CIMMYT - the International Maize and Wheat Improvement Center - is the global leader on 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 Consortium and leads the CGIAR Research Programs on Maize and Wheat. The Center receives support from national governments, foundations, development banks and other public and private agencies.
After alarm bells sounded due to rising food prices in early 2014, the world and particularly poor consumers, who spend much of their income simply to eat, were relieved by a sharp downturn in global food prices over the rest of the year, partly from strong maize and wheat harvests in regions where CIMMYT and its partners work.

Prices are still well above the decades-long, stable levels that preceded the 2008 food crisis; we now live in an age of higher and fluctuating global food prices. Reverberations of relatively local disturbances, like droughts or crop disease outbreaks, cause inordinate price spikes and worsen food insecurity for the disadvantaged worldwide.

Looking to the future for maize and wheat – which together with rice provide more than half the world’s plant-derived food energy – projections hold that farmers will need to grow at least 60 percent more grain to feed a planet of 9 billion-plus people by 2050. And they must do so using the same or less land, confronting more extreme and erratic rainfall and temperatures, and with more efficient use of increasingly scarce inputs like water and fertilizer.

Impacts in farm productivity: Highlights from CIMMYT in 2014

To help farmers meet these challenges, in 2014 CIMMYT redoubled and refined work to develop and share two of its key outputs: more productive and resilient maize and wheat varieties and efficient, environmentally-friendly farming practices.

What has been the worth of that effort? In one example, a new report by the Center for Chinese Agricultural Policy (CCAP) of the Chinese Academy of Science shows that, as a result of our longstanding wheat research partnership with China, CIMMYT breeding contributions figure in the pedigrees of more than a quarter of China wheat varieties, enhancing their performance for critical traits and adding US $3.4 billion-worth of additional grain to China’s wheat output over three decades (p. 10).

Former CIMMYT wheat breeder and director, Sanjaya Rajaram, was honored with the 2014 World Food Prize for leading work that led to the development of 480 improved wheat varieties sown on more than 58 million hectares (ha) in 51 countries (p. 6). The award announcement came during the Borlaug Summit on Wheat for Food Security in Mexico in March, an event that brought...
CIMMYT works throughout the developing world to improve livelihoods and foster more productive, sustainable maize and wheat farming. Its portfolio squarely targets today’s critical challenges: food insecurity and malnutrition, climate change, environmental degradation. Through collaborative research, partnerships, and training, the Center helps to build and strengthen a new generation of national agricultural research and extension services in maize- and wheat-growing nations. As a member of the CGIAR’s consortium of 15 agricultural research centers, CIMMYT leads the CGIAR Research Programs on Maize and Wheat, which aim and add value to the efforts of more than 500 partners.

Turning research into impact

- By conservative estimates, this work provides at least US$2 billion in annual benefits to farmers.
- CIMMYT alumni include a Nobel Peace Prize laureate and three World Food Prize winners.
- CIMMYT’s success depends on the longstanding partnerships and trust of public agricultural research systems, private companies, advanced research institutes and academia, and non-governmental and farmer organizations.
- More than 70 percent of the wheat grown in developing countries and more than 50 percent of improved maize varieties derive from CIMMYT breeding materials.
- More than 10,000 scientists have trained at CIMMYT and gone on to become leaders in their own countries. The Center empowers thousands of students, extension workers and farmers through courses, workshops and field days.

It starts with seed

CIMMYT crop-breeding research begins with its Germplasm Bank, a remarkable living catalog of genetic diversity comprising over 27,000 unique seed collections of maize and over 130,000 of wheat. From its breeding programs, each year CIMMYT sends half a billion seed packages to 600 partners in 100 countries.

With researchers and farmers, the Center also develops and promotes more productive and precise maize and wheat farming methods and tools that save money and resources such as soil, water, and fertilizer.
Celebrating 100 years of Norman Borlaug

In 2014, a major wheat summit was held to celebrate the 100th anniversary of the birth of Norman E. Borlaug, Nobel Peace Prize laureate and former CIMMYT wheat researcher.

Dr. Borlaug, who passed away in September 2009, received the 1970 Nobel Peace Prize for developing wheat varieties and farming practices that were adopted throughout the developing world, saving more than a billion from starvation and contributing to decades of historically low food prices. To celebrate his life and legacy and inspire a new generation to carry on his work, the Borlaug Summit on Wheat for Food Security in March 2014 brought together leaders, policymakers and senior researchers to discuss innovative approaches to increase food security.

The summit emphasized that agricultural research has tools to tackle challenges to wheat production, including use of untapped wheat diversity, new technology like genomic selection and precise ways to take readings on large breeding plots, and more intense but environmentally-friendly farming practices. During the Summit, CIMMYT was honored with the World Food Prize Foundation Norman E. Borlaug Medalion, which recognizes organizations and heads of state who have made outstanding contributions to improving food security and nutrition.

World Food Prize for work to develop 480 widely-sown wheat varieties

The 2014 World Food Prize was awarded to Sanjaya Rajaram, a former director of CIMMYT’s global wheat program, for his scientific research and critical breakthroughs in wheat breeding.

The Prize is the foremost international award recognizing individuals who advance human development by improving the quality, quantity, or availability of food in the world. Under Rajaram’s leadership, the CIMMYT program developed 480 wheat varieties released in 61 countries on 6 continents, and helping to increase world wheat production by more than 200 million tons per year. This is an unparalleled achievement.

Raising maize production and productivity in Asia

In October, the 12th Asian Maize Conference brought together more than 350 agricultural researchers, policymakers, farmers and service providers to create a roadmap for improved maize production, family income and nutrition in the region.

The conference concluded that there is considerable scope to double maize production in the next decade by increasing the genetic diversity of breeding lines, accelerating the development and deployment of high-yielding climate-resistant maize, strengthening the maize seed sector, and providing access to quality seed through public-private partnerships. Other recommendations from the conference include putting women at the heart of agricultural research and development, deploying bio-fortified varieties, developing and adopting sustainable farming practices such as conservation agriculture, and focusing more on post-harvest processing, value addition, packaging, storage and marketing.

Young scientist wins award for “Taking it to the Farmer”

Agronomist Bram Govaerts received the Norman Borlaug Award for Field Research and Application, which recognizes researchers under the age of 40 for work that carries on Borlaug’s legacy.

As strategic leader for sustainable intensification in Latin America, Govaerts oversaw groundbreaking initiatives with Mexican partners to transform subsistence agriculture and unsustainable farming systems into productive, more resource-conserving operations. Farmers on over 94,000 hectares are receiving training and ha on improved agricultural techniques. “The best recognition of Dr. Borlaug’s legacy is to shout out loud that farming is the future,” stated Govaerts.

