KARI
CIMMYT

IRMA Updates

Insect Resistant Maize for Africa

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Contents

The IRMA project was launched in 1999 with the primary goal of increasing maize production and food security for African farmers through the development and deployment of improved maize varieties that provide high resistance to insects, particularly stem borers. To achieve this goal, KARI and CIMMYT scientists will identify conventional and novel sources of stem borer resistance and incorporate them into maize varieties that are well suited to Kenyan growing conditions and to farmer and consumer preferences. Major funding for the project is provided by the Syngenta Foundation for Sustainable Agriculture.

IRMA Holds Third Annual Project Meeting

Nearly 30 scientists and representatives from KARI, CIMMYT, and the Syngenta Foundation for Sustainable Agriculture convened at the IRMA project's Third Annual Meeting during November 18-20 to review 2002 accomplishments, develop 2003 work plans, and conduct site visits of project activities.

On opening day at the Nairobi Hilton, activity groups presented their accomplishments and occasional shortcomings to the entire meeting. Highlights included the following:

Product Development / Genetic Engineering of Bt Maize. Team members reported that the development of source lines had progressed with the molecular characterization of second generation Bt events (6 ubi: *cry1B*; 2 ubi: *cry1Ab* and 1 act: *cry 1Ab*) and mapping of "clean events." Two new *cry* genes were acquired, *cry2A* from Canada and *cry1C* from CIRAD, France, and negotiations are in progress to procure *cry1F* for evaluation against African insect pests. A permit had been issued to import Bt leaves from Mexico for another round of bioassays slated for December 2002. Blueprints had been finalized for a level-2 biosafety greenhouse, but progress had been slowed by the requisite review and bidding processes. Nevertheless, the team anticipates that the biosafety greenhouse will be operational by mid-2003. Progress was very good on the construction and staffing of the open quarantine facility at Kiboko, where mock trials had already been planted.

Product Development / Germplasm Development. KARI and CIMMYT maize breeders reported that the development of adapted insect resistant maize germplasm was moving forward with inbred lines, single cross hybrids, and three-way cross hybrids from CIMMYT-Mexico, Zimbabwe, and Kenya having been screened for resistance to *Chilo partellus* and *Busseolla fusca*. Of 862 inbred lines, 40 of were found to be insect resistant. In particular, some three-way cross hybrids were superior in yields and stem borer resistance. The group also reported on screening for value-added traits in addition to insect resistance, including low nitrogen, drought tolerance, and resistance to *E. turcicum* and *P sorghi*.

Product Dissemination / Insect Resistance Management (IRM) Strategies. Work on IRM strategies advanced as IRMA researchers identified the optimal refugia for various Kenyan agroecologies; sorghum and maize appear to be the most promising candidates, with Sudan and Columbus grasses also having potential under some circumstances. Napier served well as a borer host but not for larval development. Results from the refugia survey indicated that the Coastal region has 20–30% natural refugia, while the highlands have less than 5% refugia, suggesting that the highlands will require structured refugia. Surface maps will be generated using GIS to identify high-risk areas for development of resistance by the stem borers and distribution of natural refugia. An interesting study using Bt biopesticide as a proxy for Bt maize showed considerably less adverse effects on nontarget insects when compared to control with a broad-spectrum insecticide.

An interesting study using Bt biopesticide as a proxy for Bt maize showed considerably less adverse effects on nontarget insects when compared to control with a broad-spectrum insecticide.

In response to farmer surveys indicating concern with postharvest storage pests, screening was initiated for resistance to maize weevil and larger grain borer.

