CGIAR

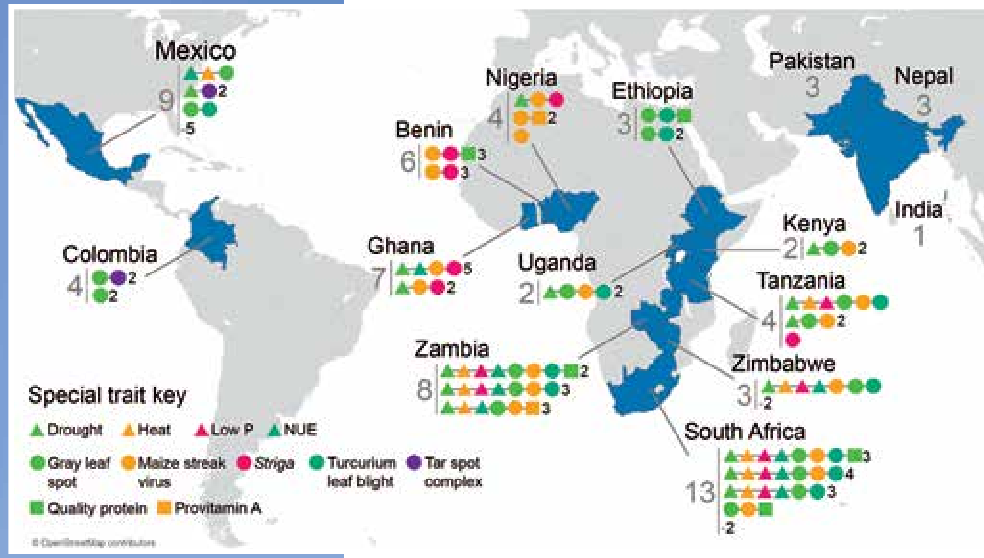
RESEARCH PROGRAM ON Maize

2015 ANNUAL REPORT

Message from the CRP MAIZE Director

B.M. Prasanna
Director, CGIAR Research Program MAIZE

2015 marked a year of exciting advances in scientific research and strengthened partnerships for the CGIAR Research Program on Maize (MAIZE). Sixty-four improved maize varieties, based on CIMMYT/IITA germplasm, were released through MAIZE partners in 2015, including 44 in sub-Saharan Africa, 13 in Latin America, and 7 in Asia. In addition to high and stable yield potential, some of the special traits stacked in these varieties include drought tolerance, heat tolerance, nitrogen use efficiency, enhanced protein quality, and resistance to diseases such as tar spot complex, turcicum leaf blight, gray leaf spot, and maize streak virus (MSV), as well as tolerance to the parasitic weed Striga.



Map of varieties commercialized by MAIZE partners in 2015, with special traits shown per variety.

* Provitamin-A enriched varieties based on MAIZE germplasm were released under Agriculture for Nutrition and Health (A4NH) in 2015.

The MAIZE team worldwide made tremendous progress in 2015 in various spheres, from the sustainable intensification of maize-based systems to the breeding, release and deployment of stress resilient and nutritious maize. National research organizations and seed companies took advantage of the maize lethal necrosis (MLN) Screening Facility at the Kenya Agricultural and Livestock Research Organization (KALRO)-Naivasha to have 10,790 germplasm entries screened for the disease under artificial inoculation, identifying several MLN-tolerant/resistant inbred lines and pre-commercial hybrids.

Great advances were made in the discovery, validation, and deployment of molecular markers for traits that are important for smallholder production. The maize doubled haploid (DH) facility at Kiboko, Kenya, developed nearly 60,000 DH lines from Africa-adapted genetic backgrounds. Nearly 33,000 DH lines were screened for resistance to MSV using a validated resistance haplotype.

In India and Nepal, Nutrient Expert®, developed through a MAIZE-funded partnership between CIMMYT and the International Plant Nutrition Institute (IPNI), has become widely recognized as a major climate-smart decision support system for raising yield while optimizing nutrient use.
Our researchers work to ensure that this scientific innovation is translated into enhanced impact for the millions of smallholder farmers and consumers who are the heart of our work at MAIZE. Over 7 million hectares were planted with improved MAIZE-derived technologies or management practices in 2015 as a result of CRP research, directly reaching more than 18 million smallholder farm families worldwide.

The above highlights were only a few of the successes of MAIZE in 2015. The progress and impacts MAIZE has been making in sub-Saharan Africa, Asia and Latin America would not be possible without the support of our donors and an array of public and private sector partners working in strong collaboration with the MAIZE team at the lead Centers CIMMYT and IITA. We extend our deepest thanks to all who are involved in the implementation of MAIZE for their commitment and hard work.

Contents

The CGIAR Research Program on Maize (MAIZE) is an international collaboration between more than 300 partners that seeks to mobilize global resources in maize research and development to achieve a greater strategic impact on maize-based farming systems in Africa, South Asia and Latin America.

Led by the International Maize and Wheat Improvement Center (CIMMYT), with the International Institute of Tropical Agriculture (IITA) as its main CGIAR partner, 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. MAIZE's overarching goal is to double maize productivity and increase incomes and livelihood opportunities from sustainable maize-based farming systems.

Targeting tar spot complex disease in Latin America

A fungal maize disease known as tar spot complex (TSC) is decimating yields across southern Mexico and Central and South America, threatening local food security and livelihoods. Named for the telltale black spots that cover infected plants, TSC causes leaves to die prematurely, weakening the plant and preventing the ears from developing fully, cutting yields by up to 50 percent or more in extreme cases. In a rapid response to this emerging disease threat, MAIZE researchers have rolled out an integrated control strategy that relies on resistant varieties – the most economical and environmentally friendly option for the region´s smallholder maize farmers.