By successfully cross-breeding winter and spring wheat lines – distinct genetic pools that had been separate for thousands of years – Rajaram and his scientists produced higher-yielding, more broadly-adapted wheat plants. Rajaram also pioneered work at CIMMYT to combine minor genes conferring resistance to wheat rust disease — the crop’s most damaging nemesis. His other accomplishments include training or mentoring more than 700 scientists from dozens of developing countries. Rajaram donated US $20,000 of his prize money to CIMMYT to support training for a new generation of wheat breeders.

The best recognition of Dr. Borlaug’s legacy is to shout out loud that farming is the future,” stated Govaerts.
The CGIAR Research Programs on Maize and Wheat: 2014 highlights

MAIZE and WHEAT were launched in 2012 and are led by CIMMYT.

MAIZE focuses on increasing maize production for the 900 million poor consumers for whom maize is a staple food in Africa, South Asia and Latin America. WHEAT works to raise the productivity, production and affordable availability of wheat for 1.2 billion resource-poor consumers who depend on the crop as a staple food. The principal research partner for MAIZE is the International Institute of Tropical Agriculture (IITA) and for WHEAT the International Center for Agricultural Research in the Dry Areas (ICARDA). Both Programs work with research-for-development networks comprising hundreds of public and private organizations worldwide, among them national programs, seed and irrigation companies, international centers, regional and local NGOs and farmers. In 2014, MAIZE and WHEAT significantly strengthened research and capacity to address gender issues (see p. 30) and both received high marks in the external evaluation reports by the CGIAR Independent Evaluation Arrangement (IEA).

MAIZE

There was strong progress on stress-resilient and nutritious maize and the sustainable intensification of maize-based systems. Partners released 70 new varieties and hybrids (48 in Africa, 15 in Mexico and South America, and 7 in Asia). Key traits included drought tolerance, nitrogen use efficiency, tar spot resistance, increased pro-vitamin A content, and disease resistance. More than 40,000 tons of certified seed of drought tolerant varieties was produced – enough to plant as much as 2 million hectares (ha). Additional innovation platforms, which now total 51 in Africa, 40 in South Asia, and 41 in Latin America, have bolstered multi-stakeholder collaboration on improved maize-based farming systems; partners in this work include Wageningen University and the Royal Tropical Institute (KIT). Over 4 million farmers are estimated to have benefited from MAIZE research outputs in 2014, more than 30,000 individuals (53 percent female) benefited from technical backstopping and capacity-building, and the Program significantly stepped up work with small- and medium-scale seed companies.

WHEAT

A study by WHEAT scientists published in Nature Climate Change showed that for every 1°C increase in growing season mean temperatures, global wheat production decreases by 6 percent – a worldwide loss of 42 million tons of grain – and that rising temperatures are already reducing the world’s wheat production. A 2014 report by the Center for Chinese Agricultural Policy (CCAP) of the Chinese Academy of Sciences documented Chinese breeders’ significant use of CIMMYT germplasm and a resulting increase of as much as 14 percent in national wheat total factor productivity, in the past three decades. Several projects under WHEAT succeeded in giving poor farmers access to high-quality seed derived from CIMMYT or ICARDA elite lines. They were funded by bilateral donors such as ACIAR and USAID. In Afghanistan, researchers supported the production of 24,000 tons of certified seed of high-yielding, disease resistant wheat – enough to sow 150,000 ha. In Kenya, 165 tons of seed of 10 improved varieties was supplied to more than 2,000 farmers. In Ethiopia, quick action and deployment of improved varieties and control methods by national partners headed off a potentially devastating outbreak of yellow rust disease. Twenty-one superior, disease resistant varieties were released – and more than 1,100 new lines qualified for inclusion in national trials – in Bangladesh, India, Nepal and Pakistan. Such achievements were made possible by pre-breeding and breeding research supported by the CGIAR Fund. Predecessor projects continued under WHEAT and the impact shows: A 2014 paper documented use of precision laser land leveling on over 1.5 million ha in South Asia, allowing farmers to save 15-30 percent irrigation water and benefit from up to 6 percent higher yields in rice, wheat and other crops. The results of partner priority survey published in 2014 and reflecting 92 responses from 37 countries showed R&D partners’ appreciation of the local presence and in-depth understanding of CIMMYT and ICARDA researchers based in 19 countries. A major donor-funded review of CIMMYT’s wheat breeding program noted the success of the International Wheat Improvement Network and considered capacity development among the program’s key comparative advantages.
Benefits of three decades of international collaboration in wheat research have added as much as 10.7 million tons of grain – worth US $3.4 billion – to China’s national wheat output, according to a 2014 study led by the director of the Center for Chinese Agricultural Policy (CCAP) of the Chinese Academy of Science.

Described in a report published by the CGIAR Research Program on Wheat, the research specifically examined China’s partnership with CIMMYT and the free use of the Center’s improved wheat lines and other genetic resources during 1982-2011. The study used a comprehensive dataset that included planted area, pedigree and agronomic traits by variety for 17 major wheat-growing provinces in China.

“Chinese wheat breeders acquired disease resistant, semi-dwarf wheat varieties from CIMMYT since the late 1960s and incorporated desirable traits from that germplasm into their own varieties,” said Jikun Huang, Director of CCAP and first author of the new study. “As of the 1990s, it would be difficult to find anything other than improved semi-dwarf varieties in China. Due to this and to investments in irrigation, agricultural research and extension, farmers’ wheat yields nearly doubled during 1980-95, rising from an average 1.9 to 3.5 tons per hectare.”

The new study also documents the increasing use of CIMMYT germplasm by wheat breeders in China. “CIMMYT contributions are present in more than...
Genes found in million-year-old grass species are helping scientists to multiply the genetic diversity of wheat and to generate varieties that yield more than eight tons of grain per hectare in southwestern China, where rain-fed wheat grows in low temperatures after sowing and winter droughts can hold back productivity.

Wheat x grass crosses – known as “synthetic” wheats – were developed 25 years ago by a CIMMYT research team and have since been used in breeding programs worldwide. The first synthetic-derived variety to reach farmers, Chuanmai 42, arrived in the Sichuan Basin of China in 2003 and allowed wheat farmers there to boost yields by as much as 20 percent – the most significant increase in the region for decades.

“Physiological Factors Underpinning Grain Yield Improvements of Synthetic Derived Wheat in South Western China,” was published in the journal Crop Science and has shed light on the physiological differences that give Chuanmai 42 and other synthetic derivatives better yields. “In our three-year study, the synthetic crosses were more vigorous in early growth stages and grew more above ground at flowering time than non-synthetic varieties,” said Garry Rosewarne, CIMMYT wheat scientist and corresponding author of the report. “At maturity, more dry matter was partitioned to grain in the synthetic varieties and the plants were more erect and compact.”