Impact Assessment. The socioeconomic team initiated baseline data collection to assess the likely adoption and impact of insect resistant maize in Kitale and Embu, and to ascertain the potential roles and strength of NGOs and extension services in diffusing agricultural technologies—key factors related to the ultimate impact of insect resistant maize in Kenya. The studies found, respectively, that farmers would be willing to pay a reasonable premium for insect resistant maize, and that while NGOs may be useful under particular circumstances, they do not have the breadth or depth to replace the national extension service in diffusing new technologies. The team also

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investigated the impacts of the liberalization of the seed maize market, and found that the number of outlets had increased, but prices remained high for resource poor farmers. Other areas studied included informal credit systems, farmer recycling of seed, maize diversity, and a pilot study on consumer awareness of GMOs.

Technology Transfer. Operations of the project's level-2 biosafety laboratory at KARI-NARL were optimized. Blueprints for the level-2 biosafety greenhouse were finalized and a contractor was selected. An open quarantine site was established at Kiboko, and Kenyan personnel were trained in its operations and security protocols, providing practical experience in biosafety and regulatory practices. More in-depth training of KARI and KEPHIS staff in greenhouse and quarantine site management and practices was conducted at CIMMYT-Mexico. Theoretical and practical backstopping at the policy and regulatory levels was provided to six upper level officials from KEPHIS, MOARD, and KARI when they visited and interacted with US and Mexican officials involved in biotechnology research and products. Visits by the team were also made to the Syngenta labs in North Carolina and CIMMYT's biotechnology facilities in Mexico (see Kenyan VIPs Confer with US and Mexican Officials, Pg. 5).

Documentation and Communication. In 2002, communication efforts went forward with a series of seminars aimed at informing the Kenyan extension service about the IRMA project and Bt technology. Five seminars, one in each of the country's five major maize growing regions, introduced 120 participants to the technology. Feedback was gathered on draft fact sheets related to insect resistant maize, and an exercise called "Star Search" was conducted to identify innovative messages and communicators from among the extension ranks. The production of IRMA project documents and IRMA Updates continued, as did monitoring of biotechnology in the Kenyan media. IRMA coordinator S. Mugo presented at a meeting on agricultural technologies with parliamentarians from East Africa.

Field visits. This was the first IRMA Annual Meeting to include field visits to sites where work was underway and according to S. Mugo, "it clearly added value to the meetings for all involved ."

At KARI-Katumani, Dr. Josephine Songa gave the group a tour of the entomology lab and pointed out the capital improvements supported by IRMA for the lab and the insectary, including a standby generator, water deionization equipment, and a refrigerator. These facilities allow researchers to synchronize the production of insects with lab experiments and field trials, an important enhancement for future insect resistance trials. Songa's team demonstrated sorting, identification, preservation, and photographing of collected insects (according to traps, type, and areas of collection). Insects collected from Kilifi, Kakamega, and Kitale are now in the IRMA database and specimens are being preserved in dry and wet forms and in digital photographs, all of which serve as resources for other research activities.

While at Katumani, the team was escorted through the biotechnology laboratory by Dr. K. Ngugi. Established in 1997, the lab works on using molecular markers to help produce materials that are tolerant to drought and insects. K. Ngugi explained that it is a real asset for training postgraduate students and that there is tremendous potential for its future use for IRMA and other KARI projects.

At KARI-Kiboko, Dr. Musembi, Ag. CD RRC Kiboko, welcomed the team and gave a brief overview of the National Range Research Center. Kiboko was selected for the open quarantine site (OQS), where it is hoped the first Bt maize in Kenya will be grown and evaluated under tight on-station conditions. S. Mugo described all the various requirements that had to be met by the OQS including isolation by distance, tightly restricted entry, protocols to prevent inadvertent pollen transfer, and monitoring of tassel and silk emergence. Mock trials, he explained, were run to train staff on OQS management and an application for registration of the site was under consideration. Treatments in the facility consist of artificial infestations of stem borers to test the efficacy of *Bt* genes.

While at Kiboko, Dr. Margaret Mulaa showed the group a nursery of potential refugia (consisting of napier, sorghum, Columbus grass, and Sudan grass) used for bioassays and for general observation of adaptability. Trials with three-way hybrids showing encouraging conventional insect resistance were highlighted at Kiboko by S. Mugo. To bring a long but productive day to a close, Mr. Paddy Likhayo explained the research underway to screen for resistance to two very destructive storage pests: the maize weevil and larger grain borer.