MAIZE scientists and their partners in Southeast Mexico and four Central American countries have established a comprehensive maize testing network, through which seven new TSC-resistant hybrids were evaluated at 30 sites across the region in 2015, and four most promising hybrids were identified for wider testing. By 2014, national partners in Mexico had already released three TSC-resistant hybrids developed by MAIZE. Five local seed companies are evaluating and promoting two MAIZE-derived TSC-resistant hybrids in preparation for commercialization, and four local seed companies in the country´s southeast have begun promoting a new MAIZE-derived TSC-resistant hybrid. Despite the serious drought, these varieties performed well.

In Honduras, a TSC-resistant MAIZE-derived hybrid (DICTA-96) has been proposed for release to national authorities, and at their request, the program is helping multiply seed for official release in the second half of 2016. In Guatemala, two TSC-resistant MAIZE-derived hybrids (HB-15 and HB-16) have been proposed for release in 2015, and seed production is underway. One more MAIZE-derived hybrid (HB-17) was evaluated in Guatemala in 2015 for potential release in 2017.

Caused by a combination of 3 fungal infections, tar spot complex occurs most often in cool and humid areas but is beginning to spread, possibly due to climate change, evolving pathogens and susceptible maize varieties. The disease was reported in important maize producing regions of central Mexico and the northern United States for the first time in 2015. These new varieties will provide much needed resistance to this growing disease threat, in addition to eliminating farmer's need to spray expensive fungicides several times each year to protect their crops against the disease, a huge financial burden that few can afford.

The first stage of fungal maize disease TSC, with tiny, black "tar spots" covering the leaf. The spots will soon turn into lesions that kill the leaf, preventing photosynthesis from occurring.

A maize ear with shriveled kernels that are poorly filled, a major side effect of TSC that reduces farmer's yields.

Moving high-tech to the field in developing countries

The world's growing population and changing climate pose a difficult challenge to agriculture–how can farmers and breeders increase yields while conserving resources and limiting negative impacts on the environment? MAIZE scientists and partners are working to tackle this complex issue by bringing cutting-edge technology into farmers' fields and national research centers across the globe, to develop accurate data and recommendations on resource use in agriculture.

In India and Nepal, Nutrient Expert®–an easy-to-use, interactive, and computer-based decision support tool that can rapidly provide nutrient recommendations for an individual farmer field even without soil testing data–has sparked significant public and private sector interest. Developed through a partnership between CIMMYT, MAIZE and the International Plant Nutrition Institute (IPNI), Nutrient Expert® has become widely

recognized as a major climate smart decision support system for yield maximization while optimizing nutrient use.

"Skywalker" advances phenotyping in southern Africa.

In 2015, IPNI and Tata Consultancy Services Limited signed a Memorandum of Understanding to out-scale the Nutrient Expert® to nearly 100,000 farmers involved in their social initiatives across India. Also in India, DuPont Pioneer has expressed interest to utilize Nutrient Expert® in their Pravakta Programme (serving 30,000 farmers) and the Unnati Abhiyan Programme (serving 1,000 farmers). The Integrated Nutrient Management Division of the Ministry of Agriculture and Farmers Welfare, Government of India has also included Nutrient Expert® as one of the key tools for disseminating precision nutrient recommendations under the national Soil Health Card program.

Unmanned aerial vehicles (UAVs) and sensors are also being used as an affordable field-based phenotyping tool. Remote sensing technology such as UAVs can be used to phenotype large numbers of plots and field trials quickly and cost-effectively, a huge advantage for breeders working to develop improved maize varieties. Thanks to a MAIZE-funded collaboration between researchers from the University of Barcelona, Spain; CIMMYT; Crop Breeding Institute, Zimbabwe; Instituto Nacional de Innovación Agraria, Peru; and the Sustainable Agricultural Institute of the High Research Council, Spain, this technology is now being used by MAIZE scientists in phenotyping for heat, drought and low nitrogen stress tolerance.

Preliminary data indicates that selection efficiency for grain yield under abiotic stress can be increased by 10 to 20 percent using selection for grain yield and traits measured through remote sensing compared to selection for grain yield alone. This approach will be applied to quantitatively measure maize lethal necrosis and tar spot complex responses in maize germplasm.

> "UAV technology has great potential to be an important tool in the fight to curb the spread of maize lethal necrosis. Screening for MLN currently involves visual ratings of disease severity, which is time consuming and subjective, and measurements have to be taken many times in many fields over a short period of time. Remote sensing can be used to rapidly and quantitatively measure the severity of MLN symptoms in individual plots."
>
> **Jill Cairns**
> CIMMYT Maize Physiologist

Impact through innovation

The process of innovation in agriculture does not occur in a vacuum, but rather in a diverse community of actors and environments that affect its final form and outcome. MAIZE supports 168 Innovation Platforms (IPs) and other multi-stakeholder interaction mechanisms across Africa, South Asia and Latin America, fostering interaction and joint work among the maize agrifood system actors, with the aim to facilitate positive change. At both local and national levels, MAIZE IPs aim to: identify needs and opportunities; pilot innovation processes; co-develop, test and adapt new technologies and practices; tackle institutional issues that hinder innovation; and collect, and act on, feedback. MAIZE utilizes global Agricultural Innovation Systems (AIS) expertise from the Royal Tropical Institute (KIT) whilst at the same time building up its own internal AIS capacity. KIT supports capacity strengthening of MAIZE partners in AIS thinking and application.