26 percent of all major wheat varieties in China after 2000,” said Huang. “But our research clearly shows that, far from representing a bottleneck in diversity, genetic resources from CIMMYT’s global wheat program have significantly enhanced China varieties’ performance for critical traits like yield potential, grain processing quality, disease resistance, and early maturity.”

Will wheat farming rise to China’s challenges?

The world’s number-one wheat producer, China harvests more than 120 million tons of wheat grain yearly, mainly for use in products like noodles and steamed bread. China is more or less self-sufficient in wheat production, but wheat farmers face serious challenges. For example, wheat area has decreased by more than one-fifth in the past three decades, due to competing land use.

“This trend is expected to continue,” said Huang, “and climate change and the increasing scarcity of water will further challenge wheat production. Farmers urgently need varieties and cropping systems that offer resilience under drought, more effective use of water and fertilizer, and resistance to evolving crop diseases. Global research partnerships like that with CIMMYT will be vital to achieve this.”

Qiaosheng Zhuang, Research Professor of Chinese Academy of Agricultural Science (CAAS) and a Fellow of Chinese Academy of Science, called the new report “…an excellent, detailed analysis and very useful for scientists and policy makers. CIMMYT germplasm and training have made a momentous contribution to Chinese wheat.”

Another study by CCAP showed that 350 Chinese researchers had taken part in CIMMYT wheat training programs since 1970. Of those, 170 benefited from visiting scientist appointments at CIMMYT; many of the alumni now hold important positions in China’s wheat research system.

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The lifeblood of CIMMYT's research and partnerships, millions of seeds are on the move. As they arrive, depart, and are shared, the seeds also undergo rigorous health testing, are grown out at research stations, and are stored in frigid germplasm bank vaults.

CIMMYT’s chief resource is the genetic variability in seed. Preserved in the germplasm bank and in breeders and farmers’ fields, maize and wheat seed attests to millennia of farmer-led domestication and offers genes for high-yielding, resilient new varieties. Seed of over 10,000 maize and wheat varieties entered and left CIMMYT headquarters in 2014, traveling to and from far-flung destinations, including breeding programs of partner countries and private companies, CIMMYT’s global offices, and Center research stations in Mexico.

Seed arriving at CIMMYT-Mexico must pass through strict testing in the seed health laboratory. “We have a duty towards all partner countries to ensure its quality and that it carries no pathogens or pests,” says Monica Mezzalama, laboratory head. The laboratory also coordinates efforts to avoid the accidental introduction of transgenics into CIMMYT's germplasm bank and to prevent the accidental introduction of transgenic maize from wind-blown pollen or seed shipped from countries where transgenic maize is grown in open fields.

Seed that gets a clean bill of health moves on, often going to a breeder who will cross its most valuable traits into improved lines. It may also be shipped to one of four CIMMYT research stations in Mexico to be multiplied for research, storage or redistribution. Some may head for testing in a grain quality or micronutrient content laboratory or be sent to the germplasm bank.

**Entering the vaults**

In its germplasm bank, CIMMYT conserves, studies, and shares more than 27,000 unique seed collections of maize and 130,000 of wheat, including the crops’ non-cultivated relatives. The CIMMYT bank is one of only three ISO-certified seed banks in the world and holds its contents in trust for humanity under the framework of the International Treaty on Plant Genetic Resources for Food and Agriculture. For Tom Payne, head of the wheat germplasm bank, the most valuable seed is that about which most is known. “That knowledge allows you to find the traits you’re interested in,” he said. To deepen its knowledge about useful maize and wheat diversity and deploy it in breeding programs, CIMMYT leads a project called Seeds of Discovery. “The CIMMYT bank is unique in having direct linkages to two leading global crop breeding programs for maize and wheat,” said Payne.

CIMMYT has also sent more than 123,000 of its seed collections for backup storage in the Global Seed Vault at Svalbard, Norway, maintained by the Global Crop Diversity Trust to keep the genetic diversity of major food crops safe against a global catastrophe. “CIMMYT will continue to send seed to Svalbard each year until its entire collection is represented in the vault,” said Denise Costich, head of the maize germplasm bank.

When seed in CIMMYT collections begins to lose its ability to germinate with age, or when supplies of frequently-requested samples run short, viable seed is sown to replenish the collection — a process known as “regeneration.” In 2014, we regenerated 1,300 maize and 12,000 wheat lines, says Biliana Espinosa, the principal research assistant who manages CIMMYT’s wheat germplasm collection.

**On the road again**

Every year, CIMMYT receives hundreds of requests for samples of bank or breeding seed. The latter is grouped into sets of lines with specific aims — high yield, heat tolerance, disease resistance, to name a few traits — and sent to partners who grow the lines, return data on their performance to CIMMYT, and incorporate the ones they like into their breeding programs.

Responsible for seed distribution from CIMMYT’s headquarters, Efrén Rodríguez estimates that public research organizations comprise about three-quarters of CIMMYT seed recipients; the rest are private seed companies and non-government organizations. “Requests from small seed companies are increasing as the sector grows in Latin America, Africa, and Asia,” he said.
Mexican smallholder farmers are profiting from native maize dishes served in exclusive Mexican and U.S. restaurants, as endangered maize landraces are being preserved and improved.

Longstanding initiatives with national partners and farmers to boost the productivity and profitability of maize landraces in Mexico, the global center of origin for the crop and its sister species teocintle, have recently found renewed impetus from an emerging niche market – exclusive restaurants in the USA and Mexico that use the landrace grain for specialty dishes.

In 2014, a number of farmers from the state of Oaxaca sold grain of their native varieties to Masienda, a New York-based company that markets the grain to chefs in leading New York restaurants, offering farmers a premium as high as 25 percent over normal maize grain prices.

“Grain of some landraces provides superior quality and flavor for tortillas and other foods,” said Martha Willcox, CIMMYT maize landrace improvement coordinator, who has been working with farmers and national research partners through MasAgro, Mexico’s program with CIMMYT for the sustainable intensification of agriculture. “The problem is the landraces on average yield less than improved varieties or hybrids and...
farmers normally receive no quality premium, when they sell the grain in conventional markets.”

Worse, said Willcox, is that these varieties, which were developed over millennia through farmer selection and once covered the Mexican countryside, may eventually end up as mere seed collections in a germplasm bank. “The landraces are actually a world treasure and embody much of maize’s extraordinary genetic diversity, but they’re disappearing as subsistence farmers migrate in search of better livelihoods,” she explained. “The interest from United States and Mexico City haute cuisine markets has instilled new pride in farmers and motivated them to improve their productivity through participatory plant breeding and adopting better farming practices.”

