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The work of CIMMYT and its many valued partners on maize and wheat farming systems is more important now than at any time in the organization’s history. Our planet’s expanding population, changing diets, limited natural resources, demand for bio-fuels and increasingly variable climate are all putting extraordinary pressure on the global food system. The evidence is all around us. In 2012, for the third time in less than six years, we faced a global food price crisis with international maize prices reaching levels double those of just two years prior. In the wake of the Arab Spring, two major wheat production and cereal importing areas, North Africa and the Middle East, remain highly stressed by rising wheat prices. In recent years average wheat imports for all of Africa have reached more than 35 million tons annually, costing the continent’s nations more than US$12 billion and threatening the supply of wheat products for resource-poor consumers.

Global grain markets are increasingly prone to severe and unpredictable weather events, driven by climate change. For example, in 2012 more than 27,000 high temperature records were broken in the USA, and the downturn in crop production there sent shockwaves through the world’s markets. Some countries resorted to export bans or panic buying. Resulting food price spikes were widely felt but most severely in the food security and diets of the poor. As described in a recent joint statement from three United Nations agencies (“Tackling the Root Causes of High Food Prices and Hunger,” FAO, IFAD and WFP; September 2012), the poor spend large portions of their incomes on food and will eat less or shift to cheaper, lower-quality foods when prices rise.

As far back as 1969 – fully 40 years before his death and only one year before he received the Nobel Peace Prize for his contributions to the Green Revolution that saved hundreds of millions from food shortages – hunger fighter and CIMMYT wheat researcher Dr. Norman E. Borlaug warned that “...the magnitude of the world food problem should not be underestimated. Recent success in expanding wheat, rice and maize production in Asian countries offers the possibility of buying 20-30 years of time.”

Once again it is clear that the world can no longer afford to rely on imports from a handful of high-production “breadbasket” countries. Low stocks of staple crops, exacerbated by financial speculation, have put humanity into a precarious situation where reduced production in just one of these breadbaskets can destabilize the entire global food exchange system.

Message from the Director General

Will food price inflation eradicate years of poverty reduction?

Thomas A. Lumpkin, CIMMYT Director General, inspects high-yielding wheat in northern Mexico.
Call to action: Strategic framework for fighting hunger

Despite the world’s seeming failure to learn from past mistakes, there is hope. Many countries could increase agricultural productivity to reduce import overreliance, benefit the rural poor and increase economic development. The potential for improvement is enormous, particularly considering the large gap between crop yields on research plots and those in farmers’ fields. Science, policymakers and regulators must provide solutions.

Individual countries must increase their investments in agriculture and agricultural development. The agriculture sector is the primary driver of many national economies in the developing world, and several examples of such national commitments appear in this report. For example, a number of nations in eastern and southern Africa have invested in developing drought-tolerant maize and improving the productivity of maize-legume cropping systems. Several are studying the potential to grow more wheat and thus reduce imports. Mexico’s MasAgro is an ambitious program to raise maize yields across the country by modernizing farming to be more productive, sustainable and environmentally friendly. CIMMYT and India have founded the Borlaug Institute for South Asia (BISA), an international agricultural research organization, to address food problems specific to the region.

Comprehensive national and international research approaches can help both smallholders and larger-scale farmers in developing countries to grow enough for their needs and for markets at all levels. Solutions must include improved agronomy (to restore soil quality), more efficient use of inputs (water, land, fertilizer and labor), improved crop varieties and storage methods (to reduce post-harvest losses), implementing biophysical and molecular research (to increase crop yields) and improving the efficiency of local and regional markets.

Farmers are where the solution starts

Farmers – particularly smallholders – are where it all starts. Based on field-based evidence and on CIMMYT experiences of nearly 50 years, providing small-scale farmers with high-yielding, disease-resistant and climate-ready varieties, promoting effective seed delivery and improving agronomic practices can dramatically benefit individual families, entire countries and the globe as a whole.

Through its unique mandate and position, CIMMYT and its partners use our global collections of maize and wheat genetic resources and state-of-the-art genotyping and phenotyping technology — including those typically available only within the multinational private sector — and make the results available to national public sector programs and small- and medium-size companies that serve farmers directly.

Expertise and experience in precision, sustainable intensification and innovation system approaches, like those that have characterized the study and promotion of conservation agriculture in Asia, Africa and Latin America, are helping farmers to save resources and face climate change. Such work features prominently in this report.

Global action plans such as the CGIAR Research Programs (MAIZE, WHEAT and Climate Change, Agriculture and Food Security, or CCFAS) provide rallying points for shared research by developing and developed countries to raise crop yields under the increasing heat and drought conditions that farmers face.

Humanity has the means to eliminate hunger and malnutrition in spite of climate change and rising demand, but we need political will and investment to empower agricultural systems and farmers. The goal is not simply to avoid another food crisis. The goal is to grow enough food sustainably and efficiently to feed the planet. Otherwise the world will continue to lurch from one food crisis to the next.

For nearly 50 years CIMMYT has been working to build food security and diminish hunger and poverty. Successes in these efforts would not have been possible without critical funding from our donors, the cooperation of our partners across the world and the contributions and hard work of CIMMYT employees. On behalf of the CIMMYT Board of Trustees, I would like to recognize CIMMYT’s donors, partners and employees and thank them for their significant contributions to our efforts.

Thomas A. Lumpkin
Director General
Precision, sustainable intensification and innovation systems
specialists point out the virtues of such approaches: labor and cost savings; improved soil structure and fertility; increased infiltration and water retention; less erosion; and lower greenhouse gas emissions. Conservation agriculture is widely practiced by farmers in the USA, Canada, Australia and the Southern Cone of South America. Its use is now spreading in the developing world.

For small-scale farmers in places like Malawi, where maize subsists on rain alone, the benefits of CA are most visible during dry spells. Then, residues, root holes and earthworms catch and channel falling rain and retard evaporation. “Maize was wilting in conventionally managed plots due to the drought,” according to a small group of Lemu farmers who gathered to talk about their management practices. “In fields managed using conservation agriculture, there is no problem.”

Southern Malawi maize farmers would lose one-third or more of their harvest to 2012’s dry weather, according to agricultural extension expert Mphatso Gama. “Of course, we always have problems with rain here,” he explained, “but 2012 was the worst in years.” Maize is Malawi’s primary food crop, but because of the prolonged drought conditions many households in southern Malawi faced a long “hungry season”— the months until the next maize harvest, after last year’s grain has been eaten.

In early March 2012, a rainstorm burst upon parched, yellowed maize fields that roll far out over surrounding hills near the city of Zomba (about 150 kilometers south of Lilongwe, Malawi’s capital). A month prior, the water might have saved the crop, which was withering under another of the region’s prolonged droughts. By the time this rain came, however, many desiccated plants were too far gone to save.

Hope will not wilt
However, not all experienced the hungry season, including more than 400 farmers and their families at Lemu in Balaka Township, southern Malawi. Over the last six years they have been using conservation agriculture (CA) — a set of practices that includes eliminating traditional ridge-and-furrow tillage systems, keeping crop residues on the soil and rotating or intercropping maize with other crops. CA specialists point out the virtues of such approaches: labor and cost savings; improved soil structure and fertility; increased infiltration and water retention; less erosion; and lower greenhouse gas emissions. Conservation agriculture is widely practiced by farmers in the USA, Canada, Australia and the Southern Cone of South America. Its use is now spreading in the developing world.

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This area receives an average of only 200-400 millimeters of rainfall per year,” said Gama. That’s barely enough to raise a maize crop. “The population is dense and the average farm landholding of less than half a hectare supports a household of five members,” added Gama. In addition to maize, farmers grow groundnuts, potatoes, cotton and cassava, and also keep chickens and goats.
“We started (conservation agriculture) with six farmers in 2005-06 and financial assistance and training from CIMMYT,” Gama explained. By the 2011-12 crop cycle, nearly one-fifth of the area’s 2,200 farmers had adopted the practices. According to Gama, many more would like to, but a lack of funds for imports has constrained access to fertilizers and herbicides – the latter needed to stop weeds in no-till systems.