IP performance and sustainability have been strengthened in a number of key MAIZE bilateral projects such as SIMLEZA, SIMLESA, CSISA and MasAgro. Key successes include enhanced ownership of IPs by national partners and key actors and improved coordination among research institutions and extension agencies, both public and NGOs, as well as increased stakeholder influence on the research agenda. In addition, NARS' interest in mainstreaming AIS in food crops research has increased, and the AIS approach has strengthened collaboration between MAIZE, Humid Tropics and Drylands Systems CRPs.

In December 2015, a KIT workshop funded by MAIZE focused on institutionalizing AIS in MAIZE, and organizing research differently. "Understanding local institutional circumstances is key in developing innovative approaches to complex agricultural problems," said Jens Andersson, a CIMMYT rural development sociologist and innovation scientist who attended the workshop. "Local-level innovation platforms may work well in one context, but not in another. AIS thinking provides a perspective and a rationale for collaboration and co-development with partners, and promotes research that focuses on the agri-food system itself, and the alternative configurations that can enhance its performance. Enhancing that research capacity within MAIZE and its partners, and integrating it in the design of all its projects, is an exciting challenge in the years to come."

The AIS approach is slowly being institutionalized in MAIZE sustainable intensification projects. For example, the BuenaMilpa Project in Guatemala used AIS to inform project design and to set up stakeholder interaction mechanisms to define priorities for action and links to research.

CSISA agricultural mechanization engineer Subash Adhikari adjusts a maize shelling machine on a farmer´s verandah in Rambasti, Kanchanpur.

Agricultural Innovation Systems (AIS) are defined as "a system of individuals, organizations, and enterprises focused on bringing new products, processes and forms of organization into social and economic use to achieve food and nutrition security, economic development, and sustainable natural resource management."

Food and Agriculture Organization of the United Nations (FAO)

Maize plant infected with maize streak virus (MSV).

Breeder-ready markers for key traits and genomics-assisted maize breeding

Molecular markers, used in molecular biology and biotechnology to identify a particular sequence of DNA in a pool of unknown DNA, are now basic tools for any modern crop breeding program. Together with doubled haploid technology (which cuts by half the time required for variety development), they bring about a paradigm shift in maize improvement. MAIZE scientists made tremendous progress this year in terms of discovery, validation, and deployment of molecular markers for traits that are important for smallholder production. They also established the world´s biggest public sector infrastructure for maize doubled haploid (DH) development, and generated useful knowledge and products.

MAIZE researchers found breeder-ready markers for a specific QTL (quantitative trait locus) on chromosome 1 underlying resistance to maize streak virus (msv1), and that selection for a set of three markers enables a 25 percent improvement in MSV resistance. These results have already generated interest among maize researchers in several African institutions, who intend to incorporate msv1 markers into their breeding programs. About 25,000 lines in the DH breeding pipeline were screened with these markers for MSV resistance. The msv1 markers are also used to convert six drought and heat tolerant donors into MSV resistant versions.

Well-adapted haploid inducers are one of the most important factors for success in DH-based breeding, together with an efficient system for haploid selection and chromosome doubling to derive DH lines. MAIZE scientists identified, validated and deployed molecular markers to select for lines that express the purple kernel color used as a marker after induction crosses, making the process more efficient. By the end of 2015, about 1,100 breeding lines had been screened with these markers for DH-based breeding. Working with an advanced research partner (the University of Hohenheim, Germany), MAIZE scientists developed tropicalized haploid inducers and also developed molecular markers to select for a major quantitative trait loci (QTL) (qhir1) that contributes to high haploid induction rate (HIR). Some 20,000 segregating progenies were screened with qhir1 markers for high HIR in crosses with lines resistant to MLN. In addition, 13 small- to medium-effect QTLs for resistance to MLN were identified and deployed in 25 widely used, Africa-adapted and MLN-susceptible inbred lines.

Recently identified molecular markers now allow scientists to select for lines that express the purple kernel color used as a marker after induction crosses, making the breeding process more efficient.

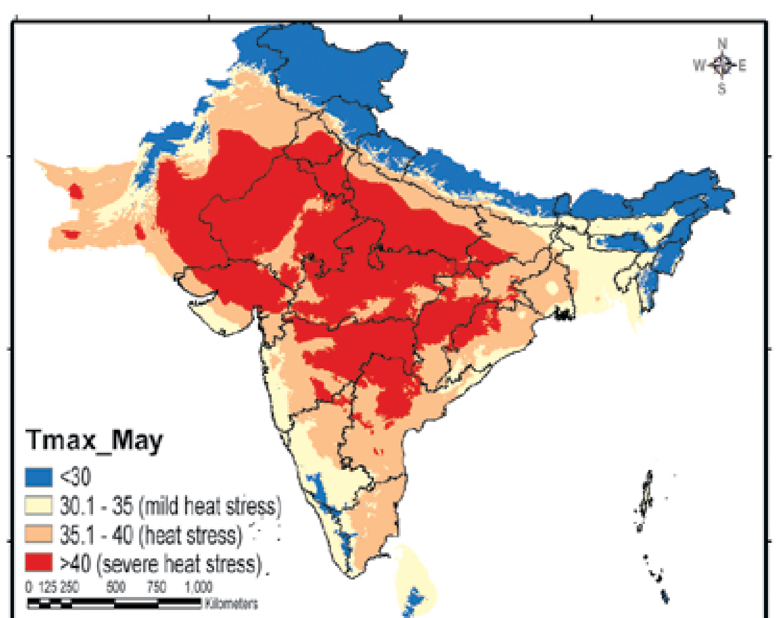
"MAIZE is aggressively incorporating MLN tolerance from sources developed outside of Africa as well as utilizing germplasm not formerly included in breeding programs to improve abiotic stress tolerance and yield potential of African germplasm. These *msv1* markers are enabling selection of individuals with acceptable MSV tolerance at lower cost than developing and screening larger populations which would be required without the *msv1* markers. We estimate that combining MSV and MLN tolerance in MAIZE breeding populations using trait-linked markers is providing cost savings of 30-60 percent compared with conventional methods.

