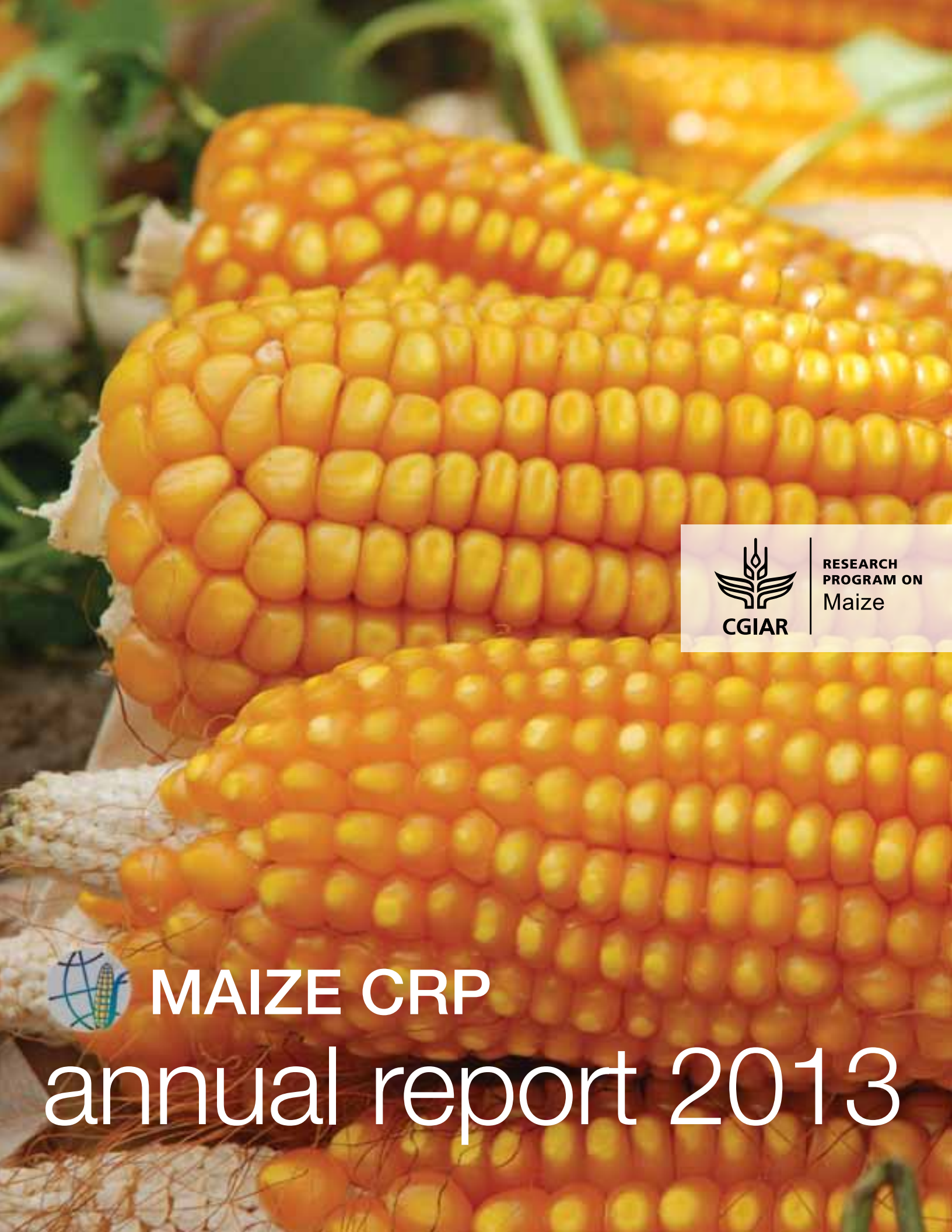


CGIAR RESEARCH PROGRAM ON Maize

MAIZE CRP

annual report 2013

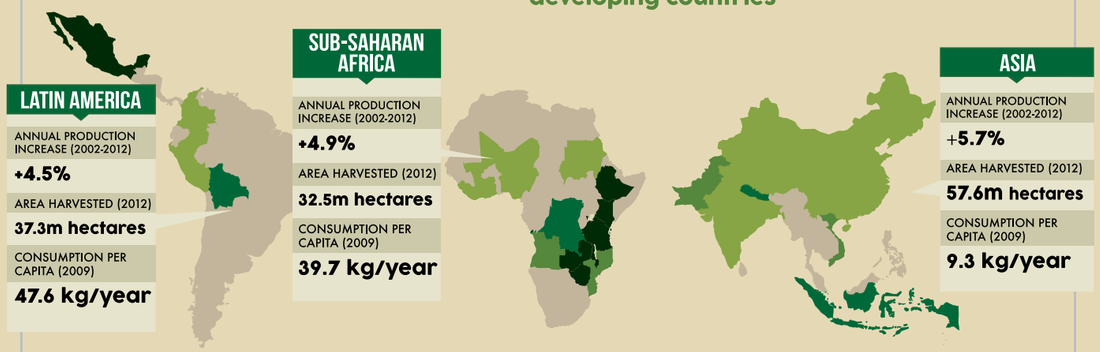
CGIAR RESEARCH PROGRAM ON Maize

CGIAR RESEARCH PROGRAM ON MAIZE

THE WORLD OF MAIZE

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

Maize, Rice and Wheat provide 30% of calories for 4.5 billion people in 94 developing countries



LATIN AMERICA

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

SUB-SAHARAN AFRICA

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

ASIA

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

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

FAOSTAT 2013

MAIZE TARGETS WITH TO HELP

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

367 million smallholders held back by lack of access to technology

New varieties

Improved technologies

Information services

Market opportunities

Poor maize consumers vulnerable to price changes

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

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

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

Biofuels: 1 ton of maize = 370 liters of ethanol

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

WHO WE ARE

CGIAR
A global agriculture research partnership

Launched in 2012, MAIZE is a CGIAR Research Program (CRP) led by:

CIMMYT
International Maize and Wheat Improvement Center

IITA Research to Nourish Africa
International Institute for Tropical Agriculture

over 300 partners

- **130** National Agricultural Research Institutes
- **75** Universities
- **21** Advanced Research Institutes
- **18** Regional and International Organizations
- **42** NGOs and Farmer Associations
- **46** Private Sector Organizations

Contents

CGIAR

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

Message from the Program Manager

MAIZE's power lies in the strength of its partners. This annual report is a means to share their exciting and important work, but also to show how they combine for greater impact in key strategic areas.

2013 witnessed the strengthening of many new and existing partner collaborations. I will name but a few. Building on the rapid response of MAIZE and the Kenya Agricultural Research Institute (KARI) in 2012 to the outbreak of the deadly maize lethal necrotic virus (MLN) in eastern Africa, this partnership both expanded and intensified in 2013. In addition to CIMMYT and KARI working hand-in-hand to combat this menace, the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), the International Institute of Tropical Agriculture (IITA), the International Centre of Insect Physiology and Ecology (ICIPE) and the Federal University of Technology-Nigeria (FUT-Nigeria) joined the fight against MLN. One major milestone in this fight against MLN was the establishment of a centralized MLN screening facility at Naivasha, Kenya.

In collaboration with the University of Hohenheim, the expansion of doubled haploid (DH) breeding technology to Sub-Saharan Africa (SSA) culminated in the opening of a maize DH facility at Kiboko, Kenya – the first DH breeding facility in Africa for the benefit of both national agricultural research systems (NARS) and small- to medium-sized seed companies.

Funded through a MAIZE competitive grant, collaboration between the MAIZE and Livestock and Fish CRPs continued to flourish in the area of dual-purpose maize. This work builds on promising bilaterally funded collaborative work between the International Livestock Research Institute (ILRI) and CIMMYT since mid-2000. Maize production is rapidly increasing in India, largely due to the growing poultry industry, and is replacing crops such as rice, sorghum, legumes and wheat in some areas. Dual-purpose maize is needed to meet both the poultry industry demand for grain and the demand for good quality stover to feed cattle.

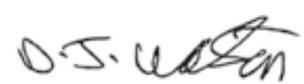
Our work on the assessment of drivers of change and systems modeling for better targeting of project interventions further expanded with the farming systems Ecology Group of Wageningen University.

In the area of sustainable intensification of maize-based farming systems, 2013 was another exciting year for MAIZE. Over 1.1 million farmers benefited directly from CIMMYT and IITA research outputs generated through our work on sustainable intensification of maize-based systems. In Mexico, the expansion of the "Take It To The Farmer" component of the MasAgro project reached over 200,000 farmers directly and increased the profitability of Mexico's maize-based farming systems by US $105 million. In Africa, expansion of the integrated control of *Striga* (witch weed) across areas in East and West Africa reached a total of 65,000 farmers, enhancing productivity and food security.

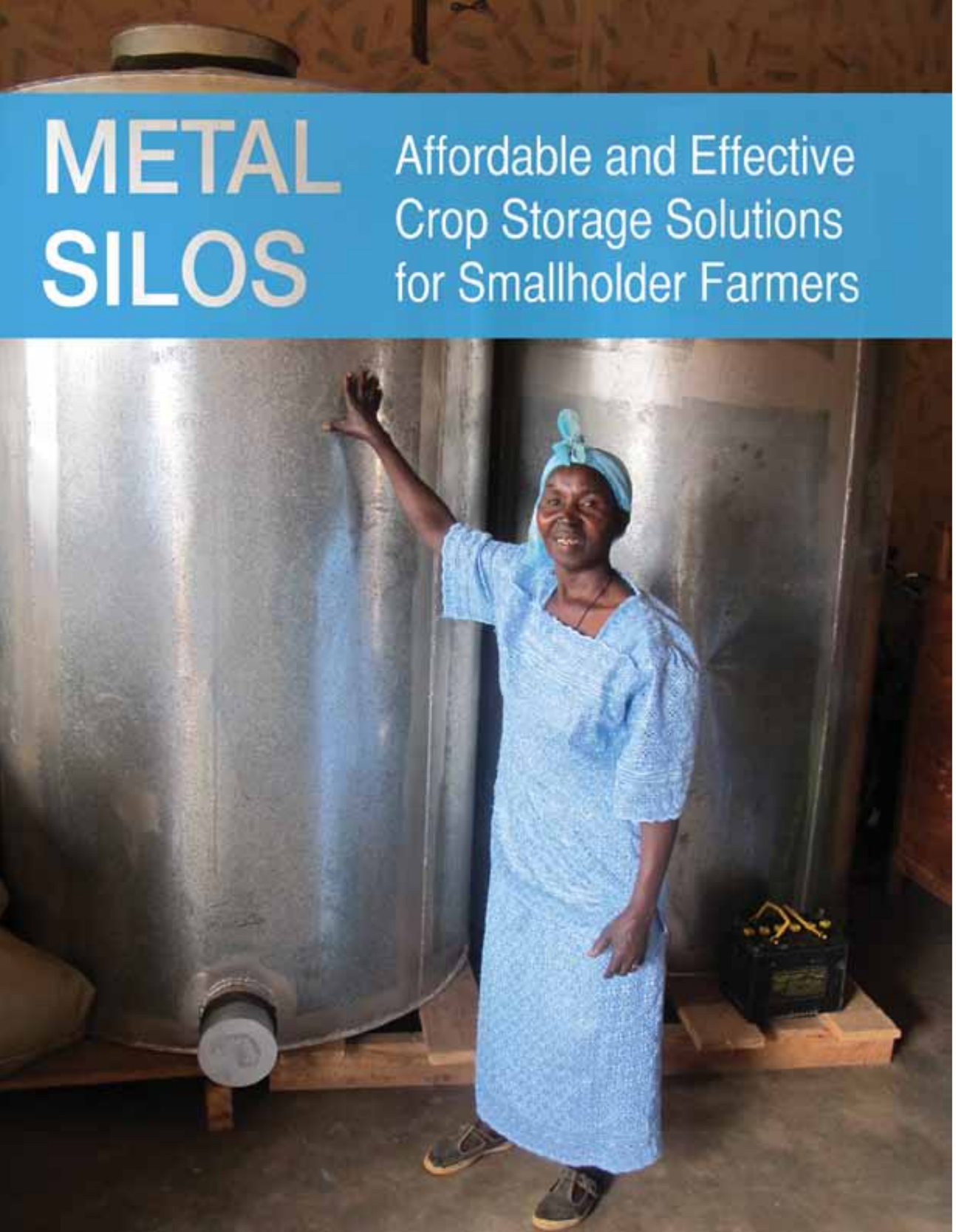
In the area of stress-resilient and nutritious maize, as many as 3 million farmers benefited from a total of 63 new maize varieties released in partnership with commercial seed companies across target countries in SSA, South Asia and Latin America. Some of the countries benefiting from the multiple release of new maize varieties, include: Bolivia, Colombia, Ethiopia, Malawi, Mexico, Uganda and Zambia. In Africa alone, over 17,000 tons of new drought-tolerant maize seed was produced in 13 African countries (Angola, Benin, Ethiopia, Ghana, Kenya, Malawi, Mali, Mozambique, Nigeria, Tanzania, Uganda, Zambia and Zimbabwe) by a network involving more than 100 small- and medium-scale seed producers and companies.