– S. Mugo and D. Poland

IRMA Stakeholders Meeting

Beginning with IRMA's official launch at the Stakeholders Meeting in March 2000, the IRMA team has met annually with groups and individuals ranging from university professors to smallholder farmers to update them on the project's progress and solicit input on future directions.

Approximately 90 people representing 42 institutions from within and outside of Kenya attended the IRMA project's Third Annual Stakeholders Meeting, held November 22 in Nairobi. Attendance was down slightly from previous years, says IRMA project coordinator Dr. Stephen Mugo, most likely because this year's meeting coincided with very vigorous national election activities. But as in the past, he said, the participants were engaged and the interactions were lively and fruitful.

Dr. John Kedera, Director KEPHIS, chaired meeting and Dr. Joseph Ochieng, Assistant Director, KARI–Food Crops welcomed the participants on behalf of Dr. Romano Kiome,Director KARI. Ochieng indicated the pride KARI attaches to the IRMA project.

Dr. Joseph Wanjama, Director of Agriculture, Ministry of Agriculture and Rural Development(MOARD), officially opened the meeting. In his remarks he noted that with Kenya's increasing population, it requires an additional 2-3 million tons of maize annually. The government policy, he said, is to assess and, when warranted, promote the use of new technologies, including genetic engineering, while ensuring the safety of the people and the environment. The director asked the farmers and other stakeholders to be patient while the scientists continued to develop the new technology and subject it to careful regulatory review.

Dr. Mugo made a presentation on the project's progress to date. He highlighted the methodologies that were being used to develop the insect resistant maize,

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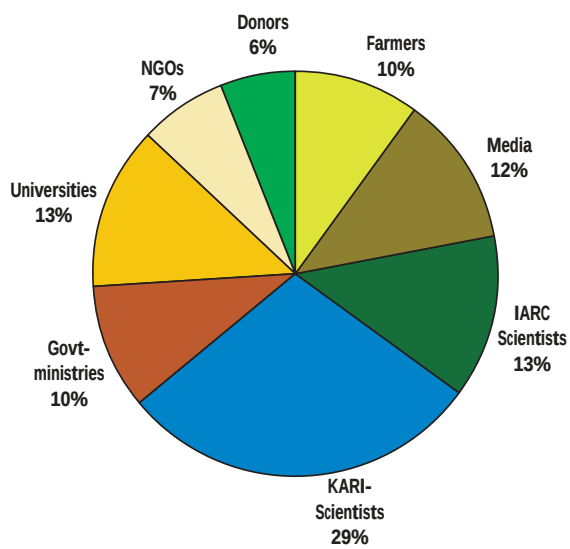
Dr. J.K. Wanjama, Director of Agriculture and Livestock Production.

Dr. Andrew Bennett, Executive Director, Syngenta Foundation for Sustainable Agriculture.

Dr. Masa Iwanaga, Director General, CIMMYT.

including screening of diverse germplasm for resistance to stem borers and screening *Bt* genes for effectiveness against different stem borer species. He reported that during the past year the project has focused on addressing environmental issues such as management of insect resistance and impact on target and nontarget organisms. Capacity building through training for KARI and KEPHIS scientists and technicians, and knowledge-building workshops for extension are building the foundations for Kenya to take ownership of the technology and its dissemination, he said. In addition, effort has gone into increased farmer awareness, as seen by the community seminar and dialog in Kiboko, and enhanced communication between scientists and the media. Mugo concluded his presentation stressing that IRMA activities will ensure that the improved maize varieties with insect resistance produced by the project will be adapted to the Kenyan ecozones and tolerant to many common stresses.

