms supported by WHEAT. In regard to funding, it was very encouraging that the Wheat Yield Consortium matured into the multi-donor International Wheat Yield Partnership that will employ cutting-edge approaches to increase wheat's yield potential.

To learn more about WHEAT and its impact please visit the CRP's website (www.wheat.org).



MAIZE CRP

Launched in 2012, the MAIZE CRP is led by CIMMYT with the International Institute of Tropical Agriculture as its main CGIAR Consortium partner. MAIZE focuses on increasing maize production for the 900 million poor consumers in Africa, South Asia and Latin America for whom maize is a staple food. The overarching goal of MAIZE is to double maize productivity and increase incomes and livelihood opportunities from sustainable maize-based farming systems. It also builds on cutting-edge international collaboration to unlock the genetic diversity in maize through CIMMYT's Seeds of Discovery project and the continuing success of increasing the stress tolerance of maize in Africa, with similar efforts now becoming stronger in Asia and Latin America.

At the core of MAIZE strategy are a number of interconnected research agendas. They cover maize-based farming systems, drought-tolerant varieties, better targeting for new technologies, policies, post-harvest management, precision agriculture and institutional innovations. MAIZE brings together over 300 research and development partners and like WHEAT, distinguishes itself by allocating funds to non-CGIAR research to fill MAIZE research gaps and capture a wider range of innovative ideas.

MAIZE is also establishing new models of collaboration for more widespread and rapid seed distribution and working closely with other CRPs such as GRiSP, WHEAT and CCAFS. MAIZE is also working in the humid tropics on



the sustainable intensification of maize- and cereal-based systems in Africa, Mexico and South Asia. This area of work also represents significant opportunities for empowering women farmers and scientists.

MAIZE is a highly collaborative program that contributes to many of the CGIAR Intermediate Development Outcomes – productivity, food security, income, gender, capacity to innovate and adapt, environment, future options and climate. In 2013, MAIZE financed research with more than 150 partners; leveraged investments, partnerships and 50,000 training events or field days in 130 bilateral projects; and collaborated effectively with other CRPs. The sustainable intensification strategy addresses maize and maize-based farming systems-related challenges through 75 innovation platforms and 13,500 study and survey sites, with more than 50 percent of them shared with other CRPs (WHEAT, GRiSP, CCAFS, Grain Legumes, Livestock or Aquatic Systems). The MAIZE germplasm research strategy annually sends new germplasm to around 100 collaborators mostly in Africa, Asia and Latin America, augments the capacity of 180 small- and medium-sized seed companies and 226 CBSPs that reach out to disadvantaged farmers, and provides major inputs to A4NH, CCAFS and the Generation Challenge Programme. Those involved in MAIZE's post-harvest research strategy work with NGOs, local entrepreneurs and A4NH. As a result, over 1 million farmers benefited from MAIZE research outputs in 2013, and many more are benefiting through germplasm that has been released by partners and from the scale-out of research outputs.



MAIZE highlights in 2013 include: a collaborative effort among MAIZE, KARI, the International Centre for Insect Physiology and Ecology (ICIPE) and ASARECA to mitigate the expanding threat of MLN disease, including the establishment of a centralized MLN screening facility at Naivasha, Kenya; in collaboration with the University of Hohenheim, the expansion of double haploid breeding technology to SSA – culminating in the opening of a Maize DH facility at Kiboko, Kenya – the first DH breeding facility in Africa for the benefit of both national NARS and small- and medium-sized seed companies; continued expansion of MasAgro's "Take it to The Farmer" project in Mexico – now reaching over 200,000 farmers; the expansion of the integrated control of *Striga* (witch weed) across hotspot areas in East and West Africa; the expansion of low-cost, hermetic grain storage in metal silos across East and southern Africa; championing commercial female-headed and socially inclusive and equitable seed businesses in Nepal; new insights on dual-purpose maize (grain and stover production) in collaboration with ILRI; an assessment of drivers of change and systems modeling for better targeting of project interventions undertaken in collaboration with Wageningen University; completion of the MAIZE gender audit and major progress on gender mainstreaming; and efforts to reduce drudgery, increase productivity and women's empowerment through small-scale mechanization for sustainable intensification in SSA, aligned with similar efforts in South Asia.



To learn more about MAIZE and its impact please visit the CRP's website (www.maize.org).

Agriculture for Nutrition and Health CRP

Hunger, malnutrition and poor health are widespread and stubborn



development challenges. Agriculture has made remarkable advances in the past decades, but progress in improving the nutrition and health of poor farmers and consumers in developing countries is lagging behind. A4NH is designed to fill the existing gap between agricultural development and its unfulfilled health and nutritional benefits. A4NH helps realize the potential of agricultural development to deliver gender-equitable health and nutritional benefits to the poor. It was created to help ensure

that agricultural practices, interventions and policies will maximize health and nutrition benefits, while reducing health risks.

The starting point for A4NH is that agricultural practices, interventions and policies can be better adapted and redesigned to maximize health and nutrition benefits and to reduce health risks. While A4NH is contributing to the achievement of all four CGIAR strategic objectives, its primary focus is on improving human nutrition and health.

To achieve this goal, A4NH brings together R&D professionals across the agriculture, nutrition and health sectors to jointly tackle key challenges and design joint solutions. The CRP has four components: Value Chains for Enhanced Nutrition; Biofortification; Prevention and Control of Agriculture-Associated Diseases; and Integrated Agriculture, Nutrition and Health Programs and Policies.



To learn more about Agriculture for Nutrition and Health and its impact, visit www.a4nh.cgiar.org.



Climate Change, Agriculture and Food Security CRP

Achieving sustainable food security while reducing rural poverty, improving health and nutrition



RESEARCH PROGRAM ON
Climate Change,
Agriculture and
Food Security



and managing our natural resources in a sustainable way are a real challenge under a changing climate. CCAFS is helping meet that challenge through outcome-focused work on adaptation to long-term climate trends (rising temperatures, sea level rise); managing climate variability (increasing floods and droughts; greater uncertainty in weather, markets and prices); and by reducing agriculture's emissions footprint.



A maize field is inundated by a flash flood in southern Bangladesh. Maize is more resilient than many other low-height crops, including chili, sesame and soybean.

No single research institution working alone can address the critically important issues of global climate change, agriculture and food security. Led by the International Center for Tropical Agriculture (CIAT), CCAFS is a collaboration of the 15 CGIAR research centers and coordinates with the other CRPs. All CGIAR Centers have a stake in CCAFS, and numerous Centers have considerable climate change expertise and activities, including CIMMYT.

CCAFS is addressing the increasing challenge of global warming and declining food security on agricultural practices, policies and measures, particularly as they impact farmers in the developing world. CIMMYT and the 14 other Centers are partnering with the Earth System Science Partnership to study the effects of climate change on agriculture – and vice versa.

CCAFS brings together the world's best researchers in the agricultural, climate, environmental and social sciences to identify and address the most important interactions, synergies and trade-offs between climate change and agriculture. CCAFS is implementing innovative and transformative research that addresses agriculture

in the context of climate variability, climate change and uncertainty about future climate conditions.

Agriculture is extremely vulnerable to climate change. Worldwide, higher temperatures are expected to reduce the yields of cereal crops and encourage weed and pest proliferation. Changes in rainfall patterns will likely cause crop failures and long-term production declines for key crops.

To learn more about Climate Change, Agriculture and Food Security, visit www.ccafs.cgiar.org.

Policies, Institutions and Markets CRP



RESEARCH PROGRAM ON
Policies,
Institutions
and Markets

Poverty and hunger are enormous problems. Nearly 1 billion people in the world go hungry, and more than 1 billion live on just US \$1.25 a day. Seventy-five percent of the poor live in rural areas, and the majority of them depend on agriculture for their livelihoods. Food prices are high and rising – a situation that points to continued challenges in food security in the coming years.

Despite global efforts to overcome these problems, one of the most promising tools for promoting development and reducing poverty – pro-poor, sustainable agricultural growth, particularly for small producers – has been underexploited. Evidence shows that agricultural growth reduces poverty by twice the rate of growth in non-agricultural sectors, but this growth has been held back by failures related to policies, institutions and markets, and will be further challenged by emerging trends such as climate change and natural resource scarcity.

Agricultural growth has also been constrained by a narrow focus on agriculture that excludes macroeconomic dimensions, environmental inputs and outcomes, and important enabling conditions, such as rural infrastructure, effective markets and complementary services like credit and agricultural extension.

It is precisely here that PIM makes a critical contribution. It will establish how these challenges and failures can be overcome so that policies, institutions and markets can be used most effectively to reduce poverty, improve food security and increase small producers' incomes.

Projected growth in agricultural productivity over the next two decades is unlikely to meet food demand without significant price increases. Small agricultural producers face enormous challenges, but they also have great potential to feed the world if they can access the inputs, technologies, markets and public services they need.

The adoption of evidence-based policies, inclusive institutions, and equitable and efficient markets – based on sound and cutting-edge research focused on the complex



agricultural development process – can help achieve this goal. PIM addresses this challenge by producing a body of knowledge to support pro-poor agricultural growth.

Developing countries not only face a tremendous variety of development challenges but also vary greatly in their policy, institutional and market capacities. Consequently, a distinguishing feature of PIM is its emphasis on supporting country-led, country-driven, and country-owned development processes through collaborative



research, partnership and capacity building. This country-led approach has so far received too little attention in the research and development community, including in CGIAR.

To learn more about Policies, Institutions and Markets, visit www.pim.cgiar.org.

Managing and Sustaining Crop Collections CRP

The Managing and Sustaining Crop Collections CRP (Genebanks) is a



RESEARCH PROGRAM ON
Managing and
Sustaining
Crop Collecting

comprehensive program for the management, as well as the secure and sustainable funding, of the collections of plant genetic resources held by 11 members of the CGIAR Consortium, including CIMMYT. The CRP is a five-year partnership between the members of CGIAR Consortium and the Global Crop Diversity Trust (GCDDT).

These gene banks hold and safeguard some of the largest, most important, most diverse, best documented and most used collections of crops most critically important to global food security. They also have a unique history and international status that sets them apart from other gene banks. However, without reliable funding, even the best gene banks face a chronic inability to plan, to invest rationally and to manage optimally.

The objective of Genebanks is to conserve the diversity of plant genetic resources in CGIAR-held collections and to make this diversity available to breeders and researchers in a manner that meets international scientific standards, is cost-efficient, secure, reliable and sustainable over the long-term and is supportive of and consistent with the International Treaty on Plant Genetic Resources for Food and Agriculture. Conservation and availability of plant genetic resources is a prerequisite for achieving such higher order goals such as food security and poverty alleviation.

Conserving CGIAR collections and making them available to users with associated information will not reduce poverty or increase food security. Nor will it be the isolated act that ensures that crops are adapted to climate change, or can be grown in a manner that is water- and energy-efficient and ecologically friendly. The conservation and availability of plant genetic resources is an imperative prerequisite for achieving such goals. The work of this CRP underpins and is essential to the activities, outputs and outcomes of much of the research undertaken in CGIAR and beyond by other AR4D organizations. The objectives of those programs, including other CRPs, should also be considered the objectives of this work.

In 2013, data submitted by CIMMYT to GCDDT consisted of the status of its wheat and maize collections measured by over two dozen indicators. These are compared with a 2011 baseline and a 2016 target, as well as across Centers.

To learn more about the Genebanks CRP, visit www.cgiar.org/our-research/cgiar-research-programs.



BISA



BISA

Borlaug Institute for South Asia

Challenges for South Asia

Climate change, ever-increasing population, persistent poverty, chronic malnutrition and declining annual crop yield gains retard human development across South Asia. Despite notable progress over the past several decades, South Asia is home to more than 300 million undernourished people (35 percent of the global total). Food price spikes exacerbate these issues and make the lives of South Asia's poorest even more difficult.

CIMMYT's Dr. Norman E. Borlaug and scientists, policy-makers and farmers worked together to spread the Green Revolution across South Asia, which took India and Pakistan from near-famine in 1965 to food self-sufficiency. Dr. Borlaug's work in agricultural research is credited with saving 1 billion people from hunger and malnutrition – many in South Asia. However, Borlaug correctly predicted that the Green Revolution boost in food production could not last, and was only a reprieve for humanity to adapt more sustainable systems and policies for managing population growth and use of natural resources. For his work, Borlaug was awarded the 1970 Nobel Peace Prize. Further honoring his efforts, BISA will catalyze AR4D in the region. BISA is a non-profit international agricultural research institute founded and managed by CIMMYT.



Time is short. A widening economic divide aggravates social, political and military tensions in a region that is critical to global security. Meeting South Asia's food and nutritional security and environmental rehabilitation needs are among the most urgent challenges facing the region and the world today. Solving these challenges will help unlock economic development for South Asia's poor smallholder farmers and consumers. AR4D, a key component of any sustainable plan, needs to accelerate and agricultural technologies must be diffused more quickly into the field.

Established initially in India, BISA is developing a state-of-the-art agricultural research platform, technology transfer centers and training facilities throughout South Asia. BISA's focus is on holistic, interdisciplinary and collaborative approaches to AR4D in breeding, CA and socio-economics for wheat- and maize-based cropping and food systems. BISA's facilities and formal institutional partnerships can create a world-class research infrastructure and lead to strategic collaborations among regional and international scientists, as well as public and private stakeholders across the region's agricultural value chains.

The Importance of BISA

Through BISA, CIMMYT and several NARS have taken a key step towards sustainable food and nutritional security. CIMMYT has a long and successful history of partnerships in South Asia, having played an important role with regional partners in catalyzing the Green Revolution. The NARS have demonstrated their commitment to regional food and nutritional security and have recognized the contribution that BISA can make to assist existing efforts in the region.

BISA's role in strengthening South Asia's food and nutritional security focuses on leveraging and accelerating efforts rather than duplicating or competing with existing institutions. BISA fills the most critical gap in present efforts in South Asia – an impartial coordinating platform for discovery and sharing information and technologies. BISA's primary focus is to strengthen knowledge- and capability-sharing through the collaborative execution of AR4D projects. This increase in resource productivity should increase food and nutritional security, environmental protection and economic development.

The benefits of knowledge exchange and modern agricultural capacity building have yet to reach millions of the region's farmers, preventing them from significantly improving their livelihoods and the region's food security. BISA is developing effective mechanisms to share cutting-edge agricultural technology and information with those who need it most. This will lead to accelerated development and the adoption of appropriate technologies by the region's engines of agricultural production – smallholder farmers and small-to-medium agribusinesses. They can then help to sustainably and affordably meet the region's accelerating food and nutritional demands.

BISA is also strengthening the links between national and international efforts, building capacity in the region's scientific community and introducing the best seed, agricultural technologies and information to improve the productivity and profitability of the region's smallholder farmers and agricultural value chains.

First High-Level International Delegation Visits BISA

On February 6 the BISA farm in Ladowal, Punjab, India, received a delegation consisting of eight members of the German Parliament (Harald Ebner, Alexander Süßmair, Max Lehmer, Heinz Paula, Alois Gerig, Eric Schweickert, Mechthild Heil and Gabriele Groneberg) and Sabine Raddatz (counselor for food, agriculture and consumer affairs at the embassy of the Federal Republic of Germany in India). The first-ever high-level foreign delegation was welcomed by the CIMMYT-BISA team including Raj Gupta, M.L. Jat, H.S. Sidhu, Christian Böber and Tek Sapkota.



The purpose of the visit was to discuss food security issues in the context of resource degradation and climate change, and BISA's role in assisting South Asian NARS in addressing these challenges. Jat summarized the themes currently covered by BISA activities: research infrastructure and farm development; research on new maize and wheat germplasm; precision and CA; climate-resilient production systems and increased mechanization; capacity enhancement through visits, advanced courses and programs for visiting scientists, students and interns; and partnerships and networking.

(Above): Members of the German Parliament and BISA-Ludhiana staff pose around the welcome sign at the entrance to the BISA farm.

The delegation visited the farm to observe and better understand activities focusing on water table depletion, labor scarcity, residue burning, soil health deterioration and climate change. The long-term effects of residues on the likelihood of fungal disease manifestation were of particular interest to the German delegation. "There has been no evidence so far showing that keeping crop residue might lead to a higher likelihood of diseases in the future," Gupta stated, addressing the concern. "However, it will be monitored under the long-term conservation agriculture trials."

When the delegation noticed a ruined winter maize crop on a non-BISA field nearby, they were curious about what happened. "This is a result of severe frost injury, which shows the importance of developing cold-tolerant maize germplasm," explained Jat. Abiotic stress-tolerant germplasm development is on BISA's agenda.

