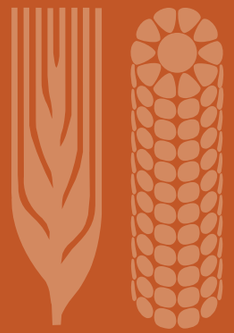
ANNUAL REPORT

maize and wheat for future climates

CIMMYT MR
International Maize and Wheat Improvement Center

Fact: Graphic designer Lance Wyman was born in Newark, New Jersey, USA, in 1937. His innovative logo and icon designs solidly established him as a leader in his field. His famous works include the Mexico 1968 Olympic Games logo and the U.S. Bicentennial Logo among hundreds of other notable designs. In 1970, Wyman created the CIMMYT maize and wheat icons, which are still in use nearly 50 years later.



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

SUSTAINABLE DEVELOPMENT GOALS

On September 24, 2013, the newly formed United Nations (UN) High-level Political Forum on Sustainable Development held its first meeting. At the Rio+20 Conference, Member States also agreed to launch a process to develop a set of Sustainable Development Goals (SDGs), which were to build upon the Millennium Development Goals (MGDs) that were established in 2000 and expired in 2015.

Of the 17 individual goals, 10 relate directly to CGIAR activities and to CIMMYT's mandate. The SDGs have set the pathway for the next 15 years of agricultural, social and economic development. Likewise, CGIAR has transformed its approach to ensure that its work aligns with the ambitious goals.

CIMMYT, through its research for development activities, is working toward a world free of poverty, hunger and environmental degradation. CIMMYT and CGIAR efforts help bring the world closer to reaching the goals, such as the empowerment of women, the reduction of greenhouse gas emissions and improvement of health and nutrition for the world's poorest people.

In this issue, SDG icons attached to each story help signal how CIMMYT's work ties to the SDGs.

Contents

Message from the Chair of the Board of Trustees

CIMMYT Trustees (left to right): Rita Mumm, Harry de Roo, Martin Kropff, William (Bill) Angus, Paul Struik (visiting ICARDA board member), Nicole Birrell, Neal Gutterson, Ramesh Chand, Feng Feng, Bob Semple, Bongiwe Njobe and Luis Fernando Flores Lui. Not pictured: Raúl Gerardo Obando Rodríguez and José Eduardo Calzada Rovirosa.

The next half century: Taking the legacy forward

In October 2016, I had the immense honor of taking over from John Snape, who made tremendous contributions as the chair of CIMMYT's Board of Trustees. This change occurred at a particularly auspicious time in the Center's history, as the depth and breadth of partnerships and donor support had just been evidenced in multiple events marking the Center's 50th anniversary. These events showcased CIMMYT's unique and distinctive comparative advantage in applying maize and wheat science to improve livelihoods.

As shown in the reports that follow and in the new "Strategic Plan 2017-2022: Improving Livelihoods through Maize and Wheat Science," activities and outputs directly address efforts to meet key U.N. Sustainable Development Goals. In particular, they target critical challenges of food insecurity and malnutrition, climate change and environmental degradation.

The board takes a keen interest in the continuous improvement of Center scientific and corporate processes, its ability to respond to new and existing threats and to take advantage of emerging opportunities for partnerships and collaborations. To enhance the Center's effectiveness, transparency and accountability, management is strengthening project management, with a focus on monitoring, evaluation, learning, and improving internal communications.

"… management is strengthening project management, with a focus on monitoring, evaluation, learning, and improving internal communications. "

CIMMYT also played a significant role in the CGIAR's 2016 transformation, with donors uniting to ensure that food and nutrition security can be realized through research with impact.

As we enter the next 50 years in CIMMYT's history, I take this opportunity to thank our worldwide donors, collaborators, fellow board members, management committee, scientists and staff for their commitment and dedication to CIMMYT's mission.

Nicole L. Birrell
Chair, Board of Trustees

Director General Martin Kropff and Nicole Birrell present a plaque to outgoing Board Chair John Snape.

Message from the

Director General

CIMMYT at 50: New pathways to sustainable food and nutritional security

In 2016, CIMMYT marked 50 years of applying excellence in maize and wheat science to improve the livelihoods of the disadvantaged. The work has brought remarkable returns on the funding we receive. A study published this year showed that as many as 63 percent of wheat varieties grown by farmers worldwide carry genetic contributions from the breeding programs of CIMMYT or of the International Center for Agricultural Research in the Dry Areas (ICARDA). Additionally, it showed that global use of the Centers' wheat lines brings annual economic benefits as high as $3.1 billion, even by conservative estimates.

However, sobering concerns put any self-congratulatory impulse on hold. In 2016, news reports described the tragic effects of severe drought in Africa caused by the El Niño weather system. Worsening political instability in 2016 affected development initiatives in several countries whose inhabitants already suffered from chronic poverty and conflict.

Dominating our awareness as well are several weighty facts: 800 million people go hungry today and, by 2030, projections indicate there will be 8.4 billion people to feed – 1 billion more than at present. While we do what we can to increase yields of two of the world's key staple crops, achieving widespread food and nutritional security is more complex than simply boosting production.

Martin Kropff hosts Mexico's Secretary of Agriculture, José Eduardo Calzada Rovirosa.

Key collaborations and science

CIMMYT pursues strong partnerships and better science to create and share innovations that farmers can use now and in the future to grow more, earn more and reduce environmental impacts. Highlights from 2016 included these examples:

- Biofortification research to raise zinc and iron content in maize and wheat grain resulted in the release of zinc-enhanced wheat varieties embraced by farmers in India and Pakistan, to help improve the nutrition of low-income wheat eaters.
- In eastern Africa, CIMMYT and its partners released five new varieties that resist maize lethal necrosis, bringing security to maize farmers with crops affected by the disease.
- With models predicting rising temperatures in South Asia, CIMMYT has intensified work with partners to produce affordable drought- and heat-tolerant maize seed for the region's farmers.
- CIMMYT and Henan Agricultural University in China jointly launched a new maize and wheat research center in the historic Yellow River Valley.
- To deliver new heat-tolerant and disease-resistant wheat varieties, CIMMYT has expanded work in advanced physiological breeding, high-throughput phenotyping, and drawing out genetic traits from heirloom varieties and native grasses.
- Conservation agriculture and drought-tolerant maize varieties from CIMMYT were used by many farmers in southern Africa to obtain harvests even during the El Niño drought.
- The Center helped to develop and now leads the new CGIAR "Excellence in Breeding Platform," designed to modernize crop and livestock breeding and increase its impact on food and nutrition security, climate change adaptation and development.

China's Vice Premier Liu Yandong visits CIMMYT.

Taking stock and mapping a course

As part of CIMMYT 50th anniversary celebrations, more than 500 distinguished representatives of diverse partner and donor institutions, among them 5 ministers of agriculture, took part in a 3-day conference to reflect on CIMMYT's past and plan for the future. Outcomes are reflected in the Center's new Strategic Plan 2017-2022. The strategy aims to better enable maize and wheat agri-food systems to produce more using less land and inputs, create sustainable livelihood opportunities for farmers, support healthy and nutritious diets, mitigate and adapt to climate change and foster equitable access for women and marginalized groups to knowledge, markets, technology and training.

Those goals entail enormous challenges. Still, we are confident of success with the ongoing commitment and support of dedicated staff, partners and donors.

Sincerely,

Martin Kropff

CIMMYT in 2016

Farmers reached:

More than

18,000,000

through improved maize and wheat system farming practices

Publications:

Global Maize and Global Wheat Program scientists were authors for

286 publications

Trainings:

64,000+

farmers, scientists, technicians and other partners trained in over

20 countries

through MAIZE and WHEAT

Partners:

300+

MAIZE and WHEAT partners

Maize and wheat seed distribution:

795
shipments

40.6
tons

sent to over

80
countries

"CIMMYT News" online newsletter:

236 news articles | **21** news editions

"CIMMYT News" top article:

Maize: From Mexico to the world

4,200+ page visits

"CIMMYT News" top video:

Nixtamalization Video Series

118,000+ YouTube views

CIMMYT First:

"Save a Seed" campaign

The Save a Seed crowdfunding campaign **raised over $50,000** to support the maize and wheat germplasm bank's seed collection and distribution.