In his first IRMA Stakeholders Meeting as the Executive Director of the Syngenta Foundation for Sustainable Agriculture, Dr. Andrew Bennett stated that he was particularly impressed with the IRMA project, noting that it is a classic example of good practice—trying to do things right by giving farmers choices and bringing together the private and public sectors to achieve that goal. With IRMA, farmers will have a choice of new varieties obtained from both conventional breeding and through incorporation of *Bt* genes. Bennett said the Syngenta Foundation was keen to remain engaged in the project until its completion and he encouraged stakeholders to continue to advise the IRMA scientists to keep them on track.



Percent of participants (by categories of institutions) attending the Third IRMA Project Stakeholders Meeting in Nairobi, Kenya, Nov. 22, 2002.

The Director General of CIMMYT, Dr. Masaru Iwanaga, also attending his first IRMA Stakeholders Meeting, said he enjoyed the opportunity to meet the Kenyan scientists who were involved with the Bt technology, which he believed would improve the livelihood of farmers in Kenya. He observed that no single institution could take on a project with the scope of IRMA by itself and that he was heartened by the strong collaboration amongst CIMMYT, KARI, and the Syngenta Foundation. It is evident, he said, that the IRMA project is steadily approaching its goal of deploying stem borer resistant maize and that Kenya is leading the way in sub-Saharan Africa in developing such varieties, adding that stakeholder input was an essential element in developing a technology that would be confidently adopted by farmers.

As in past meetings, the stakeholders engaged the experts' panel in the question and answer period, and queries ranged from points about the management of research directed to the Ministry of Agriculture to specifics about the stewardship of the technology. (Excerpts from the Q&A session may be found in "IRMA Stakeholders Get Answers," Pg.4)

"The questions asked at the meeting are an indication that the basics of the technology are now understood by the representatives of our stakeholders," says Mugo. "They are moving on to post-deployment questions, whereas in the past, they asked more about when the new technology would be available and what was the cause of the delay. This is a sign that we are on the same page in moving the project forward."

– S. Mugo and D . Poland

IRMA Stakeholders Get Answers

Dr. G. Ombakho, maize breeder at KARI Kitale responds to a stakeholder's question.

The following are excerpts from the question and answer session at the IRMA Annual Stakeholders Meeting held on 22 November, 2002 at the Hilton Hotel, Nairobi.

Questioner: Mr. Drecky E. Okeno
(Farmer, Western Kenya)

International laws on biological materials may change. The IRMA project is a joint venture between KARI and CIMMYT. What precautions are there to safeguard against any possible legal issues regarding intellectual property rights that may delay or hinder deployment of Bt maize seed supply?

Respondent: Dr. S. Mugo

The ownership of the technology will belong to the collaborating institutions, both KARI and CIMMYT. Last year the IRMA project commissioned an intellectual property rights (IPR) review by Swift-Cornell and the results were that IPR issues will be relatively uncomplicated.

Questioner: Dr. Danny Romney
(Scientist, ILRI)

i) Has the feed value of stover / thinning, etc., for ruminants been considered?

ii) What are the potential trade-offs between supplying forage for animals and use as refugia for the fodder; are there any positive effects in encouraging farmers to plant more fodder?

Respondent: Dr. S. Mugo and Dr. M. Iwanaga

i) Research on feed value has already been done by other scientists on most of the *Bt* genes in maize. It is unlikely that the addition of a *Bt* gene would change the feed value of the new variety from that of [conventional] maize. However, resistance to stem borers through conventional breeding methods may involve leaf toughness . . . which may or may not affect feed value. . . . This could be a subject of research between the IRMA project and ILRI.

ii) Refugia are good news for livestock farmers because they will increase the area under livestock feed. Some of the refugia species such as sorghum can be used for food as well.