The visitors also saw BISA efforts in sustainable intensification of the cotton-wheat system, the second most important wheat-based system in South Asia. They then

discussed the application of pesticides and herbicides, assessment of different irrigation technologies and crop management systems with the BISA team.

The delegation was shown new precision/CA machinery developed, adapted and currently being fine-tuned at BISA-Ludhiana. The BISA team demonstrated no-till wheat planted with a front-mounted knife roller (developed by BISA) and rear-mounted turbo Happy Seeder in a single pass, and explained the advantages of this eco-friendly technology (including time, energy and cost savings; reduction of environmental pollution; and climate adaptation). "BISA can play a critical role in smart farm mechanization in South Asia and other parts of the world by creating connections between stakeholders," commented Er Baldev Singh, president of the Agricultural Machinery Manufacturers Association of India.

BISA Station Becomes Wheat Training Hub

The GWP in South Asia organized a two-day field training program on wheat spot blotch disease on February 24-25.

The training was coordinated by CIMMYT wheat breeder Arun Joshi under the WHEAT CRP and took place at the BISA experiment station in Pusa, Bihar. The training program provided 12 young scientists from Rajendra Agricultural University (RAU) and the regional IARI station with greater understanding of the spot blotch pathogen.

The program covered creating artificial epiphytotic for spot blotch, disease identification and



scoring, differentiation of spot blotch symptoms from other similar factors, and the role of weather and plant factors in determining the severity of the disease. After a theoretical session, participants attended practical classes in the field. First, they focused on the technique to identify spot blotch symptoms ranging from young lesions to fully developed disease and to coalescing spots. This was followed by a disease scoring session; participants then tested their new scoring skills during an exercise which involved scoring on the same genotypes to cross-verify results. Later, they learned the method of differentiating the lesion mimic symptoms from the spot blotch and recorded lesion mimic with high severity on several wheat lines. Other topics included collection procedure and identification of dried leaves colonized by spot blotch and confirmation of spores on the infected leaves under a microscope.

BISA-Bihar staff members plan to collaborate more closely with local institutions to expand this work in the future. RAU vice-chancellor R.K. Mittal expressed support for this plan and pledged full support for the implementation of the WHEAT CRP.

Biodiversity, BISA and CIMMYT Work on Climate-Resilient Farming in Eastern India

Increased access to seeds better suited for local conditions and climate-smart crop management technologies are two strategies Biodiversity International and CIMMYT-India are using to improve the climate change resilience of resource-poor farmers. Biodiversity Director General Ann Tutwiler visited the BISA-Pusa farm and climate-smart villages in the Vaishali district of Bihar on August 14, strengthening this partnership. Under the CCAFS CRP, the two Centers are working to improve farmers' adaptation to climate change in eastern India.



M.L. Jat shows resilient cropping system options for the eastern Indo-Gangetic Plains at the BISA farm, Pusa. Biodiversity's Ann Tutweiler stands in the right foreground.

Agriculture is affected by variable temperatures and erratic climate events. Impacted smallholder farmers suffer from low production and increasing costs. Tutwiler said that CIMMYT, BISA and Bioversity have common interests and should complement each other's work in making smallholder farmers climate-smart through local adaptation of stress-tolerant seeds and providing information on better agronomic management.

Visitors saw strategic CA research at the BISA farm, as well as collaborative research between CIMMYT and IARI. Participants discussed long-term benefits of CA, such as increased productivity, improved soil fertility, cost savings and reduction of greenhouse gas emissions. "At Pusa, we have established long-term CA research in predominant cropping systems to monitor and devise resilient future cropping systems and their component technologies for the eastern Indo-Gangetic Plains," said M.L. Jat, a CIMMYT senior cropping systems agronomist. "These work as capacity building platforms for various stakeholders."

Visitors also saw climate-smart technologies promoted by CIMMYT in collaboration with other CGIAR centers and national agricultural research and extension services under CCAFS. Mamta Kumari, a woman farmer from the climate-smart village of Rajapakar said, "Rainfall has been unreliable for the last few years. Our crops and livelihoods

are at risk with changing weather. But we now get more information about seed, methods and technologies; we can see a change." With access to information on weather, better-adapted seeds and improved crop management, women farmers are now feeling more empowered. "We now save around 5,000 Rupees (about \$79) on the cost of production by using zero tillage in wheat cultivation," Kumari said.

Spreading Conservation Agriculture and Developing Researchers

Asia can benefit from site-specific CA solutions to face challenges such as diverse ecologies, soils, production systems and an expected hike in food demand by 2020 of 30 to 50 percent. To train young scientists on CA-based crop management technologies and encourage wider adoption of these practices in Asia, CIMMYT and BISA held the fourth "Advanced Course on Conservation Agriculture: Asia" from October 17-31 at Punjab Agricultural University (PAU), the BISA location in Ludhiana.

The course was organized in collaboration with ICAR and PAU, with support from the WHEAT, MAIZE and CCAFS CRPs. Fifteen researchers from NARS and IARCs in Afghanistan, India and Iran attended.



(Above): Conservation agriculture trainees inspect maize stover in an Indian field.

community-level adoption, capacity development of stakeholders at various scales and levels to adapt CA systems in diverse agro-ecologies has remained a major thrust in the region."

"Punjab is considered to be India's food bowl with 4.2 million hectares under cultivation," said S.S. Gosal, PAU director of research. "But rice-wheat cropping and rampant water and pesticide use are depleting resources. Adoption of CA and crop residue management to maintain soil health and long-term strategies involving suitable crop varieties, machinery, pest and nutrient management for CA will help reverse the trend."

B.S. Dhillon, PAU vice chancellor, explained the course would build on existing research and train researchers to adapt CA practices and incorporate farmers' innovations. He praised CIMMYT's role in starting partnerships and pushing for wider CA adoption as well as engaging students, extension agents, service providers and farmers. "BISA is serving as a common platform for research on CA, sustainable intensification, precision agriculture, climate-resilient production systems, smart mechanization and developing a new generation of scientists," he said.

M.L. Jat, CIMMYT senior cropping systems agronomist and course coordinator, said the course was instrumental in promoting CA in the area. "Significant efforts are being made by a range of stakeholders to make CA relevant to the needs of smallholder farmers. However, from farm- to

The course included interactive presentations and field sessions. Presentations focused on laser leveling and field training, recent advances in CA-based machinery in India and Mexico, hands-on training on calibration and operation of CA machinery, measuring greenhouse gas emissions, precision agriculture and nutrient management and an overview of weed and water management in CA systems. The participants also visited machine manufacturers and learned about CA's socio-economic impacts.

"The course covered in detail all aspects of conservation agriculture technologies," said participant Sadegh Afzalnia from Iran's Ministry of Agriculture. "I will take back the information and put my best effort to out-scale conservation agriculture technology in my country."

For more information about BISA, visit www.bisa.org or contact H.S. Gupta at h.s.gupta@cgiar.org.



Visitors observe a greenhouse gas emissions demonstration, which is a component of CIMMYT's long-term conservation agriculture trial in rice-wheat cropping systems at the Rajendra Agricultural University farm in Pusa, India.

Focusing on Gender to Improve Equality and Livelihoods

Gender mainstreaming in agricultural development is on the agenda of the international development community, national governments and CIMMYT. Addressing gender disparities in agriculture is necessary to fully achieve development goals. During 2013, CIMMYT incorporated gender more fully into its activities. Examples include the following:

Integrating Gender into WHEAT and MAIZE CRPs

Addressing the gender disparities between women and men farmers in the developing world has significant development potential in itself. The FAO 2011 State of Food and Agriculture report estimates that if women had the same access to production resources as men, they could increase crop yields by between 20 and 30 percent. According to FAO, this alone would raise total agricultural output in developing countries by 2.5 to 4 percent, which, in turn, could reduce the number of hungry people in the world by 12 to 17 percent – or 100 to 150 million people.

Among the first CRPs to undertake a gender audit of their activities, WHEAT and MAIZE organized a workshop

on how to implement the audits, facilitated by gender specialists from the Royal Tropical Institute (KIT) of the Netherlands, a research partner to MAIZE and WHEAT.

“A gender audit is an assessment by which an organization can identify how it addresses gender. It implies that the organization will assess its performance against some standards,” explained Chris Hunter, KIT senior advisor on social development and gender equity. “Many organizations don’t have a gender policy, so the audit assesses performance against best practice, meaning that what we do should be positive for both men and women.”

Gender mainstreaming challenges were first discussed at the Fourth World Conference on Women in Beijing in 1995. It was recognized that just having a few add-ons for women did not work. “In a subsequent conference it became clear that it still wasn’t always working, so gender audits were, in part, a response,” Hunter stated.

A gender audit usually comprises surveys and focus group discussions involving organizations, partners and those who are “watching what the organization does.” For MAIZE and WHEAT, the audits provided a baseline to assess progress on integrating gender into the CRPs and to prioritize that process. “We really want to collaborate closely with CIMMYT, ICARDA and IITA to institutionalize gender awareness within the CRPs and to support the empowerment of women farmers and those working along maize and wheat value chains,” emphasized Dave Watson, MAIZE manager. “Interventions can reinforce or alter gender relations. When gender realities are ignored, harm is done and results are not as positive as they should be,” he added. “The ultimate goal is to make our research programs more gender transformative and address both the causes and consequences of gender inequalities.”

“Building gender equality into development outcomes means that factors such as participatory decision-making and transparency in project design are considered, in addition to what it might take to see gender-equal uptake of our research products,” remarked Jenny Nelson, Global Wheat Program administrator. “This is an important, maybe even revolutionary, change in the way AR4D has worked.”

The MAIZE and WHEAT gender audit included assessments of gender knowledge, attitudes and awareness of research staff and managers of the lead Centers and key partners. This led to the development of detailed gender action plans for each CRP.

Consortium Praise for MAIZE and WHEAT Gender Strategies

“I fully appreciate the thoroughness of the steps proposed for building appropriate gender research capacity into each CRP and believe these steps lay an excellent and sustainable foundation for MAIZE and WHEAT to have clear



and significant impacts on gender equity,” commented Anne-Marie Izac, CGIAR Consortium Chief Scientific Officer, as she conveyed the Consortium’s formal approval of the MAIZE and WHEAT Gender Strategies 2013-2015.

The MAIZE and WHEAT Gender Strategies provide a framework to build internal capacity for gender analysis while strengthening gender integration in project design and implementation; a two-pronged approach that will enhance gender responsiveness and targeting of research for development of maize- and wheat-based systems.

Nutritious Maize for Ethiopia: Ensuring the Participation of Women

The Nutritious Maize for Ethiopia (NuME) project is developing and promoting quality protein maize in the major maize-growing areas of Ethiopia to improve the nutritional health of women and children. The project has a strong gender component, ensuring women’s full participation in all activities and an equal share of benefits, which was discussed during a gender analysis and strategy workshop in Addis Ababa in April. Gender analysis and gender strategy were presented to implementation partners for their input and they agreed on a project gender strategy.

According to gender-related research, while men are responsible for plowing and the purchase of inputs (including seed), women are responsible for chores such as cooking and child care. However, both men and women



In 2013, a gender audit of the CRP projects was commissioned by MAIZE and conducted by KIT.

contribute to harvesting and weeding. Planting is either a shared activity or done by men. Children are also involved in agricultural activities (herding animals and providing them feed and water). Dairy and poultry production management is largely the responsibility of women; although they receive a substantial part of the income resulting from these activities, their access to resources compared with men is largely limited, particularly when it comes to extension services. The agricultural extension system focuses on male- and female-headed households; wives are expected to learn from their husbands. Women are also rarely invited to agricultural trainings, especially when they take place away from their farm. It is much easier for women to access health extension than agricultural extension.

A NuME gender strategy was outlined to improve women's participation in project activities. The strategy involves increasing women's attendance at QPM demonstrations by inviting them directly and by organizing separate sessions for women during field days, ensuring that the time and place are convenient for them. It was also suggested that health extension workers be involved in QPM promotion and that farm radio activities specifically target women. Furthermore, partners should be given incentives to involve women more fully, and they should also be provided gender training at all levels.

The NuME gender strategy was later presented and discussed during a meeting of the Project Steering Committee on May 23. Stefna Pacquette, a representative of the Canadian Department of Foreign Affairs, Trade and Development (DFATD), NuME's donor, emphasized that the strategy needs to involve women in a meaningful way beyond simple participation in project activities. "While focusing on nutrition, NuME can provide a vehicle to strengthen women's role in the household," Pacquette noted. "It can also get men to feel more comfortable with women's presence and participation in traditional male roles."

CIMMYT/CAAFS in India – Gender, Action and Research

In June, CIMMYT's GCAP and research teams in the Indian states of Bihar and Haryana welcomed CIMMYT gender specialist Tina Beuchelt and gender consultant Cathy Farnworth to discuss integration of gender perspectives into daily research. The visit was triggered by a request from the CCAFS CRP to enhance women's access to and use of agricultural and climate-related services and information.

Discussions with researchers on how to include a gender perspective in their work plans and field experiments, demonstration plots, out-scaling efforts and surveys were held. The team visited farmers participating in CIMMYT/CAAFS projects in Bihar and Haryana, where lively small group discussions helped the visitors to gain a deeper understanding of the situation of women and men, their roles and responsibilities and gender-related constraints existing in their small-scale farming systems.

The team met with smallholder and better-off farmers, as well as landless workers and FHHs to obtain a representative picture of those involved in agriculture in CIMMYT/CAAFS target areas. Men and women were interviewed separately, and CIMMYT staff helped to explain the production systems and the basket of climate-smart farming options currently available, and shared their thoughts on how to respond to specific gender challenges.

Given the varying agro-ecological environments and socio-economic characteristics of farmers, it was agreed that new partners, allies and ideas are needed. While the discussions went well, one of the female participants gave a timely and heart-felt warning: "You ask us to take risks, but where will you be if we fail?"



Women farmers and children take part in a gender workshop in India.

The trip culminated with a workshop on "Pathways of gender equity-led climate-smart farming: learning from stakeholders" organized jointly by the DWR, ICAR and CIMMYT/CAAFS in Haryana on June 7. A mix of men and women farmers; farmer organizations; researchers from ICAR, Haryana Agricultural University and CGIAR; extension and development organizations, including the State Department of Agriculture; NGOs; private sector organizations; and politicians – about 65 participants – joined the workshop and contributed to discussions on advantages and disadvantages of different climate-smart technologies for women and more effective types of institutional support required to support women. Participants then formed small groups to discuss ideas for action to support women in agriculture, which was followed by presentations and discussions in a session chaired by DWR director Indu Sharma.

Suresh Gahalawat, Haryana State's deputy director for agriculture, who showed great enthusiasm regarding the topic during the workshop, announced, "Gender will become part of the agricultural policies of Haryana. To begin, we will include the gender component in all schemes operated in the district."

CIMMYT and Partners Introduce Biofortified Wheat to Indian Women

Women farmers in India are learning about the benefits of biofortified wheat from CIMMYT and other CGIAR researchers. Scientists met with 106 women on August 8 in the village of Pidkhir, in Mirzapur District of Uttar Pradesh state, to advocate for the use of biofortified wheat and listen to feedback on nutrition and the impacts of nutritional deficiency on women and children.

The event was part of a program conducted in more than 50 villages in India's Eastern Gangetic Plains. Collaborators included Banaras Hindu University, *Mahamana Krishak Samiti* (a farmers' cooperative in Mirzapur) and CIMMYT's South Asia office in Kathmandu, Nepal. BHU's Chhavi Tiwari led the meeting in Pidkhir, which was attended by women of different ages and occupations including farmers, housewives, daily wage workers, government employees and school teachers.

The HarvestPlus project was started at BHU in 2005 as part of a collaborative effort with the Biofortification Challenge Program (HarvestPlus) at IITA, IFPRI and CIMMYT to identify biofortified wheat varieties adapted in South Asia.



Five of the participants at the meeting participated in the HarvestPlus trials in Pidkhir that began in 2005 and said they were happy with the wheat variety. "I cannot believe that wheat with high zinc and iron could be grown in our fields," said Sursati, a woman who has worked with HarvestPlus wheat throughout the course of the project.

Most participants were new to the subject and learned about the importance of biofortified wheat – particularly its importance to the health of women and children. Women also answered a questionnaire on their backgrounds and interests in biofortified wheat.

All the women were in favor of receiving biofortified wheat developed through the HarvestPlus project. They also expressed their desire to visit and see the BHU research farm, where wheat scientists from the university are conducting research with CIMMYT's GWP team. The farmers agreed to advocate for new biofortified wheat varieties and help the BHU team when needed.

