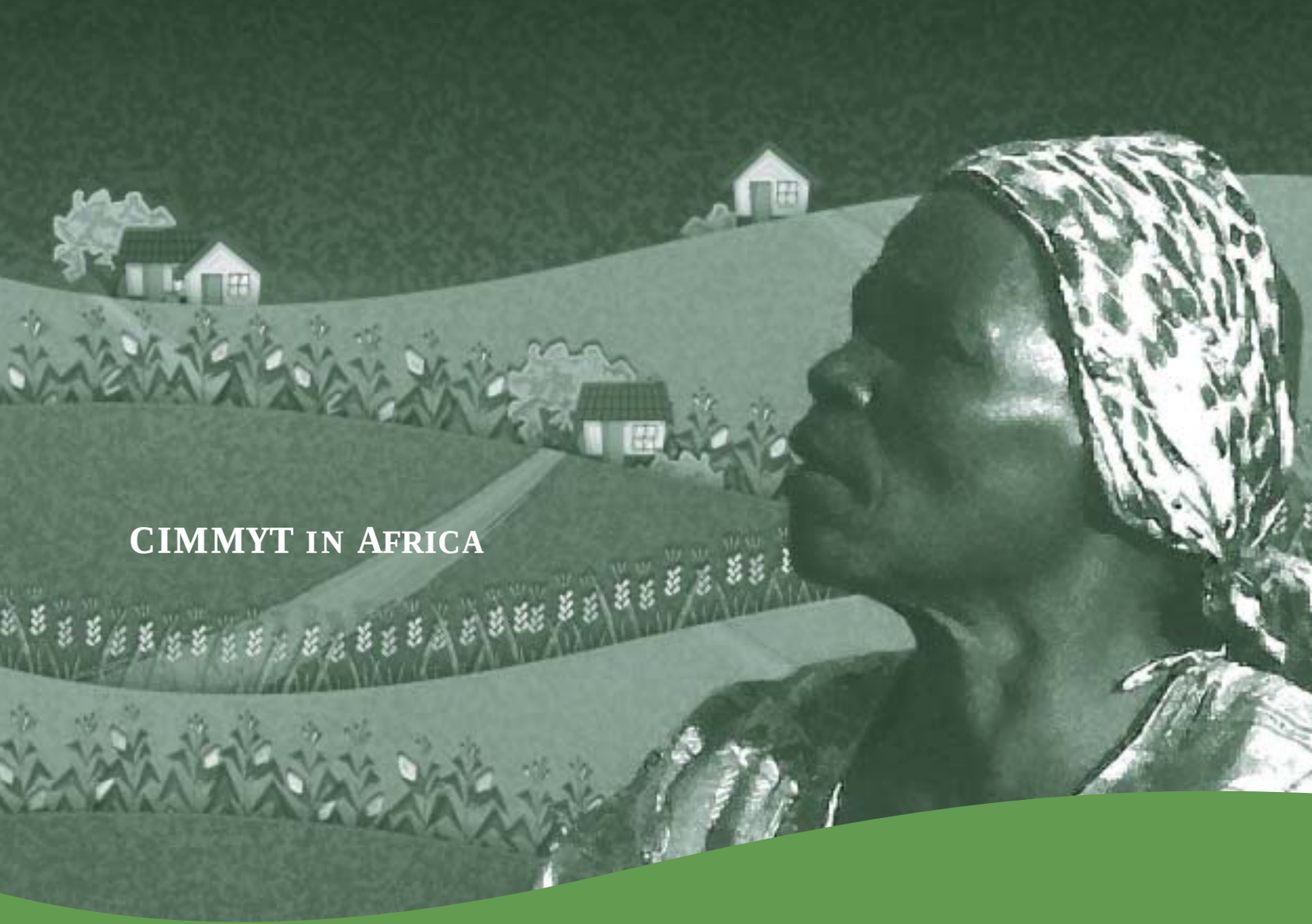

CIMMYT in Africa

Kenyan Researchers Sow First Field of Transgenic Maize

ENCOURAGED BY RESULTS OF LABORATORY AND BIOSAFETY GREENHOUSE STUDIES, THE INSECT RESISTANT MAIZE FOR AFRICA PROJECT BEGAN FIELD TRIALS WITH TRANSGENIC MAIZE. EDITORIALS IN *THE NEW YORK TIMES* AND THE *INTERNATIONAL HERALD TRIBUNE* CALLED THE PROJECT "...A CAREFUL ENDEAVOR TO TEST GENETICALLY MODIFIED CROPS AND MAKE THEM WORK FOR THE SMALL FARMER."