In the area of integrated post-harvest management, the use of hermetic, low-cost grain storage in metal silos continues to expand across eastern and southern Africa. A total of 247 metal silos were sold to farmers, schools and colleges in one of the five piloting districts alone. These grain silos are having a large impact on the welfare and food security of farm households. In Kenya, savings of US $135 annually are realized per household through reduced grain loss, less insecticide use and by selling surplus maize at higher prices five months after the harvest glut.

The number of MAIZE projects with gender integration increased from four in 2012 to 10 in 2013, reflecting the priority to integrate gender in all areas of MAIZE research and CRP functions. For example, MAIZE initiated exciting work to reduce drudgery, increase productivity and women's empowerment through small-scale mechanization for sustainable intensification in SSA, aligned with similar efforts in South Asia. In 2013, we witnessed completion of the MAIZE Gender Audit and major progress on gender mainstreaming. MAIZE also co-initiated the conceptualization and design of the global, comparative, qualitative study on gender norms and agency in relation to agricultural and natural resource management innovation – a joint cross-CRP study under the CGIAR Gender and Agricultural Research Network. Resources were committed in 2013 to undertake a minimum of 10 case studies, with a similar amount provisionally allocated for 2014.



Dave Watson



Globally, around one-third of the food produced for human consumption is lost or wasted. In developed countries, much of that loss is the result of consumers throwing away millions of tons of edible food each year. But in the developing world, farmers suffer heavy post-harvest losses estimated at 20 to 30 percent due to inadequate storage techniques.

*In eastern and southern Africa, maize provides food and income to more than 300 million smallholder farmers. After harvest, farmers typically remove maize grains from the cobs by hand, dry them in the sun and then store them in sacks kept in their home, in a shed or a traditional store. A considerable proportion of the crop may have already been lost in the field due to pests and diseases. But once in storage, it is still vulnerable, particularly to insect pests such as the larger grain borer (*Prostephanus truncatus*) and maize weevil (*Sitophilus zeamais*). Some farmers are able to apply pesticides, such as actellic dust, to their stored grain but these are expensive and need to be reapplied every few months to be effective.*

Pest-Proof Storage

To introduce affordable and effective crop storage solutions for smallholder farmers, CIMMYT launched the Effective Grain Storage Project (EGSP) with funding from the Swiss Agency for Development and Cooperation (SDC) in 2008. Led by Tadele Tefera, and working with local partners, the EGSP project is developing hermetic (airtight) technologies such as metal silos and super grain bags.

The EGSP project draws on the experiences of the POSTCOSECHA* program, which saw the wide adoption of metal silos in Central America, training local African artisans to construct metal grain silos from 0.5 mm thick galvanized metal sheet. These small cylindrical drums, with a storage capacity of 90 kilograms (kg) to 1.8 tons, have soldered seams, making them airtight and impervious to pests such as weevils, larger grain borers and rats.

First piloted in Kenya and Malawi, the silos' effectiveness has been tested alongside traditional and alternative modern storage methods. Jose Contreras, an instructor in silo-making from El Salvador, was invited to train 41 Kenyan and Malawian artisans in a series of workshops.

A simple test using a glass bottle tells farmers if the grain is dry enough to store safely.

Training materials and silo information were translated and adjusted to the African context, and two African partner organizations already working in crop storage were identified – Catholic Relief Services in Kenya and World Vision International in Malawi.

Farmers have also been trained on how to prepare grain for storage then use a candle to deplete oxygen within the sealed drum. A simple test using a glass bottle tells farmers if the grain is dry enough to store safely.

Building on Success

By 2011, 150 silos of various sizes had been constructed in Kenya and Malawi. Many of these were bought by smallholder farmers, and others were ordered by schools and urban communities.

Not only do the silos liberate farmers from the risk of losing their harvest, they also help them to gain some control over the market. Rose Owanda, a poultry farmer from Homa Bay – one of the Kenyan project sites – bought six silos, each capable of storing 2.7 tons of grain. "I intend to buy

* The POST-HARVEST, or POSTCOSECHA in Spanish, was a program developed by SDC in the 1980s in Honduras and scaled up across Central America. The program ended in 2003, but its post-harvest strategy continues to flourish today.

grains from the market during times of glut," she said. "This will not only ensure that I buy grain at the lowest prices; I am assured of enough grain to feed the birds throughout the year."

While in many places men control stored grain, women farmers have also benefited. Gladys Nthiga, a farmer in eastern Kenya's Embu County who has struggled to cope with storage pests, bought two silos with a capacity of 450 kg each. "Despite treating my grains with pesticides, I was still losing nearly half a ton of maize every year," said Nthiga, whose annual maize harvest averages 1.8 tons. "If what I have been told about the technology is true, then my problem with these pests is over," she added.

A second phase of EGSP was launched in 2012, focused on building capacity for improved technology development, testing, promotion, dissemination, policy and gender. By mid-July 2013, a total of 230 metal silos had been sold to farmers in Homa Bay district alone. A further 47 had been bought by local institutions, mostly schools and colleges.

This scaling-up of the project was achieved due to an awareness campaign, including demonstrations, videos and involvement of the local media, with much of this work carried out by national partners. Scientists, in collaboration with national partners, are conducting on-station and on-farm trials that test the effectiveness of the improved grain storage technologies across different environments, including in Zambia and Zimbabwe.

Gender Study

In line with SDC's commitment to gender equality, EGSP seeks to benefit men, women and young farmers. In order to achieve this, gender specialist Vongai Kandiwa is currently carrying out a gender analysis study in all EGSP countries that will lead to an evidence-based strategy for gender-responsive post-harvest research and technology dissemination.

While the economic benefits of improved technologies are encouraging, the EGSP team aims also to foster other social outcomes such as gender equality in improved post-harvest technology access and adoption.

Questions to be Answered:

- Who loses and who benefits from improved technologies?
- Do the technologies meet the complex storage needs and preferences of men, women and the youth?
- How do the technologies reduce or exacerbate drudgery in post-harvest management?
- In what ways do technologies change individual's access to and control over other grain?

Food spoilage and waste account for annual losses of US $330 billion in developing countries.

Sustaining an Industry

Despite the successes, however, high initial costs for the silos are a significant challenge to widespread adoption. Costs vary, but in Kenya, a silo capable of holding 1.8 tons of grain (the most popular size) costs US $336. While the silos will last for over 10 years (making them much cheaper in the long run than conventional storage technologies), the initial outlay is prohibitive for many farmers unless they can obtain affordable credit.

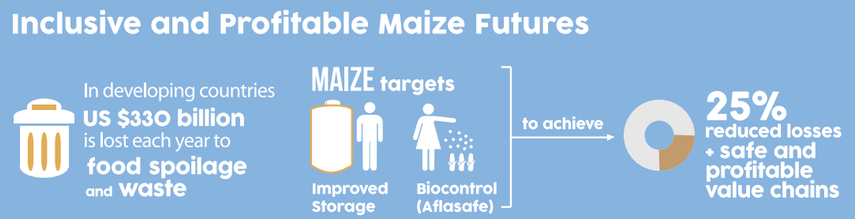
According to CIMMYT economist Hugo De Groote, metal silos storing less than a ton are not cost-effective. As the average amount of maize stored per family is 500 kg, he argues that farmers who grow less grain should be encouraged to consider other forms of hermetic storage, such as the super grain bag, which is capable of holding 90 kg of grain and is much cheaper than a metal silo. On the downside, the bags can be perforated by the larger grain borer and do not offer protection against rats.