Improving Food Security: Women Start Collective Maize Farming in Tribal India

Women farmers in tribal villages of Odisha State in eastern India are increasing their yields through the use of hybrid seed varieties, new technologies and better agriculture practices with training and support from the CSISA project and the Odisha Department of Agriculture and Cooperation.

(Below): Chavi Tiwai of Banaras Hindu University talks with women farmers in Mirzapur, India, about biofortified wheat.

Badbil Rengalsahi is a remote tribal village in the Mayurbhanj District of Odisha with high poverty and low literacy rates. The village is home to 40 tribal families who mostly farm for a living. They usually grow local



(Above): Women farmers in India display a portion of their maize harvest.

varieties of maize in home gardens for household consumption and sell their small surpluses of green cobs in the local market. Yields are often low because farmers use unimproved varieties and

traditional sowing methods and lack information about good agronomic practices, especially weed and nutrient management. Maize cake is a common breakfast and snack for children in the area, and low maize production often means they receive less food.

However, this situation could soon improve thanks to women self-help groups (SHGs) like *Johar Jaher Ayo*. A team from CSISA and state agricultural officers met with 11 women from the SHG, who learned about new technologies and improved varieties. "Members were initially hesitant about growing maize with these new methods, but after learning about the benefits they decided to grow a test plot of maize on 1 ha of fallow land," said CSISA agricultural specialist Nabakishore Parida.

The farmers bought hybrid maize seed and fertilizer using their collected savings and plowed the field with tractors instead of traditional wooden plows. CSISA team members provided the seed-fertilizer multi-crop planter with an inclined plate seed metering system. The planter – commonly called a "seed drill" – helps achieve optimum plant populations and higher fertilizer efficiency by seeding in lines at a precise depth and spacing and placing fertilizer below the seeds. "Women farmers usually don't get the right information at the right time," Parida said. "CSISA trained them on better agronomy practices such as nutrient management and timely weed control."

The farmers are delighted with the results; their production has almost doubled this year. "The work burden of these women has been reduced with the use of the seed drill," said Kuni Murmu, president of the SHG. "Since women mostly do the sowing and fertilizer application with wooden plows, it used to take a lot of our time."

In addition to harvesting 1 ton of green maize for use by their families and relatives, they earned a net profit of \$240 by selling surplus green maize and maize grain, and were even able to share green ears with neighbors. Concerned about more than financial profits, the women farmers were pleased that they could provide nutritious food for their children during the "lean" food season from August to October, when grain stores from the previous cropping season have been depleted.

Three SHGs in Matiagarh village of Mayurbhanj have successfully adopted collective maize cultivation with support from CSISA. They leased a fallow and bushy 4-ha plot from the village landlord and used a seed-fertilizer multi-crop planter provided by CSISA to line sow. Site-specific nutrient management trials were also established to raise local awareness regarding the nutrient status of the soils and the benefits of balanced fertilization.

"Line sowing with a seed drill has reduced our sowing cost and we could cover more area in a shorter period," said Babirani Sethi of the *Swarnalaxmi* SHG. With good harvests this year, the *Swarnalaxmi*, *Dhabaleswari* and *Mangala* SHGs earned respective profits of \$167 from 0.4 ha of maize, \$242 from 0.8 ha and \$400 from 1 ha.

Female-Friendly Seeder Boosts African Conservation Agriculture

A lightweight seeder designed for CA could help households headed by women in eastern and southern Africa to adopt the technology. CIMMYT's FACASI project is addressing declining farm power by delivering small-scale

mechanization to farmers. FHHs are particularly labor-constrained. They often don't own or are not permitted to use draft animals and are among the last to access land preparation services, which severely affects yield.

FACASI imported several female-friendly seeders designed by John Morrison, a consultant and adjunct professor at the University of Tennessee. Unlike other commercially available machines, which are bulky, heavy and challenging for women to use, Morrison developed a light, single-row seeder specially designed for operation in non-plowed fields. The seeder is equipped with a rake to clear crop residue from the path, a rolling coultter blade to cut any remaining residues in the path, a furrow-opener shank to open a soil slot for seeds and fertilizer and a pressing wheel to close the soil slot.

The seeder performed well during its pre-test in Njoro, Kenya. Women farmers, FACASI scientists and Morrison tested the seeder and later demonstrated it for the CIMMYT Board of Trustees. Thorough field testing also took place in Kenya and Tanzania. A business model is being developed to guarantee women farmers access to the technology.

According to the World Bank, the proportion of FHHs is particularly high in eastern and southern Africa (23 percent in Ethiopia, 32 percent in Kenya and 38 percent in Zimbabwe). Increasing the power available to these households – through small-scale mechanization and by promoting power-saving technology – is one way to close the gender gap.

For more information about CIMMYT's work on gender-related issues, contact Lone Badstue (l.badstue@cgiar.org).



A woman farmer learns to use a two-wheeled tractor during a demonstration event.

Gathering Insights from Above – New Remote Sensing Platform in Obregón

With funding from the MAIZE and WHEAT CRPs, GCAP acquired a new remote sensing system consisting of a multi-spectral camera, thermal camera, software and methods that allow semi-automated image processing. The two cameras were delivered in February by Pablo Zarco-Tejada, director of the QuantaLab remote sensing laboratory, *Instituto de Agricultura Sostenible (IAS)*, *Consejo Superior de Investigaciones Científicas (CSIC)*, in Córdoba, Spain. Zarco-Tejada and three technicians spent several days in Obregón to train a pilot and CIMMYT staff to use the equipment.

The thermal camera helps to measure a key water stress indicator – plant canopy temperature. Plants under water stress close their stomata to reduce transpiration, which increases crop canopy temperature as a result of a reduction in evaporative



Using Technology to Improve Agriculture

cooling. Consequently, temperature differences between well-watered and water-stressed plants can be used to detect water stress accurately and at early stages. This information will be used by MasAgro to measure the impact of tillage on crop water use efficiency, but it will also enable CIMMYT to develop a diagnostic tool based on the crop water stress index (CWSI) to help farmers determine the right time to irrigate wheat in Mexico's Yaqui Valley. Once validated, the CWSI may also serve to identify the best time to irrigate plots at the research station.

The multi-spectral camera measures the light reflected in green, red and near-infrared ranges. While a dense plant canopy can absorb more than 95 percent of the light in the

visible range (violet to red), it reflects most of the light in the near-infrared range. Information on the light reflectance in the visible and near-infrared ranges helps to estimate ground cover and leaf area index, parameters usually correlated with biomass and yield. With two spectral channels in the red-edge region (in between the red and near-infrared ranges), the camera also allows the canopy chlorophyll content – its 'greenness' – to be estimated. Chlorophyll content is closely related to the nitrogen status of the crop, but it also can be used to detect other nutrient deficiencies. Furthermore, the potential of using the multi-spectral camera in an airplane could enable researchers to diagnose nitrogen needs to optimize yield for around 1,000 hectares in about one hour, at a resolution of about 4 meters.

The multispectral and thermal cameras are fully operational and covered the research station in Obregón on a weekly basis until the end of April, with the resolution ranging between 0.20 and 0.40 meters, depending on the flight altitude and the type of camera. This is detailed enough to identify individual plots. The collaboration between CIMMYT and QuantaLab-IAS-CSIC will continue through the setup of a new hyperspectral camera, further research conducted on crop stress indicators and the identification of successful remote sensing indices. Canopy temperature, Normalized Difference Vegetation Index and other vegetative indices will be made available at minor cost to interested scientists. These measurements could be used for phenotyping, physiological and agronomic research.

For further information, please contact Iván Ortiz-Monasterio

(i.ortiz-monasterio@cgiar.org) or Bruno Gerard (b.gerard@cgiar.org).

Skywalker Advances Phenotyping in Southern Africa

To free phenotyping from the varietal development bottleneck, tools have been developed to enable easier plant growth, development characterization and field variability. Until recently, the potential of these tools has been limited by the scale on which they can be used, but this is changing; a new affordable field-based phenotyping platform combining cutting-edge aeronautical



CIMMYT staff and visitors watch the CIMMYT blimp and unmanned aerial vehicle over the fields in Obregón.

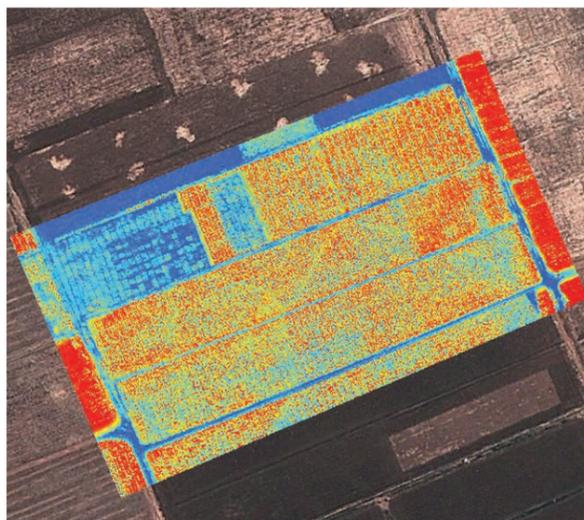




The aircraft operated near CIMMYT station in Ciudad Obregón stands ready for hyperspectral imagery collection.



A Skywalker unmanned aerial vehicle in a field in Africa.



A thermal image taken by a Skywalker in Zimbabwe.

technology and image analysis was developed through a collaboration between the University of Barcelona, Spain; the Crop Breeding Institute, Zimbabwe; *Instituto Nacional de Innovación Agraria*, Peru; AirElectronics; and the Sustainable Agricultural Institute of the High Research Council, Spain. The project was funded by MAIZE as part of its activities and focuses on new tools and methods for NARS and small and medium enterprises to increase genetic gains in maize breeding.

The new platform uses Skywalker, an unmanned aerial vehicle (UAV) which can fly as high as 600 meters at 45 kilometers per hour. The vehicle has thermal and spectral cameras mounted under each wing, and its flight path and image capturing are controlled via a laptop using Google Earth images. Jill Cairns and Mainassara Zaman-Allah tested the platform at CIMMYT-Harare along with José Luis Araus (University of Barcelona), Antón Fernández (AirElectronics president) and Alberto Hornero (Sustainable Agricultural Institute of the High Research Council) to establish the optimal flight path (distance between plane passes and height) for plot level measurements. Field experiments were phenotyped for spectral reflectance and canopy temperature within minutes; these will be compared to GreenSeeker™ results.

The measurement speed of the new platform helps to overcome changes in cloud cover and the position of the sun. It will be used by the Crop Breeding Institute to develop new maize hybrids with heat stress and drought stress tolerance under elevated temperatures.

Remote Sensing Prepares for Liftoff

Remote sensing experts, breeders, agronomists and policy-makers discussed turning their research and experiences into tools to benefit farmers and increase food production while safeguarding the environment during CIMMYT's "Remote Sensing: Beyond Images" workshop in Mexico City on December 14-15. The event was sponsored by BMGF, SAGARPA, MasAgro, MAIZE and the CSISA project.

Remote sensing devices make it possible to observe the dynamics of anything, from single plants to entire landscapes and continents as they change over time, by capturing radiation from across the electromagnetic spectrum. Images taken by cameras in the thermal-to-visible end of the spectrum can reveal a range of plant characteristics, such as biomass, water use, photosynthesis efficiency, disease spread and nutrient content. Radar imaging can be used to create detailed imaging of plant physical structure from the canopy down to the roots. When mounted on a UAV, these sensors can survey much greater areas of land than is possible from the ground, particularly in inaccessible areas. Such research can complement high-throughput phenotyping; plant breeders can design larger and more efficient crop improvement experiments.

For agronomic research, remote sensing provides information about weather, crop performance, resource use and improved genetic traits sought by crop breeders. It may also help agriculture meet the challenge of achieving more with fewer resources and include more farmers in innovation. If methods can be found to share and connect this data, farmers will also benefit from greater transparency and more informed policymaking.

Opening the workshop, CIMMYT Director General Thomas Lumpkin reminded participants of the urgency of meeting the growing demand for staple crops while overcoming crop diseases, resource scarcity and climate change-induced stresses. The advance of technologies and data processing tools allows researchers to see the potential contribution of remote sensing.

"For 30 years, the remote sensing community has been on the cusp of doing something wonderful, and now we believe it can," said Stanley Wood, BMGF senior program officer. "What excites us is the amount of energy and enthusiasm and the knowledge that their work is important." Several presentations showed how remote sensing can benefit

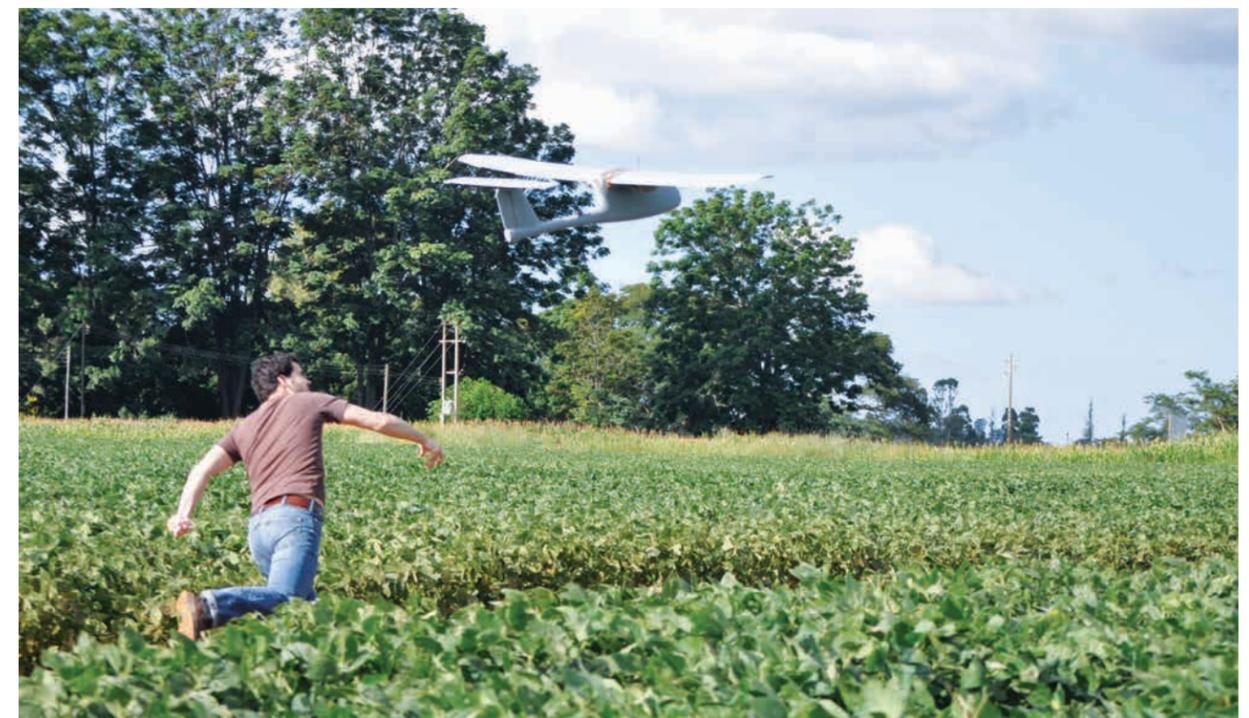


Stanley Wood of the BMGF addresses workshop attendees.

smallholder farmers. For example, DTMA is using rainfall data to target its interventions for the greatest impact.

Bruno Gérard, director of GCAP, spoke about the challenges of helping smallholder farmers to practice "more precise agriculture." The spread of ICTs in the developing world shows the potential for CIMMYT to bring recommendations derived from remote sensing to farmers and allows them to provide their own input.

The workshop ended with a panel discussion on how to develop remote sensing services that will be adopted by intended users. The workshop and similar activities will provide the strategic direction to drive a new generation of remote sensing applications with real benefits to farmers.



Combating Diseases and Pests

Diseases and pests can decimate a farmer's crop – or the crops of an entire nation. For nearly five decades CIMMYT scientists have been developing solutions to fight plant diseases and pests. Examples of CIMMYT's work in 2013 include:

CIMMYT and KARI Lead Fight Against Maize Lethal Necrosis in Eastern Africa

A new disease appeared in Kenya's Rift Valley in 2011 and 2012 and began to decimate maize crops. Maize lethal necrosis was identified by a team of scientists from CIMMYT and KARI. MLN is caused by a combination of the maize chlorotic mottle virus and the sugarcane mosaic virus and is transmitted by insects. MLN was soon found in Tanzania and Uganda and has spread to nearby countries.