Saving labor and livelihoods
Belita Maleko, small-scale maize and mixed-crop farmer in the Mwansambo extension planning area, Nkhotakota Zone of central Malawi, was widowed 19 years ago, but kept on farming with help from her family. At the invitation of government extension officers and Total LandCare (TLC), a non-governmental organization (NGO), she began adopting CA practices and sowing plots to demonstrate those practices to neighboring farmers in 2006.

Draft animals are scarce in Malawi and traditional maize cultivation involves as many as 160,000 hoe strokes per hectare (ha). It appeared strange and somehow unjust to neighbors when Maleko stopped hoe plowing and began to leave residues and stems from previous crops on her fields. “Some asked ‘How can you do this?’” said Maleko. “Others speculated that I was degrading the soil…some people thought I was mad, but I said ‘No, I’m not mad, I know what I’m doing.’”

Farmers desperately need these new practices to face the challenges coming their way, according to John Chisui, TLC Zonal Manager and Land-Use Specialist. “Climate change has played a role (in farmers’ acceptance),” he explained. “People can see that under conservation agriculture, the crop will do much better, compared to conventional agriculture.”

Housed in the Ministry of Agriculture and supported by the Food and Agriculture Organization (FAO) of the United Nations, Malawi’s National Conservation Agriculture Task Force aligns extension efforts, research and messaging to promote CA. Because CA practices are complex and knowledge-intensive, it is crucial to coordinate extension. Gama lauded the cooperation between TLC and government extension services, saying it has significantly increased everyone’s production. “On average, there is a single extension worker for every 2,000 farmers in Malawi,” he explained. “TLC and government extension jointly plan and work as part of the national strategy for agriculture.”

Malawi furnishes a good setting for CA, according to Christian Thierfelder, CIMMYT cropping systems agronomist in southern Africa. “Few farmers have livestock, so crop residues can be kept on the fields instead of going for fodder,” he explained. “There are markets for produce, and herbicide is normally available. There are vibrant extension services, especially if we look at TLC.” To enhance soil care and food security, Thierfelder and the Malawi specialists have promoted maize-legume rotations. “We’ve also been working with cowpeas and soybeans, and farmers are particularly excited about maize-groundnut rotations.” The work links with and is reinforced by a CIMMYT-led project focusing on the sustainable intensification of maize-legume cropping systems (SIMLESA) in eastern and southern Africa.

Maleko sees CA as a blessing that has helped pay for school fees and homestead improvements. “I will not stop practicing conservation agriculture, because it generates many benefits,” she said. “I have enough time to grow other crops. I’m very happy because I’ve built another house with my proceeds. I don’t even complain about being a widow – otherwise, I wouldn’t have sent my children to school. Married women come to me and ask for food. I’m a happy woman.”

For more information: Christian Thierfelder, cropping systems agronomist (c.thierfelder@cgiar.org)
CIMMYT and conservation agriculture in Africa

Most soils in southern Africa are infertile and degraded. Few small-scale farmers can afford or apply much fertilizer for maize – the main food crop – and cropping systems are generally extractive: stems and leaves are removed for fodder and other uses, with a net loss in soil organic matter year after year. Increasing populations encroach on arable land; once-common, the fallowing of fields is but a memory. Temperatures are predicted to rise, as are import prices for fertilizers and herbicides. Droughts and seasonal dry spells are already becoming more frequent and severe.

In this challenging context, CIMMYT began working with local researchers, extension agents, NGOs and farmers in 2004 to study, test and promote CA. “Conservation agriculture is the most sustainable system we currently know for this environment,” stated CIMMYT cropping systems agronomist Christian Thierfelder, “The basic principles – minimum soil disturbance, crop residue retention and diversified crop rotations – are widely applicable, but must be adapted for local conditions and farmers’ circumstances.”

Over the years, CIMMYT and its partners have studied local conditions and cropping systems, identified “best bet and best fit” practices for diverse settings and reached out to partner with organizations and communities. “A key strategy has been to establish demonstration and validation plots run by farmers in their fields, with backstopping from extension and NGO partners,” Thierfelder said. “We provide the farmers with seeds, fertilizers and herbicides, which they pay back to a community project or fund at harvest time. For farmers, the demonstration plots are successful examples of conservation agriculture and serve as learning centers. Researchers group them strategically for use as on-farm trials to evaluate the performance of conservation agriculture over the course of years.”

In partnership with regional NGOs and government extension services, these efforts in Malawi, Mozambique, Tanzania, Zambia and Zimbabwe have inspired approximately 35,000 farmers to experiment with CA technology – results of a targeted approach in 75 intervention villages on 400 demonstration plots, according to Thierfelder. “We realize this is a complex technology with many challenges to overcome. Achieving widespread adoption may take considerable time and effort, but ‘difficult’ is not a good excuse for not getting started.”

The work described has been possible thanks to funding from the Australian Centre for International Agricultural Research (ACIAR), Australia; the Federal Ministry for Economic Cooperation and Development (BMZ/GIZ), Germany; the International Fund for Agricultural Development (IFAD); the Swiss Agency for Development and Cooperation (SDC); and the U.S. Agency for International Development (USAID), as well as generous, unrestricted contributions from many CIMMYT donors.
Diversification and conservation in India’s cropping systems

In response to recent water shortages and with support from scientists, farmers in the Upper Krishna Project command area of Karnataka State in southwestern India have begun growing a winter crop of maize using zero tillage. The farmers are sowing directly into unplowed soil and crop residues, as an alternative to their tradition of two crops of flooded rice each year. Coverage reached 1,200 ha in 2011 and the practice has caught the attention of other farmers and of several research and development organizations.

Because zero-tilled winter maize boosts harvests and incomes and saves water, it is being promoted through the Cereal Systems Initiative for South Asia (CSISA) satellite hub in Karnataka, the University of Agricultural Sciences-Raichur in collaboration with CIMMYT, the International Rice Research Institute (IRRI) and other public and private sector partners, including the Indian Council of Agricultural Research (ICAR).

Many weigh in for change

In March 2012, 160 farmers from the districts of Gulbarga, Koppal, Raichur and Yadagir, and 45 scientists and extension agents from various research stations of University of Agricultural Sciences-Raichur, the Karnataka State Department of Agriculture and Ganga-Kaveri Seeds Company, attended a multi-stakeholder consultation on cropping diversification through the promotion of zero-tilled maize in Karnataka. Discussions covered a range of CA and diversification options, along with the specialized implements required. In addition, concerns such as residue, weed and pest management, cultivar choices and water-wise practices were discussed. The operation and benefits of CA machinery, including the laser land leveler, a zero-tillage multi-crop planter and a direct seeder, were demonstrated and explained. Farmers who have adopted the technologies shared their views and encouraged others to innovate.

CIMMYT cropping systems agronomist, M.L. Jat, explained the benefits of conservation agriculture for diverse cropping systems and specifically the practices CSISA is promoting. “The rice-wheat cropping system of the Indo-Gangetic Plains is labor-, water- and energy-intensive and it becomes less profitable as these resources grow scarce,” Jat stated. “Farmers are adopting new practices to manage the situation: zero- or minimum-tillage to sow wheat; direct seeding of dryland rice; precise targeting of water and nutrients; managing crop residues to avoid burning straw; and diversifying the crops grown.”

Reversing resource degradation and giving farmers a level playing field

In Matyala, a village in Ghaziabad District 35 kilometers from Delhi, Sharanjit Singh Gill has been working with CIMMYT scientists, both as part of CSISA and of BISA, to incorporate CA practices on his farm. One of many Punjab farmers who moved from Delhi in the 1960s, Gill grows rice and wheat, practices legume rotations and raises cows and buffaloes on his 83-ha homestead.