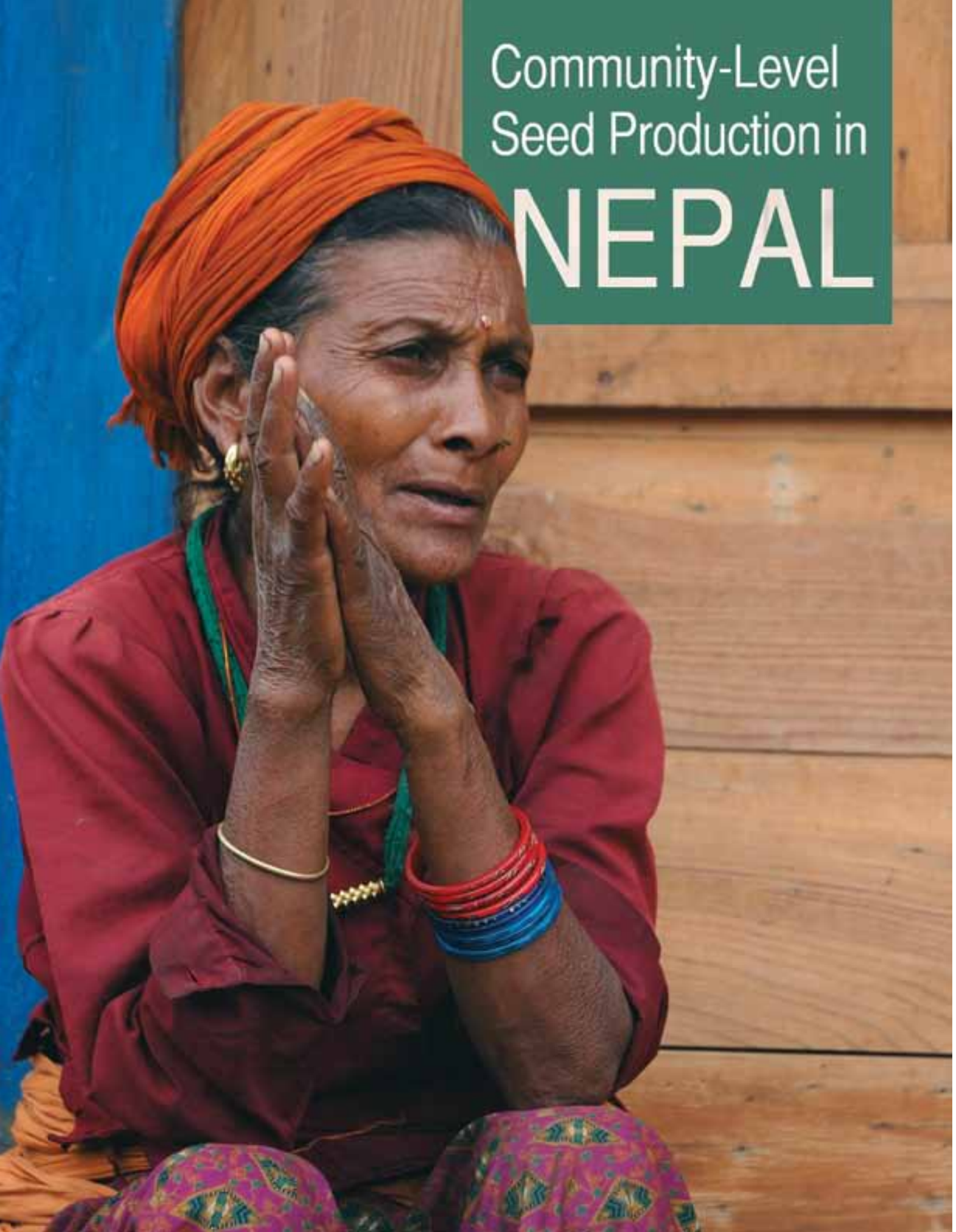
To provide initial capital, De Groote recommends that credit facilities and collective action (e.g. loan associations) should be considered. One commercial bank has already shown interest. Significant scaling up, De Groote believes, will depend on the involvement of the private sector, as well as government.

Meanwhile, CIMMYT policy economist, Jones Govereh, has called on governments to include galvanized metal sheets used for silo construction under the tax exemptions in place for other agricultural imports.

Ultimately, the goal of EGSP is to establish a well-functioning, sustainable silo production industry. To address the challenge of achieving food security for Africa's expanding population, reducing the significant loss of grain to storage pests is a cost-effective strategy that deserves much greater recognition than it currently receives.

Artisan Benjamin Njue from Embue, Kenya teaches other artisans how to make metal silos.





Changing Mentalities: The Hill Maize Research Project

Capable of being grown on sloping fields, without need for terracing or irrigation, maize is a vital crop on the mid-hills of Nepal, particularly among poorer families and disadvantaged groups. Maize accounts for 20 percent of calorie intake in the country, and is typically grown on small fields (average land holding in the hills is half a hectare) by families who spend 75 percent of their income on food. Harsh climate, poor infrastructure and market access and worsening shortages of labor are just some of the challenges they face, with crop yields also constrained by quality seed supply problems. In recent years, however, work by the Hill Maize Research Project (HMRP) is helping to address these constraints and having a positive impact on farm productivity.

Since 1999, the project has been working with national research and extension partners, non-governmental organizations, private seed companies and farmers to develop, test and disseminate high-yielding maize varieties, support seed production and marketing, and test and promote resource-conserving farming practices. “To date, we’ve reached nearly 50,000 households in 20 hill districts,” says Guillermo Ortiz-Ferrara, CIMMYT cereals breeder and HMRP leader, “and 226 community-based seed production groups participated in the project.” Results of that work have included the development and release by the National Seed Board of seven high-yielding, disease- and drought-tolerant maize varieties, including one quality protein maize type, ‘Poshilo Makai 1’ developed by the National Maize Research Program of the Nepal Agricultural Research Council.

HMRP has also introduced a number of farming systems and technologies to reduce women’s drudgery, such as grading and seed shelling machines, power tillers and intercropping of maize with ginger, tomatoes and soybeans. “Because we target women and disadvantaged groups, more farmers have adopted improved varieties and practices, and benefitted,” said Ortiz-Ferrara.

The GESI Approach

Through its Gender Equity and Social Inclusion (GESI) approach, the project targets farm families suffering from caste-, gender- and ethnicity-based discriminations and have food self-sufficiency for less than six months. Thus, women, Dalits and Janajatis are the main beneficiaries of the project.

Women and disadvantaged groups participate closely in all activities, such as research and development, community-based seed production (CBSP) and technical training. In Dailekh, women with HIV/AIDS were invited to take part in intercropping trials; for these women, increasing the output from their fields is essential to their future. Mana Sara Sijapati from Rakam village, who is 30 and was involved in the trials, commented: “Our main resource is land. We must increase our production from this land to have food security in our households during the entire year.”

Gender audit of the project by the Royal Tropical Institute (KIT).

In negotiations with seed companies, the project has advocated giving the first priority for contracts to women’s groups and groups with a significant number of members from disadvantaged groups. The positive benefits of this approach were confirmed in February 2013, through a gender audit of the CRP projects conducted by the Dutch Royal Tropical Institute (KIT) and commissioned by MAIZE.

“Income doubled by selling maize seed and membership in the cooperative; women farmers are not only able to send their children to school but also feel more safe in their family and society. HMRP has brought new hope to the lives of women farmers.”

– Mrs. Nanu Maya Ghatani
Chair of Jana Chetana Women’s CBSP Cooperative
Fulbari-8, Kavre

The audit found positive evidence for both a redistribution of agricultural technologies, resources and benefits in favor of women, and greater recognition of women as farmers and local leaders in the project areas. Women CBSP group members spoke of having greater access to resources such as improved maize seeds, information (through various individual and group trainings) and extension services.

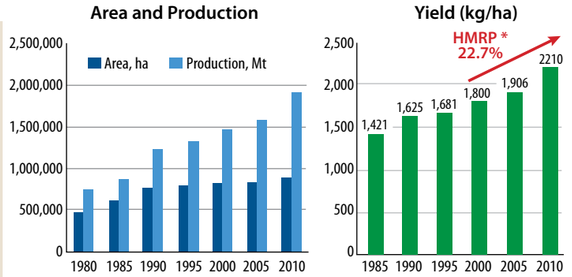
Some also reported increased yield and income, leading to greater financial independence and decision-making power in the household. Women also reported feeling empowered by their new capacities and knowledge, which they had been able to share with their husbands and thereby gain greater recognition.

Beyond the household, members of women-only CBSP groups, in particular, reported having greater bargaining power with seed-traders. Some women’s groups successfully demanded specific services (such as training in vegetable production), from the district agriculture office and financial support for their seed storage from the district development committee. There are also examples of women’s group members being invited to join decision-making fora, such as the District Seed Coordination Committee (DSSC), in recognition of their achievements.

According to USDA Production, Supply and Distribution by Market Year statistics (bit.ly/1rlvWvS), maize production in Nepal increased by 400,000 tons, or 20 percent, from 2004 to 2013. Recent research shows that HMRP increased national maize productivity by 37 percent since 2010 (www.usaid.gov/nepal/fact-sheets/hill-maize-research-program-hmrp).

Chart taken from “Improving Maize Food Security in the Hills of Nepal Through Participatory Variety Selection and Community Based Seed Production,” 11th Asian Maize Conference, Bejing, China, Nov. 7-11, 2011.

Maize Yield Increase (1985-2010)



* In partnership with NMRP, DoA, NGOs, PS, Farmers
Source: MoAC 2009/10

“The Hill Maize Research Project has completely changed our mentality, from seeing maize only as a food crop to viewing it as something we can sell.”

– Mr. Gunda Bahadur Thami
Chair, Sindhu-Tuki Seed Producers’ Cooperative
Sindupalchowk

Pre-Sowing Seed Contracts

At the 2013 annual meeting of the Global Maize Program, held in Nepal, CBSP coordinators from 10 hill districts stated their interest in ‘graduating’ from community groups to having formal status as seed companies. However, marketing and transport remain key constraints. Prior to 2012, CBSP groups were not encouraged to consider market demand and supply, resulting in surplus seed in some areas and deficits in others. Therefore, the 2013 project phase initiated pre-sowing seed contracts for improved maize varieties, assisting and guiding CBSP groups and seed buyers (seed companies, agrovets and community seed bank cooperatives) to sign formal agreements.

On February 5, 2013, the Tillottama Agriculture Cooperative – one of the CBSP groups – signed a pre-sowing seed contract for 2 tons of improved maize seed, with a local farming products retailer, Bhandari Agrovet. This contract is believed to be the first in the history of improved maize seed production in Nepal. Following this, the project, in coordination with the District Agriculture Development Offices and the Seed Entrepreneurs’ Association of Nepal, facilitated the signing of contracts amounting to 207 tons of improved maize seed between 52 other CBSP groups and 25 private buyers in the project area.

Community-Based Seed Production

Because established seed companies generally do not market seed in hill areas, HMRP has supported seed production and sale by 226 CBSP groups, most of whose members are women. In 2013 those groups produced over 1,000 tons of high-quality, improved maize seed, which was subsequently marketed across the hills of the country. Starting in 2000 with just seven groups, the CBSPs have become a successful model in Nepal, contributing to the increased adoption of improved maize varieties and technologies and helping to ensure the availability of seed in remote areas, on time and at lower prices.

Leading the Fight Against Maize Lethal Necrosis

Over 3.6 million tons of maize are required annually to feed Kenya. With more than 2 million hectares (ha) of Kenya's land under small- and large-scale maize cultivation, a majority of Kenyans depend on maize as an income-generating crop.

First identified in farmers' fields in eastern Africa in 2011, MLN results from the combined infection of two plant viruses and can cause nearly 100 percent crop loss. It is now devastating fields in Kenya, Rwanda, Tanzania and Uganda. In Kenya alone, the government has estimated that 18,500 ha of maize fields were affected by the disease in 2013, impacting hundreds of thousands of smallholder farmers. CIMMYT Global Maize Program Director, B.M. Prasanna, stated that the result is "the maize seed industry in eastern Africa is under significant pressure to quickly replace the existing MLN-vulnerable commercial varieties with resistant products and reach the affected and vulnerable communities."

CIMMYT is leading collaborative research efforts to control the deadly disease and research with KARI. Most commercial maize varieties grown in eastern Africa are highly vulnerable to the disease. Tests in 2012-2013 found that 117 of 119 varieties artificially exposed to MLN were susceptible. However, they also identified some promising inbred lines and pre-commercial hybrids with resistance to MLN. The priority now is for these to be further developed into varieties that can be multiplied and commercialized by the east African seed industry.

MLN Facility Opens

In September 2013, the CIMMYT-KARI partnership opened a dedicated MLN screening facility in Naivasha, in order to support the identification of maize lines and breeding materials with resistance to MLN. The facility, which was established as part of a CIMMYT-led project funded by the Bill & Melinda Gates Foundation and the Syngenta Foundation for Sustainable Agriculture, will enable scientists to screen maize germplasm under controlled and reliable conditions. Maize virologists from CIMMYT, KARI, IITA and institutions in the USA will work to optimize disease screening procedures and characterization of maize viruses causing MLN in eastern Africa.