"Maize is Africa's most important cereal crop, with more than 300 million of Africa's most vulnerable people depending on it for their food security and livelihoods," stated B.M. Prasanna, director of CIMMYT's GMP. "MLN has dealt a big blow to farming communities and maize-based seed companies." MLN infection rates and damage can seriously affect yields and sometimes cause complete crop loss. Infected plants are frequently barren; ears may be small or deformed and produce little or no seed.

Control of MLN is complicated because its two root viruses are difficult to differentiate individually based on visual symptoms. Joint CIMMYT-KARI studies have confirmed the vulnerability of most pre-commercial and commercial maize germplasm to MLN under natural disease pressure as well as under artificial inoculation. However, promising CIMMYT inbred lines and pre-commercial hybrids with moderate or high resistance to MLN have been identified to combat the disease through breeding efforts.

During 2013 there were numerous efforts to combat MLN. A regional workshop on MLN and strategies to manage it



Maize plants infected with maize lethal necrosis.

was held February 12-14 in Nairobi, Kenya. Organized by CIMMYT and KARI, the workshop brought together nearly 70 scientists, seed company breeders and managers, and representatives of ministries of agriculture and regulatory authorities from Kenya, Tanzania and Uganda, as well as experts from the United States.

The objective of the meeting was to establish a strong interface between research and regulatory institutions in eastern Africa to effectively tackle the MLN challenge. Ongoing efforts and further steps to identify and deploy disease-resistant germplasm, and to create a system that can ensure a constant flow of varieties were the focus.

A second CIMMYT-KARI workshop, "Identification and Management of MLN," was held June 30-July 3 in Narok, Kenya. Many scientists and technicians experience difficulty differentiating MLN from other diseases or abiotic stresses with similar symptoms. According to Stephen Mugo, GMP principal scientist, this led CIMMYT and KARI to organize the workshop to: raise awareness about MLN among scientists, technicians and skilled field staff; provide training on MLN diagnosis at field nurseries, trials and seed production fields; train on MLN severity scoring to improve the quality of data generation in screening trials; and introduce MLN management in field screening sites. The workshop brought together over 80 scientists and technicians from CIMMYT, KARI and other NARS partners from Rwanda, Tanzania, Uganda and Zimbabwe.

"It is important that the people on the ground, particularly the technicians who interact daily with the plants and supervise research activities at the stations, understand the

disease, are able to systematically scout for it and have the ability to differentiate it from similar symptomatic diseases and conditions like nutrient deficiency," Prasanna stated.

Proper and timely identification of MLN, which is a prerequisite for effective control, is not easy. CIMMYT maize breeder Biswanath Das explained: "MLN's symptoms – severe mottling of leaves, dead heart, stunted growth, leaf necrosis, sterility, poor seed set and shriveled seeds – are not always unique to MLN but could be due to other fungal diseases and abiotic conditions."

The training workshop was one of several CIMMYT-KARI initiatives to combat the disease threatening all the gains made so far in maize breeding. "With nearly 99 percent of the commercial maize varieties released to date in Kenya susceptible to MLN, it is important that institutions like CIMMYT and KARI, in strong collaboration with the seed sector, develop and deploy MLN-resistant varieties in an accelerated manner," Prasanna noted.

A key initiative is the establishment of a centralized MLN screening facility under artificial inoculation for eastern Africa at the KARI Livestock Research Farm in Naivasha. The MLN screening site facilitates reliable screening of maize germplasm and delivers MLN-resistant varieties to replace existing susceptible cultivars as quickly as possible. "In addition to accelerated development and delivery of elite MLN-resistant products to farmers, our aim is also to build the capacity of regional institutions to develop robust breeding pipelines to incorporate MLN-resistant germplasm, and ensure that farmers have access to such products at the earliest opportunity," Prasanna added. Plans are also underway to establish a network of MLN testing sites (under natural disease pressure) in the region to evaluate promising materials from artificial inoculation trials in Naivasha. "It is necessary to break the MLN disease cycle and tackle the problem from multiple perspectives," KARI director Ephraim Mukisira stated.

Participants learned about the disease's dynamics and management of MLN trials and nurseries. They also participated in practical sessions on artificial inoculation, identification and scoring.



Scientists inspect a maize field for signs of maize lethal necrosis.

The MLN screening facility was officially opened in late September (see article on page 28). While maize is Africa's most important food crop, the 2011 drought in East Africa – combined with the emergence of MLN in the same area in 2012 – resulted in significant crop losses and severe food shortages across the region. The accelerated development and delivery of MLN-resistant maize varieties with other important adaptive traits is an urgent priority for CIMMYT and its partners in the region. The MLN Screening Facility at KARI-Naivasha is a key to achieving this goal and was made possible with funding support from BMGF and SFSA.

In another step to slow MLN's spread, the farming community around the Kiboko Crops Research Station in Makueni County, Kenya, agreed to stop growing maize for two months. The decision impacts farmers who depend on maize as both a staple crop and a cash crop.

Stakeholders made the decision on October 1 during a meeting at the station to help determine how to manage the disease in the area. The maize-free window was scheduled for March and April 2014 and is critical to interrupt the disease cycle. Stakeholders agreed to plant maize by October 15 and harvest it by February 28.



Participants in a maize lethal necrosis training session pose before the KARI/CIMMYT Regional Maize Stress Screening Farm Offices.

CIMMYT produced fact sheets and videos to raise awareness; attendees received information about MLN and its identification and planned for its management. The meeting was organized by Stephen Mugo, principal GMP scientist. A maize breeder, Mugo is also the coordinator of the IRMA and WEMA projects in partnership with KARI and the Kenya MoA. More than 100 people attended, including the county administration, local community leaders, Makueni County agricultural staff, Kiboko farmers and CIMMYT and KARI scientists.

Responding to inquiries about the origin of the disease, KARI pathologist Anne Wangai said the disease was first reported in Bomet County, Kenya, where farmers have since named it *Koroito*, or “the plague.” It rapidly spread to neighboring counties. “In all these areas, it was a sudden phenomenon that could not be explained, whose cause was unknown. But it had a devastating effect on maize productivity with losses ranging from 30 to 100 percent under severe infestation,” Wangai said.

To prevent MLN from hitting Kiboko, Wangai told participants to follow advice from CIMMYT, KARI and the MoA. Prevention techniques include using crop rotation to break the disease cycle, not planting a new maize crop near an infected field and maintaining weed-free fields (particularly grasses) to eliminate alternate hosts of potential vectors. Mugo said using chemicals for prevention is too expensive for most small-scale farmers.

Farmers in areas where rainfall is year-round or maize is produced under irrigation are advised to plant maize only once a year; local quarantines should be enforced, farmers should remove infected materials from the fields and stop movement of green maize from affected to non-affected areas; seed companies must ensure that seeds are treated with appropriate fungicides at recommended rates; and good agricultural practices, crop diversification and rotation with non-cereal crops should be promoted.

Michael Kitenje, agriculture and livestock extension officer for Makueni District, called for unity and willingness from farmers and other stakeholders. “If we have the will, we can conquer MLN,” Kitenje said, urging attendees to spread the message to those who did not attend.

To learn more about CIMMYT's work combating MLN, contact Dr. B.M. Prasanna, Director of the Global Maize Program (b.m.prasanna@cgiar.org).

Capacity Building to Combat Wheat Rusts

For the fifth consecutive year, scientists from around the world met at the KARI facility in Njoro for training on “Standardization of Stem Rust Note-taking and Evaluation of Germplasm.” The course, conducted from September 22 to October 2, attracted 30 scientists from 15 countries (Bangladesh, Bhutan, Egypt, Ethiopia, India, Kenya,

Mexico, Nepal, Pakistan, Rwanda, Sudan, Uganda, United States, Yemen and Zambia).

The course increased awareness about the threat of rusts (especially Ug99) on wheat production. The research scientists were trained on new approaches to fight rust diseases (including genetics, pathology, breeding and molecular genetics) and taught common approaches to identify, score and evaluate rust diseases both in the field and in experimental plots. Practical demonstrations focused on rust methodologies and hands-on experience in recording disease scales in the greenhouse and field, according to Sridhar Bhavani, CIMMYT wheat pathologist/breeder and course coordinator.



Wheat scientists from around the world are trained about wheat diseases at the KARI-CIMMYT facility in Njoro, Kenya.

Participants had the opportunity to work with the East African component of the BGRI and Durable Rust Resistance in Wheat (DRRW) projects in Kenya. These are designed to monitor further migration of Ug99 and its variants; facilitate field screening of international germplasm; identify new sources of resistance; understand the genetic basis of resistance; develop durable, targeted

breeding programs; and enhance the capacity of national programs. Participants had the opportunity to interact with international scientists, and trainers learned of emerging problems. Attendees also visited the KARI breeding program and farmers' fields to inspect new varieties.

Members of CIMMYT's Board of Trustees and Management Committee interacted with Oliver Nightingale, a progressive farmer who demonstrated one of the new varieties (Kenya Robin) which is planted on 1,000 acres of his farm near Njoro. “Wheat farmers in Kenya have benefited greatly from the new varieties developed by CIMMYT and released by KARI. These varieties are not only resistant to rust but generate yields 10 to 15 percent higher than the local varieties,” Nightingale told the group.

added Nightingale. He thanked CIMMYT and KARI for introducing high-yielding varieties in Kenya.

The screening nursery has more than 25,000 wheat accessions from 15 countries and research institutions to be evaluated for resistance to Ug99 and close to 50,000 accessions are tested every year. According to Bhavani, more than 300,000 lines have been tested at KARI-Njoro since 2006 and eight varieties have been released since 2008 in Kenya and more than 40 Ug99-resistant varieties/advanced lines have been released globally.

“Every year as a part of CIMMYT-Kenya's shuttle breeding program nearly 1,000 F₃ and F₄ populations are selected under high disease pressure for two generations at KARI-Njoro and several high-yielding lines with good levels of Ug99 resistance have been identified,” added Ravi Singh, CIMMYT distinguished scientist. The KARI-CIMMYT screening nursery has produced global benefits that go beyond Kenya's borders – with spillover effects reaching Ethiopia, Tanzania, Uganda and Zambia.

“Commitment to the cause through global partnership, free exchange of germplasm, scientific expertise and donor funding have been the key features leading to the success of this project,” said Hans Braun, director of CIMMYT's GWP. He continued, “CIMMYT Board members were impressed with the progress in the fight against Ug99, the logistics that go into operating this global rust screening platform in Njoro and the impact that has been achieved through release and adoption by farmers of rust-resistant varieties around the globe.”

The annual course is part of the wider BGRI/DRRW project in Kenya, an initiative of Cornell University that is being implemented by CIMMYT and KARI in collaboration with 16 other research institutions worldwide. The project is funded by the BMGF and the UK Department for International Development (DFID). To date, more than 100 pathologists, breeders and geneticists have been trained at KARI-Njoro. Scientists from Australia, Kenya, the United States and CIMMYT lectured on several aspects of wheat rust research. As Zambian participant Lutangu Makweti said, “It time for us to utilize the knowledge gained in the training course and implement better surveys and breeding activities in our countries.” Participants thanked CIMMYT and KARI for the opportunity to learn about rusts, the practical, hands-on training and the opportunity to interact with the global rust community.

The long-term partnership between CIMMYT and KARI is achieving numerous milestones in the fight against the Ug99 race group and producing outcomes that benefit the entire global wheat community.

For more information contact Dr. Sridhar Bhavani, wheat breeder/coordinator DRRW-screening for stem rust in East Africa (s.bhavani@cgiar.org).

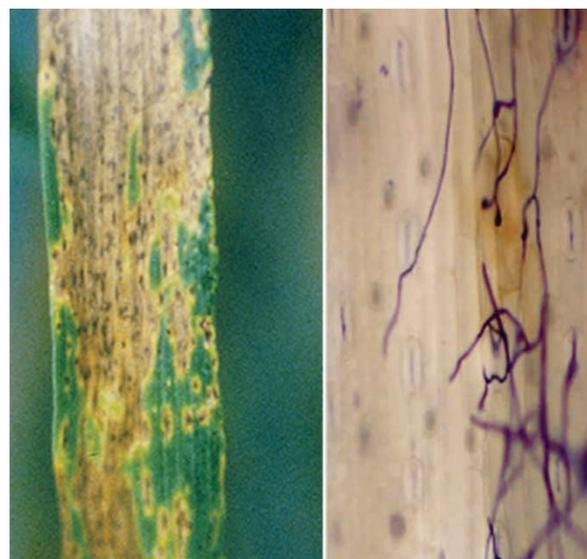
Fighting Tar Spot Complex in Mexico

Farmers across Mexico's state of Oaxaca experienced yield losses of up to 90 percent due to an aggressive strain of tar spot complex (TSC) fungal disease. Two maize landraces from Oaxaca and Guatemala, conserved in CIMMYT's gene bank and identified in SeeD field trials, were found to have strong resistance to TSC. The local farmers who observed these trials requested seed from the resistant accessions to recover yield losses. Both landraces offer new sources of disease resistance and are used to fast-track the development of improved varieties for farmers in regions susceptible to TSC.

Research Battles Wheat Spot Blotch Disease

After screening nearly 500 wheat lines and varieties at six sites in Bangladesh, India and Nepal, a group of scientists were able to identify 35 genotypes that resist spot blotch. This is the most serious wheat disease in the Eastern Gangetic Plains, damaging the crops of smallholder farmers on some 9 million hectares.

The results were reported at a meeting of participants in two projects at the Mohanpur Campus of IISER-Kolkata, India, on June 24. Funded through multi-year competitive grants from WHEAT, the two projects are "Deciphering phyto-hormone signaling in modulation of resistance to spot blotch disease for identification of novel resistance components for wheat improvement," led by Dr. Shree P. Pandey, IISER-Kolkata, and "Spot blotch of wheat: Delivering resistant wheat lines and diagnostic and molecular markers for resistance," led by Prof. Ramesh Chand of Banaras Hindu University, Varanasi. Participants discussed year-one outcomes and planned for the



A close-up of wheat infected by spot blotch disease, the primary disease impacting wheat crops in the eastern Indo-Gangetic Plains.

coming crop cycle. Chand reported on the seedling stage resistance found in the wheat tested. In this type of resistance, the pathogen is present on wheat seedlings for up to 25 days without any infection, exhibiting responses such as lesion mimic and tissue necrosis, which appear to attenuate pathogen effects. The resistance gene Sr2 was also found in most of the resistant seed.

There were discussions of biochemical and histo-pathological parameters and their possible integration in the resistance screening. Dr. Pandey and his team reported novel research to understand phyto-hormone signals that regulate wheat's resistance against *Bipolaris sorokiniana* – the causal pathogen of spot blotch – and which are synthesized in response to the pathogen's attack.

IISER is assembling a 'dictionary' of signaling genes that can serve as genomic tools for resistance breeding in wheat. "Expression of these DNA 'words' changes when plants are attacked by the spot blotch pathogen," said Pandey. "Deciphering this can elucidate the chain of command in plants to the pathogen, helping breeders design plants better-equipped with resistance genes."

According to WHEAT manager Victor Komerell, "The partners here submitted separate proposals for the projects. This meeting is an example of how WHEAT has encouraged them to collaborate."

Collaborative Wheat Breeding for Durable Resistance to Stripe Rust in China

Breeding durable resistance to stripe rust – the greatest biotic threat to wheat production in China (the largest wheat producer and consumer in the world) – was the theme of a workshop jointly organized by the CIMMYT-Sichuan office and the Sichuan Academy of Agricultural Sciences (SAAS) at the SAAS Plant Breeding Institute in Sichuan Province on May 18. The workshop promoted adoption of second-generation parents and slow-rusting breeding strategies in spring wheat-producing areas of China and facilitated collaborative breeding strategies between SAAS and its sister organizations in neighboring provinces. A seminar/discussion on germplasm and breeding strategies led by Gary Rosewarne (GWP senior scientist) and Bob McIntosh (an emeritus professor at the University of Sydney) took place, followed by a field visit to the Southern China Field Station at Xindu.

China has the largest area vulnerable to stripe rust in the world. Traditionally, the disease has been controlled through genetic strategies focused on incorporating major seedling resistance genes to provide immunity. However, this method places strong pressure on the fungus to evolve and overcome these genes. Since the 1950s, the development of virulent pathotypes to widely used resistance genes has caused numerous serious stripe rust epidemics, with major outbreaks in 1990 and 2002 resulting in the loss

of 2.65 and 1 million tons of grain, respectively. Given China's importance in the world's wheat production and consumption, any threat to the country's wheat production has implications for global food security.