On 27 May 2005, staff of the Kenya Agricultural Research Institute (KARI) sowed the first insect-resistant transgenic maize seeds into Kenyan soil, under confined field trial conditions at an open quarantine site (see "What Is an Open Quarantine Site," p. 16), as part of the Insect Resistant Maize for Africa (IRMA)[1] project. The first genetically modified maize grown in sub-Saharan Africa outside of South Africa, the experiment—and the project itself—are aimed at helping Kenyan farmers reclaim some of the 400,000 tons of maize grain they lose each year to stem borers.

A KARI-CIMMYT partnership begun in 1999, but built on decades of fruitful collaboration, IRMA uses conventional breeding and biotechnology to develop and offer locally-adapted, insect resistant maize varieties. The controlled field trial contained a maize variety that had been genetically modified with a gene from the common soil bacterium, *Bacillus thuringiensis* (Bt). The gene codes for a protein that impedes digestion in moth larvae like borers, and has served as the active ingredient in many organic pesticides since the mid-1900s. In contrast to South Africa, where Bt maize from private companies has been grown for nearly a decade, in Kenya the maize eventually delivered to farmers through IRMA will be free from legal restraints against planting or distributing saved seed. "It may seem trivial, but this type of contrast underlines the importance of IRMA, which applies cutting-edge science to benefit smallholders in Africa," says IRMA project manager and CIMMYT breeder Stephen Mugo.

The trial was intended to determine the effectiveness of different Bt genes and their combinations against four species of Kenyan stem borers under field conditions and to refine the

[1] IRMA is funded by the Syngenta Foundation for Sustainable Agriculture and the Rockefeller Foundation.

adaptation of the experimental varieties to Kenyan settings. The open quarantine trial site is a one-hectare plot on KARI's Kiboko research station 150 km southwest of Nairobi. Developed in 2003 under IRMA auspices, the facility features internationally accepted biosafety controls to ensure that plants and pollen stay within its confines.

Worldwide Attention Attends the Planting

The worldwide media spotlight shone on the trial planting, with some of the world's most influential and prestigious outlets covering the event. The BBC science and technology radio program *Discovery* featured interviews with KARI director Romano Kiome, Mugo, and KARI scientists Simon Gichuki and Catherine Taracha. Kiboko farmer Harrison Chuma spoke on the program about the myriad setbacks he faces to feed his household on his maize crop, qualifying stem borers as second only to drought in stealing yields: "Even when I use irrigation on my maize, the stem borers stop me from harvesting what I should."

IRMA Arms Farmers against Multiple Threats

IRMA is also working to safeguard the maize harvests of Chuma and other smallholder farmers in Africa by endowing seed with resistance to another insect pest—the larger grain borer—that feeds on stored maize ears. Chemical controls for this insect are costly and potentially harmful to farm families and the environment. The associated lab and field work takes place at KARI's Kiboko, Embu, and Kakamega research stations.

Six IRMA maize varieties developed using conventional (that is, non-transgenic) sources of insect resistance are being grown in Kenya national maize performance trials, after successful completion of which some or all will be released for use by farmers.

Setbacks but Steady Progress

The project has not been completely free from problems. For example, because of an experimental error—the application of a systemic pesticide to one of the Kiboko test plots in mid-June—that plot had to be harvested prematurely. After Kenya's National Biosafety Committee (NBC) and the Kenya Plant Health Inspectorate Service (KEPHIS) granted the required permissions, the trial was replanted.

As the editorial in *The New York Times* asserts, "The Kenya study is a model of how to do it and a warning about how difficult adapting this technology for poor farmers will be." IRMA will only succeed with "...financing and permissions …help from governments and foundations, and cooperation from biotech concerns."

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What Is an Open Quarantine Site?

AT FIRST GLANCE, THE KIBOKO OPEN QUARANTINE SITE IS JUST AN ORDINARY FENCED-OFF FIELD. ON CLOSER INSPECTION, HOWEVER, A LARGE SIGN IDENTIFIES THE FIELD AS THE KARI/CIMMYT QUARANTINE FACILITY. ANOTHER SIGN, NEXT TO A LOCKED GATE AT THE ENTRANCE, INFORMS YOU OF ACCESS RESTRICTIONS TO THE FACILITY, AND SPELLS OUT SAFETY MEASURES FOR THOSE WITH AUTHORIZED ACCESS.