“We normally focus on smallholder farmers,” Jat explained, “but with medium-scale farmers like Gill, you can really see the benefits of participatory technology development, as they have more risk-bearing capacity and are able to lead the way for smallholder farmers to adopt new technologies.”
The Borlaug Institute for South Asia (BISA) is a non-profit research institute dedicated to the improvement of food security and the reduction of hunger in the region. A collaboration between CIMMYT, ICAR and the government of India, BISA harnesses the latest agricultural technologies to improve farming productivity and sustainably meet the demands of the future. BISA is committed to the people of South Asia, dedicated to the region’s farmers and focused on catalyzing a second Green Revolution.

With funding from USAID and the Bill & Melinda Gates Foundation (BMGF), CSISA offers strategy, partnerships and new science and technologies to foster cereal production growth in South Asia’s most important grain baskets. It builds on technologies developed and lessons learned from the Rice-Wheat Consortium (RWC), the Irrigated Rice Research Consortium (IRRC) and other public and private investments in agricultural research and development. CSISA is implemented jointly by CIMMYT, IRRI, the International Livestock Research Institute (ILRI) and the International Food Policy Research Institute (IFPRI), in partnership with public and private organizations across South Asia.

In 2001, as part of his adoption of CA techniques, Gill hired out for laser leveling — the use of a laser to guide a tractor-scaper that flattens fields, thereby optimizing irrigation. He has practiced zero tillage for 11 years and recently began seeding rice directly into unplowed soil and crop residues using his own multi-crop zero-tillage planter known as the “Happy Seeder.” According to Gill, these farming methods increase organic matter, help to restore degraded soils and save him about $6,700 per year in reduced diesel fuel costs and less pumping of irrigation water. Overall, Gill’s resource-conserving practices have cut his labor, diesel, water and water pumping costs by 25 to 35 percent.

Conventional plowing for rice and wheat crops burns more than 200 liters of diesel – releasing over 0.5 tons of carbon dioxide (CO₂) per ha per year, causes far greater wear and tear on tractors and farm implements and requires more labor. “The environmental benefits of using zero-tillage are priceless,” Jat said. “Besides cutting fuel consumption, keeping residues on the soil instead of burning them adds 0.5 tons of carbon to the soil for every ton of residue, and farmers who have a 30-hectare farm are able to cut their emissions by more than 450 tons of CO₂ per year.”

**Having a Nobel Peace Laureate visit your farm**

Gill’s farm is not only unique for his application of CA principles, but also because of its historic ties to former CIMMYT wheat scientist and hunger fighter, Dr. Norman Borlaug. Borlaug’s high-yielding, disease-resistant Mexican wheat varieties were brought to South Asia in the mid-1960s. “Before Dr. Borlaug, India’s wheat fields were yielding only 1 to 1.5 tons per hectare. I remember the wheat varieties being very tall, with less grain and more straw. Then we heard of one farmer in the village who managed to achieve 4 tons per hectare from the new varieties.” According to Gill, by 1967 the new wheat varieties were being sown by most farmers in his area.

Borlaug received the 1970 Nobel Peace Prize for the widespread adoption by developing world farmers of improved seed and farming practices – a movement called the Green Revolution. He died in 2009, but had visited Gill earlier that decade. “Dr. Borlaug came to my farm in 2001,” he said, recalling Borlaug’s predictions. “He knew that maize would replace rice. He told us that maize would fight hunger and he knew that things would change. Limited water would cause problems for rice while higher temperatures would also cause problems for wheat.”

**For more information:** M.L. Jat, CIMMYT cropping systems agronomist (m.jat@cgiar.org).
“If no-till practices had not been used during this period of drought, our production would have been virtually non-existent. It would have been an absolute catastrophe,” said Valentin Dvurechenskii, Director General of the Kostanay Agricultural Research Institute in Kazakhstan, giving his verdict on the 2012 wheat crop.

After farmers planted their wheat in April, Kostanay – the country’s main wheat growing region – went two months without rain. Making matters worse, daily temperatures were several degrees above normal. At the time, farmer and Director General of the Agrofirm Dievskaya, Oleg Danilenko, echoed the view of peers: “I’ve been a farmer for 35 years, and I’ve never seen anything like this.” Danilenko said the harsh conditions illustrated the advantages of CA, which involves reduced or zero tillage, keeping crop residues on the soil and rotating crops. “No other results have been nearly as successful.”

Conserving where it counts

Kazakhstan is the world’s sixth-largest wheat exporter. However, more than 14 million of the country’s 15 million hectares of wheat are rain-fed, meaning virtually the entire crop relies on precipitation and is thus vulnerable to dry weather. Reports released in January 2013 said the 2012 drought had shrunk the wheat crop by 57 percent from 2011’s record harvests.

Farmers are initially attracted to zero tillage and conservation agriculture because the approaches dramatically cut their costs. These farming techniques require less labor, machinery use, fuel, water and/or fertilizers. In rain-fed cropping, conservation agriculture can also boost yields by capturing and conserving additional moisture and making it available to the crop.

The findings of a 2012 FAO Investment Centre mission to Kazakhstan suggest that adoption of zero tillage and CA had raised domestic wheat production by almost 2 million tons. According to the mission report, this represents some $580 million more income during 2010-12, enough grain to satisfy the annual cereal requirements of almost 5 million people and the sequestering of about 1.8 million additional tons of CO₂ per year.

Pushing out with better practices

With the support of CIMMYT, the Kazakhstan Ministry of Agriculture, FAO, ICARDA, the World Bank and other international organizations and donors, Kazakhstan went from practically no land under CA in 2000 to 0.5 million ha in 2007. In 2012, as a result of ongoing farmer engagement through demonstration plots, field days and close work with farmer unions, CA is now practiced on 2 million ha, or 13 percent of the country’s wheat-growing area. “This amazing level of adoption is due to a few scientists who saw the potential, but more importantly to the pioneer farmers who perfected the techniques and put them into practice; farmers believe farmers,” explained CA expert Pat Wall. Together with CIMMYT colleagues Alexei Morgounov and Muratbek Karabayev, Wall initiated field trials with Kazakhstani scientists in the country’s northern steppes in 2000.
“The main achievement of CIMMYT in Kazakhstan has been changing the minds of farmers and scientists,” observed Bayan Alimgazinova, head of the Crop Production Department of KazAgroInnovation, a specialized organization created by the Ministry of Agriculture to increase the competitiveness of the country’s agricultural sector. Based on the positive results of research trials and tests in farmers’ fields, Kazakhstan’s current state policy calls for every province to pursue zero tillage.

“Kazakhstan presently has a wheat growing area of 15 million hectares and can increase that area to 20 million hectares,” added Muratbek Karabayev, CIMMYT representative in Kazakhstan. “This is extremely important for the food security of the country, the Central Asian region and perhaps the entire world. There is a real opportunity to double yields using new advanced technologies and improved varieties. We’ve already seen this through conservation agriculture.”

CIMMYT’s conservation agriculture activities in Kazakhstan have been funded by CIMMYT’s own resources and the comprehensive World Bank Agriculture Competitiveness Project (ACP). CIMMYT received two grants between 2008 and 2010 from the World Bank’s ACP to promote CA practices in Kazakhstan.

For more information: Muratbek Karabayev, CIMMYT representative in Kazakhstan (m.karabayev@cgiar.org)
High-yielding, climate-ready varieties and seed delivery
High-yielding, stem-rust resistant wheat developed by the late CIMMYT scientist, Dr. Norman E. Borlaug, and his partners helped afford the world decades of good harvests and low wheat grain prices. Based at Cornell University, the Borlaug Global Rust Initiative (BGRI) is an international effort that carries on Borlaug’s legacy to reduce global vulnerability to stem, yellow and leaf rusts of wheat and to foster a sustained global system to contain their threat.

Nobel Prize winner Dr. Norman Borlaug once described rust as “the disease that never sleeps.” Yet for more than four decades, stem rust seemed to lie dormant, controlled by use of resistant wheat varieties estimated to have saved farmers worldwide more than $1 billion annually. Researchers were surprised when a new, virulent race of stem rust, named Ug99, was detected in Uganda in 1998. Under favorable conditions, this race can completely devastate previously resistant wheat crops, and 90 percent of the world’s wheat varieties are susceptible.