Markers for *qhir1* are similarly facilitating the development of improved DH inducers for lower cost, which will improve the efficiency of breeding programs and enable breeders to deliver even higher performance hybrids to farmers."

Mike Olsen
Upstream Research Coordinator, Global Maize Program, CIMMYT

Beating the heat in South Asia

In the face of temperature increases caused by climate change, South Asia´s vast and growing maize sector urgently needs heat-tolerant maize varieties. To help guide this work, MAIZE researchers used climate data obtained from the CMIP5 database (a database providing a framework for coordinated climate change experiments) to identify current and future hotspots in the region. They also generated monthly heat stress distribution maps. Genome-wide association studies (GWAS) revealed multiple haplotypes associated with grain yield and anthesis-silking interval (a trait that is used as a key yardstick to



Heat tolerance phenotyping sites in Asia.

Susceptible hybrids (left) compared to heat tolerant maize hybrids from the HTMA project (right).

select maize lines and populations that do well under drought) under heat stress, including nine significant haplotype blocks for yield that explain 4 to 12 percent of phenotypic variation. Twenty marker-assisted selection populations for GWAS leads were submitted for Double Haploid induction and development of heat-tolerant lines.

MAIZE supplied six national partners in Bangladesh, India, and Pakistan with heat-tolerant $F_{2:3}$ families that they had selected on the basis of test-cross performance in their target environments for use in deriving their own heat-tolerant lines. Eighteen first-generation, heat-tolerant hybrids were formally licensed to nine partners in Bangladesh, India, Nepal, and Pakistan for scaling out in their target markets. A total of 303 maize researchers and technical staff from those countries, including 32 women, were trained in developing stress-resilient maize through 10 in country/regional training courses and workshops.

> "MAIZE works to improve the incomes and food security of resource poor smallholder maize farmers living in climate-vulnerable regions of South Asia through accelerated development and deployment of heat-resilient maize hybrids."
>
> **Pervez Haider Zaidi**
> Heat Stress Tolerant Maize for Asia (HTMA)
> Project Leader and Senior Maize Physiologist, CIMMYT

Crowning the success of drought-tolerant maize breeding

The Drought Tolerant Maize for Africa (DTMA) Project has contributed to a stronger food system in 13 countries in sub-Saharan Africa, through more than 200 improved maize varieties to help farmers cope with climate change and low-fertility soils. DTMA varieties include hybrids that yield, on average, 15 percent more than widely grown commercial hybrids, giving farmers much higher yield regardless of climatic constraints – in good years or in bad years. DTMA has benefited from, and drawn on, rich partnerships with private and public institutions.

As the project approached its close in 2015, MAIZE scientists redoubled their efforts to deliver improved varieties – work that was reinforced by two new projects called Stress Tolerant Maize for Africa (STMA) and Drought-Tolerant Maize for Africa Seed Scaling (DTMASS). At least 30 new DTMA varieties were released during 2015, in addition to the more than 180 released previously. An estimated 2.3 million hectares were planted to these varieties in target countries during 2015, benefiting 5.7 million households.

"DTMA has left an incredible legacy for drought tolerant maize seed systems in Africa. A total of 233 varieties, including about 200 distinct drought tolerant maize varieties, were released under DTMA across the target countries. The project helped generate basic data that would inform maize research and development efforts, and the overall productivity of maize in DTMA target countries showed a much higher growth rate than in countries outside DTMA. The legacy of DTMA will be carried on through two new projects, STMA and DTMASS. We have created excitement and changed the narrative on maize agriculture in Africa. Our team should celebrate these accomplishments as we transition into the next level."

Tsedeke Abate
Stress Tolerant Maize for Africa (STMA) Leader,
CIMMYT Maize Systems in Africa

In some countries, the improved varieties already occupy more than 100,000 hectares, as is the case for BH661 in Ethiopia, ZM523 in Angola, Pan53 in Zimbabwe, and Sammaz15 in Nigeria.

Replacement of an old hybrid in Ethiopia is typical of developments unfolding in several countries. Release of the hybrid BH660 in 1993 was widely seen as a harbinger of improvement in the country´s maize productivity. Initially, the hybrid was marketed in moist and semi-moist areas of Ethiopia´s Maize Belt, especially in parts of Oromia and the Southern Nations, Nationalities, and People´s Region. Later, it was introduced in the Amhara region as well and has since dominated national maize production, accounting for more than 51 percent of maize hybrid seed sales as recently as 2013. Performance of the hybrid has declined in recent years, as a result of climate change – with rainfall becoming less reliable and more unevenly distributed. In response, the national maize program released another MAIZE-derived hybrid, BH661, in 2011 and vigorously promoted it across the country. Farmers prefer it because of its superior drought tolerance, earlier maturity, wider agro-ecological adaptation, and higher yield (with a yield advantage of 10 percent or more in normal years and much higher under drought). Seed production of BH661 overtook that of the old variety in 2014, followed by a fourfold increase in 2015. All seed companies in Ethiopia are now marketing the new hybrid.