CIMMYT social media content generated:

104,000 engagements | **25,000** link clicks

Social media highlight:

CIMMYT50 Conference Day 1 Photo gallery

15,600 people reached

8,600 engagements

Staff and visitors pause for a photo during the 3-day event in Mexico.

turning research into impact

To mark 50 years of applying maize and wheat science to improve livelihoods, CIMMYT held events for celebration and reflection throughout 2016, including a momentous September gathering in Mexico. In celebrations organized by the CIMMYT offices in Kenya and Zimbabwe in April, distinguished participants enjoyed first-hand tours of research activities and provided input on plans for strengthening maize and wheat agri-food systems through partnerships in the sub-Saharan Africa.

"When we speak about Africa's Green Revolution, it cannot take place without the improved varieties developed by CIMMYT and its partners," said Willy Bett, Cabinet Secretary, Ministry of Agriculture, Livestock and Fisheries, Kenya.

September events in Mexico opened with field and laboratory visits at CIMMYT headquarters and moved to a two-day, high-level conference in Mexico City. Presentations and discussions there acknowledged CIMMYT and CGIAR's considerable impacts but also highlighted critical food security gaps and the intensifying social and environmental challenges facing agriculture, including climate change and the need to focus on better nutrition and health.

"Without a CGIAR there would be 100 countries in conflict and not the 60 that we know today," said Juergen Voegele, Senior Director, Agriculture Global Practice, World Bank, and CGIAR System Council Chair, speaking to an audience of over 500 CIMMYT employees, donor representatives and partners and dignitaries, including the Ministers of Agriculture of Bangladesh, Chile, Kenya, Mexico and Pakistan. "The CGIAR has a major role to play in ensuring nutrition security and peace and conflict resolution."


Vijay Chaikam, CIMMYT maize scientist, explains doubled haploids and their value in breeding research to visitors at the Kenya CIMMYT50 celebrations.

During the conference CIMMYT and DuPont Pioneer signed a Master Alliance Agreement on the use of CRISPR-Cas gene editing technology to jointly develop improved crops with traits of interest for smallholder farmers.

In its 50th year CIMMYT achieved an organizational first, launching the online crowdfunding campaign 'Save a Seed' that allowed everyone an opportunity to be part of a food secure future and support the Maize and Wheat Germplasm Bank.

Deputy Director General Marianne Bänziger, Director General Martin Kropff and Knowledge Management Head Richard Fulss cut the ribbon to officially open the CIMMYT Museum.

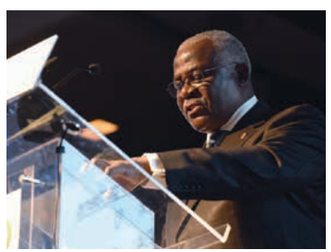
Celebrations in India, home of the Green Revolution, included ceremonies and talks during the First International Agrobiodiversity Congress.

Looking back to CIMMYT's origins as an international center in 1966, the individuals who signed the launch agreement concurred that the institute "...should become a focal point for joining the critical battle now underway to provide enough food for the rapidly increasing population of the world."

According to Martin Kropff, CIMMYT director general, the Center's founders would probably agree that CIMMYT has gone a long way toward fulfilling their lofty aspirations. "But a modern CIMMYT is still needed," Kropff said, "based on the original ideal of international collaboration in agricultural research for development."

(left to right page): Juergen Voegele from **World Bank** Agriculture Global Practice discusses the future of agricultural development investment; Tony Cavalieri from the **Bill & Melinda Gates Foundation** speaks during a panel session; Lindiwe Majele Sibanda from **FANRPAN** talks about malnutrition and gender; Kanayo Nwanze from **IFAD** speaks on the role of smallholder producers; Nora Lapitan from **USAID** speaks during a discussion panel.




RESEARCH PROGRAM ON Wheat

RESEARCH PROGRAM ON Maize

CGIAR Research Programs on

maize and wheat

The two CGIAR Research Programs (CRPs) known as MAIZE and WHEAT and led by CIMMYT are international collaborations involving hundreds of partners worldwide. The MAIZE CRP focuses on increasing production for 900 million poor consumers in Africa, South Asia and Latin America with the overarching goals of doubling maize productivity and increasing incomes and livelihood opportunities from sustainable, maize-based farming systems. WHEAT couples advanced science with field-level research and extension in lower- and middle-income countries, working with public and private organizations to raise the productivity, production and affordable availability of wheat agri-food systems for 2.5 billion resource-poor consumers in 89 countries. Following a successful initial period (2011-2016), both CRPs received CGIAR and donor approval for an additional phase.

WHEAT: One-stop source of productivity, resilience, and farm-level technologies

A total of 48 bread wheat, 10 durum wheat and one winter wheat varieties released by WHEAT partners in 18 developing countries in 2016 were either CIMMYT or ICARDA breeding lines or direct crosses with such lines. In 2016, CIMMYT alone distributed 14.5 tons of seed of experimental wheat lines in 306 shipments to 284 partners in 83 countries. Years of biofortification research and breeding bore fruit in the form of three high-yielding, zinc-enhanced varieties

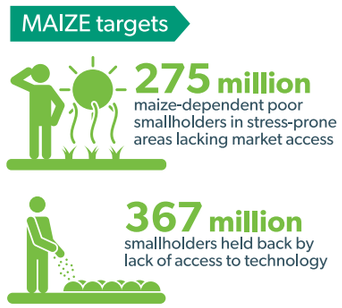
released by partners for use by farmers in South Asia. As part of an emergency response funded by the United States Agency for International Development (USAID) and its Office of U.S. Foreign Disaster Assistance, CIMMYT rapidly procured emergency supplies of maize and wheat seed for free distribution to more than 226,000 households in 67 counties of Ethiopia, benefitting more than 1.3 million people whose seed was lost from the drought. A study showed that the Turkey-CIMMYT-ICARDA International Winter Wheat Improvement Program (IWWIP) had contributed to the development and release of 61 varieties sown on some 1.8 million hectares, as of 2016.

GENNOVATE, a cross-CRP initiative focused on gender equality, completed data collection and coded data for 137 case studies on 7,000 rural men and women in 26 countries. Among the preliminary findings for wheat farming systems is that, although women of all ages still lack equal access to education or training, many men in various countries are now seeing the advantages of involving women in farm decisions.

Thanks to the joint efforts of national scientists, farmers, government, cooperation with the U.N. Food and Agriculture Organization (FAO), World Bank and other international organizations, the wheat area under zero tillage in Kazakhstan increased from virtually none in 2000 to 2.3 million hectares in 2016, providing an additional 0.72 million tons of grain in drought years and contributing to the annual sequestration of about 1.3 million tons of carbon dioxide.

MAIZE: High yields, stress tolerance and climate-smart practices

MAIZE made strong progress on both of its research strategies: stress-resilient and nutritious maize and sustainable intensification of maize-based systems. At least 5.6 million hectares were under improved MAIZE-derived technologies or management practices, directly reaching more than 11.4 million smallholder farmers. In total,



111 improved maize varieties, based on germplasm from CIMMYT or the International Institute of Tropical Agriculture (IITA), were released through MAIZE partners in 2016, including 76 in sub-Saharan Africa, 27 in Latin America and 8 in Asia. In addition to high and stable yield potential, special traits stacked in these varieties include drought tolerance, nitrogen use efficiency, tar spot complex resistance, enhanced protein quality, and resistance to tar spot complex, ear rot, mycotoxin production, and Turcicum leaf blight.

Across South Asia, MAIZE scientists under the Heat Tolerant Maize for Asia project licensed 20 new hybrids to public and private partners and 12 new seed companies, including 5 each from Pakistan and Bangladesh and 2 from Nepal, signed research collaboration agreements to join the project.