Old maize landraces on the menu and in the media spotlight

The present work is rooted in a joint effort begun in the 1990s by Suketoshi Taba, CIMMYT maize breeder and head of maize genetic resources during 1975-2011, with Flavio Aragon Cuevas of Mexico’s National Institute of Foresty, Agriculture and Livestock Research (INIFAP) and Humberto Castro García of Mexico’s Chapingo Autonomous University (UACh). Together they developed a dynamic approach whereby landraces were improved for yield and other traits while conserving farmer-valued factors like grain quality, with direct community participation. Despite limited financial support, Aragon, Castro, and their colleagues, including Willcox, have managed to refine and expand the scope of the efforts.

“The topic of native maize races has recently gotten national and international attention, partly due to concerns around the possible introduction of genetically modified maize in Mexico,” said Aragon. “There needs to be a strategy to select and improve the right native varieties for the right niches. If you try to hold onto everything, you will lose the best.”

The researchers’ studies have shown that, using the best local variety plus proper management – including targeted use of fertilizer and optimal plant density and number of seeds per sowing point – most farmers can harvest enough to feed their households and have surplus grain to sell. “We give farmers hard data about what can work best in their villages, including economic cost-benefit studies, which is beyond the support that extension normally provides,” said Willcox. Current support to farmers, she adds, tends to focus on hybrid maize production and is not easy for smallholders to access. “We need to get policymakers reliable information about why farmers choose what they do.”

Helping farmers to organize and link to institutions has been a focus for Castro. “We’re working to segment target zones, producers, and technology levels to design and deliver solutions,” he said. “A common, urgent need among smallholders is for good storage facilities, both to maintain household food supplies and to hold and sell surplus grain when markets are favorable.”

The young entrepreneurs involved in marketing native maize to restaurants see good potential. “A restaurant offering 100 meals a day would buy from 500 and 1,000 kilos of maize per month,” said Jorge Gaviria, a Masienda founder, who hopes to add 50 or more additional restaurants to his client list in 2015.

Oaxacan farmers review one of their native maize varieties as they pack the product for shipment.
Farms on over 1.5 million hectares (ha) in South Asia’s vast rice-wheat cropping zones are using a high-tech approach to level their farmland, allowing them to save 15–30 percent irrigation water and benefit from up to 6 percent higher yields for rice, wheat and other crops, over farmers who work traditionally-plowed fields.

The recent study “Impacts of Laser Land Leveling in Rice-Wheat Systems of the North-western Indo-Gangetic Plains of India” concluded that if 50 percent of the area under the rice-wheat system in Haryana and Punjab States were precision leveled, this would add 0.7 million tons of rice and nearly 1 million tons of wheat to India’s market each year, representing an annual market value of US $395 million, with significant savings in irrigation water.

“Precision levelers in action”

In northwestern India, water and electricity for irrigation are highly subsidized, “°said M.L. Jat, CIMMYT’s senior cropping systems agronomist.

“State governments must incentivize sustainable practices and technologies to stop groundwater depletion.”

During 1967–79, wheat production tripled in India, due in part to the widespread adoption of high-yielding varieties and fertilizer but supported as well by a huge expansion in irrigated area and subsidized electricity for irrigation pumps. By 2006, 90 percent of India’s total fresh groundwater use was for agricultural, and major aquifers in the North were falling as much as a meter every three years.

“From just 37 precision levelers during the Rice-Wheat Consortium days (1990s–early 2000s), there are now approximately 25,000 machines available,” said Jat. According to Jat, the success of precision levelers in Punjab Province is due largely to the “localization of manufacturing; thanks to the involvement of local shops, the cost of a precision leveler has dropped one third, from more than US $12,000 to about $4,600.”

First used in Pakistan, precision leveling was studied and promoted region-wide through joint work by CIMMYT, IRRI, and national research programs during 1994–2008. Since 2011, CIMMYT in collaboration with the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) has studied and promoted laser land leveling in the western Indo-Gangetic Plains, in conjunction with research on conservation agriculture (CA) practices such as smart fertilizer application, zero tillage, direct-seeded rice and residue management.

The business of leveling

Jagdeep Singh from Kanoi village in Punjab’s Sangrur district has been providing tractor services to local farmers since 1998. He was introduced to precision leveling by Punjab Agricultural University in 2008.

“I used the machine to level 4 hectares of my land and saved 25–30 percent of my water. This was so encouraging that I bought my own machine the very next year,” said Singh.

In 2009, Singh leveled approximately 200 ha of land for nearly 200 farmers across 17 villages. “Initially, farmers used to get just one or two acres leveled to see if it helps. But now, most are getting 6 to 10 hectares leveled at a time,” said Singh. In light of the high demand, Singh purchased a second machine in 2013 and the following year leveled over 400 ha, charging US $16 per hour for his services.

Farmers must level their fields to obtain high yields and save on water and electricity costs, through the use of precision leveling technology.
The world is getting hotter and instances of extreme weather events are on the rise. The planet’s changing climate is impacting farmers through heat, drought, floods, storms, diseases, emerging pests, shifting growing seasons, and volatile rain patterns. From Africa to Asia, CIMMYT is working with partners to develop maize lines with tolerance to drought, heat-stress and waterlogging.

In Africa, where about a fifth of the maize crop is lost each year due to drought, over 180 CIMMYT-derived varieties have been released and 3 million farmers in 13 African countries are now using them. Farmers sowing drought-tolerant hybrids developed by CIMMYT instead of traditional open-pollinated varieties could increase their productivity by 30 percent or more. A 2014 CIMMYT study predicted that during 2007-16 drought-tolerant maize could generate US $0.53 – US $0.88 billion from increased harvests and reduced risk, cutting poverty for over 4 million producers and consumers.

For farmers such as Jane Ndawa, in Makueni County Kenya, even two years of bad rains will not put them off planting maize. “Any help farmers can get to harvest more maize is most welcome, since we will keep planting it regardless of the yield because we need maize,” she said. “When things are bad like this season, we have to buy maize and maize flour for our daily food.” Availability of the new varieties – which also possess other desirable traits such as resistance to major diseases – has contributed to national maize productivity increases in some countries.

Sarah Nyamai, a mother of six from Machakos County in Eastern Kenya, tried the KDV 4 maize variety on her 0.5-ha farm, and harvested more than twice what she might have obtained from a local variety in a good year. “This is the first time I have harvested so much maize from my farm. This is a good variety and I plan to continue buying this seed.”

With funding from the United States Agency for International Development (USAID), a seed scaling project will further this legacy through strong partnerships with private and public seed companies, community-based organizations, NGOs and national extension systems. Over 50 seed companies have already signed up to produce and distribute 71 varieties. The project will improve the availability, demand for and affordability of drought-tolerant varieties in 7 countries representing 41 percent of sub-Saharan Africa’s maize area, partly through the production of 12,000 additional tons of certified seed. The improved availability of seed is expected to benefit 2.5 million people.