CIMMYT pioneered breeding of durable resistance to stripe rust through the incorporation of multiple, slow-rusting loci, a breeding strategy well-established at SAAS but largely ignored by most other wheat breeders in China. At the beginning of this century, SAAS and CIMMYT established a shuttle breeding system to introduce slow-rusting loci into Sichuan germplasm. Five high-yielding but susceptible Sichuan lines were sent to Mexico each year for three years; Ravi Singh, CIMMYT distinguished scientist and head of the Bread Wheat Improvement program, then made single backcrosses with several CIMMYT donor lines. The resulting lines were advanced in Toluca and Obregón, Mexico, and large populations of early generation materials were sent back to Sichuan for further advancement and final selection. Fixed lines from these first generation crosses have shown good levels of resistance in China, along with yields comparable to those of the check varieties. There is currently a range of second-generation parental lines with slow-rusting loci in Chinese backgrounds; it is expected that with these as donors, researchers should be able to raise yield potential further while maintaining resistance.

An example of stripe rust on an Afghan wheat landrace, photographed in Jalal Abad Province, eastern Afghanistan.



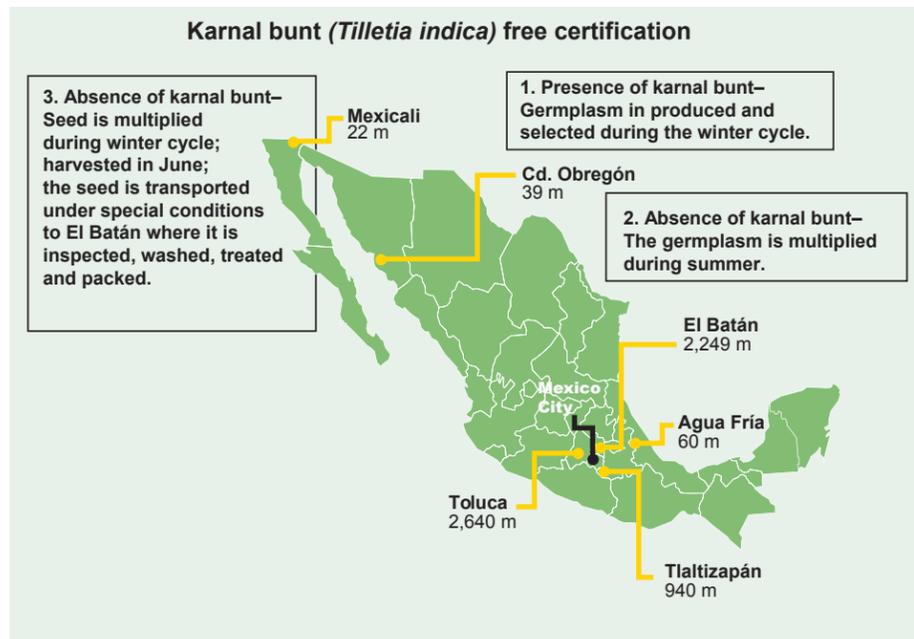
“We anticipate that through this mentoring process, breeders will feel comfortable adopting new breeding strategies that can increase their efficiencies and ensure that durable stripe rust-resistant lines are released throughout China.”

– Gary Rosewarne
GWP senior scientist

The workshop resulted in a proposed collaborative strategy which would allow breeders representing different regions of China to receive several lines of second-generation Chinese slow-rusting donors and to conduct single backcrosses with some of their elite germplasm that has become susceptible. Chinese scientists involved in the process will be invited to help select early generation materials using the bulk selection methodology. After selection, large early generation populations will be sent back to the regions for further selection and advancement under local conditions. "We anticipate that through this mentoring process, breeders will feel comfortable adopting new breeding strategies that can increase their efficiencies and ensure that durable stripe rust-resistant lines are released throughout China," explained Rosewarne.

Washing Lessens Spread of Karnal Bunt

New seed washing facilities at the CENEB station in Ciudad Obregón, Sonora, have dramatically increased CIMMYT's capacity to wash and treat wheat seeds, speeding up the turn-around time before shuttling germplasm to El Batán and ensuring that trials remain free of KB. The new equipment processes 10,000 seed samples per day, compared with the previous limit of 2,000. With this upgraded technology, the Seed Health Laboratory was able to inspect, wash and treat 125,099 samples in less than three weeks.



Mycotoxins are toxic compounds released by fungal infections in food grains. They can spoil food production, particularly cereal grains. Beyond the economic losses they cause, mycotoxins are associated with cancer, stunted growth, birth defects and, on occasion, with mass casualties. In 2004 in Ngugi's native Kenya, 125 people died and hundreds of others were poisoned by mycotoxin-contaminated maize grain. Subsequent outbreaks in 2005 and 2006 were less devastating, which Ngugi partly attributes to better awareness and testing.

KB originated in Asia and the disease spread to Afghanistan, India, Iran, Iraq, Nepal and Pakistan. KB is now also present in parts of Mexico, the USA and to a lesser extent in Brazil and South Africa. CIMMYT's headquarters and fields in El Batán are a KB-free area, but the disease is still present in parts of Sonora including the CENEB station. CIMMYT strictly adheres to Mexican phytosanitary regulations which require that seed samples can only be sent from Obregón to Toluca and El Batán and all samples are visually inspected, washed and treated. The same procedure is applied to all seed dispatched from CIMMYT to any location worldwide.

While KB does not normally cause large economic losses, the fungal disease reduces wheat flour quality, and samples with more than 3 percent of grains infected are unsuitable for human consumption. The KB fungus survives and spreads via infected seeds or spores on shoes, clothing and vehicles. To ensure zero transmission of KB, all staff and visitors to CENEB commit to washing their clothes, shoes and cars after leaving the station.

Mycotoxin Training Supports Peruvian Maize Exports

To bolster maize exports to the EU, Peru is taking measures to ensure its grain is free from mycotoxins, according to CIMMYT maize pathologist Henry Ngugi. "Peru wanted to establish a testing mechanism because the maize raised for export must meet strict EU standards," explained Ngugi. At the request of the Peruvian National Agrarian Health Service, Ngugi led a training course on mycotoxins in Mexico from October 21 to November 1.

Course participants were trained to set up a laboratory with all the necessary safety features, and on rapid and affordable methods of analysis for aflatoxins and fumonisins in food commodities. Aflatoxin B1 is the most potent carcinogen known in nature, and fumonisins have been linked to neural tube defects in embryo formation. The training used laboratory sessions to prepare trainees to perform the analyses themselves.

Although testing for mycotoxins is an established practice in the the developed world, a lack of expertise can hinder trade opportunities for other countries. The World Bank believes that EU restrictions on mycotoxins cost Africa \$670 million in lost exports each year. The potential benefits to Peruvian maize farmers and exporters are clear, but Ngugi, an expert with more than 10 years of experience in mycotoxins, saw the opportunity to address a broader threat to public health in Latin America and invited governments to send students to the course.

Nine participants represented Colombia, El Salvador, Honduras, Mexico, Nicaragua and Peru. Ngugi expects these students, some coming from countries with no prior capacity in mycotoxin testing, will begin to address the gaps in mycotoxin awareness. "I'm hoping that they start collecting data that will facilitate better policy," he said.

Many Latin American staples – such as maize, nuts, chili peppers and beans – are vulnerable to mycotoxin contamination. A 2004 study conducted in Guatemala found that half of maize samples collected from local markets would exceed WHO guidelines for fumonisin consumption if eaten regularly.

For more information, contact Henry Ngugi (h.ngugi@cgiar.org).



A diseased maize cob is stunted and the kernels are severely damaged.

Learning to Breed Insect-Resistant Maize

Scientists from Ethiopia, Kenya, Mozambique, Tanzania and Uganda gained hands-on experience in breeding insect-resistant maize at CIMMYT-Kenya (July 21-27). The training was organized and facilitated by the IRMA and WEMA projects; its purpose was to build capacity in maize breeding for insect resistance using conventional approaches, insect resistance screening and management of field and lab infestations. Participants came from the Ethiopian Institute of Agricultural Research (EIAR); KARI; IIAM, Mozambique; Selian Agricultural Research Institute, Tanzania; National Biological Control Program, Tanzania; Ministry of Agriculture, Tanzania; and the National Crops Resources Research Institute of the National Agricultural Research Organization, Uganda.

"The trip was an eye opener for me. We have no mass rearing facility in Ethiopia; neither do we practice artificial infestation of stem borers. We only undertake natural infestation for our trials, which does not give uniform infestation, leading us to wrong conclusions," said Midekssa Ardesa from EIAR's Bako Agricultural Research Center. "We are now more knowledgeable on mass rearing of stem borers and on running an insectary after our visit and practical sessions at the CIMMYT Katumani Insectary," added Abiy Dibaba from EIAR's Melkasa Agricultural

Research Center. "At the CIMMYT Kiboko Post-Harvest Lab, we learned about maize weevils and the larger grain borer, and how to screen maize for resistance against these post-harvest pests."

"The visit allowed the scientists to understand the research conducted by IRMA and WEMA and was a forum to share experiences in mass rearing, breeding and pest control among participating countries," said Stephen Mugo, CIMMYT principal scientist/maize breeder and coordinator of IRMA and WEMA. Participants visited CIMMYT insect-resistant germplasm nurseries and trials at the Embu, Kirinyaga University College and Kiboko sites where they learned how to establish, infest, manage and take data on stem borer trials and nurseries. At the KARI-Katumani/IRMA collaborative stem borer mass rearing facilities, participants learned to set up, equip and manage stem borer mass rearing; in Kiboko they focused on the set up, management and data collection of storage pests screening.

The annual IRMA program has trained more than 50 scientists since its inception in 2009. "Most of us talk very easily and confidently about insect rearing. However, it is quite a challenge when we engage in the practical aspects," said CIMMYT scientist/entomologist Tadele Tefera. Egas Nhamucho of IIAM said, "Infestation of maize with stem borers was very interesting, a delicate task of picking out very tiny insect larvae, ensuring that you do not pierce and kill them with the camel brush, and carefully placing them on each maize plant. The practical sessions made me appreciate tasks we have taken for granted."

For more information, contact Tadele Tefera (t.tefera@cgiar.org).

Scientists train to breed insect-resistant maize.



Throughout its history, training has been an important component to build the knowledge of CIMMYT staff, the staff of its partners as well as those it serves. Across the world, the sharing of information and ideas continued during 2013. Highlights of some of the key trainings that CIMMYT led or participated in include:

Training and Capacity Building

Genetic Analysis and Plant Breeding

From January 21-25, 53 researchers gathered at CIMMYT's headquarters for a week-long course on genetic analysis and plant breeding, organized by CIMMYT's Genetic Resources Program and the Generation Challenge Programme. Through lectures, practices and discussions, participants learned about plant breeding methodology, construction of genetic linkage maps, statistical comparison of different mapping methods, modeling of plant breeding and related topics. Attendees from China, Colombia, Cuba, Ethiopia, Georgia, Germany, India, Iran, Italy, Kazakhstan, Kenya, Malawi, Mexico and South Africa participated.



Pakistani Traveling Wheat Seminar

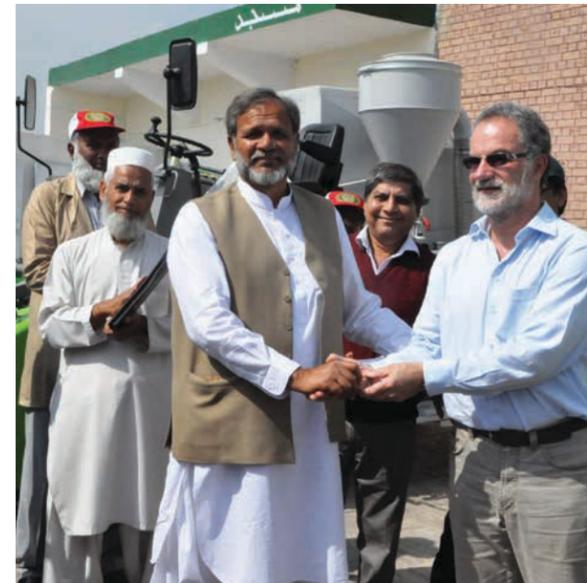
In collaboration with PARC, CIMMYT organized a national traveling wheat seminar March 3-14 in Sindh and Punjab provinces. Around 50 wheat scientists – breeders, agronomists, pathologists, entomologists, physiologists, agricultural extension workers and seed specialists from federal and provincial research institutes, the private sector and farmer groups from across the country participated.

PARC chairman Iftikhar Ahmad discussed the Council's role in coordinating and promoting scientific research to benefit smallholder farmers. He noted that traveling seminars are

one way to achieve this goal. CIMMYT country liaison officer Muhammed Imtiaz reiterated Ahmad's message on the seminar's importance: "It provides countless opportunities to participants, including the opportunity to learn more about critical evaluation of wheat areas and production trends, crop management technologies, adoption problems, financial constraints and dissemination of readily available technologies." The seminar will help to refine Pakistan's wheat research agenda to ensure it addresses emerging wheat production problems. "CIMMYT is committed to work with PARC and the agriculture sector to advance the AR4D agenda for the benefit of resource-poor farmers," Imtiaz concluded.

When participants reached the Wheat Research Institute (WRI) in Faisalabad they were joined by David Marshall (USDA/University of North Carolina), Xiaming Chen (USDA/Washington State University) and Hans Braun (GWP director). The group then jointly evaluated lines in national uniform trials, various diseases, nurseries and rust differentials. A key recommendation was to ban mega-variety Sehar-06 due to its susceptibility to leaf rust.

During the closing session, emphasis was placed on the importance of labor-saving machinery to increase efficiency. The USDA representatives and Braun presented the keys to machines purchased under the USDA-funded Wheat Productivity Enhancement Program for Pakistan over to WRI director Makhdoom Hussain.



Hans Braun (right), director of CIMMYT's Global Wheat Program, is greeted by scientists and farmers during a wheat seminar in Pakistan.

Scientists Learn About Doubled Haploids

To expand awareness on DH-based breeding and build the capacity of national partners, CIMMYT's GMP organized the second international training course on DH technology in maize breeding at El Batán from March 4-8. Ethiopia, India, Kenya, Mexico, Netherlands, Peru, Philippines, South Korea, Thailand and Zimbabwe sent participants to the course, which provided theoretical and practical exposure to the DH technology and its applications in maize breeding.

The course included lectures on key topics: DH line development; DH-based maize breeding; potential benefits of using DH technology in breeding programs; rapid cycle breeding with DH lines and genomic selection; and the use of DH lines in genetic studies. Emphasis was put on demonstrations of the key steps in the DH production process including haploid inductions, haploid kernel identification, chromosome doubling and agronomic management of the D₀ (haploid plants subjected to chromosomal doubling) nursery to derive DH lines. Participants visited the laboratory,

greenhouse and fields at the Agua Fria Experiment Station; identifying haploid kernels based on the anthocyanin color marker system, safely subjecting haploid seedlings to chromosomal doubling treatment and assessing the haploid induction rate. During field visits, they saw the newly developed, first-generation tropical inducers compared to temperate inducers in tropical environments, design of the induction nursery, agronomic management of the haploid induction and D₀ nurseries and current GMP efforts to develop second-generation haploid inducers.

Third International Wheat Yield Consortium Workshop Held in Mexico

John Snape, CIMMYT Board of Trustees member, welcomed representatives of 28 countries to Mexico as he opened the 3rd International Workshop of the Wheat Yield Consortium. The meeting, sponsored by SAGARPA (through MasAgro), was held at CENEB near Ciudad Obregón in Sonora state, March 5-7.

Vicky Jackson of the UK's Biotechnology and Biological Sciences Research Council updated stakeholders on the status of the new Wheat Yield Network (which became the International Wheat Yield Partnership in 2014) that will supersede the WYC. IWYP will expand the WYC funding base and research agenda. CIMMYT wheat physiologist Matthew Reynolds provided an overview of the global wheat yield situation, stating, "Although production has increased steadily, the price of wheat continues to increase at a considerably faster rate."

IWYP is an international network of scientists working together to address these issues. Wheat productivity is crucial for global food security; IWYP seeks a 50 percent increase in wheat's genetic yield potential within

Wheat in the fields of the Campo Experimental Norman E. Borlaug in Obregón is carefully labeled.



20 years through: increasing crop biomass by improving photosynthetic capacity; optimizing partitioning to maximize agronomic yield; and incorporating improved yield potential traits into elite breeding lines adapted to wheat agro-ecosystems worldwide. “We are establishing a balanced research portfolio with a strong output-oriented agenda to provide solutions for wheat farmers and consumers throughout the developing world,” Reynolds explained.