The new facility will help to ensure a continuous flow of MLN-resistant breeding material and varieties, and will serve not only CIMMYT and KARI, but other national agricultural research institutions in eastern Africa, and small- to medium-sized seed companies. It will also serve as a hub for training young African researchers and students on technologies to tackle MLN.

Already, the facility has begun offering MLN phenotyping services to both public and private sector institutions in the region. A number of improved varieties with reasonable levels of tolerance to MLN have been released in Kenya, and many more resistant varieties are currently undergoing national performances trials.

Artificial inoculation with the viruses that cause MLN at Naivasha, Kenya.

Progress Through Partnership

During the 2012-1013 cropping season, a CIMMYT-KARI team evaluated a broad range of maize germplasm for resistance to the disease. "We evaluated over 2,000 CIMMYT inbred lines and over 2,000 experimental hybrids,"

Will and Unity

Maize-free seasons were adopted by farming communities near KARI's Kiboko Crops Research Station, beginning in April 2014. At a meeting attended by more than 100 people in early October 2013, the farmers agreed to harvest their maize crop by the last day of February. Addressing those present, including the Makueni County administration, local community leaders, country agricultural staff, Kiboko farmers and CIMMYT and KARI scientists, district agricultural extension officer Michael Kitenje called for willingness and unity among farmers and other stakeholders to adhere to the maize-free window. He urged them to spread the message to others who did not attend the meeting: "In case you meet resistance, use your persuasive skills to make them understand the need for a community approach to controlling MLN in Kiboko," he said.

explained CIMMYT pathologist George Mahuku. “We are also evaluating over 3,000 inbred lines and hybrids from seed companies and national agriculture research institutes at the MLN screening site in Naivasha,” he added. Keen to turn a challenge into an opportunity, the team is looking forward to the marketing of MLN-resistant varieties once the research is complete.

MLN technician Janet Kimunye and maize pathologist George Mahuku examine plants for infection.

Four trials were conducted under artificial inoculation and natural disease pressure, at Narok and Naivasha. While over 95 percent of commercial maize varieties released in Kenya were found to be susceptible to MLN, some promising pre-commercial hybrids were identified, together with some CIMMYT breeding lines that showed either high or moderate resistance to the disease. The MLN-resistant lines are now being used as breeding sources to improve MLN resistance in future germplasm, as well as to convert currently susceptible but widely used CIMMYT maize lines into resistant versions.

Broad collaboration is needed if MLN is to be controlled. To this end, CIMMYT and KARI organized a regional workshop for 70 scientists, seed company breeders and managers, agricultural ministry representatives and regulatory authorities from Kenya, Tanzania, Uganda and the USA in February 2013. Several important actions were identified, including surveillance, preventing movement of seeds from disease-prone areas and the use of maize-free seasons to reduce the population of insect vectors.

Raising Awareness is Key

In June and July 2013, CIMMYT and KARI organized an ‘Identification and management of MLN’ workshop for 80 scientists, technicians and skilled field staff, both from their own staff and from NARS partners in Rwanda, Tanzania, Uganda and Zimbabwe. They learned about field-based MLN diagnosis, severity scoring for screening trials and MLN management. “It is important that all the people on the ground, particularly the technicians who interact daily with the plants and supervise research activities at the stations, understand the disease, are able to systematically scout for it, and have the ability to distinguish it from similar symptomatic diseases and conditions like nutrient deficiency,” said Prasanna.

Later, in November 2013, participants at a Seed Trade Association of Kenya (STAK) congress – including seed sector representatives from Burundi, India, Kenya, Malawi, Rwanda, South Africa, South Sudan and Zimbabwe – toured the new MLN screening facility in Naivasha, and were invited to submit seed to the facility for screening. “We will use lessons learned on this trip to strengthen surveillance of the disease in South Sudan,” said Cirino Oketayot, head of the research unit in South Sudan’s agricultural ministry. Speaking at the congress, Mahuku urged seed companies to recognize MLN symptoms and notify scientists should they be spotted.

Looking forward, steps to tackle the disease include continuing the search for new and better sources of MLN resistance, and rapid production and dissemination of the most promising resistant material. Changes need to be made in current maize breeding ‘pipelines’ in order to remove MLN-susceptible maize types. Maize breeding populations need to be aggressively screened, and advanced testing of MLN-resistant materials is required. “Besides accelerated development and delivery of elite MLN-resistant products to farmers, our aim is also to build the capacity of regional institutions to develop robust breeding pipelines to incorporate MLN-resistant germplasm, and ensure that farmers have access to such products at the earliest opportunity,” said Prasanna.

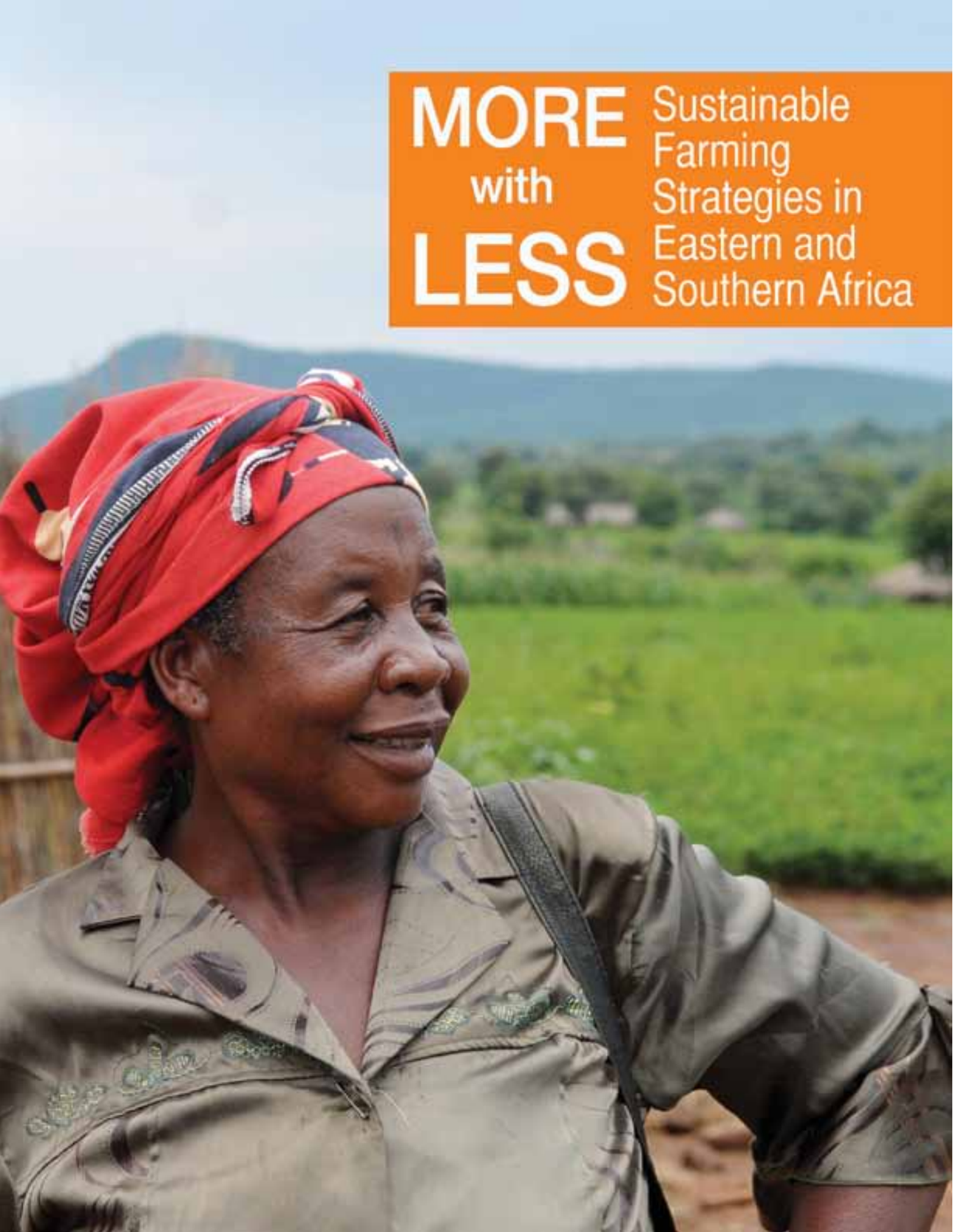
“Besides accelerated development and delivery of elite MLN-resistant products to farmers, our aim is also to build the capacity of regional institutions to develop robust breeding pipelines to incorporate MLN-resistant germplasm, and ensure that farmers have access to such products at the earliest opportunity.”

– B.M. Prasanna

Doubled Haploid Facility: Cutting Breeding Times by Half

The Naivasha MLN screening facility will be aided by a second facility, also established in 2013. The state-of-the-art maize DH facility at KARI’s Kiboko research station will enable breeders to develop parental lines of maize hybrids in just two to three crop seasons, compared to seven to eight seasons with conventional breeding. While DH technology is used routinely by multinational companies, the new CIMMYT-KARI facility will make the technology available to public sector maize breeding programs, as well as small- to medium-sized African seed companies.

Establishment of the new facility follows the development and release of the first tropically adapted DH inducer, jointly developed by CIMMYT and the University of Hohenheim. The development of these inducers represents the removal of an important bottleneck to the effective integration of DH technology in developing world maize breeding. In the last quarter of 2013, the new facility launched its DH production service to public (NARS) and private (small- to medium-sized seed companies) in the region. 2013 also saw the discovery of key genomic regions and promising groups of genes that confer resistance to MLN. To save time, validation and large-scale marker application for MLN resistance is now simultaneously taking place in 22 widely used and high impact, Africa-adapted CIMMYT maize lines.



Getting 'More with Less'

Across eastern and southern Africa, good-quality arable land and water are running out. This, combined with climate change, which could leave another 50 million hungry by 2050, requires intensifying food production – getting 'more with less.' But it has to be sustainable, with more prudent use of inputs, lower greenhouse gas emissions and with positive growth in natural capital and resilience. Smallholder farmers are important to agriculture in developing countries and so will be responsible for much of this task, but if they are to meet these ambitious targets, improving their access to modern farming information and technology will be vital. Indeed, truly sustainable intensification will require more than just inputs and technology. According to Sir Gordon Conway, a contributor to the 2013 Montpellier Report, sustainable intensification should now be the basis for all investments in farming, both big and small.

To find innovative, sustainable farming strategies that address the challenge of getting 'more with less,' and take a broader approach to system intensification (including conservation agriculture elements, soil fertility, pest management and diversification), MAIZE is working through a competitive grant with David Mariote, maize breeder at the Agricultural Research Institute of Mozambique (IIAM) on promoting conservation agriculture technologies in cereal-legume based systems in Mozambique, and also with the Australian Centre for International Agricultural Research (ACIAR)-funded* Sustainable Intensification of Maize-Legume Systems for Food Security in Eastern and Southern Africa (SIMLESA) project, partnering with national agricultural research institutes from Ethiopia, Kenya, Malawi, Mozambique and Tanzania. A similar initiative, SIMLEZA, is funded by USAID and has been operational in the eastern province of Zambia, in collaboration with the national program and IITA.