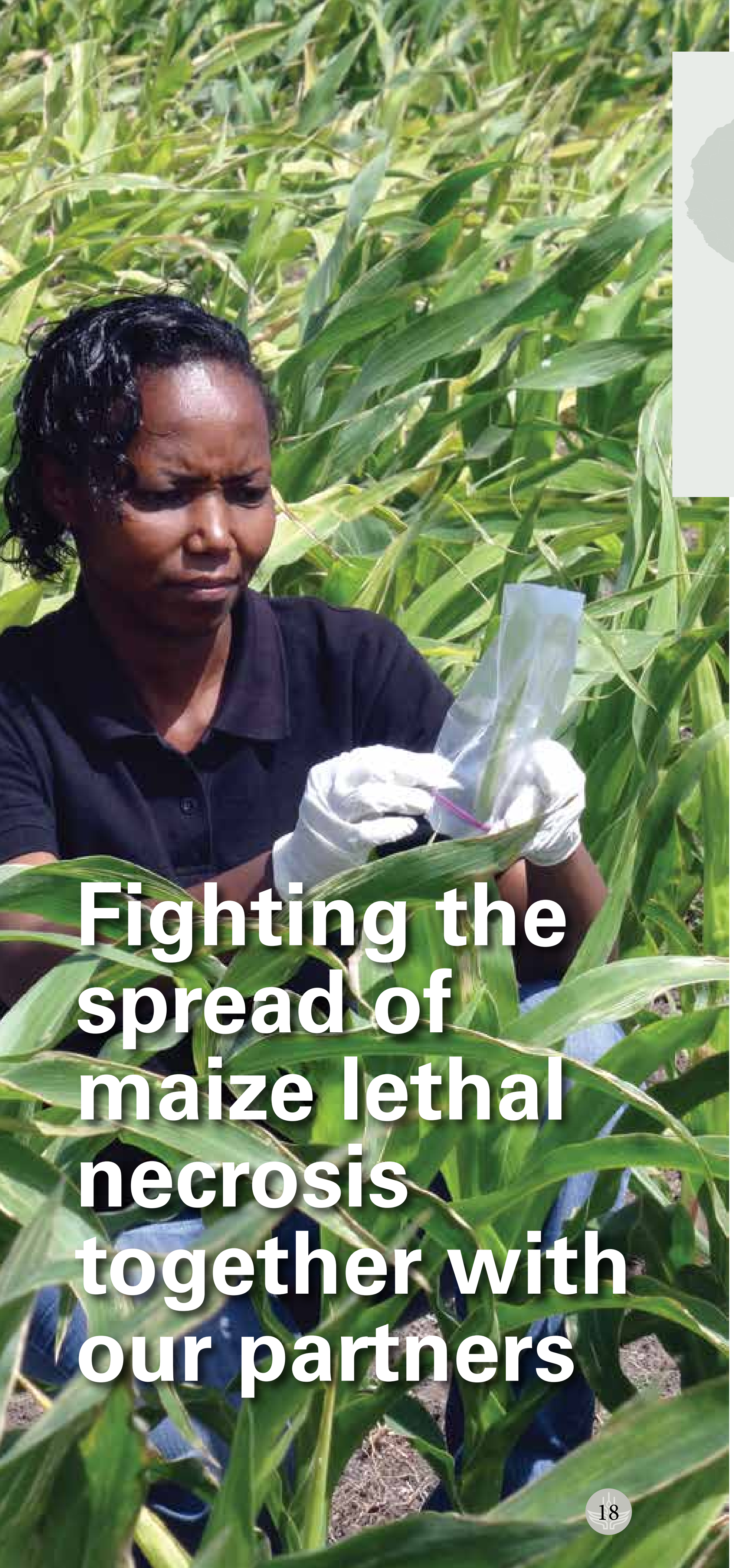
Getting the upper hand on aflatoxin

Aflatoxins, invisible, tasteless poisons produced by Aspergillus flavus, a mold commonly found infecting crops such as maize and groundnuts, both in the field and in storage, pose a major threat to public health and grain trade in Africa. While acute exposure to aflatoxins can kill, prolonged exposure leads to impeded growth, liver disease, immune suppression and cancer, with women, children, and the poor most vulnerable. Aflatoxins also impact international trade, with African economies losing USD 450 million every year from barred exports. In a major effort to counter aflatoxins, capacity to produce the Aflasafe™ family of effective biocontrol products was expanded to meet increasing demand. In 2015, MAIZE scientists began development of biocontrol agents for two countries – Burundi and Uganda. In Burundi, 380 maize and 120 peanut samples were collected, from which 2,910 isolates were obtained, while in Uganda, 256 maize and 186 peanut samples were collected. More than 3,000 isolates obtained from the Ugandan samples are being characterized to identify atoxigenic isolates, which are being purified and sent to our research partner, the Agricultural Research Service of USDA at the University of Arizona in Tucson, for further analysis using simple sequence repeats (SSRs), a small segment of DNA that repeats itself a number of times. With the innovative technologies that MAIZE scientists and their partners used to characterize fungal germplasm, it is possible to identify haplotypes (or DNA variations) that are distributed in several countries of eastern Africa and could provide the basis for biocontrol products that are effective across the region and not just in individual countries.

Farmers receive Aflasafe products to prevent aflatoxin contamination in maize.