**Public-private sector partnerships in Asia**

CIMMYT’s heat- and drought-tolerant maize is being used to develop and deliver improved, stress-resilient and certified varieties, through strong public-private partnerships and funding from the Syngenta Foundation for Sustainable Agriculture, BMZ/GIZ-Germany, and the Generation Challenge Program of CGIAR. Five promising drought-tolerant hybrids that significantly outperform other varieties will be evaluated and deployed in the dry belt of central India. In Bangladesh, Bhutan, India, Nepal and Pakistan, a set of 24 first-generation heat-tolerant hybrids have been identified and taken forward for large-scale trials and potential scaling out. Five hybrids in Bangladesh and four in Nepal have already been identified for formal registration and deployment, with support from USAID.

Based on climate predictions showing a higher incidence of extreme rainfall or drought alongside a gradual rise in temperature, CIMMYT is also working to combine tolerance to waterlogging and drought in Asian maize. In 2014, a region of the genome that is strongly associated with combined drought and waterlogging tolerance was identified, for marker-assisted selection to rapidly introduce this trait in tropical breeding programs.

**Adapting farming methods**

In addition to developing new maize varieties, CIMMYT research is highlighting management options to help farmers make the most of their maize. In India, for example, successive demonstrations at one site proved that bed planting of hybrid monsoon maize outperformed other options due to improved soil drainage, while elsewhere zero-till maize outperformed rice while using 50 percent less irrigation water.

Making maize climate-ready
In September 2011, reports came of a devastating new maize disease in the Southern Rift Valley of Kenya. The symptoms were described as mottling of the leaves, small cobs with few grains, and necrosis of young leaves leading to “dead heart” and eventually plant death. It was common for affected fields to show 100 percent infection rates, meaning that some farmers faced losing the entire crop.

By October 2012, a study team sent by CIMMYT and the Kenya Agricultural and Livestock Research Organization (KALRO) confirmed the disease to be maize lethal necrosis (MLN). Caused by a combination of three pathogens, the disease spread quickly throughout Kenya and later to Tanzania, Uganda, South Sudan, the Democratic Republic of Congo and Ethiopia. The U.S. Department of Agriculture (USDA) forecasts that at this rate, the disease will spread and intensify across Africa by 2020.

An upcoming publication from the CIMMYT socioeconomics program indicates that 23 percent of Kenya’s maize production was lost to MLN in 2014; about 2.1 million metric tons. How can the tide of this disease be turned in Africa, and similar devastation prevented elsewhere?

In search of resistance

In the Biosafety Laboratory at CIMMYT headquarters, Monica Mezzalama cuts up some MLN-infected maize leaves and crushes them into a buffer solution. Passing through two further sets of safety doors, she arrives at the greenhouse where several hundred young maize plants await inoculation. The plants are dusted with a fine grey powder to cause surface damage, allowing the disease-causing viruses to enter when Mezzalama brushes the youngest leaf of each plant with the solution of infected plant matter.

This is the beginning of a systematic process to find sources of MLN resistance from samples in the germplasm bank at CIMMYT.

As Terry Molnar, maize breeder at CIMMYT, explains: “The maize industry has always been very fast at responding to diseases, but this has been difficult in the case of MLN. What’s scaring people is that it’s spreading so fast in eastern Africa, the two viruses that cause it are common across all tropical maize growing countries, and we’re not finding many sources of resistance.”

Luckily, the geographic information attached to maize accessions within the CIMMYT collection provides a map to resistance; the one thousand accessions being tested are landraces chosen from areas known to be affected by one of the MLN pathogens in Latin America and the Caribbean. After the first round of testing, several accessions remained healthy after inoculation and will be tested further to confirm their resistance. However, depending on the level of efforts that can be funded, it may take several years to turn resistant maize landraces into elite breeding material.

Responding on all fronts

The rapid emergence of MLN in eastern Africa was met by an equally impressive effort to offer farmers varieties capable of surviving MLN.

With funding from the Bill & Melinda Gates Foundation, the Syngenta Foundation for Sustainable Agriculture and MAIZE, CIMMYT and KALRO jointly established an MLN screening facility at Naivasha, Kenya, in 2013 that is widely used. After a mass screening of 21,000 pre-commercial hybrids, 26,000 inbred maize lines and 60 commercial cultivars, 5 maize hybrids with moderate resistance to MLN are already in varying stages of commercial release in Kenya, Tanzania, and Uganda.

“This first generation of hybrids is based on chance finds in available germplasm. The second generation will come from the inbred lines we are developing from truly resistant sources,” said B.M. Prasanna, director of the CIMMYT global maize program.

“In the long run we need to develop diverse sources with greater resistance to MLN to prevent a breakdown of resistance,” said Mezzalama.

Beyond seed

In the meantime, it is essential to complement the response from plant breeders with a greater understanding of how the disease emerged and how it can be controlled.
The revolution in phenomics – work that the CIMMYT wheat physiology group helped pioneer, especially remote sensing of plant temperature and reflected radiant energy – means that we can quickly evaluate physiological traits in many more breeding lines than before.

— Maria Tattaris
CIMMYT wheat physiologist

In the battle to raise wheat production by more than 60 percent over the next 35 years and satisfy rising global demand, scientists believe they have begun unravelling the genetic mysteries to deliver a more productive and resilient wheat plant.

Recent experiments at 26 international sites showcased a new generation of improved wheat breeding lines that were crossed and selected for superior physiological traits. Their yields were 10 percent higher on average than those of other improved wheat varieties.

“What we have revealed is a proof of concept – namely, that designing crosses on the basis of wheat’s physiology results in novel genotypes that show significant improvements in yield and adaptation,” said Matthew Reynolds, a CIMMYT distinguished scientist and wheat physiologist. “We have a long road ahead, but we hope this work will eventually lead to the discovery of the best gene combinations that enable wheat to better withstand higher temperatures and drier conditions.”

Climate studies predict more erratic rainfall and more extreme and longer heat waves in this century. Wheat is particularly sensitive to heat: wheat production decreases by 6 percent for every 1° C increase in growing-season temperatures, according to a 2014 paper in the leading science journal Nature Climate Change.

“The study also shows that rising temperatures are already reducing global wheat production,” said Reynolds, a co-author for the paper. “This is why farmers need more heat-resilient wheat varieties right now.”

The work is both pressing and complex, according to Reynolds, requiring gene discovery, development and use of DNA markers for target traits, large-scale field assays of breeding lines at heat- and drought-stress locations, careful data management and bioinformatics, and international testing and sharing of the best lines.

To capture the requisite global expertise and resources for this work, CIMMYT has launched and is facilitating a multidisciplinary partnership known as the Heat and Drought Wheat Improvement Consortium (HeDWIC).