Adoption of Technologies

In these six SSA countries, maize is the main staple and legumes are an important source of protein for the rural poor. Legumes are widely used as an intercrop and/or rotation crop in maize systems, and are also a significant source of income for women. In addition, the intensification and stabilization of rain-fed maize-legume cropping systems offers considerable promise for boosting productivity, improving food, feed and nutrition security and helping reverse the decline in soil fertility.

SIMLESA focuses on five countries in Africa – Ethiopia, Kenya, Malawi, Mozambique and Tanzania (with spillovers anticipated in neighboring countries).

Through participatory research with farmers, extension agencies, non-governmental organizations, universities and agribusiness, the initiative aims to improve maize and legume productivity by 30 percent and to reduce the expected yield risk by 30 percent on approximately 650,000 rural households within 10 years.

* Additional partners include the Association for Strengthening Agricultural Research in East and Central Africa (ASARECA), the International Center for Research for the Semi-Arid Tropics (ICRISAT), the Agricultural Research Council of South Africa (ARC RSA), the Department of Employment, Economic Development and Innovation, Queensland, and Murdoch University in Western Australia.

But to reach this ambitious goal, a more rapid adoption of technologies among farming communities is essential. “There are so many different technologies bombarding farmers. The real work therefore lies in dealing with the psychological, social, cultural and environmental factors of the farmer that will determine the adoptability and adoption of introduced technologies,” said Derek Byerlee, co-chair of the SIMLESA Steering Committee, during the project’s annual regional planning and review meeting, which took place in Mozambique in early 2013.

drought-tolerant ones developed in collaboration with CIMMYT and released by KARI. He observed that, at the end of the day, farmers are economists and will balance between risks and possible benefits. “We realize farmers prefer to use the varieties they know and have used for many years,” Mekuria said. “However, we have farm-level evidence that the new varieties grown under sustainable intensification practices contribute to increased yield, decrease drought risks, reduce production costs and improve soil fertility over time.”

A demonstration plot in Malawi shows conservation agriculture practices.

In Kenya, local innovation platforms which have emerged from the project have begun to have the desired impact on farmer practices. In October 2013, scientists from CIMMYT, KARI, SIMLESA and ICRISAT visited farmers in western Kenya who are members of the Boro and Bungoma South farmer innovation platforms. During the visit, farmers described how they had adopted conservation agriculture and intercropping, and switched to using herbicides to control weeds. Farmer Ferdinand Makhanu reported how his maize harvest had risen from 10 to 15 bags. “I attribute this yield increase to utilizing the rich information I got during innovation platform meetings,” he said.

During the visit, SIMLESA project leader Mulugetta Mekuria spoke with the farmers about new maize varieties, including

‘A Steady Flight Path’

A great deal of progress occurred in 2013. “SIMLESA has attained a ‘steady flight path’ and is on track to deliver significant impacts,” Byerlee stated. In Tanzania, SIMLESA signed a memorandum of understanding with three partners for production and scaling out of two newly released maize varieties, bred by a local seed company. The number of innovation platforms also increased in Tanzania, in order to promote the adoption of sustainable cropping systems and improved crop varieties.

In Mozambique, representatives of the public extension services and development agencies have devised action plans to implement gender-sensitive approaches in their work, with specific targets for the 2013-2014 cropping season. This was one outcome of a two-day gender-mainstreaming workshop in August, which revealed a widespread poor understanding of gender concepts, including, for instance, the inequality in how farmers are selected to take part in demonstration trials. The workshop introduced a range of tools for integrating gender in extension activities in order to reach vulnerable groups.

Looking ahead to a Phase II for SIMLESA in 2014, Inacio Maposse, director general of IIAM said, “We want to add another dimension to the project, and perhaps a different philosophy, one that will lead us to greater success.” But what might this success look like? “For me,” he continued, “success means to get farmers smiling sustainably – smiling because they are better off. For this to happen, we have to design Phase II with heart and wisdom.” ACIAR’s John Dixon agreed: “Where resources are limited, sustainable intensification is the only option to feed the extra two billion people by 2050.”

“New varieties grown under sustainable intensification practices contribute to increased yield, decreased drought risks, reduced production costs and improved soil fertility over time.”

– Mulugetta Mekuria
SIMLESA project leader

Farmers participating in pigeonpea variety selection at Nsingisi village, Tanzania.

Fertilizer recommendations are generated by providing inputs to the computer program.

Nutrient Expert®

In South Asia, 90 percent of smallholder farmers using fertilizer do not achieve optimum crop yields due to a lack of access to soil testing services. In response to this information gap, the International Plant Nutrition Institute (IPNI) South Asia Program developed the Nutrient Expert® decision support tools in partnership with MAIZE to provide location-specific fertilizer recommendations for farmers growing maize and wheat.

The decision support tool received the award for Best Innovation at the Bihar Innovation Forum, which recognizes innovations to improve rural livelihoods in India. Nutrient Expert® is the product of close collaboration with key partners such as national agricultural research and extension systems (NARES), seed and fertilizer industries, NGOs, farmers' and women's self-help clubs in India.

"The advantage of developing the Nutrient Expert® in a participatory mode was that the partners were on-board from day one and ultimately 'owned' the innovation," said Dr. Kaushik Majumdar, Director of IPNI South Asia.

By canvassing the 450 researchers and extension workers in East India who received training in the computer-based tools, IPNI estimates that their potential outreach was over 60,000 farmers. The aim is to embed the Nutrient Expert® approach in university and state agriculture department extension systems even further and reach more cereal farmers through multiple channels.

No 'One Size Fits All' Solution

Dr. Majumdar believes that farmers' perceptions of fertilizer use will improve as a result of better advice. "A resource-driven fertilizer recommendation strategy would be more acceptable to farmers instead of 'one size fits all' recommendations."

The Nutrient Expert® tool is also one of the important flagship interventions for the Climate Smart Villages (CSVs) under the CGIAR research program on Climate Change, Agriculture and Food Security (CCAFS) in India. Other IPNI programs in China, SSA and North Africa are also adapting the tools to their local situations.

A study funded by a MAIZE Competitive Grant Initiative (CGI) in 2012 and 2013 contributed an understanding of the types of farm systems in use in eastern India and the positive impact of Nutrient Expert® recommendations. New materials and trainings to spread awareness of the tools were also commissioned.

"Once we knew the resource classes of farmers through the typology survey, it was easier for us to decide the target yields," said Majumdar. "Farmers would ultimately be the beneficiaries if the work funded by MAIZE could start the process of making fertilizer recommendations more flexible as well as science- and resource-driven."

A version of Nutrient Expert® for SSA has now been developed and validated, in partnership with MAIZE. Nutrient Expert® integrates data from multi-location nutrient omission trials to determine farm specific fertilizer requirements, and takes account of the most important factors affecting nutrient management recommendations, including site characteristics, climate, input prices, and crop produce prices. Researchers have found that crops make use of fertilizers applied according to Nutrient Expert® recommendations more efficiently than fertilizers applied according to farmers' normal practices.

The Nutrient Expert® tool has also been developed for China, and is under development in North Africa by the respective IPNI Programs.

Researchers have found that crops make use of fertilizers applied according to Nutrient Expert® recommendations more efficiently than fertilizers applied according to farmers' normal practices.

Nutrient Expert® for hybrid maize helps to:

- Develop an optimal planting density for your location
- Evaluate current nutrient management practices
- Determine a meaningful yield goal based on attainable yield
- Estimate fertilizer nitrogen, phosphorus and potassium (NPK) rates required for the selected yield goal
- Translate fertilizer NPK rates into fertilizer sources
- Develop an application strategy for fertilizers (right rate, right source, right location, right time), and compare the expected or actual benefit of current and improved practices.

Is the Two-Wheeled Tractor the Mechanization Africa Needs?

While smallholders in most developing countries are increasingly using mechanized equipment for tasks such as land preparation, weeding and threshing, in Africa the number of tractors and draft animals is stagnating or even in decline. As a result, back-breaking physical labor continues to be a marked feature of African agriculture, with much of this drudgery falling to women and children. Female-headed households have particular challenges, as they often don't own or are not permitted to use draft animals and are among the last to access land preparation services, with severe impacts on their yield.

Drawing on a technology that has transformed Bangladeshi agriculture, the Farm Mechanization and Conservation Agriculture for Sustainable Intensification (FACASI) project is investigating the potential of two-wheeled tractors for smallholder farming in Ethiopia, Kenya, Tanzania and Zimbabwe*. While not powerful enough to plow, the tractors can be used for direct seeding – which requires far less energy – and are thus well-suited to conservation agriculture systems. In addition, they are light weight, easy to operate and maintain and relatively inexpensive.

More important than testing and adapting machinery, however, is the need to develop commercial models to provide farmers with access to two-wheeled tractors. Inspired by Bangladesh, where only one out of every 30 tractor users actually owns a machine, the project will stimulate the development of tractor-hiring services based on local entrepreneurs.

Agribusinesses will be encouraged to invest time and resources in promoting the machines, training farmers in their use and developing adequate credit facilities in order to buy and maintain them.

FACASI will also create jobs for around 360 rural service providers, for example in fuel supply and tractor repairs. Activities in Ethiopia and Zimbabwe are scheduled to begin in February 2014.

Demonstrations of how easy it is to operate a two-wheel tractor.

* FACASI is led by CIMMYT with multiple partners and funded by the Australian Centre for International Agricultural Research (ACIAR).

Finally, a MAIZE competitive grant will build on the 2013 tests by involving KIT to investigate gender relations and mechanization, starting in Kenya and Tanzania in 2014. Social scientists will explore the potential consequences of adoption from a gender perspective, including consequences for marginal groups. “This study is key for FACASI,” says Baudron, “and hopefully will help us understand better how much of the gender-gap is explained by differences in access to farm power.” A gender specialist will also join the team in 2014, to assess the likely demand for small mechanization among men and women.

According to CIMMYT agronomist Frédéric Baudron, more than 35,000 farmers will benefit from the project, with conservation agriculture farmers expected to increase incomes by 50 percent.

FACASI is investigating the potential of two-wheeled tractors for smallholder farming.

Testing and Adaptation:

Operating since March 2013 in Kenya and Tanzania, the project has been chiefly involved in mapping the tasks that are characterized by low labor productivity and drudgery, in order to understand farmers’ needs and to identify technologies in use regionally and globally that could meet their likely demand. Some machines have already been imported for testing and adaptation in African conditions, including a light, single-row seeder designed by John Morrison, a consultant from the University of Tennessee. In September 2013, the seeder was ‘pre-tested’ in Njoro, Kenya, by women, FACASI scientists and Morrison, and found to work well. Full field testing of this and other machines took place later in the year in Kenya and Tanzania.

Sowing Drought-Tolerant Maize in Africa

The vast majority of maize produced in SSA is rainfed, making it highly vulnerable to drought. Current estimates suggest that 25 percent of maize production in Africa is threatened by frequent drought, and 40 percent affected by occasional drought. But with rising temperatures and more severe droughts as a result of climate change, that situation is worsening.

The drought-tolerant varieties bred through the Drought-Tolerant Maize for Africa (DTMA) project provide at least part of the answer. Capable of outperforming many existing varieties under good rainfall conditions as well as drought, several also have resistance to major diseases such as maize streak virus and gray leaf spot. But breeding a good variety is no guarantee of adoption, and significant challenges to commercialization exist, including production of breeder and foundation seed, achieving high seed quality, effective branding and packaging and adequate promotion of new varieties by seed companies through demonstrations.