In parallel work in southern Africa, MAIZE scientists identified candidate atoxigenic biocontrol isolates from several countries in 2013-2014; in 2015, these were characterized by USDA in Tucson into SSR haplotypes. Haplotype distribution across the region was also determined as an indicator of adaptation. On this basis, several haplotypes were selected as active ingredients for regional products. Two regional haplotypes were found in Malawi, Mozambique, Tanzania, and Zambia. Native isolates belonging to these two haplotypes can now be used to develop regional products for all four countries. In fact, one haplotype appears widely distributed in Africa and is already used in Aflasafe products in Burkina Faso and Nigeria. In West Africa, two biocontrol products were developed – Aflasafe GH01, which is specific to the region and contains four well distributed haplotypes, and Aflasafe GH02, which is for use only in Ghana.

Maize cobs colonized with Aspergillus.



Fighting the spread of maize lethal necrosis together with our partners

Map of MLN-affected countries.

Maize lethal necrosis (MLN) continued causing serious damage to maize production in Kenya, where the disease was first reported in 2011. According to the US Department of Agriculture, losses amounted to 10 percent in 2014/2015, with a value exceeding USD 50 million. The presence of the disease was also confirmed in Democratic Republic of the Congo, Ethiopia, Rwanda, Tanzania, and Uganda. In response, MAIZE and its partners have put in place a comprehensive solution that benefits the millions of consumers and smallholders already affected, while also shielding those in the path of disease spread.

By 2015, five MLN-tolerant hybrids were released in Kenya, Tanzania, and Uganda, where national partners are multiplying seed for delivery to farmers in 2016. Meanwhile, in national performance trials, several new hybrids outperformed the first-generation hybrids under disease pressure. MAIZE scientists are also converting 25 MLN-susceptible inbred lines that are widely used in Africa as parents in commercial hybrids into resistant versions through molecular marker-assisted backcrossing. In addition, national research organizations and seed companies took advantage of the facility set up at Naivasha, Kenya, to have 10,790 germplasm entries screened for the disease, resulting in the identification of several disease-tolerant inbred lines and hybrids.

> "While progress has been made in developing and releasing MLN-tolerant maize varieties, we need to intensify inter-institutional actions on MLN disease surveillance and monitoring in eastern Africa, and ensure that the disease does not spread further from the MLN-endemic to the non-endemic countries. Our goal is to strengthen the national plant protection systems to effectively detect, monitor and contain the spread of MLN particularly through seed, while coordinating with the commercial maize seed sector to produce and commercialize MLN-free clean seed to the farmers."
>
> **B.M. Prasanna**
> Director of CGIAR Research Program MAIZE and Director of CIMMYT's Global Maize Program

To stress the importance of MLN, CIMMYT organized two meetings in 2015: an MLN diagnostics and screening workshop in March and the International Conference on MLN Diagnostics and Management in Africa in May. This conference, organized jointly with the Alliance for a Green Revolution in Africa and the Bill & Melinda Gates Foundation, in collaboration with the Kenya Agricultural and Livestock Research Organization (KALRO), brought together critical players in the maize sector, particularly seed companies, to discuss how to effectively control seed transmission of MLN pathogens by ensuring the production, distribution and cultivation of non-contaminated commercial seed, which is a major concern for CIMMYT. Specific recommendations were made to prevent MLN spread, reduce virus infections and efficiently screen seed lots.

To fight the spread of the disease, and as a follow-up step from the conference, a new MLN project has been launched in November. Funded by the United States Agency for International Development (USAID), the four-year project will coordinate regional efforts to strengthen response to the rapid emergence and spread of MLN. It will establish a community of practice among the national plant protection organizations (NPPOs) for implementing harmonized MLN diagnostic protocols for detecting MLN-causing viruses and enable commercial seed companies to implement necessary standard operational procedures to produce MLN-free clean seed at various points along the maize seed value chain.

CIMMYT scientists inspect plants that show tolerance to MLN in Naivasha, Kenya.

Maize lethal necrosis disease has continued to wreak havoc on maize production in East Africa since it was first reported in Kenya in 2011. The disease, caused by a combination of the maize chlorotic mottle virus (MCMV) and sugarcane mosaic virus (SCMV), causes irreversible damage that kills maize plants before they can grow and yield grain. MLN pathogens can be transmitted not only by insect vectors but also through contaminated seed.



Highlighting MAIZE gender research

In 2015, MAIZE continued strategic and integrated gender research in a number of areas. The CRP supported the comparative study on Gender Matters in Small-scale Mechanization as well as a four-country (Kenya, Malawi, Zambia and Zimbabwe) comparative gender analysis of hermetic grain storage technologies in eastern and southern Africa. In these same regions, an interdisciplinary team of MAIZE researchers collaborated in the review of gender and conservation agriculture.

As part of a project focusing on promotion and diffusion of Quality Protein Maize (QPM), a series of tools and products were developed to help project staff and partners' mainstream gender in the project's participatory interventions with men and women. In South Asia, MAIZE researchers helped poor women farmers increase their maize harvest and incomes.

Under the GENNOVATE initiative MAIZE continued to investigate how gender norms – social rules prescribing men's and women's daily behaviors – affect the uptake of agricultural innovations in key target regions. This work will guide efforts to better integrate gender in agricultural research and to design practical tools for researchers. In 2015, this included the establishment and training of local field teams in Ethiopia, Nepal, Nigeria, Tanzania, and Zimbabwe as well as planning and implementation of field-level data collection. MAIZE case studies were completed in 27 villages in major maize producing countries.