More than 20 presentations covered all three research areas. Chaired by Bill Davies of Lancaster University, the crop biomass improvement session covered topics such as optimizing leaf and canopy photosynthesis and photosynthetic potential of spikes. Gemma Molero of CIMMYT pointed out that while the importance of spike photosynthesis has been recognized for 50 years, no breeding program has yet tried to systematically improve this trait. Presentations on partitioning optimization chaired by Martin Parry of Rothamsted Research followed, and then a session providing updates on breeding for yield potential and research support platforms was chaired by Bill Daniel Calderini of the *Universidad Austral de Chile*.

Participants also had the opportunity to visit the Mexican Phenotyping Platform for a field day and presentations on wheat yield potential and wheat stress adaptation. They saw CIMMYT’s first blimp, which was launched in 2012, as well as the new airborne remote sensing platform in action.

“I was particularly interested in Sean Thompson’s presentation using the ground penetrating radar as a phenotyping tool for roots. This tool is fascinating because it allows for non-destructive ground penetration and it can help breeders to phenotype and select optimal root biomass in breeding populations,” said Yosra Ellemsi, an agronomist from Tunisia who is a GCAP trainee.

Davies thanked Reynolds and his team for organizing the workshop and for their work to achieve WYC’s goals. “We believed in this when we first started talking about it and you have moved it forward. This workshop has been a great opportunity to discuss the latest developments and to be in the field.”

2nd ARIA-CIMMYT Maize Workshop in Afghanistan

Increasing maize production in Afghanistan and defining research imperatives to address major constraints were the topic of the second ARIA-CIMMYT maize workshop April 9-10 at MAIL’s Plant Protection and Quarantine Department in Kabul. About 40 participants from ARIA, FAO, CIMMYT, ICARDA, MAIL, JICA and PSE discussed



Participants in an Agricultural Research Institute of Afghanistan-CIMMYT Maize Workshop pose for a group photo.

several challenges. Although maize ranks third among the Afghan government’s crop priorities after wheat and rice, its 2011 production was only about 1.64 t/ha, about one-third of both the Central Asian and world averages. Official import figures are not available, but it is assumed that Afghanistan imports large quantities of maize from neighboring countries, as the 300,000-ton harvest is not sufficient for the population of 30 million. (Afghanistan harvested between 650,000-750,000 tons in the 1960s and 1970s when its population was only 11 to 13 million.)

The biggest constraint discussed at the workshop was the unavailability of locally adapted, disease- and pest-resistant high-yielding varieties and their quality seed. Although CIMMYT contributed to the development of four OPVs during the last few years, their seed is still largely unavailable. Key achievements of the previous season, including the first-ever hybrid maize trials, were discussed, as was a proposal that ARIA appoint at least one maize researcher at each research station. Constraints to maize production, last year’s breeding trial results, the country’s maize agronomy research agenda, planning of the technical program for the upcoming crop season, maize diseases and insect pests, expectations of the private sector (the need for new varieties – particularly hybrids) and precautions to be observed during maize seed production were also topics.

High Temperature Modeling

International experts from 18 leading research institutions participated in a workshop June 19-21 on “Modeling Wheat Responses to High Temperature.” The workshop was organized by CIMMYT’s Wheat Physiology group and funded by CCAFS in collaboration with the Agricultural

Model Inter-comparison and Improvement Project (AgMIP). A common goal of CCAFS and AgMIP is to enhance global climate change impact assessment and adaptation capacity.

Workshop attendees focused on understanding where and why crop simulation models diverge in their simulation of wheat responses to high temperatures. According to CIMMYT post-doctoral candidate Phillip Alderman, “Previous studies by AgMIP-GWP showed that temperature effects are one of the largest limitations in modeling the impacts of climate change. We hope that this workshop will enhance our understanding of wheat responses to high temperatures and facilitate discussions to improve modeling to predict climate change impacts on wheat.”



Participants in a high temperature modeling training course pose for a group photo.

The AgMIP-GWP team will embark on a systematic analysis of temperature response algorithms, as well as continuing the evaluation of wheat models, using

CIMMYT wheat physiology data from high temperature environments. The research is expected to lead to better policy decisions to improve the food security of smallholder farmers in countries that depend on wheat as a staple food and are most likely to be impacted by climate change.

ARIA and CIMMYT Organize Afghanistan Wheat Research Workshop

Wheat remains the most important food crop in Afghanistan, occupying about 80 percent of the country’s total cereal acreage. CIMMYT has been supporting wheat research in Afghanistan for more than a decade. About 55 percent of the Afghan wheat crop is rain-fed and food security in this landlocked country is heavily dependent on rain. CIMMYT has introduced numerous new, improved wheat lines and, in association with ARIA, evaluates them annually. This led to the release of three wheat and two barley varieties in 2013.

ARIA and CIMMYT-Afghanistan organized the third annual wheat researchers’ workshop August 26-28 at the MAIL in the capital city, Kabul. The workshop had 64 participants from organizations such as AusAID, the Directorate of Agriculture, Irrigation & Livestock, FAO, ICARDA, Joint Development Associates, Kabul University, MAIL and USAID.

Mohammad Asif Rahimi, MAIL minister, opened the workshop and congratulated CIMMYT and ARIA on their successful completion of three years of annual workshops and also thanked AusAID and ACIAR for supporting CIMMYT-Afghanistan. He highlighted the importance of wheat in Afghan life and said wheat accounted for more than 50 percent of agriculture’s share of the national GDP. Rahimi pointed out that though wheat might bring less profit to farmers than grapes or pomegranates, it is more important to food security. He also stated that his ministry is pushing the expansion of storage facilities and an agriculture development bank is being established to provide credit to farmers.

Rajiv Sharma, CIMMYT senior scientist and country leader for Afghanistan, thanked Rahimi and explained that the workshop was designed to ensure continuity in wheat experimentation and technology development. He also stressed the need to make technologies affordable for farmers

and to properly staff research stations to carry out technology development work smoothly.



Participants in an Agricultural Research Institute of Afghanistan-CIMMYT Wheat Research Workshop pose for a group photo.

The workshop included presentations on CA and how it is applicable to Afghanistan's unique needs, the stem rust race Ug99, rust management in wheat, research results from the previous season and a technical program for the ensuing crop season. T.S. Pakbin, technical advisor to MAIL, thanked CIMMYT for helping streamline and shape Afghan wheat research.

ICAR-CIMMYT Organize Molecular Tools in Wheat Training

Young scientists from India and Nepal learned about existing and 'pipeline' wheat breeding tools during a training program. Continuing earlier training programs initiated during the last few wheat crop cycles in India, the GWP organized the three-day "ICAR-CIMMYT Molecular Breeding Course in Wheat" on August 25-27. It took place at ICAR's Directorate of Wheat Research in Karnal. The training was for 20 young scientists from different wheat research stations in India involved in a BMZ-funded project to increase the productivity of wheat under rising temperatures and water scarcity in South Asia.

The training enhanced attendees' understanding of existing molecular tools for wheat breeding as well as emerging tools such as genomic selection. "Molecular tools will play an increasing role in wheat breeding to meet challenges in coming decades," said Indu Sharma, DWR director. The program covered both theory and practice on the use of molecular markers in wheat breeding, especially those

Participants in ICAR-CIMMYT molecular tools in wheat training course pose for a group photo at the Indian Directorate of Wheat Research.

which could be used to enhance early heat tolerance.

Practical sessions in the DWR molecular laboratory focused on extraction, quantification and quality control of DNA, polymerase chain

reaction amplification and electrophoresis. During various sessions, instructors explained the molecular tools used for such work. Participants tested their skills during an exercise to score the bands and cross-verifying results.

CIMMYT wheat breeder Arun Joshi and Vinod Tiwari, principal scientist and principal investigator of crop improvement for DWR in Karnal, coordinated the training under the WHEAT CRP. A laboratory manual "ICAR-CIMMYT Molecular Breeding Course in Wheat" was also developed and was later released at the All India Wheat and Barley Workers meeting.

Workshop Advances Promising Maize and Wheat Technology Modeling

A workshop to model promising maize and wheat technologies brought together modelers, breeders, physiologists and socio-economists in Addis Ababa from August 27-30. The workshop was organized by the PIM CRP; CIMMYT is a contributing Center to the CRP.

Attendees reviewed progress on modeling maize and wheat technologies; reached agreement on the conceptual framework developed for modeling benchmark promising and "ideal" technologies; identified and prioritized traits and crop management practices for foresight analysis of maize and wheat systems; identified plausible adoption pathways to estimate the benefits of investments in promising and ideal technologies; and facilitated interaction and data exchange among scientists working in different fields.

Bekele Shiferaw presented the workshop objectives, the importance of foresight analysis (studies on the future of agriculture) in identifying priorities, threats to food security and the role modeling plays in foresight. Progress on modeling maize and wheat technologies was presented by CIMMYT's Sika Gbegbelegbe, Kindie Tesfaye and Uran



(Above): Modeling workshop attendees in an Ethiopian field.

Chung. University of Florida crop modeler Senthold Asseng shared insights on the methodological concepts used in crop modeling.

CIMMYT's Kai Sonder presented progress on improving maize and wheat mega-environments (specially classified maize and wheat growing regions) and domains that are important for geospatial crop modeling.

Breeders and physiologists shared insights on relevant traits and performance characteristics of improved germplasm. P.H. Zaidi and Biswanath Das presented on maize while Bekele Abeyo and Marta Lopes presented on wheat. Participants also discussed the bio-economic impact of climate change, including the impact of weather extremes on food security in the developing world.

Participants visited ongoing wheat and maize research activities at the Kulumsa and Melkassa agricultural research centers. CIMMYT collaborates with both centers, which are part of EIAR. Attendees discussed the role of modeling in foresight, breeding and physiology, trait identification for modeling, model data requirements, data availability and data gaps.

The maize working group agreed on minimum datasets that need to be collected in field trials for modeling and progress on breeding improved germplasm with tolerance to drought, heat and other stresses. It also agreed on the need to revise the current maize mega-environments.

The wheat working group focused its discussion on tolerance to drought and heat stresses and key traits that influence yield potential. The wheat breeders and physiologists shared their knowledge on key traits and reached an agreement with the crop modelers on how such traits should be translated in crop models.

MasAgro Trainees Evaluate Maize Quality and Improve Tortilla Production

Mexico ranks fifth in national maize consumption. It is also the leading annual consumer of maize for food; its population eats 70 percent of available maize grain. The maize food groups included in this percentage can be divided into three main areas – home consumption, the nixtamalized flour industry and the maize dough and tortilla industry. Businesses in the latter sector must have a supply of maize grain of uniform quality so that maize processing will be more efficient, stable and profitable.

Thirty Mexican dough and tortilla manufacturers, grain marketers and seed producers attended the practical training course "Maize Grain Quality and Technology," led by MasAgro researchers on September 2-3 at the Cereals Laboratory of the School of Agro-industrial Engineering of UACH. Representatives from UACH, INIFAP and CIMMYT studied the effects that physical, structural and chemical grain characteristics have on tortilla appearance and the tortilla-making process.



MasAgro helps train industry representatives to improve the tortilla production process.

Participants used simple methods to evaluate grain quality and the efficiency of tortilla making and did basic testing to determine the quality of the tortillas they made. "By using these lab techniques and processing maize grain with different textures and colors, and seeing the difference it makes in the appearance, texture and color of the tortillas, I acquired the tools to evaluate the grain I buy for my business," said a participant. "Until now, I've constantly been adjusting the process and mixing different types of grain and sometimes I don't get it right and I lose money."



Businessmen, grain merchants and seed producers showed interest in revising Mexican Regulation 034-1 on grain quality so that the range of values matches the current dough- and tortilla-making process. In their opinion, the different links in the maize production chain are increasingly demanding when it comes to the raw materials, processes and products they use.

For this reason, Gricelda Vázquez of INIFAP's Valley of Mexico Experiment Station thinks continued collaboration among research and industrial institutions is needed to ensure that research results extend beyond the production process. As David Tecotl pointed out, "Only by attending these courses do we acquire first-hand knowledge of these important alternatives." He and his fellow trainees tested the best techniques for mixing nixtamalized flour (made from beans, barley, oats, amaranth and maize) to make more nutritious tortillas, as did the UACH students who are doing their Ph.D. research under the supervision of Ofelia Buendía, one of the course organizers.

Climate Change Workshop Addresses Ethiopian Research Outputs

Climate change research in Ethiopia must be nationally relevant for research outputs to be used broadly – from farms to influencing policy – said CIMMYT researcher Kindie Tesfaye at the country's National Climate Change Adaptation Workshop.

EIAR's Biometrics, GIS and Agro-meteorology Directorate (BGAD) organized the event with CIMMYT, CCAFS and the Rockefeller Foundation. More than 50 participants from CGIAR centers, the community, federal and regional research institutions, NGOs, the media and universities attended the workshop in Addis Ababa on September 19. The workshop's purpose was to receive feedback from stakeholders on the climate change research EIAR is conducting with its partners.

Participants in a climate change workshop in Ethiopia pose for a group photo.

Major issues presented, discussed and displayed at the workshop included: decadal and seasonal climate forecast information for farmers; the

mainstreaming of climate change; trends and implications of extreme climatic events; downscaling future climate data for local climate change analysis; drought frequencies and trends; climate change vulnerability mapping; and climate database building.

Fantahun Mengistu, Director General of EIAR, said climate change is already affecting Ethiopian agriculture in the form of frequent droughts and floods, which impact the livelihoods of millions of smallholder farmers. He added that the Ethiopian government is aware of the challenges posed by climate change and has policies, strategies and programs in place to increase the resilience of the agriculture sector and the economy, such as the national Climate Resilient Green Economy (CRGE) strategy.

Tesfaye said the major reason that CIMMYT-CCAFS works with EIAR and other stakeholders in Ethiopia is to make its climate change research applicable on a national level. The climate research outputs generated by BGAD and partners were used as inputs during the development of Ethiopia's CRGE strategy and to advise the firm developing the national climate change adaptation strategy.

BGAD Director Andualem Shimelis highlighted the importance of agriculture to Ethiopia's economy and its vulnerability to climate change. He said Ethiopia needs to adapt agriculture to the threat of climate change because food security and rural development are crucial to the country and its people.

Promoting integrated agricultural technologies and knowledge of climate science is not a choice, but a matter of survival, Mengistu said. All those involved in climate change research and development should work together in order to contribute to a climate-adapted agricultural sector and a climate-resilient economy.

Partnering to Build the Capacity of African Seed Companies

CIMMYT and partner organizations are helping to build the human capacity of seed companies, which contribute to food security by ensuring farmers have access to certified



seed. One of the most important inputs farmers need to improve their grain yields and livelihoods is certified seed.

CIMMYT organizes regular training sessions for seed company staff from countries across Africa, in collaboration with the Seed Enterprise Management Institute (SEMI) project, which is funded by AGRA and hosted at the University of Nairobi College of Agriculture. "AGRA realized that many seed companies across the continent lacked knowledge on seed production, processing, marketing and other key aspects of seed quality," said David Ndung'u, SEMI's project manager. Both AGRA and CIMMYT receive funding from the BMGF. Over the past three years, SEMI has trained more than 450 seed producers from 17 SSA countries. "This training has been identified as one of the triggers for the huge increase in production of high-quality seed by AGRA-funded seed companies all over SSA," Ndung'u said.

The seed production course, taught by John MacRobert, seed systems lead for CIMMYT, is among the most popular with seed companies, according to Ndung'u. The course focuses on challenges companies face in managing hybrid maize seed. MacRobert's book, *Seed Business Management in Africa*, is included in course materials. CIMMYT's DTMA project also utilizes the book in training sessions for seed company staff.

CIMMYT has conducted seed production management courses in Angola, Ethiopia, Swaziland, Tanzania, Uganda and Zimbabwe, training more than 200 personnel from the private and public sectors over the past six years. The trainings emphasize cooperative learning while providing technical information and management tools. CIMMYT seed systems specialists also made more than 80 follow-up visits to seed company partners in 2013.

Ngila Kimotho, CEO of Dryland Seed Company in Machakos, Kenya, attended a 2008-09 seed course. "The course enhanced my understanding of seed business management through the value chain – from research to the market," Kimotho said. "I didn't understand the business initially," added Kimotho, whose background is in food technology. In 2011, Gloria Kimotho, his daughter, attended a CIMMYT course in Zimbabwe and is now actively involved in the Dryland Seeds management team.