MAIZE scientists are promoting climate-smart technologies such as conservation agriculture and drought-tolerant maize varieties to adapt to the negative effects of climate variability and to increase smallholder farmers' productivity. Malawi maize farmers were able to harvest more in 2016 while spending 35 to 45 fewer days of labor through conservation agriculture farming practices such as direct seeding, in place of conventional ridging and traditional weed control strategies.

MAIZE and WHEAT are grateful to the generous CGIAR Window 2 donors that support their work, including Australia, China, Mexico, South Africa, the United Kingdom's Department for International Development, and the United States Agency for International Development, as well as all Window 1 donors: Australia, the Bill & Melinda Gates Foundation, Canada, France, India, Japan, Korea, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and World Bank. Principal research partners for MAIZE and WHEAT are the International Institute of Tropical Agriculture and the International Center for Agricultural Research in the Dry Areas. For more information, visit www.maize.org or www.wheat.org.

Wheat versus chaff:

Is the gluten-free diet fad waning?

An anti-wheat movement inspired by populist claims that gluten is bad for human health rumbles on, but scientists are now leading a strong campaign to refute trendy claims and promote the many nutritional benefits of wheat.

A vital food providing 20 percent of calories and protein in the human diet worldwide, wheat has taken a reputational beating from celebrity doctors who say it is responsible for causing obesity, mental malaise and other negative health conditions.

Scientists are concerned that false claims maligning wheat will lead to further food insecurity and poor health for low-income consumers with wheat-based diets who may reject this staple food due to misinformation.

A customer chooses bread in a small shop in Dinajpur, Bangladesh.

Such assertions in "Wheat Belly" by William Davis (2011) and "Grain Brain" by David Perlmutter (2013) run counter to current medical and nutritional advice in international dietary guidelines established by FAO and the World Health Organization (WHO).

Much of the anti-wheat argument hinges on claims that the properties of current wheat varieties are somehow different and less healthy than the "ancient" wheat grains first grown and consumed 9,000 years ago, due to scientific intervention, according to Carlos Guzmán, head of the wheat chemistry and quality laboratory at CIMMYT.

"Since the anti-gluten movement began, scientific reports have shown that, contrary to claims stating otherwise, commercially available wheat does not lead to weight gains or chronic disease, and it's certainly not transgenic," said Guzmán.

Apart from the estimated 1 percent of populations in Europe and the United States with celiac disease and an estimated 5 to 10 percent who have gluten sensitivity, wheat is safe and healthy to eat, according to the authors of "Does Wheat Make Us Fat and Sick?", a study that appeared in the *Journal of Cereal Science*.

"In fact, the research shows that regularly eating whole grain products is healthy and associated with significantly less risk of developing type 2 diabetes, heart disease, and certain forms of cancer, and it can also help with long-term weight management," added Guzmán.

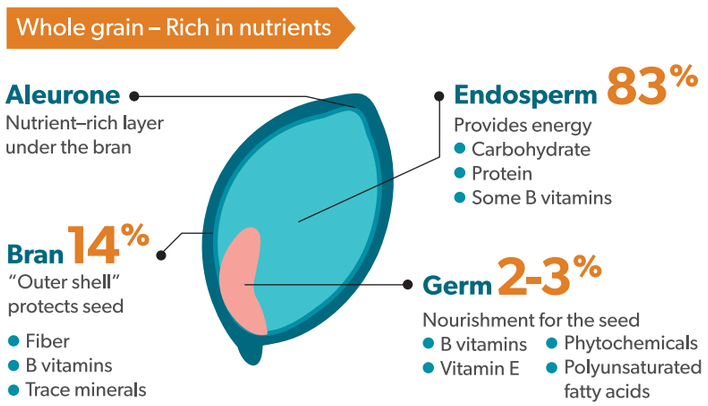
Guzmán works with scientists researching ancient grains and landraces, the predecessors to contemporary wheat that are estimated to be available in about 25,000 different forms. Bread wheat arose from the spontaneous, natural cross-pollination of a primitive wheat with a wild grass, rather than through any scientific intervention.

A recent study titled, "The contribution of wheat to human diet and health" argues that dietary fiber in wheat makes such a vital contribution to human health that research should focus on enhancing the characteristic through breeding.

Nutritionist Julie Miller Jones spoke at CIMMYT's 50th anniversary conference in September 2016, adding clout to the arguments in favor of whole grain consumption, pointing out benefits and showing how wheat surpasses beef in protein levels. Miller Jones argues that the key to weight loss and good health is to eat a healthy, balanced diet featuring smaller portions and to exercise.

Dietary fiber in wheat makes such a vital contribution to human health that research should focus on enhancing the characteristic through breeding

Julie Miller Jones discusses the myths and facts about the benefits of wheat and grain at CIMMYT50.



Zimbabwean farmer Appollonia Marutsvaka displays her heat- and drought-tolerant maize.

SDG 1 SDG 2 SDG 13

Maize for

dryer, hotter climates

New technologies such as drones are speeding up breeding to provide farmers with maize varieties that stand up to climate change. Despite severe drought in Zimbabwe, new maize varieties bred to withstand heat and drought have yielded twice as much as commercial varieties, helping farmers ensure household food security.

New maize varieties conventionally bred to withstand extreme weather are helping farmers stay one step ahead of climate change in sub-Saharan Africa.

Temperatures are increasing in Africa and the past three decades have been the warmest on record, according to the International Panel on Climate Change.

Farmers are especially feeling the heat in sub-Saharan Africa, where maize is the key staple food crop and nearly all of it is grown with increasingly erratic rainfall, rather than irrigation.

"We are no longer sure when to prepare the land for planting or when to start planting," said Appollonia Marutsvaka, a 62-year old farmer from Zaka, a rural village in Zimbabwe. "If the situation persists, then most of us who have small farms will sink deeper into poverty."

Concerned by the expected impact of increasing heat on African maize yields, CIMMYT researchers began breeding heat tolerance into maize five years ago, crossing their lines with sources of heat tolerance and selecting the best offspring.

In 2016, the new, hardy maize was put to the ultimate test by a severe regional drought, which was brought on by the El Niño weather phenomenon and described by the UN as the worst in decades.

"El Niño had a devastating impact on agricultural

production in southern Africa and high temperatures have been one of the biggest yield-reducing factors associated with El Niño, in many areas of Zimbabwe," said Jill Cairns, a senior maize physiologist at CIMMYT.

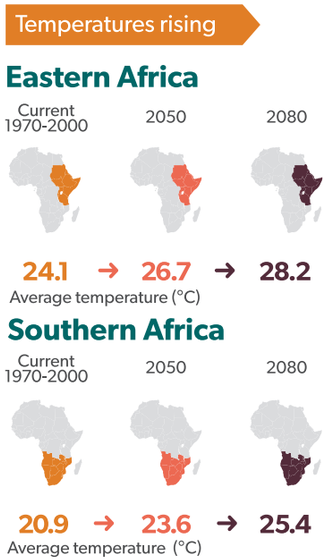
Marutsvaka tested CIMMYT's climate-smart maize and said it worked in her fields. Despite the harsh drought, she was able to harvest enough from the trial plot to round out grain stores in her household.

"In the past, I harvested nothing as my crops were literally burned by the scorching heat," she said. "During the 2015-2016 growing season, I realized almost 200 kilograms of white grain."

Overall, the on-farm trials showed that the heat- and drought-tolerant varieties yielded twice as much as current commercial maize varieties in a severe drought, so farmers who grow the new maize can improve their harvests even under difficult conditions.

The value of foresight

New crop varieties take years to develop, and the new heat- and drought-tolerant varieties would not be available if researchers had not started breeding for those traits, based on climate change projections back in 2011.



"If breeding had only started with demand, the first heat-tolerant varieties would not have been ready until 2021 and many more people would have gone hungry," Cairns said. "This underscores the need for breeding programs and investments to keep pace with the latest climate projections."

Most maize varieties grown in Africa were bred over 30 years ago for a much cooler climate. CIMMYT's maize breeders are working to speed up breeding efforts to help farmers stay ahead of climate change.