The two signs, two-meter-high chain-link perimeter fence topped with barbed wire, locked gate, and round-the-clock security are just some of the many special features that ensure genetic and material confinement within the one-hectare facility, as stipulated by the Kenya Plant Health Inspectorate Service (KEPHIS).

The distance of the site from other maize fields—some 400 meters—is another important biosafety feature. This, along with the disinfectant-treated stepping mat and drive-through at the single entry point, pits for burning biological residues from the trials, and dustcoats for use inside, ensures that no pollen, seed, or other plant material can escape the trial area and that the transgenic maize will not cross inadvertently with maize not included in the experiments. Excess plant and other biological material is gathered, dried in the sun, and burnt, and the ash buried in pits on site. Bright yellow basins atop wooden stands are traps to monitor the diversity and numbers of flying insects in the trials. Plastic tumblers sunk into the ground and containing a preservative liquid capture and allow measurement of crawling insects. Finally, IRMA provides continuous training for on-site personnel.

CIMMYT Maize Shines at World's First Millennium Village

THE TURN-AROUND IN THE FORTUNES OF THE VILLAGERS OF BAR SAURI, THE WORLD'S FIRST MILLENNIUM VILLAGE, MAY FIGURE AMONG THE MOST SUCCESSFUL DEVELOPMENT EFFORTS. CIMMYT MAIZE IS CONTRIBUTING TO THE VILLAGE'S NEWFOUND WELLBEING.

The millennium village concept, the brainchild of Jeffrey D. Sachs, UN Special Envoy on the Millennium Development goals (MDGs), is an experiment designed to show that, for a modest investment and support, it is possible to pull people out of hunger and poverty and set them on the road to prosperity.

Just a year ago, the 5,000-odd smallholders of Bar Sauri in western Kenya were among the poorest in Kenya. Hunger, malaria, and HIV-Aids had since the 1980s taken their toll on the community, effectively arresting any chance the villagers had for development. The normal farm in Sauri is less than half a hectare and typically supports a three-generation household numbering as many as 12 persons. Until 2003, most Sauri farmers grew *nyamula*, a local maize variety that yielded at best around 800 kilograms a hectare—insufficient to see even the smaller households through to the next harvest. Sauri residents were undernourished, particularly the women and children, and it was showing in consistently low grades at Sauri's Nyamnina Primary School. Still, the villagers' resilience and will to help themselves led to Sauri's selection as the model millennium village in 2004. The village became the beneficiary of and participant in a five-year project to show how poverty can be eliminated.

The first hurdle was to overcome hunger, making agriculture the immediate priority intervention. In early 2005 villagers received farming inputs—hybrid maize seed and fertilizers—and training on the proper way to grow their maize. "We were looking for the best hybrid maize varieties available in Kenya," says Pedro Sanchez, Co-chair of the UN Millennium Project Hunger Task Force, the Earth Institute, Columbia University, and former director general of the World Agroforestry Center. Sanchez selected two hybrids developed as part of the Africa Maize Stress project,[1] a joint effort of CIMMYT, the International Institute of Tropical Agriculture, and national research programs in West, Central, and Eastern Africa. Project leader and CIMMYT maize breeder Alpha Diallo explains how the two hybrids came out on top: "WH502 and WH505 are high yielding, but they're also able to tolerate locally important diseases and low nitrogen and drought stress." Commercialized by the Western Seed Company just two years ago, they have quickly become the most popular hybrid maize varieties in western Kenya, and are sown by some 200,000 farmers on approximately 50,000 hectares.

Jeffrey D. Sachs

By July 2005 the villagers were able to witness what a combination of quality seed, proper management, and good rains could do for their crop, harvesting 4 tons of maize per hectare. "The last time we saw maize like this was 1970!" says farmer Euniah Akinyi Ogola, whose plants gave cobs the length of her forearm. The unprecedented bumper crop prompted villagers to organize a harvest festival marked by drumming, singing, and dancing. "I am thrilled that CIMMYT materials met the MDG challenge so brilliantly!" says Diallo, who took part in the festivities along with Sachs and dignitaries from around the world. ▶

[1] The full name of the project is "Developing and Disseminating Stress Tolerant Maize for Sustainable Food Security in West, Central and East Africa." It is funded by IFAD, Sida, BMZ and the Rockefeller Foundation.

UNICEF Executive Director and former US Secretary of Agriculture Ann M. Veneman was guest of honor. "The MDGs, with their promise for a better future, are all about the children," she said in her address. "The world has come to celebrate your harvest with you!" Hons. Mrs. Charity Ngilu, Kenya's Health Minister, remarked that if the Sauri experience could be replicated throughout Kenya, the country would have no trouble meeting the first Millennium Development Goal—halving extreme poverty and hunger—by the target of 2015.