Fortunately, programs such as the Borlaug Global Rust Initiative (BGRI) responded quickly to the new threat and identified several Ug99-resistant wheat lines. The race was on to replant as much of the susceptible area as possible with these new, high-yielding improved varieties; an area representing more than 40 million ha in the developing world. In 2008, USAID spotted a problem: there were resistant wheat varieties, but could developing countries produce enough resistant seed?

Seed versus pathogen in a race to multiply
The multiplication and dissemination of stem rust-resistant wheat seed was initiated as the USAID Famine Seed Project, a unique collaboration of CIMMYT, the International Centre for Agricultural Research in the Dry Areas (ICARDA), BGRI, national research programs, national seed organizations and farmers. Together, these partners sought to identify suitable Ug99-resistant varieties, conduct pre- and post-release seed production and deliver this seed to farmers in Afghanistan, Bangladesh, Egypt, Ethiopia, Nepal and Pakistan.

In 2012, USAID undertook a final evaluation of the project and determined that this fledgling fast-response initiative had grown into a concerted and ongoing effort to reduce crop losses attributable to Ug99 and other stem rusts. While large-scale seed multiplication usually begins at cultivar release, this project initiated the process much earlier to ensure that large quantities of seed would be available by the time that cultivars were released. Parallel, multi-location testing and seed multiplication then allowed seed to be disseminated to farmers as quickly as possible. The project also linked with CSISA to utilize its existing technology dissemination and adaptation hubs.

A recipe for success
By 2012, four of the countries had reached the goal of producing enough rust-resistant seed to sow 5 percent of their national wheat areas – the minimum coverage required so that, in case of a stem rust outbreak, in one season enough seed of the resistant varieties could be multiplied to sow a country’s entire wheat area. Two countries – Egypt and Ethiopia – far exceeded this...
Farmer Mohammad Ashraf of Sariushap Village, Bamyan Province, Afghanistan, is one of many who have benefited recently from use of high-yielding, early-maturing, stem rust-resistant wheat varieties. In 2012 CIMMYT began a new phase of a project supported by the Australian Agency for International Development (AusAID) and ACIAR. Called “Sustainable Wheat and Maize Production in Afghanistan,” it builds on a decade of successful research, development and capacity-building activities with added emphasis on rain-fed rust resistant wheat and hybrid maize.

In Afghanistan, Bangladesh and Nepal the area covered by resistant wheat rose from 16 ha in 2008 to more than 60,000 ha in 2012.

This achievement was partly due to the active involvement of private companies in each of the countries. However, the role of progressive farmers increased year by year; by 2012 farmers were the leading seed multipliers of resistant varieties in all six countries. Overall, farmers now produce 80 percent of the Ug99-resistant seed.

Arun Joshi, CIMMYT senior wheat breeder for South Asia, credits the impact of the project to a fast, funded response by the donor. “The fact that this threat to food security was recognized and there was a strong momentum to research and disseminate seed, supported by strong funding, was the key factor in the success of this project.”

**Obvious benefits need no hard sell**

The new varieties were grown in trial plots in all six countries, allowing farmers to see the results for themselves. Even in the absence of rust, the varieties produced 10 to 15 percent higher yields than existing cultivars. The new varieties were seen as insurance against a spreading disease, and because of their rust resistance and high yield farmers were quick to adopt them. In Bangladesh, for example, the Ug99-resistant variety Francolin was released in 2012 and became “popular among farmers because of its high grain yield potential and good agronomic traits,” according to T.P. Tiwari, cropping systems agronomist at CIMMYT-Bangladesh, who added that the variety also performed better than other varieties during on-farm testing.

By late 2012, more than 1.5 million farmers had directly benefitted from the project and the value of the higher yielding rust-resistant wheat was more than $700 million. Farmers who chose to sell the new wheat varieties as seed instead of grain also found that they were able to earn 10 to 15 percent more, as well as reducing production costs because they no longer needed to apply fungicide.

The area under Ug99-resistant varieties in the six countries expanded from 52 ha in 2009 to around 250,000 ha in 2012, with an estimated 750,000 tons of resistant seed produced during 2011-12, compared to just 114 tons in 2009-10. Afghanistan and Egypt both released the same Ug99-resistant variety. Because Egypt had already produced large amounts of its seed, the country’s authorities agreed to provide 120 tons to Afghanistan, furnishing the stock for rapid seed multiplication. The U.S. Department of Agriculture (USDA) supported and organized this seed transfer.

“This was one of the most successful – if not the most successful – international efforts in recent decades to multiply wheat seed and reach farmers in a very short time,” explained Hans Braun, director of CIMMYT’s global wheat program.

For more information: Arun Joshi, senior wheat breeder, South Asia (a.k.joshi@cgiar.org)
Like many in his circumstances worldwide, Zambian wheat breeder Lutangu Makweti had received university instruction in the agronomic sciences and understood the genetic theory behind crop improvement. He’d even had some practical experience. But a modern, large-scale crop breeding program is like an intricate engine where theory must mesh with complex operational logistics. Supported by his former employer, Seed Co. Limited (the leading African seed company), Makweti jumped at the chance to attend the 2012 CIMMYT course on wheat crop improvement.

One of 23 course participants from wheat-producing countries throughout the developing world, Makweti was profoundly impressed by what he learned from the coordinated classroom lectures and field practicums. “My attitude towards work has really changed and even my fellow breeders dealing with other crops have noticed that,” he said, in an unsolicited message of gratitude from his home base in Lusaka. “I now speak with confidence on wheat issues. I’ll never forget (how this training) made a difference in my career.”

The value of training:
Knowledge gained and shared
Because of the growing demand for wheat-based products by Zambia’s expanding (and rapidly urbanizing) population, upon Makweti’s return Seed Co. tasked him to launch a breeding program targeting domestic markets. “This was the first time our company ventured into wheat crossings in Zambia,” Makweti said. “Before, all the breeding and crossing had been done in Zimbabwe and crosses were sent to Zambia for evaluation.” From a national output of just over 50,000 tons in 2000, Zambia boosted its wheat production to 250,000 tons in 2012 and national policymakers see it as a strategic crop.

In addition, Makweti also undertook outreach with small-scale farmers. “In Zambia, we only have irrigated wheat,” Makweti said, “but we started a rain-fed wheat breeding program and acquired a set of rain-fed wheat trials from the International Wheat Improvement Network (IWIN, led by CIMMYT), to help smallholder farmers join the wheat sector.” Makweti and his colleagues chose 40 varieties from that seed collection and grew them in participatory trials; farmers selected those they considered outstanding.

Reflecting on his training experience, Makweti cited as especially valuable his interactions with the world-renowned wheat researchers who served as lecturers – people like retired CIMMYT wheat pathologist H. Jesse Dubin, University of Missouri Professor Perry Gustafson and retired University of Sydney Professor Bob McIntosh. “Scientists were at hand to help and answer all questions,” Makweti remarked. “They would stop to explain to us what and why we were doing the assigned activities.”

He also felt the course and the CIMMYT work ethic embodied important values, including planning and dedication, respect and teamwork among scientists and field workers, use of advanced technology and passion. “I have never seen such dedication to work as that exhibited by CIMMYT staff, be it a driver, a pollinator, scientists or a data collector,” he observed. “They take the work as a calling, a special duty for humankind.”

Training supports wheat’s dramatic rise in Zambia
Wheat is increasingly in demand in Sub-Saharan Africa (SSA) as a result of income growth and the demand for convenience foods as more women enter the workplace. However, SSA countries and Africa as a whole produce only about 30 percent and 40 percent, respectively, of their domestic requirements, causing a heavy dependence on imports. Therefore the region and the continent are highly vulnerable to global market and supply shocks.