In 2013 DTMA strengthened its connections with seed producers by establishing a joint working group with the Program for Africa's Seed Systems (PASS), an initiative of the Alliance for a Green Revolution in Africa (AGRA). PASS already works with seed companies and agro-dealers, helping to ensure that they stock enough seed and have good distribution networks to reach farmers across the continent. Many face challenges in seed production, such as inadequate irrigation facilities and lack of personnel to manage the crop lines.

Partners to Scale Up

The work of national partners, such as the NARS, is also vital in scaling up the use of drought-tolerant maize. Supporting those partners through capacity building is therefore a central feature of the DTMA project. In the 2012-13 cropping season, DTMA trained maize breeders and technicians, rehabilitated seed storage facilities and supported research institutes to release varieties, produce breeder seed and begin hybrid seed production in places where private seed companies are not operating.

One partner, KARI, is heavily involved in drought screening activities and is also conducting household surveys across the country, in collaboration with DTMA, to gather evidence-based research findings for policy advocacy. In 2013, in partnership with CIMMYT, KARI opened two important new research facilities to speed up maize breeding and screening for resistance to MLN. These facilities will be a valuable resource for those developing new drought-tolerant varieties for partners, including NARS and small- to medium-sized seed companies.

Moving forward, DTMA project leader Tsedeke Abate said that the project will continue to work towards a number of key objectives: mainstreaming drought-tolerant varieties; enhancing seed system partnerships in collaboration with AGRA-PASS; building the capacity of NARS to produce breeder seed; mainstreaming gender within the project; and supporting further socio-economic research to provide evidence for policymakers.

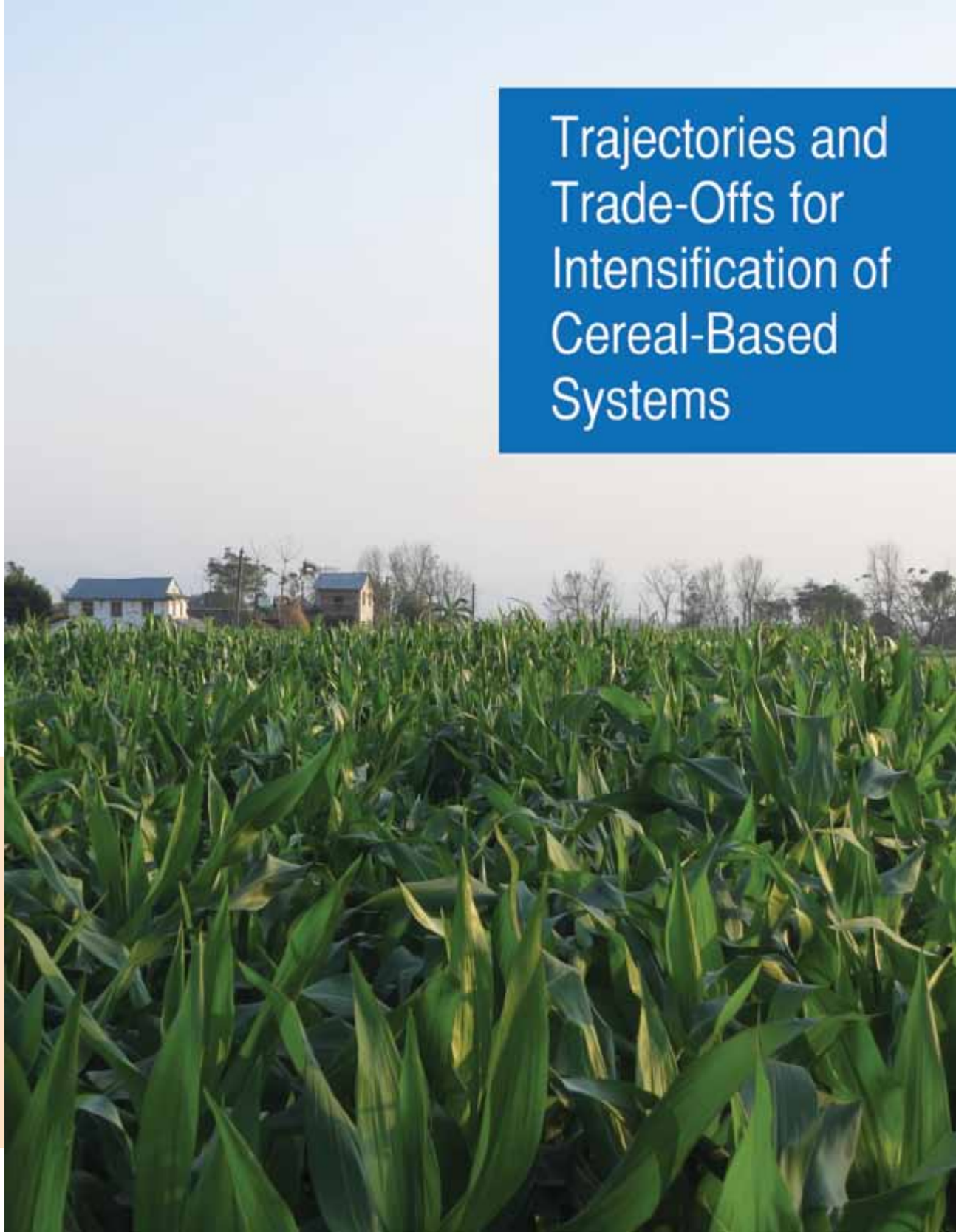
DTMA

The goal is to reach over 30 million farmers by the end of 2016.

- 2007-2013: **140 new maize varieties released**, including 81 hybrids and 59 open pollinated varieties, with 20-30 percent greater yield than traditional varieties
- **Adopted by 110 African seed companies** for production and sale to farmers
- 2013: **20,000 tons of drought-tolerant maize seed** produced in 13 African countries
- **1 million hectares of land planted** with drought-tolerant varieties by 3 million households

A Tanzanian farmer stands in front of her maize plot, where she grows DTMA variety TAN250.

Trajectories and Trade-Offs for Intensification of Cereal-Based Systems



Understanding Past and Present to Create a Better Future

Agricultural research has developed countless new technologies to support more intensive farming, but adoption rates on the promise of improvement alone are often disappointing. Farming households make decisions based on a more complex set of factors, such as cash crops and food production, varying rates of return on investment or labor and balancing higher productivity with minimum risk of losing crops or investments.

The Trajectories and Trade-Offs for Intensification of Cereal-Based Systems (ATTIC) project, a collaboration between MAIZE and Wageningen University in the Netherlands, is studying how and why farming systems in Ethiopia, Mexico and Nepal have changed over time to show how research into new technologies, practices and policies can have a greater impact in the future. A key dimension of the project is to study the interactions between farming systems and the landscape, with farms both contributing to and benefiting from the features of the landscape and the services it provides, including water flows, soils and biodiversity.

Funded in part through the MAIZE Competitive Grant Initiative, ATTIC research is being carried out through three PhD projects. The three studies are using similar research processes in very different locations; all involve field-based studies and link participatory research, field measurements and experiments and systems models at different scales. Operational funds are provided by three other MAIZE key partner projects – CCAFS, CSISA and SIMLESA.

Competitive grants awarded in 2012 and 2013 will also fund training of local staff (CIMMYT and close regional partners) in use of the systems analysis tools developed during the study period. The first training program will begin in Zambia in March 2014.

A pig roots among maize ears on a farm in the Dalit community of Belhara village, Dhankuta district, in the mid-hills of Nepal.

Case Studies

In Ethiopia, Yodit Kebede is studying the social and ecological processes that have shaped the landscape in order to understand some of the ecosystem services that agriculture is providing, particularly pest control. By analyzing the frequency of maize fields and how this affects the incidence of the maize stem borer, Kebede aims to find out how farmers can reduce pest pressure even when they cannot afford to buy pesticides. Her work is also assessing push-pull options for pest management in conservation agriculture systems, and informing the design of new, diverse cropping systems that have a pest control advantage.

In Nepal, Victoria Alomia's PhD thesis examines alternative forms of crop-livestock integration, through intensification of maize and wheat production in association with fodder crops, in order to diversify diets and incomes. Studying resource management and decision-making in zones prone to climate change risks, and where migration is high and labor is scarce, her research combines system models, field experiments and participatory research, and focuses particularly on nutrient cycling.

Leendert van Wolfswinkel is working in the central highlands of Mexico, where he is studying how the landscape has evolved in response to changes in land use, migration and urbanization. He is particularly focused on hydrological services linked to agriculture, such as increased recharge of groundwater aquifers and reduction of downstream flood risk.

His work aims to quantify the water regulation services provided by agriculture (particularly maize farming, but also wheat and oats), in comparison to other land uses such as urban areas or forests.

"Rural communities shape their landscapes in response to resource-use priorities, but also due to demographic changes throughout their history. The resulting landscape patterns and organization have a strong influence on the functioning of the agro-ecosystem."

– Pablo Titonell
Professor of Farming Systems
Wageningen Univesity

He is also comparing how different cropping systems – conventional, conservation agriculture, fruit-maize agroforestry and maize-legume intercropping – perform in delivering these services at the micro-watershed level.

"Effects at field-scale may be different from effects at the watershed scale," says van Wolfswinkel. "I work to bridge the gap between these scales, looking at such questions as: if this cropping system is beneficial, which location on the landscape would be the most favorable? And if the location of different land uses and cropping systems within a watershed matters, which external drivers have influenced the configurations of different landscapes within the central Mexican highlands?"

(Above): Leendert van Wolfswinkel (right) is working in the central highlands of Mexico.

(Left): Farmers in Ethiopia plow in a maize-livestock system.

Challenging Our Built-In GENDER BIAS

by Katrine Danielsen and Franz F. Wong,
Gender Advisors with the Royal Tropical Institute

In order to understand gender-based dimensions and differences in MAIZE and to leverage this knowledge so that interventions can better address gender-specific needs, MAIZE undertook a gender audit of its activities in 2013.

Carried out by researchers from KIT (a Dutch knowledge institute), the audit comprised surveys, documentation analysis, focus group discussions and more than 100 individual interviews involving a variety of organizations and program partners (including women and men farmers). The Gender Audit was based around four key questions: how is gender currently addressed and how can this be strengthened; the capacity of project teams to conduct gender-aware research; how different program functions affect gender integration; and how the CRP's approach to gender is influenced by its understanding of what counts as 'knowledge.'

Gender Realities in MAIZE Projects

The Gender Audit found that MAIZE projects' efforts to integrate gender concerns were to a large degree informed by the individual understandings of staff members, rather than a CRP-wide approach; this sometimes limited the scope of gender integration in specific research. However, we found several examples of positive results from personal initiatives to integrate gender concerns. For instance, in Bangladesh, KIT met two hub managers committed to promoting gender equality, who had contextual understandings of how gender relations operate in agriculture and in the wider society. They were also able to go beyond the bio-physical understanding of their discipline and gain an appreciation of the social analysis needed to integrate gender in the work of MAIZE.