Sanchez, a noted agronomist whom the villagers have fondly nicknamed *Odera Kang'o* (a famous chief of the Luo people during Kenya's colonial period), told Bar Sauri inhabitants they could expect sustained good harvests, thanks to the *Calliandra* trees intercropped with the maize: "These nitrogen-fixing trees will improve the soil's fertility, reducing or eliminating the need for additional mineral fertilizers."

While the final impact of the MDG project on Sauri and other villages remains to be seen, the five-year pilot phase has already strengthened the school feeding program and made a previously defunct village clinic operational. Sachs said the project would now work with the villagers to construct safe storage facilities for harvests and start planting higher value crops. He also spoke of scaling up the MDG concept to hundreds of thousands of villages in Kenya and throughout the world. Already Koraro village in Ethiopia has started MDG-focused programs.

For Diallo, the challenge remains to continue breeding even better maize to counter the diverse climatic and biological stresses in developing world ecologies, because, as he says, "…you never know where the next Sauri will be."

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An Extra Coat Helps Maize Seed Fight Pernicious Weed

A QUICK AND INEXPENSIVE SOAKING IN HERBICIDE MAKES MAIZE SEED IMPERVIOUS TO ONE OF ITS WORST ENEMIES IN SUB-SAHARAN AFRICA—THE PARASITIC FLOWERING PLANT, *STRIGA* SPP. THE PRACTICE, WHICH INVOLVES THE USE OF HERBICIDE RESISTANT SEED, WAS DEVELOPED BY CIMMYT AND PARTNERS. FARMERS IN EASTERN AFRICA MAY ENJOY FAR BETTER HARVESTS AND FEWER WORRIES.

Yearly, the weed choked the crop on Zedekiah Onyango's 0.3 hectare plot, stealing half the harvest. When Western Seed Company sought farmers to test a new *Striga*-fighting maize, Onyango was eager. "Western gave me the seed, and I grew it using my usual farming techniques on this plot," says Onyango, near a five-by-five-meter patch of a healthy, *Striga*-free maize crop surrounded by *Striga*-stunted maize.

The technology comes from nine years of Rockefeller Foundation-funded collaborative research by CIMMYT and multiple partners—"…a classic example of partnership," according to Peter Matlon, director of the Rockefeller Foundation's Africa Regional Program. Partners included the Kenya Agricultural Research Institute (KARI), the Weizmann Institute of Science (effort led by Jonathan Gressel), BASF, private seed companies, and local non-governmental organizations. The practice is simple: herbicide resistant maize seed is coated lightly with Imazapyr; the herbicide kills the *Striga* sprout when it tries to attach to the maize seedling. As part of this research, CIMMYT and partners took advantage of a natural mutation in maize to breed locally-adapted varieties that withstand imidazolinone-based herbicides. BASF is marketing the seed-and-coat control system under the commercial name Clearfield®.

Farmer field studies show that the practice restores the 50-100% production otherwise lost to the weed, and is affordable to even the lowest-income groups. For just under US$ 4 for a 2-kg bag of the seed (enough to sow 0.1 hectares), on-farm trials found a three-fold yield increase over *Striga*-infested maize—at an average value of US$ 53. The practice also helps protect future harvests by depleting the weed's seed reservoir.

PUTTING *STRIGA* ON ITS HEELS REGION-WIDE

A highly invasive parasite, *Striga* infests 400,000 hectares of Kenya's farmland. The weed overruns 40% of the arable land in Africa's savannahs, threatening the livelihoods of more than 100 million people who depend on cereal crops for food and income. Kenyan maize farmers lose at least US$ 50 million annually in grain to *Striga*. The parasite hits hardest in the shallow, depleted, and acidic soils cropped by the poorest farmers.

Three seed companies in Kenya are producing the new herbicide-coated hybrid maize under the common name *Ua Kayongo* (literally "kill *Striga*") H1–4. The new control method will be released in Tanzania, Uganda, and, later, 16 other countries of sub-Saharan Africa, in a process spearheaded by the African Agricultural Technology Foundation (AATF) with DFID support.

CIMMYT agronomist Fred Kanampiu says the technology is not a permanent solution, "...but a stopgap that buys farmers time and resources to apply other control measures. It will also allow breeders to develop strong *Striga* resistance in maize."

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Starved of nutrients by *Striga*, infested maize develops more root hairs than normal to pull additional sustenance from the soil—thus the fluffy appearance.