Maize breeder Nakayi Matongera compares the performance of heat- and drought- tolerant maize and varieties currently used in Zimbabwe.

"It is more than just a single variety, it's a process," said Cairns. "Our investments in breeding efficiency through new molecular and phenotyping tools helped us develop heat-tolerant varieties that yielded so well under El Niño in just five years."

Traditionally, varieties can take up to 20 years to reach farmers. However, new technologies, such as data from flying drones loaded with cameras and other sensors can cut the time to monitor crop health from days to minutes (see sidebar).

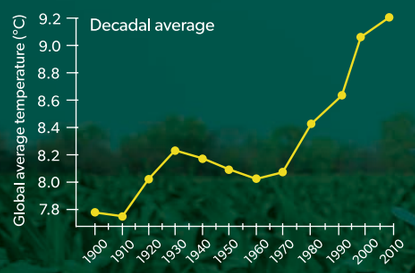
Maize breeders are working to speed up breeding efforts to help farmers stay ahead of climate change.

Scientists are also working in public and private partnerships to improve seed systems and speed the deployment of climate-ready varieties to farmers.

The importance of adapting African agriculture to climate change was highlighted at the 2016 Marrakech Climate Change Conference, and the story of heat-tolerant maize in Zimbabwe was shared as an example of how agriculture can adapt to a changing climate.

Maize breeding work in Africa is supported by the United States Agency for International Development, the Bill & Melinda Gates Foundation and the CGIAR Research Program on Maize.

Global climate change



Source: 2014. CRU 4.0, Harris et al.


Drones cut the time it takes to monitor crop health from days to minutes.

Revolutionizing crop observation tools

Focusing on the rapid advance in technologies to observe and record plant growth using technologies such as drones and automated sensors, 200 world-class scientists from over 20 countries gathered at CIMMYT headquarters in Mexico for the 4th International Plant Phenotyping Symposium.

Aiming to make breeding for food crops faster and more effective, experts shared news on the latest tools to measure plant traits and, combined with cutting-edge genetics and statistics, to sharpen their understanding of how crops adapt to the environment – a research area known as "phenotyping."

In addition to learning from each other's experiences, a half day was dedicated to drafting position papers on priority areas for future research and a keynote talk and discussion on harmonizing the many phenotyping platforms that have emerged in recent years.

CIMMYT partnered with the International Plant Phenotyping Network to organize the event.

SDG 6 SDG 12

Beating South Asia's water crisis

CIMMYT and partners are promoting ways to use South Asia's precious water more carefully and productively.

South Asia accounts for nearly a quarter of the world's food production but has access to less than 5 percent of its annual renewable water resources, with per capita water availability decreasing by nearly 70 percent since the 1960s. Yields of wheat, maize and rice in South Asia could decrease by as much as 30 percent over this century, unless farmers adopt innovations to mitigate rising temperatures and changing rainfall patterns.

With a large and growing population, declining arable land, escalating energy costs and intensifying groundwater scarcity in many areas, South Asia's food and nutritional security challenges typify those of lower- and middle-income regions worldwide: how to produce more food in a water-limited future.

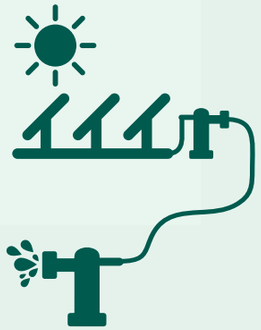
Pakistan

Poverty has been reduced for up to

20%

of farmers who switched to alternative energy sources for water pumping

Source: 2016. *Renewable and Sustainable Energy Reviews.*



Nepal

Lay-flat pipes boost water savings more than

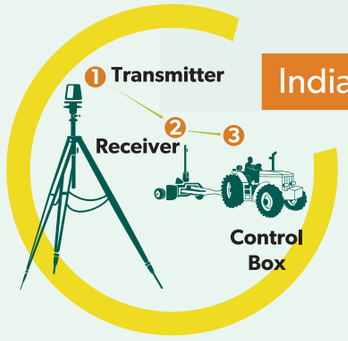
30%

Source: 2015. The International Food Policy Research Institute.

Map: Ground water stress

- *Low*
- *Low to medium*
- *High*
- *Extremely high*

Groundwater stress measures the ratio of groundwater withdrawal relative to its recharge over a given aquifer. Areas not highlighted either experience non-groundwater related water stress, or have no data available.



India

Precision land leveling can raise wheat yields more than

16%

with over 130% higher water productivity

Source: 2015. *Food Security.*

Map sources:
2017. World Resources Institute.
2015. FAO.
2008. CGIAR-CSI.

Bangladesh

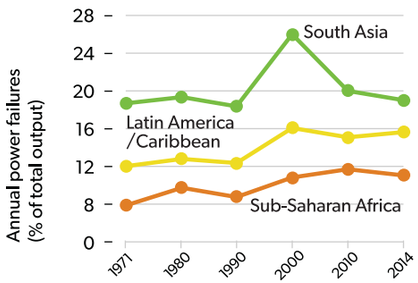
Surface water irrigation could generate over

$100 million of revenue annually

thanks to newly mapped rivers and canals.

Source: 2017. *Land Use Policy.*

Interruptions in electrical power supplies



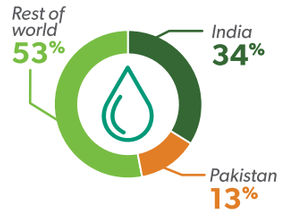
Power failures directly threaten food security as demand for electricity-powered irrigation grows.

While power outages have declined nearly 10% in South Asia since 2000, the region continues to have the most electricity disruptions in the world.

Sources: 2014. World Bank.

Diminishing water resources

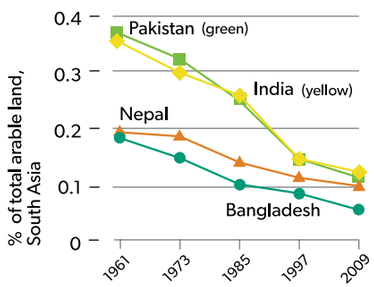
Global groundwater depletion for irrigation



Global groundwater withdrawals for irrigation rose over 20% from 2000 to 2010. Today, 70% of global water withdrawals are for agriculture.

Sources: 2017. World Bank. 2017. *Nature.*

Limited land for production



Arable land decline results from human and climatic factors including degradation, extreme weather, soil quality and urbanization.

Source: 2014. World Bank.

A Guatemalan farmer examines plants of his traditional maize varieties.

Storing and restoring priceless maize

seed collections in Guatemala

The CIMMYT maize germplasm bank serves as a backup for farmers and researchers in times of catastrophic seed loss by safeguarding maize genetic diversity, a crucial building block in global food security. CIMMYT also trains local and national seed bank staff in best practices to preserve maize genetic diversity.

Natural disasters can have a dramatic impact on crop genetic diversity, threatening local and global food security. When Hurricane Stan swept through Guatemala in 2005, leading to 1,500 deaths, many farmers lost entire crops. Some indigenous communities were unable to harvest seed from their traditional maize varieties, known as landraces.

Generations of selection by farmers under local conditions had endowed these varieties with resistance to drought, heat, local pests and diseases.

Conservation of diverse maize landraces in the Sierra de los Cuchumatanes region, Guatemala.

1,800
farmers benefitted
from community seed reserves through Buena Milpa

> ***"…International seed banks play a vital role as 'safe deposit boxes for the world'."***
>
> *Denise Costich*
> *Head, CIMMYT maize germplasm bank*

As the country struggled to rebuild and replant, it was found that the entire maize seed collection at Guatemala's national seed bank had been damaged by humidity that made the seeds vulnerable to insects and fungus and could not be replanted.

In 2016, drawing upon the back-up seed stores in its maize germplasm bank in Mexico, CIMMYT sent Guatemalan collaborators seed of more than 700 native Guatemalan maize varieties, including some of the varieties that had been lost.