"Capacity building in local seed companies is important," said Bob Shuma, executive director of the Tanzania Seed Trade Association, encouraging participants to seek opportunities to enhance their skills and knowledge of the seed business from CIMMYT and other partners. "Products and services of good quality are key to building customers' trust, which contributes to the success of the company. This can only be achieved through training and adherence to laws and regulations," he added.

SEMI and CIMMYT are also collaborating in field demonstrations of DTMA varieties to promote adoption by farmers because seed companies are able to pick suitable products by closely watching field performance. "Having many seed varieties is good for diversity," explained Mosisa Worku Regasa, a seed systems specialist. "With the emergence of MLN, many maize varieties from seed companies in eastern Africa are susceptible to the disease." An efficient seed system will contribute to the rapid scale-up and dissemination of MLN-resistant varieties.

"To be a great 'seeds person' you really need to understand your plants well," said Ndung'u, who worked as a visiting scientist for DTMA under CIMMYT maize breeder Dan Makumbi. "My knowledge and understanding were greatly enhanced during my time at CIMMYT."



Honors and Awards

Each year, CIMMYT staff members and colleagues are honored for their work. Among the 2013 honorees were the following:

Former Global Wheat Program Director Boosts Wheat Training

Two additional trainees will have the opportunity to participate in CIMMYT's wheat improvement course next year, thanks to the generous donation of \$20,000 by Sanjaya Rajaram, former director of CIMMYT's GWP (and the 2014 recipient of the World Food Prize).

Presenting the check to CIMMYT, Rajaram said he "hoped it would serve as an example to other people who believe in training." Rajaram started his CIMMYT career as a post-doctoral fellow, working alongside Norman Borlaug. He then went on to lead the bread wheat breeding team from 1973 through 1995 and develop hundreds of wheat varieties that are grown worldwide. He served as GWP director from 1996 to 2002.

In his four decades at CIMMYT, Rajaram trained more than 400 wheat scientists. "He influenced so many trainees who

now lead wheat breeding in their home countries and many who became national research leaders," said current GWP Director Hans Braun. "Thank you, Raj, for your dedication to training the next generation of wheat breeders," Braun stated.

Dr. Evangelina Villegas Moreno Honored

On May 7, Dr. Evangelina Villegas Moreno was presented the Outstanding Alumni Award from the Kansas State University (KSU) Department of Grain Sciences and Industry. The KSU award honored Dr. Villegas for her work to help alleviate hunger and malnutrition. She also received CIMMYT's Norman E. Borlaug Award for her contributions to the Green Revolution. "Eva is an incredible woman who helped to achieve amazing progress in the improvement of maize and wheat," said Thomas Lumpkin, CIMMYT Director General, during the ceremony.



Dr. Evangelina Villegas Moreno and Dirk Maier, head of the Kansas State University Department of Grain Sciences and Industry. Maier is holding the plaque given to Villegas honoring her as the recipient of the Department's Outstanding Alumni Award.

Dr. Villegas spent more than 20 years working for CIMMYT as a cereal chemist in charge of the cereal protein quality laboratory. "It was in that laboratory that Dr. Villegas worked with Dr. Surinder K. Vasal to develop quality protein maize," noted Lumpkin. By the year 2000, QPM was grown on more than 1 million hectares worldwide, dramatically reversing the effects of malnutrition and increasing child nutrition. This work earned the two researchers the 2000 World Food Prize. Dr. Villegas was the first woman ever awarded this accolade, and she became a role model for women worldwide. But her "contributions to society did not end with science," Lumpkin reminded the audience. Dr. Villegas was also responsible for overseeing an education fund for the young 'bird boys' of CIMMYT, who were hired to protect experimental crops from being eaten by birds. Her efforts helped many of them pay for their schooling.

"I am so excited to be here," she said. "This award is not just for me," she added, "it is for everyone who worked with me, and everyone I worked with. I have such fond memories of my time both at Kansas State and CIMMYT, and I am very appreciative of the awards I received today."

Dr. Villegas earned her Master's degree in 1962 from the KSU Department of Grain Sciences and Industry. Dirk Maier, head of the department, said "I was reading Noel Vietmeyer's *Our Daily Bread, The Essential Norman Borlaug* and from it I learned about Dr. Villegas. We are very sorry that it took us so many years to realize what a distinguished alumna we have in Dr. Villegas. We use her story to inspire our students; it helps them to understand the importance of food production and food security."

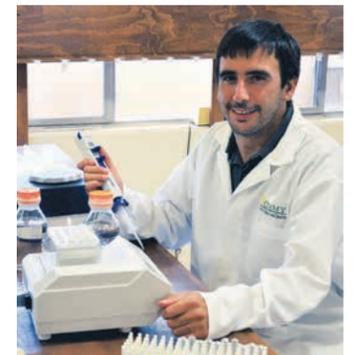
Jesús Moncada de la Fuente, Director General of *Colegio de Postgraduados* and long-time friend of Dr. Villegas, then lauded her friendly personality and incredible flexibility in her work. "Usually, people work only on wheat, or only on

maize, but Evangelina worked on both. She was a hybrid in that sense."

"We are honored to call Dr. Evangelina Villegas a member of the CIMMYT family, and are delighted that she chose to receive her award from Kansas State here at CIMMYT's headquarters," concluded Lumpkin before taking Dr. Villegas and her guests on a tour, including the new biosciences complex.

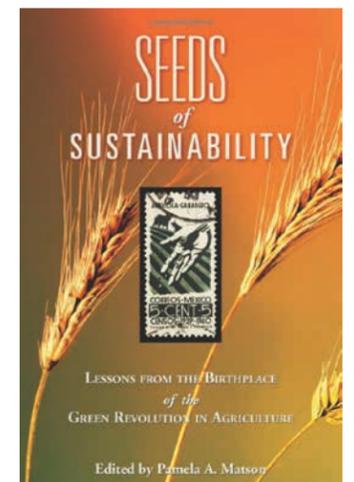
Outstanding Doctoral Thesis Award

Carlos Guzmán, post-doctoral fellow in the GWP Quality Laboratory, received an Outstanding Doctoral Thesis Award from the University of Córdoba, Spain. Guzmán joined CIMMYT in January 2012 and, as part of his thesis research, worked on a collaborative project between CIMMYT and the University of Córdoba to characterize molecular and chemical characteristics of Mexican landraces. The results of this work were published in a 2013 article in *Euphytica*. Guzmán is currently working on a research project determining the composition of starch and non-starch polysaccharides that are relevant in processing and nutritional quality.



2013 Sustainability Science Award

The Ecological Society of America (ESA) awarded Ivan Ortiz-Monasterio, CIMMYT agronomist and wheat harvest coordinator, as well as Pamela Matson, Walter Falcon, Ashley Dean, Rosamond Naylor, David Lobell, John Harrison, Toby Ahrens, Mike Beman, Lee Addams, Gerrit Schoups, Jose Luis Minjares, Ellen McCullough, David Battisti and Peter Jewett the 2013 Sustainability Science Award for their 2011 book *Seeds of Sustainability: Lessons from the Birthplace of the Green Revolution*. "This award is given because your book tackles a central challenge of sustainable



Dr. Sanjaya Rajaram and Hans Braun pose in a wheat field with Dr. Rajaram's donation to cover the costs of two additional participants in CIMMYT's wheat improvement course.



development: agricultural modernization,” stated Scott Collins, ESA president, in an award letter addressed to Ortiz-Monasterio.

Seeds of Sustainability is the product of 15 years of research, analysis and evaluation in the Yaqui Valley, one of Mexico’s main breadbaskets, the birthplace of the Green Revolution and the home of CIMMYT’s primary field station, *Campo Experimental Norman E. Borlaug*. The book is an invaluable resource for researchers, policy-makers and students, as it examines new approaches in agriculture that make sense for people and the environment. “This was possible because of the multi-disciplinary approach of our work,” said Ortiz-Monasterio in reaction to the award.

Nepal Wheat Scientists Receive Award

The Government of Nepal and NARC awarded Madan Raj Bhatta, Sarala Sharma, Deepak Bhandari, Dhruva Bahadur Thapa and Nutan Raj Gautam the first-ever Borlaug Global Rust Initiative Gene Stewardship Award. The scientists



A group of Nepalese scientists were recipients of the Borlaug Global Rust Initiative Gene Stewardship Award.

received the award for their outstanding contributions to food security through the development and promotion of rust-resistant wheat varieties in the country and for highlighting the country’s research globally. The award – 1 million Nepalese rupees (\$11,440) and a plaque – were presented by Tek Bahadur Thapa Gharti, the Minister of Agricultural Development on May 8 (the 22nd anniversary of NARC) in Khumaltar, Lalitpur.

On behalf of the awardees, Bhatta and Sharma thanked the Government of Nepal and NARC for recognizing their contributions and praised the role of CIMMYT’s Global Wheat Program and BGRI in promoting agronomically superior rust-resistant wheat varieties crucial for food security in the region. “I am going to use 100,000 rupees of my prize money to fund an annual award to two farmers

or technicians for significant contributions in wheat rust management,” said Sharma in her award acceptance speech. On behalf of CIMMYT, wheat breeder Arun Joshi congratulated the award-winning team and NARC for their remarkable contributions in the development and release of rust-resistant wheat varieties, seed multiplication of resistant varieties with diverse genetic backgrounds, disease surveillance, participatory research with farmers and improvement of livelihoods of small-scale farmers to combat the problems of food security.

“Wheat has played a great role in Nepal’s food supply; a role equivalent to more than 26 billion rupees annually,” said B.B. Gurung, NARC executive director. “The new technologies and wheat varieties introduced by the team have brought a significant increase in wheat area [from 0.7 million hectares to 0.8 million hectares], production [1.4 million tons to 1.8 million tons] and productivity [2.1 t/ha to 2.3 t/ha] in the last five years,” he added.

Maize Scientist Honored

Retired CIMMYT scientist Alejandro Ortega y Corona was honored for his 59 years of maize research. Ortega received recognition for his work with CIMMYT and Mexico’s INIFAP at a special meeting of the Biodiversity Project of Mexico and CIMMYT’s MasAgro initiative in Ciudad Obregón, Sonora State, Mexico.

Kevin Pixley, director of CIMMYT’s Genetic Resources Program, extended thanks and gratitude for the 23 years Ortega served in the organization’s maize program in the areas of entomology, physiology, breeding and pathology. Pixley read letters sent by former CIMMYT maize physiologist Greg Edmeades and Marianne Bänziger, Deputy Director General for Research and Partnerships, who worked closely with Ortega in developing drought- and heat-tolerant maize varieties. A statue of a Yaqui dancer was presented to Ortega to honor his years of hard work, dedication and leadership at CIMMYT.

INIFAP’s Salvador Fernandez and Rafael Ariza congratulated Ortega for his service and dedication. Erasmo Valenzuela Cornejo, director of INIFAP’s Northwest Regional Research Center, spoke about Ortega’s accomplishments and contributions such as the mass rearing of insects for CIMMYT maize breeders, QPM



(Above): Alejandro Ortega y Corona was honored for his contributions to maize research. Next page (top left): Ortega y Corona poses in a maize field.



maize and screening for heat and drought tolerance. Ortega produced the heat-tolerant hybrid H431, which continues to be the number-one hybrid in commercial production for summer plantings in southern Sonora.

Silver Prize for CIMMYT Poster

Tina Beuchelt and Lone Badstue won the silver prize for their poster, “Towards nutrition- and climate-smart agriculture: discussing trade-offs from a gender and intra-generational perspective,” at the first International Conference on Global Food Security. The poster details research on nutrition- and climate-smart agricultural technology and ways to enhance gender and social equity.

(Photos from the poster are shown below.)



CIMMYT Partner Honored

A long-time colleague of CIMMYT received the inaugural 2013 World Agriculture Prize from the Global Confederation of Higher Education Associations for the Agricultural and Life Sciences (GCHERA), which recognizes contributions to the field by a university faculty member.



Ronnie Coffman, recipient of the 2013 World Agriculture Prize from GCHERA, and a colleague are shown in the field.

Ronnie Coffman, international professor of plant breeding at Cornell University and director of the Durable Rust Resistance in Wheat project, was awarded the prize for his leadership in crop improvement. He received the award on October 20 during GCHERA’s annual meeting in China.

During his acceptance speech Coffman said, “The world’s farmers need access to the best science that the many great institutions of GCHERA can deliver in order to produce crops that are nutritionally adequate and best-adapted to future challenges.”

Coffman spent a year as a visiting scientist with CIMMYT’s wheat program in 1970 and has continually collaborated with the Center since then. Dr. Norman Borlaug, the late CIMMYT wheat scientist and Nobel Laureate, supervised Coffman when he was a graduate student, and the two worked together to address the stem rust disease Ug99

and other wheat diseases. Coffman is vice chair of the Borlaug Global Rust Initiative, which was established to respond to wheat disease threats. He worked in the Philippines as a rice breeder for the International Rice Research Institute in the 1970s, where he developed new varieties, before joining the Cornell faculty in 1981. More recently, he has focused on fighting wheat diseases and mentoring students.

Coffman has served on the board of various CGIAR centers, including the International Center for Agricultural Research in the Dry Areas and the International Crops Research Institute for the Semi-Arid Tropics.

CIMMYT Trustee Receives Yara Prize

Dr. Lindiwe Majele Sibanda, a member of CIMMYT's Board of Trustees, received the 2013 Yara Prize. The award honors people who have significantly contributed to African agriculture. Sibanda, CEO of the Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), was honored for her work with African farmers.



Sibanda, a trained animal scientist and commercial beef farmer from Zimbabwe, became CEO of FANRPAN in 2004 and has been a researcher and advocate in southern Africa for years. FANRPAN focuses on food and agricultural policies to reduce poverty, improve food security and foster sustainable development

Dr. Lindiwe Majele Sibanda was the recipient of the 2013 Yara Prize.

in Africa. Sibanda developed the organization's current strategy and has helped FANRPAN grow as a policy research and advocacy organization with a global voice, focusing especially on female farmers and youth. In addition to being a member of CIMMYT's Board of Trustees, she chairs the International Livestock Research Institute Board of Trustees.

"Advocacy is something that is close to my heart and I'm passionate about it," Sibanda told the publication *Africa Green Media* after winning the award. "I am an animal scientist by training, but this passion for policy advocacy developed when I realized that we were failing to put research into use."

MasAgro Posters Recognized at International Conference

Two posters developed by scientists from CIMMYT, UACH and the National Polytechnic Institute (IPN) as part of maize quality collaborative projects were recognized during the Fifth International Nixtamalization Conference in Monterrey, Nuevo León, Mexico. Nixtamalization is a method of processing maize. The poster "Nixtamalized flour mixtures



for tortillas," a collaboration between UACH and CIMMYT, won second place, while third place went to the IPN and CIMMYT poster "Effect of the traditional and extruded nixtamalization process on yellow maize carotenoids." The conference's supervising committee evaluated 40 posters for coherence with research objectives and clarity in explanation and design.

CIMMYT Wheat Breeder Receives Award from President of Iran

Hassan Rouhani, President of the Islamic Republic of Iran, presented a plaque of recognition to CIMMYT wheat breeder M.R. Jalal Kamali for his long service to the country in cereal improvement and promotion of scientific and sustainable agricultural production and contributions to



farmers in Iran. Kamali received the award at the 4th Congress of the Farmers House of Iran, held in Tehran on October 28. The Farmers House of Iran serves farmers by representing their interests and promoting sustainable agriculture. More than 600 farmers and officials from throughout the country



CIMMYT wheat breeder M.R. Jalal Kamali was honored by the Islamic Republic of Iran.

attended the ceremony, which was broadcast on national TV networks.

Kamali, principal scientist in the GWP, came to CIMMYT in 2007. He has worked for more than 37 years in cereal seed improvement in Iran and has contributed to the release of seven bread wheat cultivars. He was previously recognized by various organizations, including the Crop Science Society of Iran in 2012.