Reynolds said the proposal is based on a direct consultation with over 100 crop scientists worldwide. “HeDWIC will capitalize on decades of investment in plant stress research, bridging islands of knowledge and a wealth of practical experience and infrastructure to improve wheat’s adaptation in a timely and efficient way,” he explained.

Breaking the yield barrier

In addition to improving crucial traits like tolerance to heat and drought, the CIMMYT wheat physiology team is a key player in efforts to dramatically boost wheat’s genetic yield potential, to satisfy the food demands of a world population expected to exceed 9 billion by 2050.
“Global demand for wheat is increasing 1.7 percent each year,” Reynolds said, “but conventional breeding improves wheat yield potential by less than 1 percent per year. At this rate, we’re quickly falling behind the curve on meeting global wheat demand, and we’ve already seen how shortages in wheat grain stocks can cause price hikes, uncertainty and unrest in wheat-importing countries, and hardship for resource-poor consumers who eat wheat.”

With these challenges in mind, CIMMYT served as a founding member and was instrumental in precursor initiatives for the International Wheat Yield Partnership (IWYP), a public-private endeavor launched in 2013 to substantially increase the genetic yield potential of wheat.

Under the new initiatives, scientists will reshape the wheat plant for adaptive traits relating to temperature extremes, photoperiod, soil depth, and other environmental factors. New goals will include dramatically enhancing wheat’s use of sunlight and understanding the internal signals whereby plants coordinate their activities and responses to the environment. Crops like rice – whose metabolism resembles wheat’s but which tolerates greater heat – can serve as models. New technology will allow the more effective study of roots and their potential to boost wheat yields and stress adaptation.

“We’ve already screened 70,000 seed collections from the CIMMYT germplasm bank and have identified a veritable powerhouse of novel material to support breeding and gene discovery for decades to come,” Reynolds said.

“Got a question about wheat? Whether you are a scientist, a researcher or simply interested in learning more about the vital staple crop that provides 20 percent of the world’s calories, the Wheat Atlas can help.”

The Wheat Atlas provides up-to-date information on new wheat varieties released worldwide, production challenges, and reports from international wheat nurseries. The information is geographically organized and can be viewed using maps and charts.

Recent updates have made it easier to access diverse information on wheat production, markets and research. Improvements include a redesigned user interface, site and database structure and navigation; the website homepage also features daily wheat news.

Launched in 2009, the Atlas now draws an average of 2,000 unique visitors a month, had more than 107,000 page views in 2014, and has been cited as an information resource in scientific journal articles, according to Petr Kosina, who with Paul Moncada has led the site’s development and recent revamp.

“We’re in continuous ‘beta mode,’ improving the functionality of the site and user experience,” said Kosina.

CIMMYT contributors have included many staff, including Hans Braun, Global Wheat Program director; as well as David Hodson, GIS and decision support systems specialist; Kai Sonder, GIS specialist; and Tom Payne, head of the wheat germplasm bank. Until 2013, the Wheat Atlas was supported by the Durable Rust Resistance in Wheat project, led by Cornell University.
CIMMYT increased investments in gender research to ensure that projects engage men and women more effectively.

“We’re in charge. Women know very well how to farm here,” explained a young woman from San Gabriel de las Molinas, a hillside village in Mexico, in response to a question suggesting that men were more productive farmers. The focus group where this conversation took place was part of a pilot exercise in over 70 villages around the world, developing data collection tools to explore why some agricultural innovations lead to women’s empowerment while others do not.

The pilot in Mexico was one of 19 case studies completed in 2014 by the CIMMYT-led CGIAR Research Programs on Maize and Wheat for the CGIAR Global Study on Gender Norms, Agency and Innovation in Agriculture and Natural Resource Management (Gennovate). “CGIAR research programs are ‘raising the game’ by committing to a concerted effort to improve gender equality in agriculture” explained Lone Badstue, CIMMYT’s strategic leader for gender research. “Without appropriate incorporation of gender considerations, technically-superior innovations are limited in their impact and may instead exacerbate gender inequalities.”

Tackling the gender gap in research

Integrating gender

During 2014, MAIZE also implemented the “Gender Matters in Farm Power” project, led by the Royal Tropical Institute (KIT) and which is investigating opportunities to empower men and women through scale-appropriate mechanization. Other activities included efforts to integrate gender into participatory variety selection, the creation of a gender strategy for maize seed system development, and initiatives to integrate gender into advisory services and small-scale entrepreneurship.

Notable work by WHEAT included the design of a Glasgow Caledonian University study on gender relations in key wheat regions in Bangladesh, India, Nepal and Pakistan. The Program also mobilized resources for an ambitious project to better understand gender and shape research activities to empower resource-poor women in wheat-growing areas of Afghanistan, Ethiopia, and Pakistan.

Jointly, MAIZE and WHEAT carried out a study to improve gender equality and empower women professionals in research. The programs also endorsed revised gender strategies, while the demand from scientists and research teams for gender inputs for wheat research continued to increase. Overall, the number of CIMMYT projects with an explicit gender focus rose from four in 2011 to 20 in 2014 (while the number of gender staff increased from one in 2011 to four in 2014).
Making the most of appropriate machinery across regions

Across diverse farm settings in sub-Saharan Africa, Latin America, and South Asia, experts are sharing knowledge and experiences to re-design and adapt machinery for women and men.

“Improved farming techniques can only be promoted if appropriate equipment is available,” said Jelle Van Loon, leader of CIMMYT’s machinery and mechanization unit in Mexico. With potential to increase agricultural labor efficiency and effectiveness, mechanization projects across eastern and southern Africa, Latin America, and South Asia are working to identify or manufacture suitable machines, and develop commercial models to deliver mechanization to smallholder farmers.

In Mexico, four affordable and efficient machinery prototypes for smallholders were developed by the Sustainable Modernization of Traditional Agriculture (MasAgro) project in 2014. This and other products and learning are shared across regional projects. “In South Asia we’ve found that there is more adoption of machines and consequent service provision to farmers where rural credit...
A tractor with large attachments in Mexico.

A seeder attachment used in China.

women did not have enough negotiating

concluded that women’s labor burden

“Gender Matters in Farm Power” study

men and women farmers through

opportunities to empower small-scale

FACASI) project, funded

Conservation Agriculture for Sustainable

mechanization.”

develop women-friendly technologies.

“Yet the solution may not be simply to

affected by low farm mechanization,”

Justice said, “and it actually saves money

mechanization, like two-wheeled tractors,

for two decades to promote small-scale

Bangladesh.