Questioner: Mr. Peter E. Kataka
(Farmer Kakamega)

i) Farmers concerns on Bt maize are possibilities of physiological disorders on maize plants and different taste as food. Will the Bt maize be safe for human consumption?

ii) Is there a possibility of combining resistances to stem borers, foliar diseases, the parasitic *Striga* weed, and tolerances to drought and low nitrogen into a single maize variety and for this to reach farmers as a package?

Respondent: Dr. S. Mugo

i) Research done on food safety shows that Bt maize is safe for humans and other mammals. The human stomach has higher acidity compared to that of an insect that is primarily basic . . . Humans and other mammals do not have receptor cells for the Bt endotoxins . . . . and specificity is seen even among different species of stem borers. The physiology, appearance, taste, and other qualities will be like the maize varieties that farmers are growing. World bodies like FAO and WHO, and national agencies in the United States such as the USDA, FDA, and EPA have put out considerable information on the safety of Bt maize. These organizations indicate that Bt is safe based on the science.

ii) It is possible to combine genes for tolerance to various stresses in one variety. The *Bt* gene will be incorporated into varieties with resistance to the stresses you mentioned.

Questioner: Dr. Sabina Wangia
(Lecturer, Egerton University)

Most farmers are resource poor and would prefer low input strategies for maize production. Will the Bt maize cost less or more than the open pollinated varieties being used by the farmers currently?

Respondent: Dr. S. Mugo

Bt maize seed may or may not be more costly than its non-Bt equivalent. However, if it is, the farmers will save money by foregoing the need to purchase pesticides for stem borer control. The other management practices, e.g., weeding and fertilizer use, will be similar to the current recommendations given by KARI and the Ministry of Agriculture.

Questioner: Mr. Henry Wahinya
(Journalist; The People Daily)

The majority of farmers are small scale and do not practice monoculture. What impact might Bt maize varieties have on other complementary crops grown on the farm if insects are deterred from their natural feeds.

Respondent: Dr. S. Mugo

Maize does not have any wild relatives in Kenya, therefore there will be no cross

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pollination with other crops or wild plants. Most crop species planted with maize are legumes such as beans and cowpeas, which are not usually damaged by stem borers. Cereal intercrops like sorghums and millets and fodder species like napiers would even be considered a blessing because they provide refugia for the Bt maize.

Questioner: Prof. Samuel Gudu
(Lecturer, Moi University)

Which maize varieties are your first targets for incorporation of Bt resistance? Do you target hybrids, OPVs, or landraces?

Respondent: Dr. S. Mugo and Dr. J. Wanjama

The Bt technology is targeting both small- and large-scale farmers. Hybrid Bt would be the easiest for seed companies and for stewardship of the technology. However, Kenyan society has a place for OPVs. Small-scale farmers grow hybrids as well as OPVs, while large-scale farmers mainly grow hybrids. . . . Open pollinated varieties will be made, but will require farmer training on seed selection and management of Bt maize. As we intend to put Bt in improved genetic backgrounds, Bt will not be added to landraces per se, but it should be recognized that some of the OPVs trace their origin from elite landraces.

Questioner: Mr. Francis Ndambuki
(Research Manager, Kenya Seed)

How long would it take and at what cost to convert a maize line to Bt?

Respondent: Dr. D. Hoisington

There are various issues of biosafety and training from evaluation of the technology to the time it will reach farmers. The project is still looking at different *Bt* genes to identify those that will be effective against *Busseola fusca*. Once the most effective *Bt* genes are found for all the major stem borers, which we hope will be soon, the conversion process does not take long. The costs will be established then.

Questioner: Dr. Esther Magiri
(Lecturer, Jomo Kenyatta University)

i) Will facilities for transformation with Bt genes be set up in Kenya instead of transformation being done in Mexico?

ii) Has the (gene) cleaning process been done on Bt maize in Mexico to remove antibiotic resistance and other sequences? If yes, how?