Together with WHEAT, MAIZE revised and completed the GENNOVATE Data Coding tree, developed frameworks and procedures for GENNOVATE data cleaning and coding, and set up a coding platform including training and supervision of the coding process.

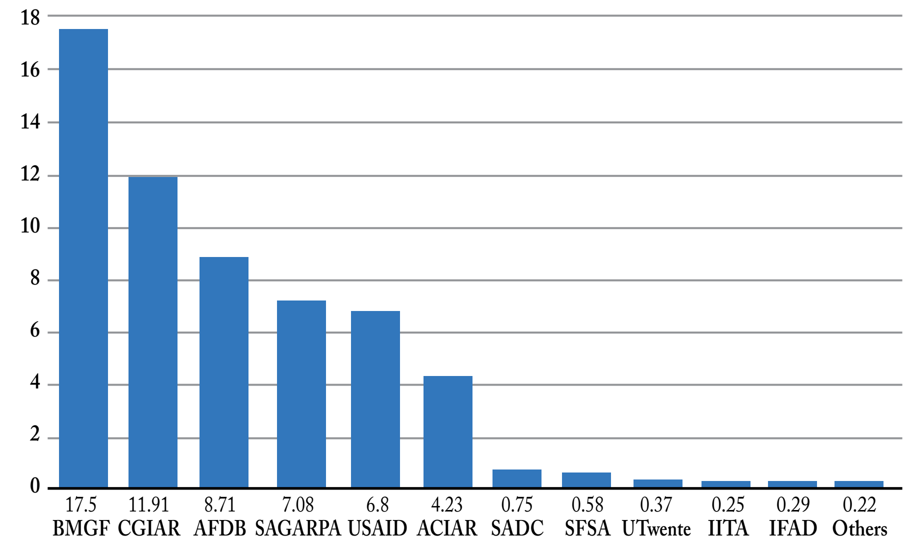
MAIZE published several research papers on gender in 2015, as well as a photo documentary, "Portraits of Women Working with Maize in Mexico," using images and testimonies of women describing their lives as farmers, food-makers, artisans and vendors.

GENNOVATE is a cross-CRP, global comparative research initiative which addresses the question of how gender norms and agency influence men, women and youth to adopt innovation in agriculture and natural resource management.

For more information, visit https://gender.cgiar.org/collaborative-research/gennovate/

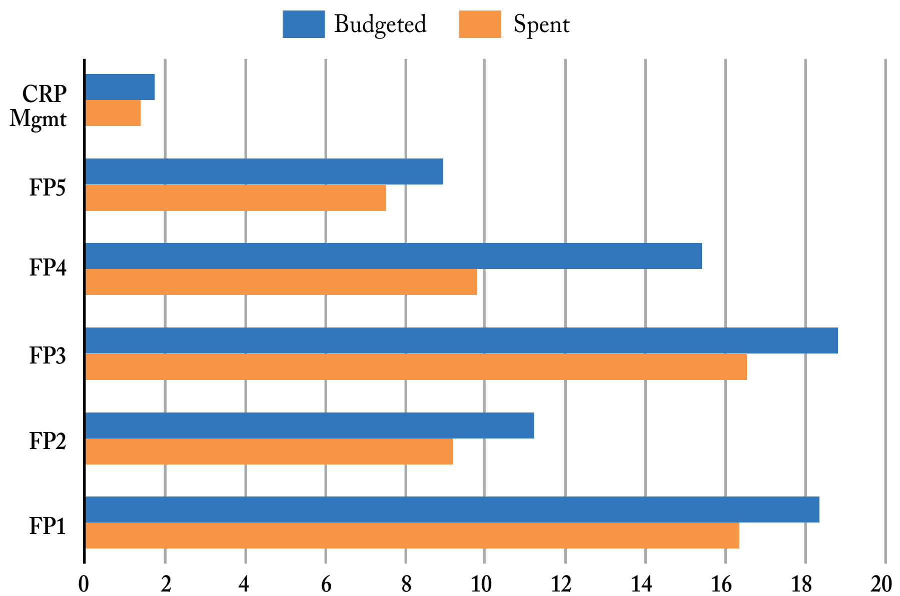
Financial Highlights

Top donors
(US$ millions)



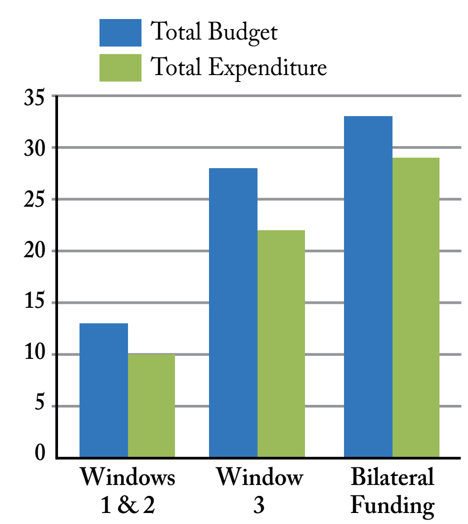
BMGF - Bill & Melinda Gates Foundation
CGIAR, A Global Agricultural Research Partnership
AFDB - African Development Bank
SAGARPA - Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (Mexico)
USAID - United States Agency for International Development
ACIAR - Australian Centre for International Agricultural Research
SADC - Southern African Development Community
SFSA - Syngenta Foundation for Sustainable Agriculture
University of Twente (Netherlands)
IITA - International Institute of Tropical Agriculture
IFAD - International Fund for Agricultural Development

2015 Financial Summary by Flagship
(US$ millions)



Flagship project 1 - Enhancing MAIZE's R4D strategy for impact.
Flagship project 2 - Novel diversity and tools for increasing genetic gains.
Flagship project 3 - Stress tolerant and nutritious maize.
Flagship project 4 - Sustainable intensification of maize-based systems for improved smallholder livelihoods.
Flagship project 5 - Adding value for maize producers, processors and consumers.