Timothy Krupnik, who leads CIMMYT’s

relatively well-functioning markets,” said

improve the performance of their crops,”

and appropriate machinery to save

progressively demanding more affordable

the initial success of this pilot, CSSA

working with its partners to formalize and expand the project. “Farmers are progressively
demanding more affordable and appropriate machinery to save
effort, energy, labor, and to improve the performance of their crops,” commented Krupnik.

Crop

Climatology

eco-environments.

conditions.

Danquah, E.; Hearne, S. 2014. Genetic analysis

deletion bins to anchor and order sequences


Bello-Lopez, J.M.; Dominguez- Mendoza, C.A.;

and appropriate machinery. Due to

dimensions are addressed. “Women are

As farm power mechanization directly

relates to agricultural labor, careful

analysis is key to ensuring that gender
dimensions are addressed. “Women are

often the ones performing the most labor

tensive tasks and are disproportionately

affected by low farm mechanization,” explained Frederic Boudron, CIMMYT’s
continents agroecosystems in Asia.

“Yet the solution may not be simply to
develop women-friendly technologies. It

may be more about ensuring that women have access to mechanization

services and that women’s high labor

burden translates into actual demand for

mechanization.”

In 2014, the Farm Power and

Conservation Agriculture for Sustainable

Land Degradation (CAASS) project, funded

by ACIAR, commissioned a gender

analysis in Ethiopia and Kenya to identify

opportunities to empower smaller-scale

men and women farmers through

appropriate-scale machinery. The “Gender Matters in Farm Power” study

concluded that women’s labor burden was unlikely to translate into demand

for mechanization because their labor is poorly valued or not recognized,

and women did not have enough negotiating

power to influence household decisions about investments in mechanization.

In this context, mechanizing men’s tasks may have indirect positive effects on

women’s tasks, according to Boudron. Timelessness of crop establishment for

example affects weeding intensity, which can demand work of women and men.

The Cereal Systems Initiative for South Asia (CSSA) project, funded by the Bill

and Melinda Gates Foundation and USAID with in-kind contributions of national

partners, is also working to increase

gender equality. In 2014, CSSA-Nepal

placed an engineer, Surmana Parui, with a

micro-finance bank to explore the possibility of using micro-credit loans to

enable women to purchase scale-

and gender-appropriate machines. Due to

the initial success of this pilot, CSSA

is working with its partners to formalize and expand the project. “Farmers are progressively
demanding more affordable and appropriate machinery to save
effort, energy, labor, and to improve the performance of their crops,” commented Krupnik.


Arunjuelo, I.; Arrese-Igor, C.; Molero, G. 196:21-23.


Bautista, J.C. 2014. Characterization of

Yr54

J.C. 2014. Characterization of


Genotypic correlations and G×E correspondences between line performance and test performance in spring wheat are required to define Conservation Agriculture in sub-Saharan Africa: The appropriate use of fertilizer to enhance maize yield in sub-Saharan Africa. 


CLIMATE CHANGE AND MAIZE IN ASIA

TEMPERATURES ARE ALREADY RISING IN ASIA

Temperature change in crop-growing regions 1980-2008

15% losses to Asian maize yields predicted due to climate change by 2080

70% of maize in Asia is rainfed and vulnerable to drought

GROUNDWATER is already in decline while upstream water sources are at high risk

70% of maize in Asia is already in decline while upstream water sources are at high risk

ADAPTATION OPTIONS

NEW VARIETIES AND PLANTING TIMES

Could increase yields by 23% and adapt agriculture to changing climates

PRECISION AGRICULTURE

Climate-smart technologies like laser land leveling are increasingly available

CROP DIVERSIFICATION

Swapping winter rice with maize in Asia can save water

CONSERVATION AGRICULTURE

New practices such as no-till and good nutrient management can reduce labor and resource-use

WHEAT

WHEAT PROVIDES 19% OF OUR TOTAL AVAILABLE CALORIES

WHEAT IS THE LARGEST PRIMARY COMMODITY

GLOBAL PRODUCTION IS OVER 700 MILLION TONS

TOTAL EXPORT VALUE

46.8 billion US$

TOP 5 PRODUCERS

<table>
<thead>
<tr>
<th>Country</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>122</td>
</tr>
<tr>
<td>India</td>
<td>94</td>
</tr>
<tr>
<td>USA</td>
<td>58</td>
</tr>
<tr>
<td>Russian Federation</td>
<td>52</td>
</tr>
<tr>
<td>France</td>
<td>39</td>
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</table>

TOP 5 IMPORTERS

<table>
<thead>
<tr>
<th>Country</th>
<th>2009-11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>9.8</td>
</tr>
<tr>
<td>Italy</td>
<td>7.1</td>
</tr>
<tr>
<td>Algeria</td>
<td>6.1</td>
</tr>
<tr>
<td>Brazil</td>
<td>5.8</td>
</tr>
<tr>
<td>Japan</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Source: FAOSTAT
Honing the life and legacy of Wilfred Mwangi, CIMMYT agricultural economist

December 2014 marked the passing of Wilfred M. Mwangi, distinguished Kenyan scholar, statesman, and researcher who dedicated his career to improving farmers’ food security and livelihoods. In 27 years at CIMMYT, Mwangi made significant contributions both as a principal scientist and distinguished economist with authorship on nearly 200 publications, as well as country and regional liaison officer, associate director of the global maize program, leader of the Drought Tolerant Maize for Africa (DTMA) project and CIMMYT regional representative for Africa.

Mwangi also mentored hundreds of young, national program scientists from Africa and elsewhere, according to Derek Byerlee, retired World Bank policy researcher who led CIMMYT’s socioeconomics team in the late 1980s-early 90s and recruited Mwangi. “He served CIMMYT with distinction for decades and was enormously important in promoting smallholder maize research in Africa,” Byerlee said. “Even more, he was a great human being who was highly-respected throughout the region.”

Born in 1947, Mwangi grew up in Nakuru County, Kenya. He completed a B.A. in Economics and Rural Economy at Makerere University, Uganda, in 1972 and M.A. and Ph.D. studies in Agricultural and Development Economics at Michigan State University (MSU) in 1975 and 1976. Returning to Kenya, Mwangi eventually became a Professor and Chair of the Department of Agricultural Economics at the University of Nairobi. He joined CIMMYT in 1987.

His career included stints as Deputy Permanent Secretary and Director of Agriculture and Livestock Production in Kenya’s Ministry of Agriculture and Rural Development, and as a World Bank economist. As Deputy Permanent Secretary, he served as part of a “dream team” of eminent figures convened in 1999 by Richard Leakey, then head of the Kenya Wildlife Services, at the behest of President Daniel arap Moi, to help reform government administration.

Knowledgeable in politics and with prominent policy contacts, Mwangi provided invaluable support for CIMMYT’s Africa-based partnerships and work to develop and promote better maize and wheat crop varieties and farming systems, particularly to benefit the region’s hundreds of millions of smallholder farmers.