Guatemalan scientists are now planting seed from the historic CIMMYT samples to ensure the varieties will grow well under local conditions. The best materials will be returned to local and national seedbanks in Guatemala, where they will be available for farmers and researchers to grow, study and use in breeding programs.

The effective conservation of seeds in the genebank outside their natural habitat is complex and costly, according to Denise Costich, head of the maize germplasm bank at CIMMYT.

Back-up seed

CIMMYT returned copies of over
700 native Guatemalan maize varieties
that had been lost

"Seeds must be stored at constant low temperatures and humidity," Costich said. "Seed bank curators must also regularly monitor the seed's ability to germinate and, when a sample's capacity falls too low, grow out the healthy seed in controlled plantings at a location similar to the environment of origin of the collection."

Given the challenges and resource constraints faced by many countries with important native maize collections, international seed banks play a vital role as "safe deposit boxes for the world," she said.

In addition to natural disasters, civil wars can also impact genetic diversity as people are forced to flee their homes, leaving seed of their traditional crops behind.

"Many believe that seed banks are needed only in the case of an "Armageddon" – some sort of global disaster that would completely disrupt agriculture as we know it," Costich said. "But vulnerable smallholder farmers may face several 'mini-Armageddons' in a lifetime, crises that cost them entire crops, and with that, the loss of traditional seed varieties. If such seed is not safely stored elsewhere, then the matchless diversity it represents is forever lost to humanity."

CIMMYT's maize germplasm bank team based at headquarters in Mexico conserves, studies and shares some 28,000 unique collections of seed of native maize varieties and wild relatives for the benefit of humanity in accordance with the 2007 International Treaty on Plant Genetic Resources for Food and Agriculture.

Helping smallholders

13,000 farmers
have applied improved practices and technologies through Buena Milpa

The germplasm bank also supports national initiatives such as the Buena Milpa project in Guatemala, which is improving storage practices in community seed reserves – tiny, low-tech seed banks meant to serve as backups for villages in cases of catastrophic seed-loss. A workshop for Guatemala's national seed bank and Buena Milpa personnel on best practices for storing maize germplasm took place in 2016 at the CIMMYT maize germplasm bank in Mexico.

CIMMYT maize germplasm bank staff training technicians from Guatemala on seed germination monitoring techniques.

The Buena Milpa project is supported by funding from the United States Agency for International Development's Feed the Future program.

India farmers put aside the plow,

save straw and fight pollution

Researchers and policymakers are promoting zero tillage for wheat to stop rice residue burning in northern India and help prevent smog in New Delhi, as well as to cut farmers' costs and conserve soil and water resources.

Farmers who deploy a sustainable agricultural technique known as "zero tillage" in the rice-wheat cropping rotations grown throughout northern India can significantly contribute to reduced air pollution in India's capital, helping urban dwellers breathe more easily.

Traditional tillage to sow wheat in northern India involves removing or burning rice straw and driving tractor-drawn implements back and forth over fields to rebuild a soil bed from the rice paddy, a costly and protracted process.

Media reports in 2016 depicted the 19 million inhabitants of New Delhi under siege from a noxious haze generated by traffic, industries, cooking fires and the burning of over 30 million tons of rice straw on farms in the neighboring states of Haryana and Punjab.

Rice-wheat rotations in South Asia account for nearly a quarter of the world's food production

H.S. Sidhu (left) of the Borlaug Institute for South Asia (BISA) and B.S. Sidhu, agricultural commissioner of Punjab State.

Since the 1990s, CIMMYT scientists have worked with national agricultural partners and advanced research institutes in India, Nepal, and Pakistan to test and promote the resource-conserving approach of sowing wheat seed directly into untilled soil and rice residues in a single tractor pass, a method known as zero tillage.

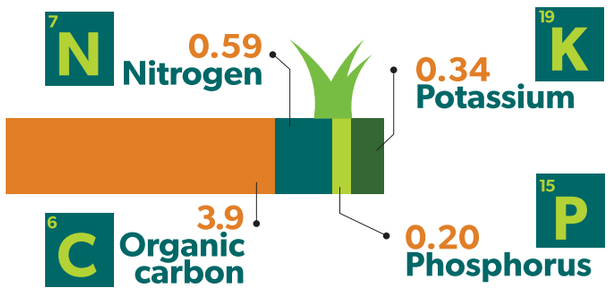
Originally deemed foolish by many farmers and researchers, the practice or its adaptations are being used on as much as 1.8 million hectares in India. It has gained popularity because it allows farmers to save money and fuel through less work and tractor use, to reduce weather risks as well as to sow their wheat up to two weeks earlier; this means the grain fills before the withering heat of pre-Monsoon season.

Environmental benefits of zero tillage include healthier soils, significant water savings and a 90 kilogram-per-hectare reduction in greenhouse gas emissions, according to M.L. Jat, senior agronomist at CIMMYT.

"This emission savings figure considers only soil respiration," said Jat, "but if we talk about carbon sequestration based on life cycle analysis, the greenhouse gas savings range from 500 to 1,000 kilograms of carbon dioxide equivalent per hectare, each crop cycle."

Soil nutrient depletion

A high cost of burning rice residues (million tons)



"Rice-wheat rotations constitute a key source of grain and income in South Asia, but unsustainable farming practices threaten the region's productivity and are worsening global climate change."

Andy McDonald
CIMMYT cropping systems agronomist

The seeder drives adoption

Zero tillage requires the use of a special, tractor-mounted implement, which, in a single pass, chops rice residues, opens a rut in the soil, and precisely deposits and covers the seed.

Development of this special seeder was first funded by the Australian Centre for International Agricultural Research (ACIAR) and led by Punjab Agricultural University, with contributions from CIMMYT and other organizations. The latest version, the Turbo Happy Seeder, costs $1,900 – an investment that many farmers still struggle to make.

"As an alternative, we've been saying that not all farmers need to own a seeder," according to Jat. "Many farmers can simply hire local service providers who have purchased the seeder and will sow on contract."

In Bihar and the neighboring state of Uttar Pradesh, the number of zero-tillage service providers rose from only 17 in 2012 to more than 1,900 in 2015, according to Jat, who leads CIMMYT's contributions to "climate-smart" villages in South Asia, as part of the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS).

The Turbo Happy Seeder sows a rotation crop directly into the residues of a previous crop.

Given New Delhi's smog troubles, Haryana and Punjab policymakers are providing limited subsidies for purchases of the seeder and other policy support for burn-free, climate-smart agricultural practices.

Work on the Turbo Happy Seeder has been funded by the Australian Centre for International Agricultural Research and the CGIAR Consortium and Fund Council. Zero tillage for rice-wheat rotations is one of the technologies studied and promoted by the CIMMYT-led Cereal Systems Initiative for South Asia, a project implemented jointly with the International Food Policy Research Institute and the International Rice Research Institute and funded by the Bill & Melinda Gates Foundation and the United States Agency for International Development. BISA is funded by the Indian Council of Agricultural Research and, for the work described, by the government of Punjab state, India.

Seed companies and farmers

improve maize yields in Mexico

The Mexican maize seed industry has upgraded its portfolio of products to better address the needs of smallholder farmers. More than 50 local companies have seen sales increase by 70 percent in the last 5 years. In 2016 alone, these small and medium-sized enterprises (SMEs) sold over 1.1 million bags of 100 maize hybrids.

Mexican seed companies have traditionally marketed obsolete maize hybrids and open pollinated varieties on a land area of about 1.25 million hectares, representing 42 percent of the seed market in Mexico. At the same time, large multinational seed companies dominated a market of 1.75 million hectares in the best rain-fed and irrigated regions of Mexico. Meanwhile, Mexican smallholder farmers have struggled to raise their maize yields.

Bags of hybrid seed marketed in Mexico.

Now, most Mexican seed companies offer high-yielding, stress-tolerant hybrids adapted to rain-fed conditions. These hybrids yield from two-to-four times the average yield of obsolete varieties in target areas. Three larger local companies are now challenging multinational companies' share of the most valuable markets in the country, fostering competition that will eventually push seed prices down. Access to better seed in new areas could increase average maize yields on a scale that would lead Mexico to become self-sufficient in the production of its most important crop.