This was one conclusion reached by some 250 researchers, policymakers, farmers and seed company representatives who attended the conference “Wheat for food security in Africa: Science and policy dialogue about the future of wheat in Africa,” held in Addis Ababa in October 2012. Organized by the Ethiopian Institute of Agricultural Research (EIAR), CIMMYT, ICARDA, IFPRI, the African Union and WHEAT (a CGIAR Research Program led by CIMMYT), the event was intended to raise awareness about the potential to grow wheat and to reduce imports of the crop. Conference attendees also discussed policy, and institutional and infrastructure constraints. “In 2012, African countries spent about $12 billion to import some 40 million tons of wheat,” said Hans Braun, director of CIMMYT’s global wheat program. “If Africa does not push for wheat self-sufficiency, it could face more hunger, instability and even political violence, as bread riots in North Africa illustrated in recent years.”

Attendees came from 23 African nations, as well as from Asia, Europe and the Americas, and included four ministers of agriculture (Burundi, Ethiopia, Sudan and Zimbabwe) and the directors of national agricultural research programs of 16 African countries. Deemed a great success by participants and organizers, the event and the issues discussed were reported widely in regional and global media.

Recent conference gets wheat back on Africa’s map

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The professional fortunes of Makweti took another turn in late 2012 when he met a Zambian research director at a conference on wheat in Africa (see box below) and was invited to join the Zambia Agricultural Research Institute as a crop breeder; an invitation he has since accepted. In addition to wheat, his expanded duties include managing a legume breeding program project under the USAID Feed the Future program, in collaboration with the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). “Wheat research remains my area of interest,” he said, “and I hope to help the national program to increase the research even amidst financial constraints.”

For more information: Amor Yahyaoui, CIMMYT wheat training officer (ah.yahyaoui@cgiar.org).

According to Bekele Shiferaw, former director of CIMMYT’s socioeconomics program and co-author of a major report on wheat farming in Africa, an equally important outcome was the “Addis Declaration,” formulated by conference participants and intended to get wheat onto Africa’s policy map as a strategic product for food security. “Unlocking the potential of wheat will require changes in attitudes and policy, as well as donor support for adapting farming systems, empowering African farmers and developing value chains for seeds, input supply and output markets,” Shiferaw said.

Launched in 2006, the Drought Tolerant Maize for Africa (DTMA) project is helping to mitigate drought and other constraints to maize production in SSA, increasing maize yields by at least 1 ton per hectare and with a 20 to 30 percent increase over farmers’ current yields, benefiting 30 to 40 million people in 13 African countries. The project brings together men and women farmers, research institutions, extension specialists, seed producers, farmer organizations and NGOs. DTMA is jointly implemented by CIMMYT and the International Institute of Tropical Agriculture (IITA), in close collaboration with national agricultural research systems in participating nations. Millions of farmers in the region are already benefitting from the outputs of this partnership, which include support and training for African seed producers and promoting vibrant, competitive seed markets.

- Between 2007 and 2012, participants marketed or otherwise made available 60 drought-tolerant hybrids and 57 open pollinated varieties to smallholder farmers. The varieties yield 20 to 30 percent more than other varieties previously available to smallholder farmers. In addition to drought tolerance, the new varieties and hybrids also possess such desirable traits as resistance to major diseases (e.g. maize streak virus, turcicum leaf blight and gray leaf spot) and superior milling or cooking quality.

- Close to 29,000 tons of seed were produced in the 2011-12 season – enough to sow more than 1.1 million ha, benefitting about 2.9 million households (about 20 million people). Production of drought-tolerant maize seed could reach 60,000 tons by 2016.

- Engaging government officials in policy dialogue has helped to fast-track varietal releases and fostered competitive seed markets and more widespread access to quality seed at affordable prices.

- To help ensure farmers’ access to the best possible products and services, DTMA has coordinated various capacity-building events and activities for maize breeders, technicians, seed producers, extension workers, NGOs and farmers. DTMA scientists have also provided technical and advisory support to 50 undergraduate and 28 graduate students from across Africa.

Initial funding for DTMA came from the BMGF, the Howard G. Buffett Foundation, USAID and DFID. The 2012-16 phase of the project is funded by the BMGF and aims to expand smallholder farmers’ use of drought- and other stress-tolerant maize seed to benefit 30 to 40 million people and provide added grain worth $160-200 million each year in drought-affected areas of SSA.
The seed chain: Producing better seed for Mexico’s smallholder farmers

“As an agronomist I feel a duty to contribute something, and this is my contribution to Mexico,” said María Esther Rivas, the director general of Bidasem seed company in the central Mexican plains region known as the Bajío. Bidasem produces approximately 10,000 bags of maize seed per year, each holding 22.5 kilograms (kg). Despite their small size, Bidasem and similar companies play an important role in improving farmers’ livelihoods. “Our aim is to provide farmers with quality seed at accessible prices and adapted to Bajío conditions.”

At first glance, Rivas seems an unlikely candidate for an agricultural career. However, agriculture is in her blood. As a child she was fascinated by insects and loved spending time outside with her agronomist father. “For me it was normal to be in the field with farmers, trying to understand how they think, what they need and how we could help them.” Any doubts about Rivas’ career choice evaporate once you see her in action. She is full of questions for her close-knit team and is involved in every part of the business, from examining plants to helping sort seed to visiting distributors. Rivas is a woman on a mission – to produce the best seed she can.

At CIMMYT, breeders are developing ever more productive maize to improve global food security and reduce poverty. Breeding is only the first step in a chain stretching from scientists all the way to farmers and consumers and in which seed companies like Bidasem are vital. “We have huge untapped opportunities,” observed CIMMYT seed systems specialist John MacRobert. “Seed businesses can transform farmers’ livelihoods and the economies of their countries. Improved seed gives farmers hope.”

A big cake

As in many countries throughout the developing world, most Mexican farmers do not plant the best available seed. More than three-quarters of the maize planted in Mexico is of traditional varieties with relatively low yields. Lack of improved seed is often a constraint, as seed production is a complex and challenging business, with long production lead-times and a perishable product that is vulnerable to losses both in the field and in storage. Small regional seed companies are uniquely placed to reach local markets and smallholder farmers, but also need support. Bidasem’s offices are surrounded by neat green fields, food processing factories, grain silos, machinery vendors and, unusually, several other seed companies of varying sizes. The Bajío was once known as Mexico’s breadbasket, and has stayed true to its roots. Rivas is not intimidated by competition. “The needs are great, and we all have to be more
We could not exist without CIMMYT

Although the company produces and markets seeds of other crops, maize seed is Bidasem’s primary product. “Without CIMMYT, we couldn’t exist,” Rivas remarked. She sells four different maize hybrids all formed from freely available CIMMYT parent lines. “Really, the most important thing is to produce your own hybrids, and for us it wouldn’t be possible if we didn’t have germplasm from CIMMYT. What we’re currently producing is 100 percent CIMMYT.” The relationship between Bidasem and CIMMYT is now deepening through the company’s participation in MasAgro (see box).

Companies like Bidasem provide varieties that excel in non-irrigated, rain-fed areas and under adverse conditions. “We look for different niches,” Rivas said. “Our materials may not be very pretty, they’re not as uniform as others, but they’re really tough. They withstand drought well, and when excessive rains are a problem they can still generate a good yield.”

Farmers’ traditional varieties feature similar hardiness and suitability to local conditions, but produce lower yields. Climate change also means that many varieties which used to be perfectly adapted are now struggling. Small- and medium-sized seed companies can reach small-scale farmers with varieties that can give higher, reliable yields and, thus, improved food security and incomes.

Bidasem works closely with distributors and farmers, providing carefully targeted recommendations, and holds frequent field days and tours to demonstrate company materials and provide technical support.

Thinking of the future, Rivas’ thoughts turn to climate change and the need for new varieties to face it. “In agriculture the major limiting factor is climate. Our hybrids have to respond to the adverse conditions we’re facing – principally water stress and temperature.”