With typical modesty and humor, Mwangi once observed that “Despite all my academic expertise and impressive career, my mother still tells me how to farm.”

CIMMYT staff in 2014

Headquartered in Mexico, CIMMYT has 1,238 staff members, 214 of whom are internationally-recruited scientists and other experts. Of the latter, slightly more than half work outside of Mexico at 19 Center offices in 14 major maize- and wheat-producing countries of the developing world, assisted by 358 support staff. The 728 CIMMYT staff members in Mexico are distributed among the Center’s main office and 4 other principal research stations.
CIMMYT financial overview

2014 and 2013 financial statements

A summary of the combined financial statements of CIMMYT is, and CIMMYT A.C., is set out in Table 1. Total revenues for 2013 amounted to US $167.7 million and US $152.2 million in 2014. Total net assets increased by US $4.9 million in 2013, to US $58.0 million, and by US $4.1 million in 2014, to US $62.2 million. Unappropriated, unrestricted net assets increased to US $31.4 million in 2013 and to US $39.8 million in 2014.

Combined statement of activities

As of December 31, 2014 and 2013 (US $ 000s)

<table>
<thead>
<tr>
<th>ASSETS 2014</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash and cash equivalents</td>
<td>82,448</td>
</tr>
<tr>
<td>Cash set aside due to Generation Challenge Program</td>
<td>4,035</td>
</tr>
<tr>
<td>Total current assets</td>
<td>115,469</td>
</tr>
<tr>
<td>Non-current assets</td>
<td>22,856</td>
</tr>
<tr>
<td>Total assets</td>
<td>138,325</td>
</tr>
</tbody>
</table>

LIABILITIES AND NET ASSETS

Current liabilities

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<tr>
<th>Liabilities 2014</th>
<th>2013</th>
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</thead>
<tbody>
<tr>
<td>Accounts payable</td>
<td>39,011</td>
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<tr>
<td>Other</td>
<td>1,017</td>
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<tr>
<td>Total current liabilities</td>
<td>39,028</td>
</tr>
<tr>
<td>Total liabilities</td>
<td>76,163</td>
</tr>
<tr>
<td>Net assets</td>
<td>62,162</td>
</tr>
</tbody>
</table>

2014 and 2013 funding overview

Total funding for 2013 was US $167.6 million and US $152.0 million in 2014. This included other income of US $1.2 million in 2013 and of US $1.3 million in 2014. Grant income amounted to US $166.4 million in 2013, comprising US $0.4 million in unrestricted grants and US $166.0 million in restricted grants (Table 2). For 2014, grant income amounted to US $148.9 million, comprising US $148.0 million in restricted grants.

Table 2. Schedule of grant revenue

For the years ended December 31, 2014 and 2013 (US $ 000s)

<table>
<thead>
<tr>
<th>Donors 2014</th>
<th>2013</th>
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</thead>
<tbody>
<tr>
<td>Restricted</td>
<td>Unrestricted</td>
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<tr>
<td>CGIAR</td>
<td>148,919</td>
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<tr>
<td>Other</td>
<td>1,260</td>
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<tr>
<td>Surplus</td>
<td>3,832</td>
</tr>
<tr>
<td>Total revenue and gains</td>
<td>150,179</td>
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Top donors, 2014 (US $ 000s)

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<thead>
<tr>
<th>Country</th>
<th>2014</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States of America</td>
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<td>21,634</td>
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<tr>
<td>United Kingdom</td>
<td>15,532</td>
<td>19,009</td>
</tr>
<tr>
<td>Mexico</td>
<td>2,226</td>
<td>20,775</td>
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<tr>
<td>Canada</td>
<td>8,375</td>
<td>10,157</td>
</tr>
<tr>
<td>Germany</td>
<td>2,507</td>
<td>2,752</td>
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<tr>
<td>France</td>
<td>2,026</td>
<td>2,026</td>
</tr>
<tr>
<td>Japan</td>
<td>71</td>
<td>453</td>
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<tr>
<td>Netherlands</td>
<td>2,791</td>
<td>3,582</td>
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<tr>
<td>Australia</td>
<td>2,226</td>
<td>20,775</td>
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<tr>
<td>Mexico</td>
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<td>20,775</td>
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<tr>
<td>China</td>
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<td>123,849</td>
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MOPA

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<td>Mexico</td>
<td>412</td>
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<tr>
<td>Mexico</td>
<td>999</td>
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Acronyms

ACIAR Australian Centre for International Agricultural Research
ADB Asian Development Bank
BMGF Bill & Melinda Gates Foundation
CA Conservation agriculture
CAAS Chinese Academy of Agricultural Science
CCAFS CGIAR Research Program on Climate Change, Agriculture and Food Security
CCAP Center for Chinese Agricultural Policy of the Chinese Academy of Science
CCSHAU Chaudhary Charan Singh Haryana Agriculture University
CIMMYT International Maize and Wheat Improvement Center
CRP CGIAR Research Program
CSBA Cereal System Initiative for South Asia
DRRW Durable Rust Resistance in Wheat
FACASI Farm Mechanization and Conservation Agriculture for Sustainable Intensification
Gennovate Global Study on Gender Norms, Agency and Innovation in Agriculture and Natural Resource Management
GCAP Global Conservation Agriculture Program
GIS Geographic Information Systems
GMP Global Maize Program
GWP Global Wheat Program
HIW/WIC Heat and Drought Wheat Improvement Consortium
ICAR Indian Council of Agricultural Research
INIFAP Mexico's National Institute of Forestry, Agriculture and Livestock Research
IRRI International Rice Research Institute
IWVP International Wheat Yield Partnership
KALRO Kenya Agricultural and Livestock Research Organization
KIT Royal Tropical Institute, the Netherlands
MAIZE CGIAR Research Program on Maize
MasAgro Sustainable Modernization of Traditional Agriculture
MLN Maize Lethal Necrosis
PAU Punjab Agriculture University
R4D Research for development
SeeD Seeds of Discovery
SVBiPjUAR Sardar Vallabh Bhai University of Agriculture and Technology
UACU Chapingo Autonomous University, Mexico
USAID United States Agency for International Development
USDAA U.S. Department of Agriculture
WHEAT CGIAR Research Program on Wheat

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Inside this issue: Ashwamegh Banerjee, Frédéric Baudron, Clyde Beaver, Ivan Vázquez Cruz, Khotchit Iwondi, MJ. Jat, Peter Kosina, Peter Loven, Ranak Martin, Alan McHugh, Garry Rosewarne, Alfredo Saénz, Sam Storr, Annie Wangalachi, Patrick Wall, Martha Wilcox and CIMMYT archives.

ISSN in process.