Today, local companies control 30 percent of the seed market in Mexico and their total sales of improved seed have increased by 70 percent, since first partnering with CIMMYT in 2011.

"Improved maize seed is grown on 3 million hectares across Mexico, of the total of 8 million hectares sown to the crop," said Arturo Silva, leader of the International Maize Improvement Consortium for Latin America.

"As a result of public and private efforts, the market of improved seed will grow to cover 5.5 million hectares by 2020."

Local companies in Mexico

Control 30% of the market

Have increased their sales by 70%

These encouraging results are the product of a partnership with public research institutions and more than 50 local seed companies that annually test dozens of high-yielding, disease-resistant and climate resilient maize hybrids developed by breeders in the Sustainable Modernization of Agriculture (MasAgro) project, which is supported by Mexico's Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA).

After five years of collaborative field trials and pre-commercial tests since 2011, 49 new white and yellow CIMMYT hybrids were released to the Mexican seed sector. These materials contributed to more than

CIMMYT hybrids:

From the **1.1 million** bags of improved seed **more than 500,000** were CIMMYT hybrids

500,000 of the 1.1 million bags of improved seed sold by Mexican companies in 2016.

These maize hybrids have been specifically adapted to the needs of smallholder farmers and are put to the test on hundreds of sites across Mexico. Seed companies help farmers by hosting training sessions on hybrid seed production and commercialization.


Farmers select ears of the Zapolote Chico landrace in Santa Rosa de Lima, Oaxaca.

This work was conducted as part of the MasAgro project in collaboration with Mexico's National Institute of Forestry, Agriculture, and Livestock Research, Chapingo Autonomous University, Antonio Narro Agrarian Autonomous University, the Agricultural Research and Training Institute in Mexico State, the Autonomous University of Mexico State, and supported by Mexico's Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food and MAIZE.

Participatory native maize improvement in Mexico

Maize is grown in highly-diverse settings throughout Mexico, often by smallholder farmers who prefer specific types of grain for local dishes or use maize plants in varied ways. CIMMYT and its partners work with these farmers to raise the productivity and profitability of landrace maize and heirloom varieties, which have often been grown for generations in tough, local conditions and carry genes for hardiness and other traits of interest.

This participatory breeding work, or breeding that involves close farmer-researcher collaboration to bring about plant genetic improvement within a species, is conducted in these communities through the MasAgro project, in which traditional landraces are selected by farmers with the assistance of Mexico's National Institute of Forestry, Agriculture, and Livestock Research (INIFAP), the Chapingo Autonomous University and CIMMYT scientists. Selection and crosses are made using the best samples from farmers in the community and, where needed, seed collections from CIMMYT's germplasm bank or breeding lines and populations. This allows communities to develop new, improved maize varieties with higher yields and stress resistance, while preserving valued landrace traits such as preferred grain and cooking quality.

In 2016, participatory trials in 9 target communities were conducted in the state of Oaxaca, involving 240 men and 160 women farmers from 46 communities who attended multiple training events.

"We are targeting the poorest and most underserved farmers and have helped to increase their yields," said Martha Willcox, maize landrace improvement coordinator at CIMMYT. "This has helped communities increase their local food security as they no longer have to purchase additional maize to eat, and has allowed some to access markets specific to landrace maize at prices higher than hybrid grain."

Added to other benefits, improved livelihoods from these efforts have allowed some farmers to stay with their families all year, rather than migrating to the United States to work.

Maize Molecular Atlas: Climate change-responsive

varieties for the future

The new Maize Molecular Atlas comprises an online resource of data, knowledge and tools to describe, explore and use the genetic diversity of more than 28,000 maize samples. It will help plant breeders and scientists respond to the challenges of new diseases, heat and drought stresses affecting crops.

Key data and tools to identify and use crop genetic resources are being linked in a powerful, emerging maize molecular atlas that provides new and easier ways to access valuable contents from the black box of maize genetic diversity.

Like a car navigation system that helps drivers to steer through a complex network of information, the Atlas synthesizes valuable physical information to reach a desired destination – in this case, the maize genetic regions associated with desirable traits and in the most appropriate germplasm.

The goal is to enable scientists to use knowledge about maize diversity to respond to existing and new breeding challenges.

Most Atlas information relates to maize landraces, ancestral varieties that farmers adapted

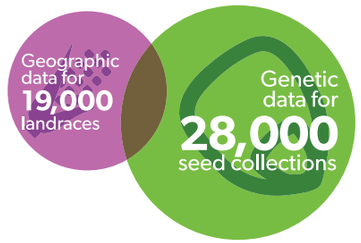
The goal is to enable scientists to use knowledge about maize diversity to respond to existing and new breeding challenges.

to local environments over thousands of years and which represent the broadest range of native genetic diversity.

The Atlas combines genetic fingerprint data of 28,000 seed samples that form the entire maize collection in CIMMYT's germplasm bank, together with collection site geographic data for more than 19,000 landraces and wild relatives of maize and data from targeted phenotypic evaluations.

The system also features data collection and visualization software, search and statistical analysis tools and training links, allowing users to find landraces of interest online.

Maize Molecular Atlas



The data are interpreted against background knowledge on maize biodiversity generated by MasAgro Biodiversidad, the Mexican government's contribution to the CIMMYT-led Seeds of Discovery project, which associates desirable agronomic traits to known regions in the maize genome.

SAGARPA invited CIMMYT to present the Maize Molecular Atlas during the 13th Meeting of the Conference of the Parties (COP 13) to the Convention on Biological Diversity that took place in Cancún, Mexico, in December 2016.

More than 250 Mexican researchers and students have participated in workshops to learn how to use molecular atlas data and tools in their work to develop climate change-responsive maize varieties for the future.

Protecting maize and wheat genetic diversity across the globe

SDG 2 SDG 17

At its headquarters outside Mexico City, CIMMYT maintains a vast "seed library" holding the world's most important collection of maize and wheat genetic diversity.

The diversity embodied in these seed collections, which number 180,000, includes original races of maize and wheat that were domesticated over millennia by farmers. The seed is conserved, studied and shared by CIMMYT with breeders, specialists and farmers worldwide. In 2016, 41 tons of wheat and maize seed were shipped to 100 countries.

For decades, CIMMYT maize and wheat breeders have drawn on this diversity for genes to strengthen the disease resistance and climate resilience of modern, improved varieties.

The CIMMYT genebank also safeguards and restores seed collections lost or threatened by conflicts. Genebank staff are working with ICARDA to preserve and genetically analyze ICARDA wheat seed collections that were relocated from Syria with the outbreak of civil war.

Under the Seeds of Discovery project, a joint initiative of CIMMYT and SAGARPA through the MasAgro project, scientists have genetically analyzed approximately 90,000 CIMMYT maize and wheat seed collections from more than 100 countries and nearly 30,000 wheat and wheat wild relative samples from ICARDA.

Exploring and using diversity: heat tolerance

1. Find landraces from environments of interest.
2. Find landraces from places with long-term high temperatures during flowering or that perform well under high temperature stress.
3. Use genetic fingerprint data to define a diverse subset of landraces for field evaluation.
4. Conduct field evaluations to identify the best heat tolerant landraces and use them to develop varieties.
5. Upload data to share with the broader community.