For more information: Felix San Vicente, Leader, International Maize Improvement Consortium for Latin America (f.sanvicente@cgiar.org)

MasAgro: Better together

The Sustainable Modernization of Traditional Agriculture (MasAgro) is a Mexican initiative launched in 2010 to help smallholder farmers increase their crop yields and incomes and reduce the effects of climate change on Mexico’s agricultural output. It is a partnership among the Mexican Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA), CIMMYT and numerous public, private and farmer organizations, with funding from the government of Mexico.

Bidasem is just one of many companies participating in regional field trials of hybrid varieties under rain-fed conditions. Seed companies are invited to enter their own hybrids to determine how they perform at different locations as well as compare them with the latest seed from CIMMYT and other research organizations. “Our goal is to increase total maize production in Mexico by 85 percent in 10 years,” explained Marc Rojas, coordinator of the Maize Improvement Consortium for Latin America (IMIC-LA), one of four MasAgro components. “I don’t care where the product comes from, as long as the farmer gets more productive seed.”

As part of this, MasAgro offers training courses on seed production and seed company administration. “Administration is not my area, so my new knowledge is really helping me,” Bidasem’s Rivas said. The resources and information provided by CIMMYT and MasAgro increase my knowledge and help to strengthen my company, giving me confidence to move forward.”
When a devastating maize disease hit Bhutan in 2007, the Bhutanese National Maize Program and CIMMYT collaborated to contain the disease and offer farmers new, disease-resistant, quality protein maize varieties.

Bhutan maize provides quality protein and defies fungus

A meal without maize? Unthinkable!
A 2007 outbreak of gray leaf spot (GLS), a highly destructive fungal disease, was a dramatic setback for Bhutanese maize farmers, many of whom lost nearly all of their harvests. “When GLS was reported for the first time in Bhutan, it posed a colossal challenge to the national maize program,” confirmed Tirtha Katwal, principal research officer at the Renewable Natural Resources (RNR) program of the Research and Development Centre in Wengkhar, Mongar, Bhutan. A major staple in Bhutan, maize is grown by about 70 percent of the nation’s households. Resource-poor families eat the grain, put it in animal feed and process it for sale. To foil the fungus, the National Maize Program (NMP) tried applying a pesticide, but the steep, muddy fields, lack of sprayers and high product costs posed too great a challenge.

New seed sourced from around the world
Therefore, Katwal sought a “global” solution for this local crisis. “To contain the disease and as a quick response, the NMP collaborated with CIMMYT’s South Asia Regional Office in Nepal to develop or identify new disease-resistant maize adapted to the high-altitude, rain-fed maize-growing highlands of Bhutan,” he explained. According to Katwal, over 100 GLS-resistant maize varieties were introduced from joint CIMMYT breeding programs with Colombia, Mexico, Nepal and Zimbabwe. The treasure trove of breeding materials was screened at a site where GLS occurs naturally and in abundance. “CIMMYT’s technical support and provision of disease-resistant seeds have been immensely valuable to the small Bhutanese NMP,” Katwal said.

Farmers call the shots
To start, an RNR maize research team selected the 15 most disease-resistant varieties at a highland location. This was followed by several years of multi-location, nationally coordinated evaluations with farmers. The final decision came down to two entries from CIMMYT-Colombia, provisionally released under the names Shafangma Ashom (a quality protein maize, or QPM) and Chaskarpa. During 2011 more than 2.6 tons of seeds were supplied in small packets to farmers in disease-affected areas for demonstrations and to replace the seed of susceptible varieties. The large-scale demonstrations succeeded and the two varieties were endorsed by the Technology Release Committee of the Ministry of Agriculture and Forests in June 2012.
Disease out, nutrition in

The new varieties have been considered a great success so far – they yield 10 percent more than available highland varieties and are much more resistant to GLS. They are recommended particularly for GLS-affected areas higher than 1,500 meters above sea level and for subtropical maize production zones at 600-700 meters. Both varieties have the farmer-preferred yellow flint grains and are open-pollinated, which means farmers can save seed from their harvests to sow the following season. “The Bhutan NMP aims to replace at least 80 percent of seeds in areas affected by GLS in the country,” Katwal stated.

Seed supplies have been topped up through community-based seed production. In 2011 and 2012, over eight tons of seed were supplied to GLS-affected farmers in 10 districts. Production of basic and foundation seed has started at research farms and will be used by community-based seed producers. The NMP cooperates with the National Seed Center and those producers. Farmers are saving the seed varieties and selling them for a profit. “Our maize production has increased due to the supply of good seeds, and we are also able to earn cash at our doorstep by selling the maize seed,” said a farmer from Broksar in the Tawang District. “We are able to replace our old seeds and varieties.”

The evaluation of GLS-tolerant maize varieties in Bhutan was funded by the SDC and the European Union, with technical support from CIMMYT. “The rapid response to Bhutan’s request for assistance shows the collaboration, interest and support that CIMMYT gives to national agricultural research systems,” explained Guillermo Ortiz-Ferrara, team leader of CIMMYT’s Hill Maize Research Project, who is based in Kathmandu, Nepal. Ortiz-Ferrara coordinated CIMMYT’s work with Bhutan. The NMP is currently funded through the World Bank Decentralized Rural Development Project.

For more information: Guillermo Ortiz-Ferrara, cereal breeder (g.ortiz-ferrara@cgiar.org)
Catalyzing the force of maize and wheat farmers:
Reports from CGIAR Research Programs

The ever more complex issues facing agriculture require innovative answers. No single research institution working alone can address the critically important issues of global climate change, increased agricultural production, food security and rural poverty. The ambitious CGIAR Research Programs (CRPs) tackle cross-cutting issues in agricultural development across the globe. CIMMYT leads two major programs (MAIZE and WHEAT) and contributes appreciably to work on climate change in the Climate Change, Agriculture and Food Security CRP (CCAFS).
Launched in 2011, the CGIAR Research Program on Maize (MAIZE) is a global strategy led by CIMMYT and IITA. MAIZE is designed to ensure that publicly funded international agricultural research helps to double the productivity of maize-based farming systems. MAIZE also seeks to make these farming systems more resilient and sustainable, while significantly increasing farmers’ income and livelihood opportunities. All this is being done without using more land and as climates change and fertilizer, water and labor costs rise. The MAIZE strategy draws upon knowledge and experiences obtained through decades of extensive partnerships with national and international research and development partners (both public and private) and many farming communities.

2012 was a productive year for MAIZE. Over 860,000 farmers benefited from CIMMYT and IITA research outputs, and many more are benefiting from improved maize varieties released in countries such as Bangladesh, El Salvador, Ethiopia, India, Kenya, Malawi and Mozambique.

The work of researchers and partners has generated results and impact in Africa, Asia and Latin America. For example, the rapid response of MAIZE and the Kenya Agricultural Research Institute (KARI) to the outbreak of the deadly maize lethal necrotic virus (MLN) in eastern Africa in 2012 resulted in the quick identification of promising CIMMYT inbred lines and pre-commercial hybrids with resistance or moderate resistance to MLN, offering considerable hope to combat the disease through breeding.

Two million smallholder farmers across SSA are using varieties developed by the DTMA project (see p. 16), involving CIMMYT and IITA in collaboration with national agricultural research systems. With better yields than leading commercial varieties under drought conditions – and outstanding harvests when rains are good – the DTMA varieties improve food security and the incomes of farmers in 13 countries.

The release of the first publicly available inducer line for doubled haploids in collaboration with the University of Hohenheim was met with great enthusiasm and engagement among MAIZE partners. Already in high demand among maize breeders from national agricultural research systems and small- and medium-size seed companies, this technology reduces costs and speeds breeding significantly.

MAIZE also initiated a gender audit to find new avenues for increasing women’s participation in maize value chains.

Use of the innovation called “Aflasafe,” a non-toxic, affordable and natural product that can reduce aflatoxin contamination in crops, began in 2012. Caused by the fungus Aspergillus flavus, which infects maize both in the field and in storage, aflatoxins are one of Africa’s most serious food safety threats. Aflasafe was developed and is being promoted by IITA.