For example, the Khulna hub invests in women farmers as a strategy. The rationale is that women are more involved than men in both agriculture and in the maintenance of agricultural households. Still, women's roles in agriculture are not invested in and often remain invisible to agricultural scientists because they tend to look at the crop rather than the people and societal relations through which the crop is produced. Also, the migration of men is causing labor shortages and women are stepping in to fill the gap by managing and providing on-field labor. Investment in women is thus seen as strategic to preparing for the future, meeting project objectives and highlighting the importance of their roles.

The project does this through a combination of initiatives. On the one hand, new technologies are being provided for tasks commonly performed by women such as kitchen gardens. On the other hand, not only are women's roles being supported and gendered constraints to poverty

addressed, women are also being supported to be leaders of the new technologies for maize. Where possible, technologies are introduced through women's groups formed for the purpose of growing maize. While women may not own the land, they can own the technology.

The Benefits of Ownership

Interviews with women participants in Nepal reveal that HMRP has an effect on the redistribution of benefits by allowing women greater access to agricultural inputs. Some women identify results in terms of greater control over both inputs and the resulting benefits accrued from the use of these resources, such as income. As one HMRP community-based seed production group leader said: "Women have become independent" by depending less on their husbands for money. This can translate into a greater sense of dignity and self-value, as a member from another group said that, if not for the CBSP group, "that would be like the 19th century… We have come far."

Receiving training can contribute to the recognition of women as both knowledge bearers and brokers. Encouragement from husbands to participate in the training is part of this recognition. Women trained by HMRP found that they were able to convey what they learned to their husbands, who then afforded them more recognition. With internal and external recognition comes increased self-confidence. One member of a CBSP group says: "Before, we were shy. We could not even introduce ourselves. Now we can answer back to our husbands – even with a loud voice."

Gender and 'Knowledge'

The Audit found that the integration of gender into MAIZE activities is affected by the way knowledge is constructed and reality is understood and approached in the different disciplines. One example is the belief that gender-sensitive research merely involves counting the number of men and women participating in project activities. Another example can be found in the tendency to classify households as a simple binary – male- or female-headed. This risks reinforcing the understanding that male heads are the norm and female the anomaly, with the associated idea that men are the farmers and therefore the 'knowers,' while women and women's knowledge are relegated to the sphere of the household. These understandings are often based on assumptions rather than empirical evidence.

There is a need to strengthen the integration of research methods of both the social and the bio-physical sciences in the CRP and to develop alternative paths in agricultural research for development (AR4D) to advance women's rights and gender equality.

This is not to say that inter-disciplinary work is straightforward, and there are no easy answers when it comes to getting teams to work both collaboratively and efficiently. However, we have encountered some good examples of attempts to formulate integrated research questions throughout the MAIZE projects visited. Where there are linkages between different disciplines and/or interdisciplinary work, it seems to happen when the working environment is conducive to collaboration, with individuals taking the initiative themselves.

"The gender audit is a stock-taking exercise. In other words, it is not an evaluation but rather a constructive, reflective and interactive exercise for the CRP to identify how gender issues are addressed in its programming and processes and how to strengthen this further. The Gender Audit process in itself helped build awareness of gender in the CRP and with collaborators. It very much fostered openness and curiosity which has subsequently led to more demand from scientists. And that in itself is an important move forward."

– Lone Badstue
MAIZE Gender Specialist

Amazing Maize: International Crop Research Benefits SSA

Research on maize improvement by international agricultural research centers and partners in SSA is increasing harvests in the region and enhancing farmers' lives.

In Nigeria, farmers say that improved varieties are addressing constraints such as the parasitic weed *Striga*, drought, poor soil fertility and pests and diseases that limit productivity, reduce yield and make farming unattractive. For farmer Hajiya Hafsatu Riruwai the encounter with improved maize technologies last year brought a profound change to her life.

"I have been farming for the past 30 years but this is my best year so far," she said. Mrs. Riruwai is one among thousands of farmers benefiting from the improved farming practices being promoted by the Integrated Striga Management in Africa (ISMA) project in the maize-producing belt. As a seed producer using improved varieties and better management technologies, she harvested 1.3 tons of maize from 0.25 ha in contrast to 0.2 tons from the same piece of land using local varieties. "Many farmers now come to my house to buy my maize seeds because of their performance," she said.

Milka Wilson, another farmer, has a similar story. "With the new varieties and new knowledge on maize cultivation, I was able to get a bumper harvest. Other farmers are now buying seeds from me." Income from sales is helping Mrs. Wilson to send her children to school, something she had not been able to do before. "Before, my kids could not go to school," she said. "My thanks go to ISMA and its partners."

In western Kenya, George Martin Mitende, a lead farmer in Bonda village in Migori County, also gets more maize by using a combination of new, improved farm practices. In 2011, he donated part of his land which was badly affected by *Striga* to the ISMA project to set up a demonstration field trial.

Since 2011, *Striga* had been dramatically reduced on this piece of land. He harvested 360 kg of maize from one-tenth of a hectare in the last two growing seasons. In the past, he usually harvested 90 kg or 180 kg from the whole farm. "My favorite *Striga* control technology is intercropping *Desmodium* with WS303 – an Imazapyr herbicide-resistant maize variety being marketed by the Western Seed Company. I will extend this technology to my whole farm," he said.

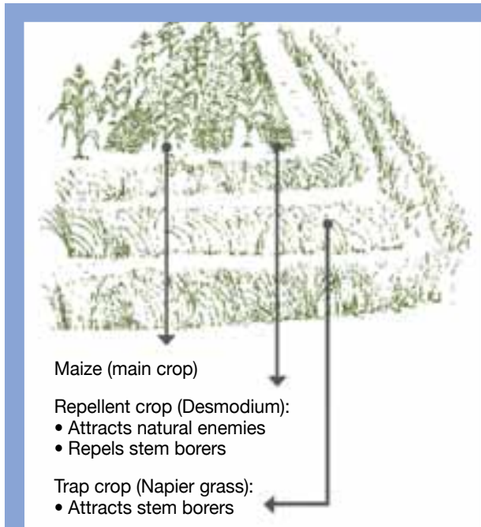
Desmodium is a legume that is also fed to livestock. It is intercropped with maize to suppress the growth of *Striga* as part of the push-pull management technology developed by ICIPE and partners. ISMA, launched in 2011, is capitalizing on existing technologies developed by IITA and CIMMYT and other partners to increase the productivity of maize with particular focus on addressing *Striga* – a major constraint to production in SSA.

A farmer in Kenya counting his losses due to *Striga* infestation of his maize fields.

Combined Management

ISMA seeks to improve the livelihoods of over 15 million smallholder farmers in northern Nigeria and 10 million in western Kenya by promoting and deploying a variety of technologies that reduce the weed's emergence, improve soil fertility and increase crop yields.

In Kenya, ISMA works with national partners, extension workers, policymakers, community-based seed producers



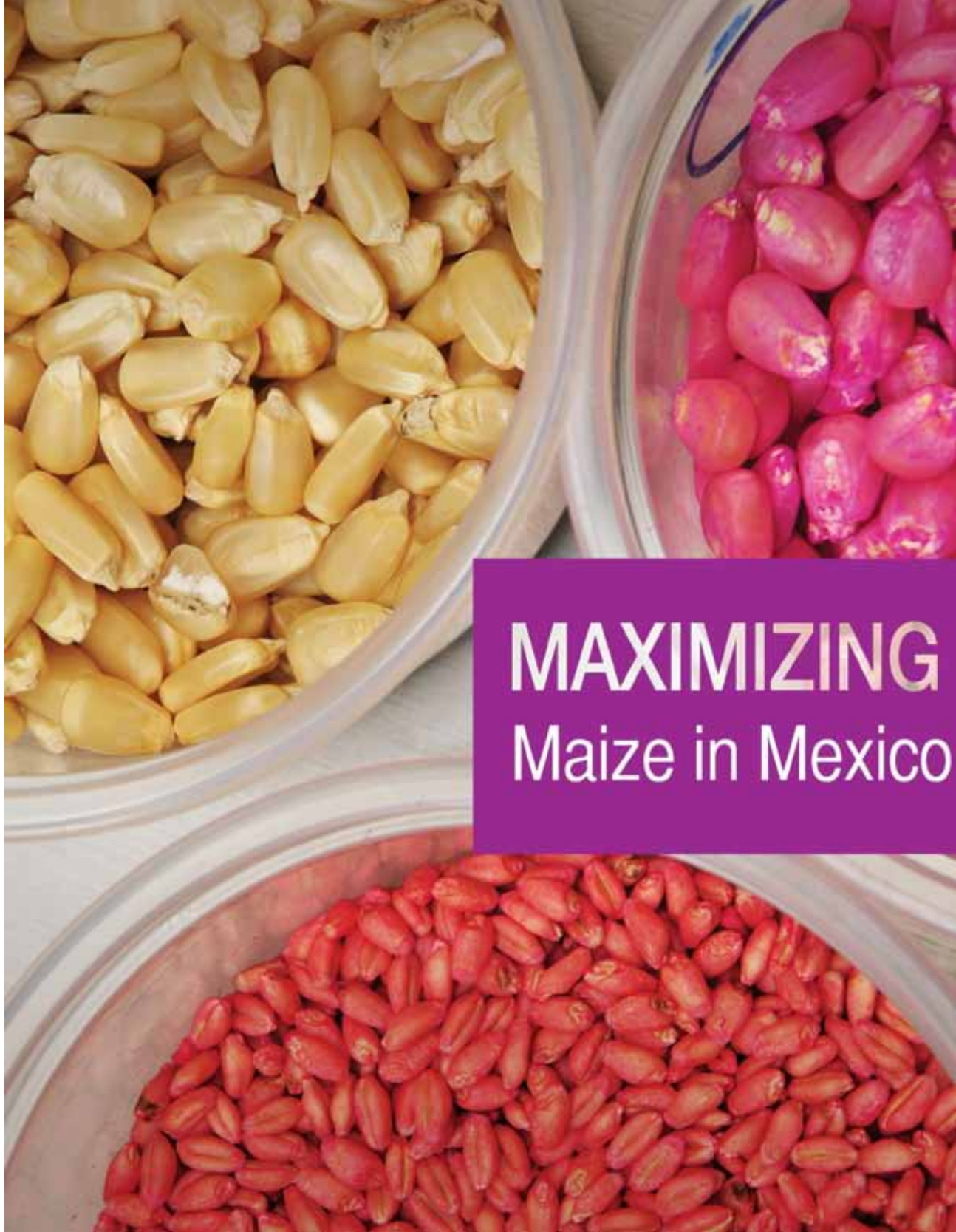
The push-pull technology is an innovation from ICIPE. It is a pest management approach that uses repellent intercrops in combination with an attractive trap plant. Pests are repelled from the food crop while being simultaneously attracted to the trap crop. It is mostly used to control stem borers and *Striga*.

and farmers. Extensive demonstration trials involving different management options have shown that both Imazapyr-resistant maize (IR-maize) and *Striga*-resistant hybrids reduced *Striga* emergence by more than 60 percent and increased yields by up to 70 percent compared with commercial hybrids. Demonstration trials showed that intercropping the legumes *Desmodium* and groundnuts with IR-maize and *Striga*-resistant hybrids is the best management option, increasing grain yield and significantly reducing *Striga* emergence. Farmers who intercropped maize with *Desmodium* (push-pull technology) achieved reductions of 60-100 percent in infestation and three-fold increases in grain yields.