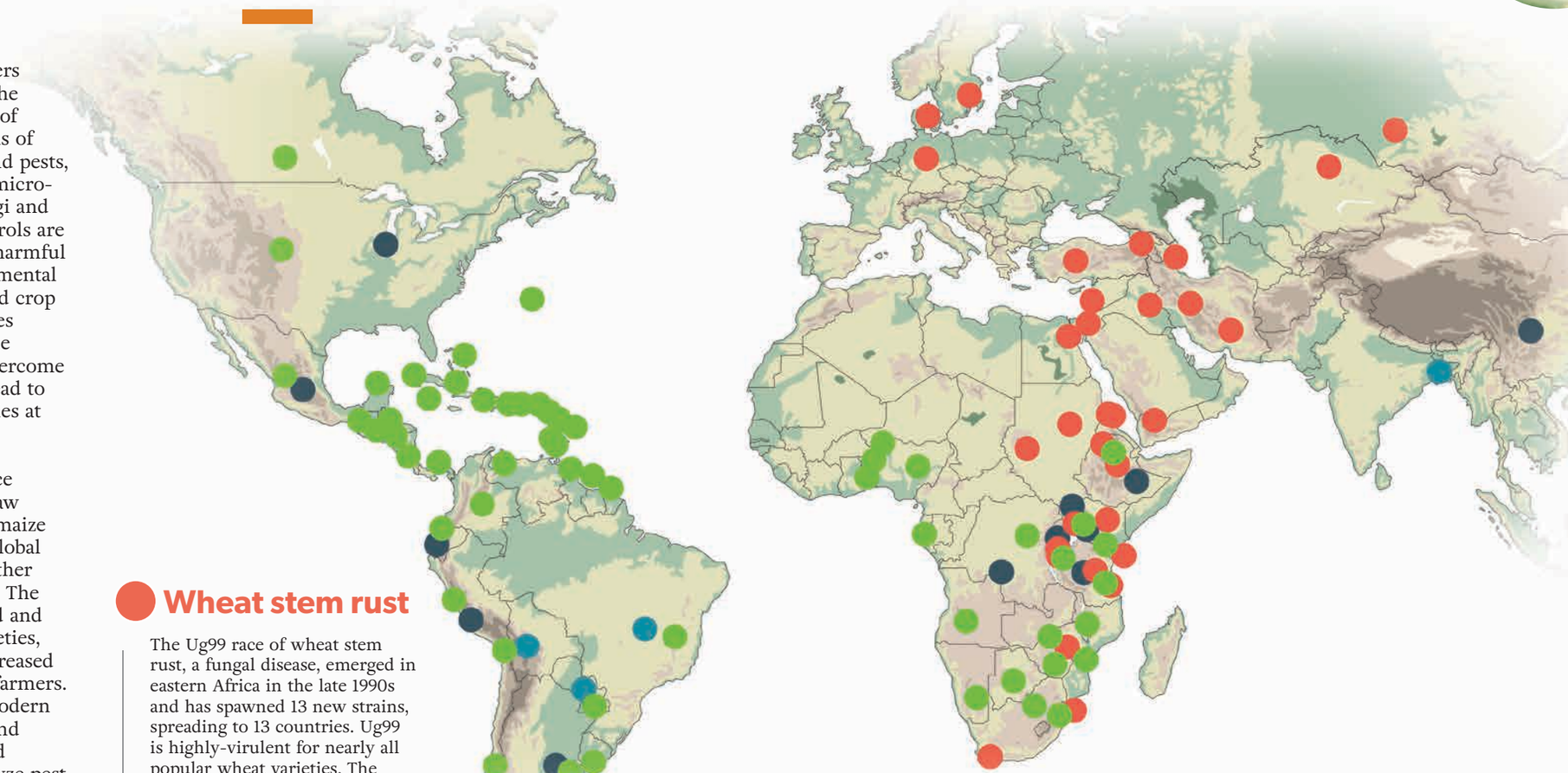
This work was implemented by CIMMYT as part of the Seeds of Discovery project made possible by the generous support of Mexico's Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food under the Sustainable Modernization of Traditional Agriculture (MasAgro) project, the CGIAR Research Program on MAIZE, Biotechnology and Biological Sciences Research Council (BBSRC), WHEAT, and Mexico's National Institute of Forestry, Agriculture and Livestock Research.

Evolutionary clash:

Plant pests and diseases battle humankind for control in the fields

Maize and wheat farmers worldwide are facing the emergence and spread of new or modified strains of deadly crop diseases and pests, including insects and micro-organisms such as fungi and viruses. Chemical controls are costly and potentially harmful to human and environmental health. Genetically-bred crop resistance and pesticides work for a time, but the organisms evolve to overcome those restraints or spread to susceptible crop varieties at new locations.

CIMMYT applies science and partnerships to draw resistance genes from maize and wheat landraces, global seed collections, and other crop genetic resources. The genes are used to breed and test new, resistant varieties, whose seed is then increased and made available to farmers. Scientists also wield modern systems to track pest and pathogen evolution and movements. They analyze pest and pathogen interactions with crops and create combinations of new genes that offer longer-lasting resistance. The diseases and pest described here are examples of those that have made the news recently.



Wheat stem rust

The Ug99 race of wheat stem rust, a fungal disease, emerged in eastern Africa in the late 1990s and has spawned 13 new strains, spreading to 13 countries. Ug99 is highly-virulent for nearly all popular wheat varieties. The national research programs in Ethiopia and Kenya have supported the yearly screening of as many as 50,000 wheat lines from breeding programs worldwide under strong natural Ug99 infections, allowing rapid development of new, resistant varieties. Enough seed has been multiplied so many countries in the projected path of Ug99's spread are safe from serious outbreaks. Another stem rust race group known as TKTTF has spread to over a dozen countries in Africa, Asia, and Europe, since its detection in Turkey in 2005.

The fall armyworm

A moth from the Americas that appeared in Africa in 2016 and whose larvae feed on numerous crops, the fall armyworm is able to destroy as much as 70 percent of a maize harvest and, once adult larvae are established, is not easily controlled by pesticides. Scientists from CIMMYT and IITA are working with partners worldwide on integrated approaches including chemical and biological controls, resistant varieties, agronomic management, and tracking and early-warning systems.

Maize lethal necrosis (MLN)

Involving a deadly alliance of two viruses and first reported in eastern Africa in 2011, MLN disease kills plants before they can grow, and the pathogens are transmitted by insects or contaminated seed. Serious damage to the region's maize has led many farmers to stop growing the crop. Progress to counter MLN includes the production and distribution of resistant hybrids.

Wheat blast disease

Long confined to South America, the mysterious fungal disease known as wheat blast suddenly appeared in Bangladesh in 2016, causing 25-30 percent losses on 15,000 hectares of wheat and threatening to spread quickly throughout South Asia's vast wheat lands, where no varieties are resistant. CIMMYT and WHEAT partners are at the center of an urgent global response to monitor, characterize and control blast and, especially, to develop and deploy resistant wheat varieties.

CIMMYT **financial overview**

Top donors, 2016 (thousands of U.S. dollars)

Donor	
United States Agency for International Development	40,740
CGIAR W1/W2 contributions:	23,739
Australia, Bill & Melinda Gates Foundation, Canada, China, India, New Zealand, Norway, Mexico, Sweden, Switzerland, UK, USA and World bank	
Bill & Melinda Gates Foundation	17,374
Secretaria de Agricultura, Ganadería, Desarrollo Rural y Pesca (SAGARPA, Mexico)	16,963
Australian Centre for International Agricultural Research (ACIAR)	6,628
HarvestPlus	2,790
African Agricultural Technology Foundation (AATF)	2,586
CGIAR Research Program on Climate Change, Agriculture and Food Security (including contributions from CGIAR Fund donors Australia, Ireland, Netherlands, Switzerland, Thailand, and the UK)	2,540
Cornell University	2,100
Global Crop Diversity Trust	1,754

Table 1. Combined statement of financial position as of 31 December, 2016 and 2015 (thousands of U.S. dollars).