MAIZE experts joined forces with the Royal Tropical Institute (KIT) of the Netherlands in support of farming systems-focused innovation platforms helping researchers and local partners understand farmers’ needs and realities from a ‘systems’ perspective. The goal? Better mechanisms for multi-stakeholder interaction to share beyond the MAIZE program.

For more information: Dave Watson, MAIZE CRP manager (d.watson@cgiar.org)
The CGIAR Research Program on Wheat (WHEAT) is an international, collaborative effort to raise the productivity and resilience of wheat farming systems, including fighting the global threat of stem rust disease. WHEAT helps wheat farmers in developing countries to grow their crops in hotter and drier conditions with less water, fertilizer and pesticides. Led by CIMMYT, with ICARDA as its main CGIAR Consortium partner, WHEAT aims to increase wheat production for the 2.5 billion poor consumers who depend on high-quality, nutritious wheat as their main source of calories and proteins. Farmers want higher yields, so WHEAT research focuses on yield, with built-in heat or drought tolerance to face the growing impact of climate change, and resistance to pests and diseases. The aim is to grow more with less, not using more land and enabling wheat to be grown in more marginal areas.

Building on the strength of over 200 public and private partnerships, WHEAT applies developments from crop genomics, genetics, pathology, physiology and agronomy and directs emerging technologies into varieties and production systems adapted for countries that struggle with poverty and hunger. Partners test and adapt WHEAT lines and release them as new varieties; they co-develop and spread improved agronomy practices and precision agriculture solutions.

In 2012, some 1.6 million farmers made use of the results of 145 projects operating under WHEAT. Millions more have benefited from input-saving agronomy and precision agriculture tools and other research results, generated through past CGIAR funding for wheat research. Indeed, CGIAR-derived improved varieties are grown on over 60 percent of the developing world’s farmland dedicated to wheat, where two-thirds of global production is located. In 2012, WHEAT funding ensured that the demand for improved experimental varieties from 620 collaborators in 120 countries was met by CIMMYT and ICARDA.

This year, six countries on two continents ensured their ability to confront an outbreak of Ug99, a devastating stem rust race that is spreading across the world. In India, enough seed of two new Ug99-resistant wheat varieties was sold to sow 50,000 ha.

In advanced research, an initiative known as Seeds of Discovery started the largest genetic diversity analyses ever, in search of heat-tolerant wheat.

Across the globe, wheat research is funded mostly by public sources. WHEAT made strides to better leverages and coordinate national, regional and global investments. Researchers from 36 institutions jointly developed the Wheat Yield Consortium Business Plan and took it to 21 donors and research councils from 17 countries. WHEAT is a founding member of the G-20 Wheat Initiative, which seeks to better coordinate G-20 countries’ large national research programs. But better research and development coordination across organizations and institutions is not enough. Greater long-term investments in wheat research for development are needed to avoid “pricing out” 1.2 billion wheat-dependent poor, who need access to a healthy and diverse wheat-based diet.

Wheat is grown in many male-dominated societies, so WHEAT initiated a gender audit to improve participation by women in wheat value chains.

With increasing populations and urbanization and more women entering the workforce, CIMMYT and ICARDA are acting to sustainably improve food security in Africa. Wheat is no longer a minor crop for consumers in SSA; the region’s 2012 wheat imports totaled $6 billion. African agriculture ministers have recognized this and the African Development Bank began investing in wheat research and development. Building on their interest, WHEAT is developing a “Wheat for Africa” strategy to encourage national and international actors to join forces.

For more information: Victor Kommerell, WHEAT CRP manager (v.kommerell@cgiar.org)
The Climate Change, Agriculture and Food Security CRP (CCAFS) brings together the world’s best researchers in agricultural, climatic, environmental and social sciences to identify and address the most important interactions, synergies and trade-offs between climate change and agriculture.

CIMMYT’s 2012 activities focused on refining model outputs for high temperature impacts on crop production, in collaboration with the University of Florida and Stanford University. The initial analysis concentrated on a few well-calibrated locations (for example, irrigated wheat in India and Sudan) to “train” a statistical model which can then be applied more quickly for many regions. A statistical model of spring wheat yield responses to temperature, based on data from historical trials conducted by CIMMYT, has been completed. The statistical model was then used to predict impacts of 1°C and 2°C warming at all locations. The sites within each country that were among the worst 20 percent of impacts were then identified as “hotspots.” This process was repeated with 500 different iterations of the statistical model to identify sites that are robust hotspots. The model has also begun to be applied to irrigated wheat sites around the world. Parallel simulations of fully irrigated wheat were performed using the APSIM-N, SALUS and DSSAT wheat models for the same locations and climate files. The next steps will be to compare the statistical and process-based model estimates and then incorporate actual climate projections. The methodology developed in these projects will be shared with the Agricultural Model Intercomparison and Improvement Project (AgMIP) and will become the foundation for temperature impact assessments in other climate vulnerable regions and hotspots and for future studies in rain-fed regions.

In the case of maize, climate projections for both temperature and rainfall at the maize mega-environment level were developed for SSA, using the outputs of 19 global climate models (published in Food Security). Changes in rainfall patterns were found to be highly variable; in many areas the total rainfall did not change but rainfall distribution did. By 2050, air temperatures are expected to increase throughout SSA by an average of 2.1 °C. Parallel research for South Asia provides evidence that temperatures will rise in food crop production areas.

Numerous past studies have highlighted drought as a significant constraint to maize yields. Recent research suggests that higher temperatures — both alone and in combination with drought — will increasingly limit maize production more than drought alone. In 2012, CIMMYT and IITA led a comprehensive analysis and synthesis of data from tests of 300 experimental maize hybrids across different water and temperature regimes. Published in Crop Science, the results confirm for the first time in maize that the genetic basis of combined tolerance to drought and heat stress is distinct from the genetic bases of tolerance to either factor alone. Importantly for maize breeders, this means that selection under drought or heat alone will not confer tolerance to the combined effect of drought and heat.

Based on these findings, CIMMYT, IITA and other partners are developing a network to identify and improve combined drought and heat stress tolerance in current maize varieties of Africa and South Asia. Actions have included setting up screening sites in Bangladesh, Ethiopia, India, Nepal, Pakistan and Zimbabwe, as well as installing weather stations throughout those regions and holding training courses on phenotyping — the precise assessment and analysis of the field performance of individual varieties across environments.

For more information: Clare Stirling, CCAFS Project Coordinator (c.stirling@cgiar.org)
2012 and 2011 financial statements

A summary of the combined statements of activities and changes in net assets and combined statements of financial position for CIMMYT, Int., and CIMMYT, A.C., is set out in Table 1. Total revenues for 2011 amounted to $81.0 million and $123.5 million in 2012.

Total net assets increased by $8.9 million in 2011, to $47.2 million, and by $5.9 million in 2012, to $53.1 million. Unappropriated, unrestricted net assets increased to $29.2 million in 2011 and decreased to $11.7 million in 2012.

Table 1. Statement of financial position, 2012 and 2011.