Farmers read a *Striga* management handbook.

The project had also engaged companies in Kenya to produce 370 tons of seeds of the IR-maize hybrids and open-pollinated varieties (OPV). Over 256 tons were directly distributed through agro-dealers, providing over 72,000 farmers with IR maize within three years. In addition, community-based producers and selected companies produced 4 tons of *Desmodium* seeds. Over 111,000 farmers now have access to new *Striga* management technologies in Kenya through field days, agricultural shows and seed sales. Among these, 24,183 farmers have adopted the push-pull technology.

In Nigeria, the project established broad-based partnerships to test and deliver technologies to smallholder farmers in Bauchi and Kano states. These technologies included the use of *Striga*-resistant OPV and *Striga*-resistant and herbicide-resistant maize hybrids. Also recommended were the rotation of maize with soybeans or *Striga*-resistant cowpeas and biocontrol of the weed with a fungus (*Fusarium oxysporum* f. sp. *strigae*) that is specific to *Striga*. Researchers, seed companies, NGOs, CBSPs, state extension services, dealers in agro-chemicals and policy-makers came together and created innovation platforms to help scale out project outputs and deliver technologies to control *Striga* in farmers' fields. In three years, the project has directly reached 264,370 farmers. Over 1,285 tons of seeds of *Striga*-resistant maize and 346 tons of seeds of *Striga*-resistant cowpeas have been produced by companies and community-based producers and disseminated to farmers in northern Nigeria.



Seed company representatives active in the MasAgro project select competitive maize hybrids.

Maximizing Maize in Mexico

While Mexico is the fourth-largest producer of maize in the world, yields are low and very little seed planted by Mexican maize farmers is produced by domestic seed companies. Responding to these issues, the Mexican government and CIMMYT launched MasAgro* in 2010, which is increasing the production of seasonal maize varieties in Mexico by developing more robust and productive seeds, and by promoting sustainable agricultural practices.

A central component of the project has been the creation of an international consortium for the improvement of maize (IMIC), in order to increase maize productivity and strengthen the competitiveness of the maize seed sector, both in Mexico and more widely in the Latin American region. Now in its third year of operation, the consortium – which includes the regional maize seed industry, public sector researchers and CIMMYT – delivers elite germplasm, software tools and molecular breeding technologies to small- and medium-sized breeding programs in Mexico. In time, the same support will be extended more widely in the region.

Results in 2013

The MasAgro breeding program delivered 6.6 tons of basic seed to 19 small- to medium-sized companies and to Mexican research institutions in 2013. Companies that participate in MasAgro's network have received 8 tons of seed of 16 maize hybrids adapted to Mexico's rainfed growing regions.

* The Sustainable Modernization of Traditional Agriculture (MasAgro) project promotes the work of Mexican growers through the support of organizations dedicated to improve agriculture in Mexico.

As a result, the companies will be able to multiply and to commercialize enough hybrid seed to sow 1 million hectares in 2014 (one-eighth of the total land used to grow maize in Mexico). These hybrids have the potential to yield 60 percent more than Mexican farmers' average yield.

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

IMIC also distributed 27.7 tons of pre-commercial seed of 16 maize hybrids to 18 companies and two public research centers in 2013. In sum, MasAgro has distributed 31 tons of pre-commercial seed to the companies that participate in its germplasm evaluation and exchange networks. To assist the distribution of seed for trials in the networks, IMIC developed an online seed request and management system in 2013.

Identifying Priority Zones

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

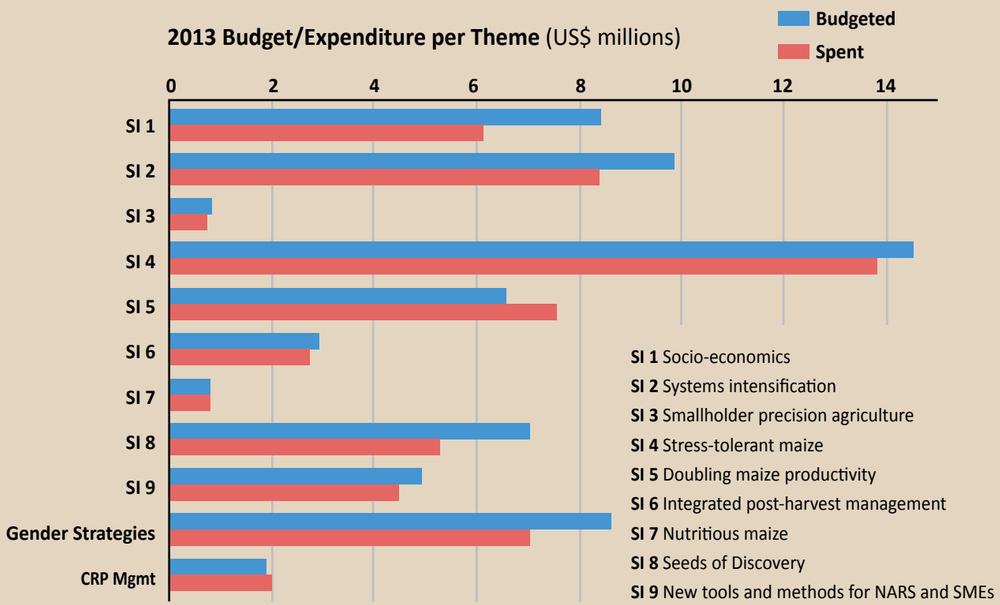
Finally, the MasAgro socioeconomics team concluded five studies that applied surveys to seed producers and to growers to identify priority intervention zones, and to estimate the potential growth of improved seed markets in Mexico. The findings show that 740,000 hectares in southeast Mexico and 372,000 hectares in the High Valleys have the highest productivity potential. Both zones combine high yield gaps with high potential use of improved seed. Seed companies in MasAgro networks could see their sales double by 2018 if these markets reach their full potential. Another finding from a study conducted by INIFAP confirmed that 54, 68 and over 90 percent of smallholder farmers in the states of Mexico, Oaxaca and Veracruz, respectively, want to use hybrid seeds. The studies also classified current maize productivity in the different regions of Mexico. Evidence showed that the most productive maize growing zone is western Mexico, followed by Bajío, the High Valleys, southeast, northeast and the landlocked northern states.

International Maize Improvement Consortium for Latin America (IMIC)

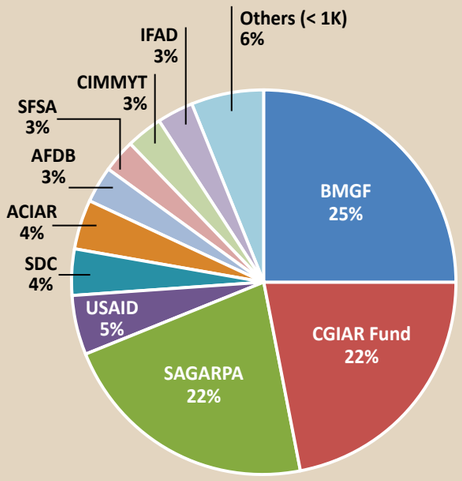
Objectives:

- **To have the technology and genetic materials needed to raise average rainfed maize production in Mexico from 2.2 to 3.7 tons per hectare over a 10-year period.**
- **To increase the use of high-yielding, improved maize seed in Mexico over an area of between 1.5 and 3 million hectares.**
- **To raise Mexico's production of rainfed maize between 5 and 9 million tons in 10 years.**
- **To promote the development of the maize seed industry in Mexico.**
- **To strengthen food security in Mexico and in the rest of the world.**

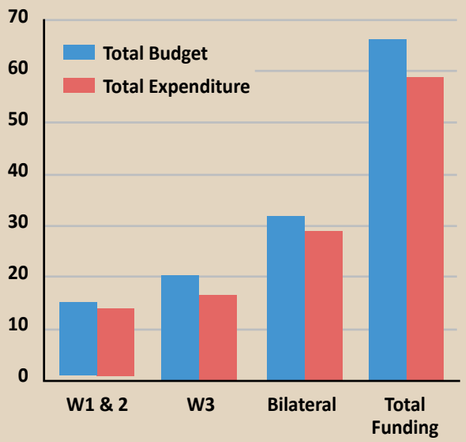
MAIZE 2013 Financial Highlights



2013 Funding Sources
(Top 10 Donors)



2013 Budget/Expenditure per Funding Source
(US$ millions)



Acronyms

ACIAR	Australian Centre for International Agricultural Research
AfDB	African Development Bank Group
AGRA	Alliance for a Green Revolution in Africa
ASARECA	Association for Strengthening Agricultural Research in East and Central Africa
ATTIC	Trajectories and Trade-Offs for Intensification of Cereal-Based Systems
BMGF	Bill & Melinda Gates Foundation
CBSP	Community-based seed production
CCAFS	CGIAR Research Program on Climate Change, Agriculture and Food Security
CIMMYT	International Maize and Wheat Improvement Center
DTMA	Drought-Tolerant Maize for Africa project
EGSP	Effective Grain Storage Project
GRiSP	Global Rice & Science Partnership
ha	hectare
HMRP	Hill Maize Research Project
ICIPE	International Centre of Insect Physiology and Ecology
ICRISAT	International Center for Research for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
IIAM	Agricultural Research Institute of Mozambique
IITA	International Institute of Tropical Agriculture
IMIC	International Maize Improvement Consortium for Latin America
INIFAP	Instituto Nacional de Investigaciones Forestales Agrícolas y Pecuarias
IPNI	International Plant Nutrition Institute
ISMA	Integrated Striga Management in Africa project
KARI	Kenya Agricultural Research Institute
kg	kilogram
KIT	Royal Tropical Institute
MasAgro	Sustainable Modernization of Traditional Agriculture project
MLN	Maize lethal necrosis
OPV	open-pollinated variety
PASS	Program for Africa's Seed Systems
SAGARPA	Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food in Mexico
SDC	Swiss Agency for Development and Cooperation
SFSA	Syngenta Foundation for Sustainable Agriculture
SIMLESA	Sustainable Intensification of Maize-Legume Systems for Food Security in Eastern and Southern Africa
SIMLEZA	Sustainable Intensification of Maize-Legume Systems for the Eastern Province of Zambia
USAID	United States Agency for International Development

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Recurrent food price crises—combined with the global financial meltdown, volatile energy prices, natural resource depletion and climate change—threaten the livelihoods of millions of poor people.

Together with rice and wheat, maize provides at least 30 percent of the food calories of more than 4.5 billion people in 94 developing countries.

They include 900 million poor consumers for whom maize is the preferred staple, 120-140 million poor farm families and about one-third of all malnourished children.

Between now and 2050, the demand for maize in the developing world will double, and by 2025 maize will have become the crop with the greatest production globally and in the developing world.

But harvests at current levels of productivity growth will still fall short of demand and millions of farm families will remain in poverty. Unless vigorous measures are taken to accelerate yield growth, increase incomes from more productive, sustainable and resilient maize-based systems, and give greater opportunities to women and young adults, the outcome will be less affordable food for millions of poor maize consumers, continuing poverty and childhood malnutrition, deforestation, soil degradation, reduced biodiversity and accelerated depletion of water and fertilizer reserves.

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RESEARCH PROGRAM ON Maize