Assets	2016	2015
Current assets		
Cash and cash equivalents	90,990	93,295
Cash set aside due to Integrated Breeding Platform	4,898	4,756
Accounts receivable:		
Donors	11,041	11,333
CGIAR	3,391	2,293
Other	2,827	2,763
Allowance for doubtful accounts receivable	(3,343)	(2,519)
Inventory and supplies, net	1,255	1,362
Total current assets	111,059	113,283
Non-current assets		
Property and equipment, net	22,190	22,753
Prepaid rent - ICRAF, Nairobi	500	500
Total non-current assets	22,690	23,253
Total assets	133,749	136,536
LIABILITIES AND NET ASSETS		
Current liabilities		
Short-term employee benefits	723	1,018
Accounts payable		
Advance grant payments, donors	40,120	38,782
Advance grant payments, CGIAR centers	3,794	6,458
Integrated Breeding Platform	5,609	5,518
Other	7,319	7,278
Accruals	670	845
Total current liabilities	**58,235**	**59,899**
Non-current liabilities		
Employee termination benefits	12,226	11,312
Provisions	120	227
Total non-current liabilities	**12,346**	**11,539**
Total liabilities	**70,581**	**71,438**
Net assets		
Unrestricted		
Designated	22,190	22,753
Undesignated	40,978	42,345
Total unrestricted net assets	**63,168**	**65,098**
Total liabilities and net assets	**133,749**	**136,536**

2016 and 2015 financial statements

A summary of the combined statements of financial position and combined statements of activities for CIMMYT Int. and CIMMYT A.C., are set out in tables 1 and 2. Total revenues for 2016 amounted to $133.3 million and $135.8 million in 2015 (including financial incomes for each year). The loss for 2016 totaled $1.6 million and the surplus for 2015 $2.9 million.

Total net assets decreased by $1.9 million in 2016, to $63.2 million and increased by $2.9 million in 2015, to $65.1 million.

Table 2. Combined statement of activities as of 31 December, 2016 and 2015 (thousands of U.S. dollars).

	2016	2015
Revenues and gains		
Grant revenue	132,661	135,115
Other revenue and gains	405	425
Total revenue and gains	**133,066**	**135,540**
Expenses and losses		
Research expenses	77,305	76,822
CGIAR collaboration expenses	11,033	12,978
Non-CGIAR collaboration expenses	32,658	31,024
General and administration expenses	13,425	11,320
Other expenses and losses	8	(30)
Total expenses and losses	**134,429**	**132,114**
Financial incomes	265	227
Financial expenses	497	718
Surplus	**(1,595)**	**2,935**
Expenses by function		
Personnel costs	47,167	48,759
CGIAR collaboration costs	11,033	12,978
Other collaboration costs	32,658	31,024
Supplies and services	34,039	30,233
Travel	4,786	5,013
Depreciation	4,386	4,255
Cost sharing percentage	360	(148)
Total operating expenses	**134,429**	**132,114**

2016 and 2015 revenue overview

Total grant revenue for 2016 was $132.7 million and $135.1 million in 2015 (Table 3). Other revenues, gains and financial incomes amounted to $0.7 million in 2016 and $0.7 million in 2015.

Table 3. Schedule of grant revenues for the years ending 31 December, 2016 and 2015 (thousands of U.S. dollars).

Donors	2016	2015
Restricted		
African Agricultural Technology Foundation (AATF)	2,586	2,436
Agrovegetal S.A.	45	-
Asareca	94	36
Australia		
Australian Centre for International Agricultural Research	6,628	7,057
Grains Research and Development Corporation	359	871
Bangladesh		
Bangladesh Institute of ICT in Development	40	-
Bayer	34	-
Bill & Melinda Gates Foundation	17,374	20,946
Borlaug Institute for South Asia	139	-
Canada		
Canadian International Development Agency	-	1,784
Department of Foreign Affairs, Trade and Development	1,109	-
NRC, Canada	79	62
Field Crop Development Centre, Alberta Agriculture and Rural Development	32	36
CGIAR Centers		
International Center for Agricultural Research in the Dry Areas (ICARDA)	-	252
World Agroforestry Center (ICRAF)	79	107
The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)	151	117
International Livestock Research Institute (ILRI)	126	240
International Rice Research Institute (IRRI)	-	1,522
International Institute of Tropical Agriculture (IITA)	1,004	1,173
International Potato Center (CIP)	38	-
Center for International Forestry Research (CIFOR)	43	78
International Food Policy Research Institute (IFPRI)	65	-
International Plant Nutrition Institute (IPNI)	62	-
CRP on Climate Change, Agriculture and Food Security	2,540	2,789
CRP on Policies, Institutions and Markets	451	249
Challenge Programs		
HarvestPlus	2,790	3,547
China	189	172
Cornell University	2,100	3,319
CGIAR Funds		
CRP on Wheat	12,031	11,989
CRP on Maize	11,708	9,776
GCDT		
CRP for Genebanks	1,311	1,197
European Commission	-	64
Food and Agriculture Organization (FAO)	376	144
Germany	1,257	1,721
Global Crop Diversity Trust	443	476
IDE-UK	112	1
India	729	458
International Fund for Agricultural Development (IFAD)	105	223
Iran, Islamic Republic of	182	66
International Water Management Institute (IWMI)	-	23
Japan		
Japan International Research Center for Agricultural Sciences	53	11
Ministry of Agriculture, Forestry and Fisheries	202	258
MOFA	61	-
Kazakhstan, Republic of	147	176
Korea, Republic of	69	224
Mexico		
Secretaría de Relaciones Exteriores-Agencia Mexicana de Cooperación Internacional para el Desarrollo	9	-
Instituto de Investigación y Capacitación Agropecuaria, Acuícola y Forestal del Estado de México (ICAMEX)	65	-
Instituto Nacional de Investigaciones Forestales, Agricolas y Pecuarias (INIFAP)	(17)	134
Gobierno de Guanajuato	971	1,193
MasAgro Querétaro	15	-
Mexico (MasAgro)		
Secretaria de Agricultura, Ganaderia, Desarrollo Rural y Pesca (SAGARPA)	16,963	18,325
Norway		
Development Fund	128	-
OPEC Fund for International Development	-	20
Peru	-	1
Spain	(210)	221
Seed companies	5	183
Switzerland	-	759
Syngenta Foundation for Sustainable Agriculture	1,034	1,063
Turkey, Republic of (MARA)	147	230
United Kingdom		
Biotechnological and Biological Sciences Research Council	784	-
Catholic Relief Services	41	-
United Way Worldwide/ Kellogg	30	-
United States Agency for International Development	40,740	35,470
United States Department of Agriculture	520	1,270
University of California, Davis	138	-
University of Texas, Austin	22	-
Montana State University	3	327
Harvard University	191	-
University of Hohenheim	39	50
Columbia University	71	-
Private sector	289	72
University of Twente	698	-
Total Land Care (TLC)	178	-
Rwanda Agricultural Board (RAB)	27	-
Arcadia Biosciences	142	-
Miscellaneous research grants	2,694	2,196
Total donor grants - Restricted	**132,660**	**135,115**

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Acronyms

AATF	African Agricultural Technology Foundation
ACIAR	Australian Centre for International Agricultural Research
BBSRC	Biotechnology and Biological Sciences Research Council
BISA	Borlaug Institute for South Asia
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CIAT	Centro Internacional de Agricultura Tropical
CIFOR	Center for International Forestry Research
CIP	International Potato Center
CoP	Conference of the Parties
CRISPR-Cas	Clustered regularly interspaced short palindromic repeats – CRISPR-associated systems
CRP	CGIAR Research Program
CSISA	Cereal Systems Initiative for South Asia
DG	Director General
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FAO	Food and Agriculture Organization of the United Nations
ICAMEX	Instituto de Investigación y Capacitación Agropecuaria, Acuícola y Forestal del Estado de México
ICAR	Indian Council of Agricultural Research
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRAF	World Agroforestry Center
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IITA	International Institute of Tropical Agriculture
INIFAP	Mexico's National Institute of Forestry, Agriculture, and Livestock Research
IPNI	International Plant Nutrition Institute
IRRI	International Rice Research Institute
IWMI	International Water Management Institute
IWWIP	International Winter Wheat Improvement Program
MasAgro	Sustainable Modernization of Agriculture project
MDG	Millennium Development Goal
MLN	maize lethal necrosis
NSFC	Chinese Bureau of International Cooperation
RAB	Rwanda Agricultural Board
SAGARPA	Mexico's Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food
SDG	Sustainable Development Goal
SME	small and medium-sized enterprise
TLC	Total Land Care
UN	United Nations
USA	United States of America
USAID	United States Agency for International Development
WHO	World Health Organization

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