<table>
<thead>
<tr>
<th>ASSETS</th>
<th>2012</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current assets</td>
<td></td>
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<tr>
<td>Cash and cash equivalents</td>
<td>63,618</td>
<td>63,629</td>
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<tr>
<td>Cash set aside due to Generation Challenge Program</td>
<td>8,852</td>
<td>7,927</td>
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<tr>
<td>Accounts receivable</td>
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<td></td>
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<tr>
<td>Donors - Net</td>
<td>13,317</td>
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<td>CGIAR centers</td>
<td>2,436</td>
<td>808</td>
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<tr>
<td>Other</td>
<td>3,068</td>
<td>730</td>
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<td>Allowance for doubtful accounts</td>
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<td>(3,809)</td>
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<td>Inventory and supplies</td>
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<td>Less allowance for obsolescence</td>
<td>(53)</td>
<td>(107)</td>
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<td>Total current assets</td>
<td>87,608</td>
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<tr>
<td>Non-current assets</td>
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<td></td>
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<tr>
<td>Property and equipment, net</td>
<td>41,409</td>
<td>17,977</td>
</tr>
<tr>
<td>TOTAL ASSETS</td>
<td>129,017</td>
<td>98,105</td>
</tr>
</tbody>
</table>

| LIABILITIES AND NET ASSETS | | |
| Current liabilities | | |
| Current portion of labor obligation | 376 | 504 |
| Accounts payable | | |
| Donors | 46,445 | 28,668 |
| CGIAR centers | 1,085 | 808 |
| Generation Challenge Program employees | 8,852 | 7,927 |
| Other | 3,068 | 730 |
| Accruals and provisions | 715 | 648 |
| Total current liabilities | 66,085 | 43,405 |
| Non-current liabilities | | |
| Labor obligation | 8,605 | 7,529 |
| Total non-current liabilities | 9,833 | 7,529 |
| Total liabilities | 75,918 | 50,934 |
| Net assets | | |
| Designated | 41,409 | 17,977 |
| Undesignated | 11,690 | 29,194 |
| Total unrestricted net assets | 53,099 | 47,171 |
| TOTAL LIABILITIES AND NET ASSETS | 129,017 | 98,105 |

Combined statements of activities, 2012 and 2011.

<table>
<thead>
<tr>
<th>Revenue and gains</th>
<th>Total 2012</th>
<th>Total 2011 Audited</th>
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</thead>
<tbody>
<tr>
<td>Grant revenue</td>
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<td>79,918</td>
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<td>Other revenue and gains</td>
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<td>1,051</td>
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<tr>
<td>Total revenue and gains</td>
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<td>80,969</td>
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<td>Expenses and losses</td>
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<tr>
<td>Research expenses</td>
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<tr>
<td>General and administration expenses</td>
<td>7,105</td>
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<tr>
<td>Other losses</td>
<td>14</td>
<td>31</td>
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<tr>
<td>Sub-total</td>
<td>117,595</td>
<td>72,112</td>
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<tr>
<td>Indirect cost recovery</td>
<td>(0)</td>
<td>-</td>
</tr>
<tr>
<td>Total expenses and losses</td>
<td>117,595</td>
<td>72,112</td>
</tr>
<tr>
<td>Surplus (deficit)</td>
<td>5,928</td>
<td>8,857</td>
</tr>
<tr>
<td>Expenses by natural classification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personnel</td>
<td>33,340</td>
<td>26,194</td>
</tr>
<tr>
<td>Supplies and services</td>
<td>27,855</td>
<td>22,691</td>
</tr>
<tr>
<td>Collaborators - CGIAR centers</td>
<td>7,534</td>
<td>-</td>
</tr>
<tr>
<td>Collaborators - partners</td>
<td>28,716</td>
<td>14,354</td>
</tr>
<tr>
<td>Travel</td>
<td>5,356</td>
<td>3,813</td>
</tr>
<tr>
<td>Depreciation</td>
<td>14,464</td>
<td>4,825</td>
</tr>
<tr>
<td>System cost (CSP)</td>
<td>330</td>
<td>235</td>
</tr>
<tr>
<td>Sub-total</td>
<td>117,595</td>
<td>72,112</td>
</tr>
<tr>
<td>Indirect cost recovery</td>
<td>(0)</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>117,595</td>
<td>72,112</td>
</tr>
</tbody>
</table>
Table 2. Schedule of grant revenue, 2012 and 2011.

For the years ended 31 December, 2012 and 2011
(Thousands of U.S. dollars)

<table>
<thead>
<tr>
<th>Donors</th>
<th>2012</th>
<th>2011</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unrestricted</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australia</td>
<td>-</td>
<td>1,909</td>
</tr>
<tr>
<td>China</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>-</td>
<td>253</td>
</tr>
<tr>
<td>Mexico</td>
<td>-</td>
<td>430</td>
</tr>
<tr>
<td>Philippines</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>South Africa</td>
<td>(50)</td>
<td>-</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>-</td>
<td>466</td>
</tr>
<tr>
<td>CGIAR</td>
<td>-</td>
<td>3,145</td>
</tr>
<tr>
<td><strong>Subtotal - unrestricted</strong></td>
<td>88</td>
<td>6,210</td>
</tr>
<tr>
<td><strong>Restricted</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CRP on Climate Change, Agriculture and Food Security</td>
<td>3,169</td>
<td>4,220</td>
</tr>
<tr>
<td>CRP for Genebanks</td>
<td>894</td>
<td>752</td>
</tr>
<tr>
<td>CRP on Wheat</td>
<td>12,012</td>
<td>-</td>
</tr>
<tr>
<td>CRP on Maize</td>
<td>13,365</td>
<td>2,742</td>
</tr>
<tr>
<td>African Agricultural Technology Foundation (AATF)</td>
<td>1,889</td>
<td>1,520</td>
</tr>
<tr>
<td>Agrovegetal, S.A.</td>
<td>135</td>
<td>195</td>
</tr>
<tr>
<td>AgroBio, Mexico</td>
<td>68</td>
<td>130</td>
</tr>
<tr>
<td>Australia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Australian Centre for International Agricultural Research</td>
<td>7,817</td>
<td>4,106</td>
</tr>
<tr>
<td>Grains Research and Development Corporation</td>
<td>1,355</td>
<td>1,412</td>
</tr>
<tr>
<td>Bayer Crop Science</td>
<td>90</td>
<td>92</td>
</tr>
<tr>
<td>Bill &amp; Melinda Gates Foundation</td>
<td>15,222</td>
<td>12,630</td>
</tr>
<tr>
<td>Brazil</td>
<td>4</td>
<td>47</td>
</tr>
<tr>
<td>Canada</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canadian International Development Agency</td>
<td>873</td>
<td>107</td>
</tr>
<tr>
<td>Alberta Agriculture, Food and Rural Development</td>
<td>91</td>
<td>90</td>
</tr>
<tr>
<td>CGIAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Centro Internacional de Agricultura Tropical (CIAT)</td>
<td>28</td>
<td>-</td>
</tr>
<tr>
<td>International Center for Agricultural Research in the Dry Areas (ICARDA)</td>
<td>51</td>
<td>41</td>
</tr>
<tr>
<td>World Agroforestry Center (ICRAF)</td>
<td>34</td>
<td>-</td>
</tr>
<tr>
<td>International Food Policy Research Institute (IFPRI)</td>
<td>161</td>
<td>271</td>
</tr>
<tr>
<td>International Livestock Research Institute (ILRI)</td>
<td>140</td>
<td>116</td>
</tr>
<tr>
<td>Bioversity International (formerly IPGRI)</td>
<td>137</td>
<td>191</td>
</tr>
<tr>
<td>International Rice Research Institute (IRRI)</td>
<td>4,312</td>
<td>4,147</td>
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<tr>
<td>International Institute of Tropical Agriculture (IITA)</td>
<td>492</td>
<td>206</td>
</tr>
<tr>
<td><strong>Subtotal - restricted</strong></td>
<td>122,319</td>
<td>73,708</td>
</tr>
<tr>
<td><strong>Total grants - donors unrestricted and restricted</strong></td>
<td>122,407</td>
<td>79,918</td>
</tr>
</tbody>
</table>
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The International Maize and Wheat Improvement Center, known by its Spanish acronym, CIMMYT® (www.cimmyt.org), is a not-for-profit research and training organization with partners in over 100 countries. The center works to sustainably increase the productivity of maize and wheat systems and thus ensure global food security and reduce poverty. The center’s outputs and services include improved maize and wheat varieties and cropping systems, the conservation of maize and wheat genetic resources, and capacity building. CIMMYT belongs to and is partially funded by the Consultative Group on International Agricultural Research (CGIAR) (www.cgiar.org) and also receives support from national governments, foundations, development banks, and other public and private agencies. CIMMYT is particularly grateful for the generous, unrestricted funding that has kept the Center strong and effective over many years.

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