Wheat Researchers Receive Fellowships

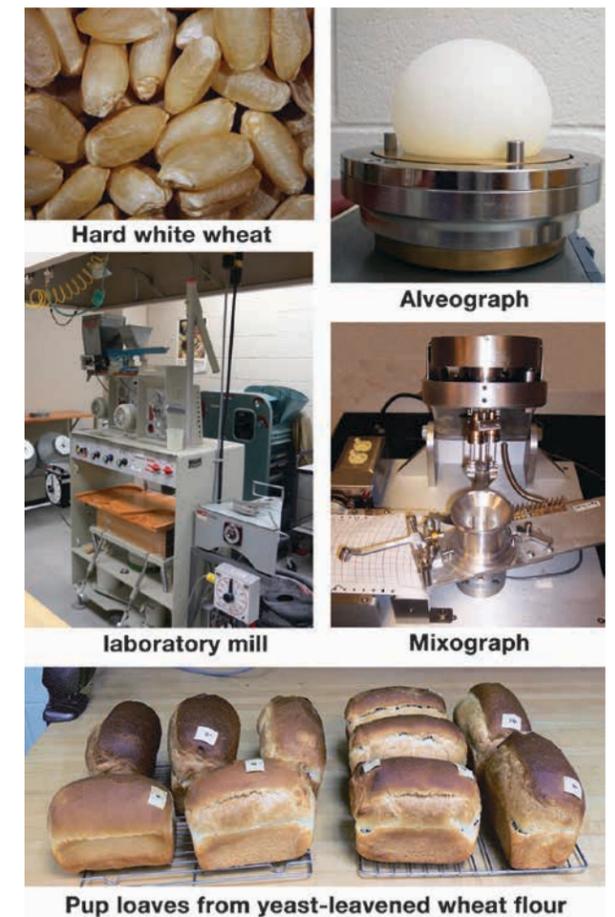
Two CIMMYT scientists received prestigious fellowships. Wheat physiologist Matthew Reynolds (below, left) became a fellow of the Crop Science Society of America (CSSA) while wheat breeder Zhonghu He (below, right) received a fellowship from the American Society of Agronomy (ASA).



The fellowships are the highest recognition bestowed by the societies, whose members nominate worthy colleagues based on their professional achievements and meritorious service. The awards were based on professional achievements and are only awarded to the top 0.3 percent of each society. He, based in China, was promoted to CIMMYT distinguished scientist in 2012 and received the CSSA fellowship in 2009. Reynolds is based in Mexico and received the ASA fellowship in 2011.

CIMMYT-KSU Research Recognized

Collaborative research between CIMMYT and KSU was recognized during the 2013 annual meetings of the ASA, CSSA and the Soil Science Society of America. KSU student Sarah Battenfield's poster "Applying Genomic Selection to CIMMYT Spring Wheat for End-Use Quality" (below) won third place in the CSSA Plant Breeding and Genetics Division C-01 Graduate Student Poster Competition.



Hard white wheat

Alveograph

laboratory mill

Mixograph

Pup loaves from yeast-leavened wheat flour

CIMMYT Financial Overview

Top Donors in 2013 (in millions of U.S. Dollars)

SAGARPA	33,824
CGIAR	30,714
Carlos Slim Foundation	20,379
USAID	19,960
Bill & Melinda Gates Foundation	18,655
Australian Centre for International Agricultural Research	9,208
Cornell University	3,708
International Rice Research Institute	3,642
Swiss Agency for Development and Cooperation	3,582
Syngenta Foundation for Sustainable Agriculture	2,990
HarvestPlus	2,752
Germany	2,212

Table 1. Statement of Financial Position, 2013 and 2012

As of December 31, 2013 and 2012
(Thousands of U.S. Dollars)

ASSETS	2013	2012
Current Assets		
Cash and cash equivalents	59,960	63,637
Cash set aside due to Generation Challenge Programme	7,061	8,852
Accounts receivable:		
Donors – Net	19,217	11,448
CGIAR Centers	7,261	4,305
Other	6,754	3,050
Allowance for doubtful accounts	(5,026)	(4,655)
Inventory and supplies	1,503	1,024
Less allowance for obsolescence	(45)	(53)
Total current assets	96,685	87,608
Non-current assets		
Property and Equipment, net	26,664	41,409
Prepaid rent – ICRAF Nairobi		500
Total non-current assets	27,164	41,409
Total Assets	123,849	129,017
LIABILITIES AND NET ASSETS		
Current Liabilities		
Current portion of labor obligation	670	376
Accounts payable:		
Donors	31,288	40,034
CGIAR Centers	815	7,496
Generation Challenge Programme	7,643	8,852
Other	11,646	9,081
Accruals and provisions	1,490	48
Total current liabilities	53,552	65,887
Non-Current Liabilities		
Employee termination benefits	11,247	8,803
Provisions	997	1,228
Total non-current liabilities	12,244	10,031
Total Liabilities	65,796	75,918
Net Assets		
Unrestricted:		
Designated	26,664	41,409
Undesignated	31,389	11,690
Total unrestricted net assets	58,053	53,099
TOTAL LIABILITIES AND NET ASSETS	123,849	129,017

2013 and 2012 Financial Statements

A summary of the combined statements of activities and changes in net assets and combined statements of financial position for CIMMYT, Int. and CIMMYT, A.C. is set out in Table 1. Total revenues for 2012 amounted to \$123.5 million and \$167.7 million in 2013.

Total net assets increased by \$5.9 million in 2012, to \$53.1 million, and by \$4.9 million in 2013, to \$58.0 million. Unappropriated, unrestricted net assets decreased to \$11.7 million in 2012 and increased to \$31.4 million in 2013.

Combined Statement of Activities

As of December 31, 2013 and 2012
(Thousands of U.S. Dollars)

	2013	2012
Revenue and Gains		
Grant Revenue	166,442	122,407
Other Revenue and Gains	1,219	1,117
Total Revenue and Gains	167,661	123,524
Expenses and Losses		
Research Expenses	150,038	108,932
General and Administration Expenses	12,069	8,650
Other Losses	568	14
Sub-total	162,675	117,596
Indirect Cost Recovery	-	-
Total Expenses and Losses	162,675	117,596
Surplus (Deficit)	4,986	5,928
Expenses by Natural Classification		
Personnel	45,927	33,340
Collaborators – CGIAR Centers	11,619	7,534
Other collaboration	34,527	28,716
Supplies and Services	35,030	28,185
Travel	6,409	5,356
Depreciation	29,163	14,464
Sub-total Expenses and Losses	162,675	117,596
Indirect Cost Recovery	-	-
Total Operating Expenses	162,675	117,596

2013 and 2012 Funding Overview

Total funding for 2012 was \$123.5 million and \$167.6 million in 2013. This included other income of \$1.1 million in 2012 and \$1.2 million in 2013. Grant income amounted to \$122.4 million in 2012, comprising \$0.1 million in unrestricted grants and \$122.3 million in restricted grants (Table 2). For 2013, grant income amounted to \$166.4 million, comprised entirely of restricted grants.

Table 2: Schedule of Grant Revenue

For the years ended December 31, 2013 and 2012
(Thousands of U.S. Dollars)

Donors	2013	2012
Unrestricted		
China		130
Philippines	4	8
South Africa		(50)
Subtotal – Unrestricted	4	88
Restricted		
CRP on Wheat	11,462	12,012
CRP on Maize	13,932	13,365
CRP on Climate Change, Agriculture and Food Security	3,945	3,169
CRP for Genebanks	943	894
CRP on Policies, Institutions and Markets	323	
IWMI/CAAFS – Climate-Smart Villages	109	20
African Agricultural Technology Foundation	2,284	1,889
Agrovegetal, S.A.	157	135
AgroBio, Mexico	-	68
Australia		
Australian Centre for International Agricultural Research	9,208	7,817
Grains Research and Development Corporation	949	1,355
Bayer Crop Science	-	90
Bill & Melinda Gates Foundation	18,655	15,222
Brazil	4	4
Canada		
Department of International Development	1,199	873
Alberta Agriculture, Food and Rural Development	82	91
CGIAR		
International Center for Tropical Agriculture (CIAT)	62	28
International Center for Agricultural Research in the Dry Areas (ICARDA)	9	51
World Agroforestry Center (ICRAF)	154	-
International Center for Research in the Semi-Arid Tropics (ICRISAT)	134	34
International Food Policy Research Institute (IFPRI)	258	161
International Livestock Research Institute (ILRI)	-	140
Bioversity International	84	137
International Rice Research Institute (IRRI)	3,642	4,312
International Institute of Tropical Agriculture (IITA)	484	492

Donors	2013	2012
Restricted		
Challenge Programmes		
Generation	493	729
HarvestPlus	2,752	2,267
China	262	284
Colombia	-	4
Federación Nacional de Cafeteros de Colombia (FEDERACAFE)	86	32
Cornell University	3,708	4,211
European Commission	153	43
Food and Agriculture Organization of the United Nations	100	140
Fontagro	32	6
Germany	2,212	1,087
University of Hohenheim	25	-
Global Crop Diversity Trust	551	345
GRM International Limited	2	204
Howard G. Buffett Foundation	-	4
IDE-UK	290	176
India	676	342
International Fund for Agricultural Development (IFAD)	1,619	1,419
Iran, Islamic Republic of	265	175
Japan		
Economic Cooperation Bureau, Ministry of Foreign Affairs	98	303
Japan International Research Center for Agricultural Sciences	355	220
Kazakhstan, Republic of	231	55
Korea, Republic of	190	46
Mexico		
Instituto Carlos Slim de la Salud	20,379	3,052
Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias (INIFAP)	195	228
Patronato para la Investigación y Experimentación Agrícola del Estado de Sonora	-	83
Secretaría de Agricultura, Ganadería, Desarrollo Rural y Pesca (SAGARPA)	33,824	30,932
Fundacion Sonora	157	47
Seed Companies	271	220
National University of Lesotho	(66)	40
OPEC Fund for International Development	21	130
Peru	125	98
Pioneer Hi-Bred International	44	42
Switzerland	3,582	2,967
Syngenta Foundation For Sustainable Agriculture	2,990	1,694
Turkey, Republic of (MARA)	230	269
United States of America		
United States Agency for International Development	19,960	4,977
United States Department of Agriculture	1,570	2,591
United Nations University	-	13
University of Tennessee	79	-
Vilmorin	229	166
World Bank	17	125
Miscellaneous Research Grants	651	194
Subtotal	166,438	122,319
Total Grants – Donors Unrestricted and Restricted	166,442	122,407

Donors and Partners

A partial list of valued donors and partners during 2013.



Trustees and Management Committee

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John Innes Foundation Emeritus Fellow, United Kingdom.
- Pedro Brajcich Gallegos** (Mexico) (ex officio member)
Vice-Chair, Board of Trustees
Director General of Agricultural Research, National Institute of Forestry, Agricultural and Livestock Research (INIFAP), Mexico.
- Nicole Birell** (Australia)
Director – SMS Management & Technology Ltd., Superpartners Pty Ltd. & Wheat Quality Australia Pty Ltd., Australia.
- Cornelis F. Broekhuijse** (The Netherlands)
Financial Management, USA.
- Alfonso Cebrenos Murillo** (Mexico)
Director of Government Relations, Maseca Group, Mexico.
- Neal Gutterson** (USA)
Vice President of Agricultural Biotechnology, DuPont Pioneer, USA.
- Thomas A. Lumpkin** (USA) (ex officio member)
Director General, CIMMYT.
- Enrique Martínez y Martínez** (Mexico) (ex officio member)
Secretary of Agriculture, Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA), Mexico.
- Rita Mumm** (USA)
Associate Professor, Emerita, Quantitative Genetics and Plant Breeding, University of Illinois Urbana-Champaign, USA.
- Matin Qaim** (Germany)
Department of Agricultural Economics and Rural Development, Georg-August-University of Goettingen, Germany.
- Bob Semple** (Ireland)
Director of Suas and Global Standards 1, Ireland.
- Lindiwe Majele Sibanda** (Zimbabwe)
Chief Executive Officer and Head of Diplomatic Mission, Food, Agriculture and Natural Resources Policy Analysis Network (FANRPAN), South Africa.
- Manuel Villa Issa** (Mexico) (ex officio member)
Coordinator for Research, Innovation and Partnerships, National Institute of Forestry, Agricultural and Livestock Research (INIFAP), Mexico.

Management Committee

- Thomas A. Lumpkin**¹, Director General (t.lumpkin@cgiar.org)
- Marianne Bänziger**, Deputy Director General for Research and Partnerships (m.banziger@cgiar.org)
- Thomas W. Short**², Deputy Director General for Corporate Services (t.short@cgiar.org)
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- Anna Herremans**³, Director, International Finance
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Acronyms and Abbreviations

2WT	Two-wheel tractors	ICRISAT	International Center for Research in the Semi-Arid Tropics
ACIAR	Australian Centre for International Agricultural Research	ICT	information and communications technology
AFP	axial flow pump	IDE	International Development Enterprises
AIFSC	Australian International Food Security Centre	IFAD	International Fund for Agricultural Development
AIP	Agricultural Innovation Program	IFPRI	International Food Policy Research Institute
ANEP	Agriculture, Nutrition and Extension Project	IITA	International Institute of Tropical Agriculture
AR4D	agricultural research for development	ILRI	International Livestock Research Institute
ARIA	Agricultural Research Institute of Afghanistan	IMAS	Improved Maize for African Soils project
AusAID	Australian Agency for International Development	IPNI	International Plant Nutrition Institute
BGRI	Borlaug Global Rust Initiative	IRMA	Insect-Resistant Maize for Africa project
BISA	Borlaug Institute for South Asia	IRRI	International Rice Research Institute
BMGF	Bill & Melinda Gates Foundation	IWWIP	International Winter Wheat Improvement Program
CA	conservation agriculture	IWYP	International Wheat Yield Partnership
CAAS	Chinese Academy of Agricultural Sciences	JICA	Japan International Cooperation Agency
CASFESA	Conservation Agriculture and Smallholder Farmers in Eastern and Southern Africa	KARI	Kenya Agriculture Research Institute
CBSP	community-based seed production	KB	Karnal bunt
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security	kg	kilogram
CENEB	<i>Centro Experimental Norman E. Borlaug</i>	MAIL	Ministry of Agriculture, Irrigation and Livestock (Afghanistan)
CRP	CGIAR Research Program	MAIZE	CGIAR Research Program on MAIZE
CSISA	Cereal System Initiative for South Asia	MasAgro	Sustainable Modernization of Traditional Agriculture
CSISA-MI	Cereal Systems Initiative for South Asia-Mechanization and Irrigation project	MLN	maize lethal necrosis
DFATD	Department of Foreign Affairs, Trade and Development (Canada)	MoA	Ministry of Agriculture
DFID	Department for International Development (UK)	NARC	National Agricultural Research Center (Pakistan)
DH	doubled haploid	NARC	Nepal Agricultural Research Council
DRC	Democratic Republic of Congo	NARS	national agricultural research systems
DST	decision support tool	NGO	non-governmental organization
DTMA	Drought Tolerant Maize for Africa project	NUE	nitrogen use efficiency/nutrient use efficiency
DWR	Directorate of Wheat Research (India)	NuME	Nutritious Maize for Ethiopia project
EGSP	Effective Grain Storage for Sustainable Livelihoods of African Farmers	OPV	open-pollinated variety
EIAR	Ethiopian Institute of Agricultural Research	OSS	Office of Special Studies
EU	European Union	PARC	Pakistan Agricultural Research Council
FACASI	Farm Mechanization and Conservation Agriculture for Sustainable Intensification project	PPP	public-private partnership
FAO	Food and Agriculture Organization of the United Nations	QPM	quality protein maize
FHH	female-headed households	R&D	research and development
FTF	Feed the Future	SAG	Secretary of Agriculture and Livestock (Mexico)
GCAP	Global Conservation Agriculture Program	SFSA	Syngenta Foundation for Sustainable Agriculture
GM(O)	genetically modified (organism)	SAGARPA	Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (Mexico)
GMP	Global Maize Program	SeeD	Seeds of Discovery project
GRiSP	Global Rice Science Partnership	SDC	Swiss Agency for Development and Cooperation
GWP	Global Wheat Program	SIMLESA	Sustainable Intensification of Maize and Legume Cropping Systems in Southern and Eastern Africa project
ha	hectare	SSA	Sub-Saharan Africa
HMRP	Hill Maize Research Project	UACH	Chapingo Autonomous University
HTMA	Heat Tolerant Maize for Asia project	USAID	United States Agency for International Development
IARI	Indian Agricultural Research Institute	USDA	United States Department of Agriculture
ICAR	Indian Council of Agricultural Research	WEMA	Water Efficient Maize for Africa project
ICARDA	International Center for Agricultural Research in the Dry Areas	WHEAT	CGIAR Research Program on WHEAT
		WPEP	Wheat Productivity Enhancement Project
		ZARI	Zambia Agricultural Research Institute

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Cover: Tanzanian farmers use the engine of a two-wheel tractor to power a maize shelling machine. Photo: Frédéric Baudron/CIMMYT.

Back Cover: A smallholder farmer uses a mechanized reaper to harvest wheat in Gopalganj District of Bangladesh. Photo: Ranak Martin for CIMMYT.

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