2015 Budget/Expenditure per Funding Source
(US$ millions)



Acronyms

AIS – Agricultural Innovation Systems
CIMMYT – International Maize and Wheat Improvement Center
CRP – CGIAR Research Program
CSISA – Cereal Systems Initiative for South Asia
DH – doubled haploid
DTMA – Drought Tolerant Maize for Africa
DTMASS – Drought Tolerant Maize for Africa Seed Scaling
FAO – Food and Agriculture Organization of the United Nations
GWAS – genome-wide association studies
HIR – haploid induction rate
HTMA – Heat Stress Tolerant Maize for Asia
IITA – International Institute of Tropical Agriculture
IPNI – International Plant Nutrition Institute
KALRO – Kenya Agricultural and Livestock Research Organization
KIT – Royal Tropical Institute
MasAgro – The Sustainable Modernization of Traditional Agriculture
MAIZE – CGIAR Research Program on Maize
MCMV – maize chlorotic mottle virus
MLN – maize lethal necrosis
MSV – maize streak virus
NGO – non-governmental organization
NPPO – National plant protection organization
QPM – quality protein maize
QTL – quantitative trait locus
SCMV – sugarcane mosaic virus
SIMLESA – Sustainable Intensification of Maize-Legume Cropping Systems for Food Security in Eastern and Southern Africa
SIMLEZA – Sustainable Intensification of Maize-Legume based Cropping Systems for Food Security in Eastern Province of Zambia
SSR – simple sequence repeat
STMA – Stress Tolerant Maize for Africa
TSC – tar spot complex
UAV – unmanned aerial vehicle
USAID – United States Agency for International Development
USDA – United States Department of Agriculture

Writers/Editors: Bianca Beks, Jennifer Johnson, Nathan Russell, Dave Watson

Contributors: Tsedeke Abate, Jens Andersson, Lone Badstue, Ranajit Bandyopadhyay, Yoseph Beyene, Jill Cairns, Bruno Gérard, Jeroen Groot, Sudha Krishnan Nair, Aleksandre Loladze, Terry Molnar, Mike Olsen, B.M. Prasanna, Felix San Vicente, Brenda Wawa, Martha Willcox, Mariana Wongtschowski, P.H. Zaidi

Photos: J.L. Araus/University of Barcelona, M. DeFreese, Jennifer Johnson, Andreas Krappweis, Peter Lowe, G. Mahuku, Florence Sipalla, P.H. Zaidi, IITA and CIMMYT archives

Infographics and maps: Gerardo Mejia, Sam Storr

Graphic design and layout: Miguel Mellado, Antonio Luna

MAIZE Management Committee

B.M. Prasanna
Chair
Director, MAIZE CRP and CIMMYT Global Maize Program

Marianne Bänziger
Deputy Director General for Research and Partnership, CIMMYT

David Chikoye
Director for the Regional Hub for southern Africa and the Plant Production and Health Management thematic area

Olaf Erenstein
Socioeconomics Program Director, CIMMYT

Bruno Gérard
Sustainable Intensification Program Director, CIMMYT

Ylva Hillbur
Deputy Director General for Research, IITA

Abebe Menkir
Maize Breeder/Geneticist, IITA

Kevin Pixley
Genetic Resources Program Director, CIMMYT

Mike Robinson
Chief Science Advisor, Syngenta Foundation for Sustainable Agriculture

Joyce N. Malinga
Director, KALRO Food Crops Research institute

Dave Watson
Ex-officio
Program Manager, MAIZE

Claudia Velasco
Ex-officio
Program Administrator, MAIZE

MAIZE Independent Steering Committee (ISC)

Mary Ann Sayoc
Chair
General Manager, East-West Seed Company

Martin Kropff
Director General, CIMMYT

Marianne Bänziger
Ex-officio
Deputy Director General for Research and Partnership, CIMMYT

Nteranya Sanginga
Director General, IITA

B.M. Prasanna
Director, MAIZE CRP and CIMMYT Global Maize Program

Marco Ferroni
Executive Director, Syngenta Foundation for Sustainable Agriculture

Pastor Tunji Adenola
President, Maize Association of Nigeria

Luis Flores Lui
Director General, Mexican Forestry, Agriculture and Livestock Research Institute (INIFAP)

Felister W. Makini
Deputy Director General for Crops, KALRO

Dave Watson
Ex-officio
Program Manager, MAIZE

Correct citation: MAIZE. 2016. The CGIAR Research Program on Maize 2015 Annual Report. Mexico City: MAIZE.

Printed in Mexico.

RESEARCH PROGRAM ON Maize
CGIAR

The CGIAR Research Program on Maize (MAIZE)
Email: maizecrp@cgiar.org • Web: http://maize.org

International Maize and Wheat Improvement Center (CIMMYT)
Apdo. Postal 6-641
Mexico D.F., Mexico 06600
Tel: +52 (55) 5804 2004
Email: cimmyt@cgiar.org
www.cimmyt.org

International Institute of Tropical Agriculture (IITA)
IITA-Nigeria Ibadan,
PMB 5320, Ibadan
Oyo State, Nigeria
Tel: +234 2 7517472
Email: iita@cgiar.org
www.iita.org