Respondent: Dr. S. Mugo and Dr. D. Hoisington

i) The project started by using *Bt* genes and products that are available at CIMMYT-MEXICO and training personnel on genetic engineering and biosafety issues in the management of Bt materials. After training and setting up biosafety laboratories, greenhouses, and a quarantine field, as required by the biosafety regulations in Kenya, the backcrossing will be done in Kenya after obtaining import permits. Facilities are being set up for transformation in Kenya.

ii) The cleaning process has been done. The first generation events had selectable markers. The second generation "clean events" have only the gene of interest. The selectable marker has been removed by co-transformation, whereby the selectable marker is segregated out after transformation.

Comments: Mr. Paul Okong'o
(Chairman TATRO group, a CBO in Western Kenya)

Farmers who have been attending these IRMA stakeholders meetings for the last three years are very appreciative because farmers have been involved from the beginning and this gives us the opportunity to spread the information to other farmers. Through stakeholders meetings, we have been following the whole process of the development of Bt maize technology and now understand the problems that scientists are facing and recognize the fact that they need more time for research.

Kenyan VIPs Confer with US and Mexican Officials on Biosafety Regulations and Facilities

The Kenya team is conducted around greenhouses by an USDA-ARS Beltsville scientist (right). Security notices were posted outside the greenhouse where transgenic tomato and tobacco are being evaluated (left).

A team of Kenyan administrators and scientists from three key institutions involved in GMO technology, development, regulation, and dissemination visited government and private sector institutions in the USA and Mexico to familiarize themselves with biotechnology development and regulation.

Team members were Dr. Wilson Songa, Assistant Director, KEPHIS; Ms. Jane Wangui Mumo Gathuru, Plant Inspector, KEPHIS; Dr. Ephraim A. Mukisira, Deputy Director, KARI; Dr. Christopher Ngichabe, Center Director, KARI Biotechnology Center; and Mr. Joel K. Ng'eno, Deputy Director of Agriculture, Research / Extension Liaison, MOARD, and Chairman of the Kenya National Biosafety

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(Kenyan VIPs Confer cont'd...)

Committee. The group was accompanied by Dr. Stephen Mugo, Scientist / Breeder, Maize Program CIMMYT-Kenya and Dr. Scott McLean, CIMMYT's scientist in-charge of the biosafety greenhouse operations, CIMMYT-ABC, Mexico.

In the USA, the group met with officials from the Department of Agriculture (USDA), The Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA) who all play complementary roles in the oversight of agricultural biotechnology. Aside from meeting with administrators and scientists from these agencies, the group toured various facilities related to the oversight activities. Before leaving the USA, the team visited the Syngenta biotechnology laboratories in Raleigh, North Carolina, where they toured the company's state of the art facilties.

KEPHIS staff, (left to right) B. Kuria, K. Onchuru, W. Songa, and J. Mumo at the entrance of the level-3 biosafety CIMMYT greenhouse, in Mexico.

In Mexico the team met with representatives of the Ministry of Agriculture (INIFAP) and the advanced research institute CINVESTAV to learn about how Mexico handled biosafety and research issues related to GMOs. The visit concluded with a tour of the CIMMYT facilities where they saw Kenyans being trained in the operation of biotech labs and greenhouses and met with Dr. Masa Iwanaga, Director General of CIMMYT.

From the regulatory standpoint, clear differences were seen between the US and Mexican approaches. In the USA, where Bt maize has been grown and consumed since the mid-1990s, acceptance of the technology was high and testing regimes were somewhat less constrained. In Mexico, on the other hand, a moratorium on field testing GM maize is in force. Participants noted that the field inspection regime in the United States was less stringent than the regimes being adapted in the East African region. They also observed that these experiences should allow them to address the regulatory process from a more informed and scientific perspective. Participants have been encouraged to share their experiences with Kenyan colleagues involved in biotechnology development and regulation.

The team also returned to Kenya with a wealth of information in printed literature, references, websites, and contacts with experts in the field, which allows them to avail themselves of the latest news and developments in the fields of biotechnology, biosafety, and associated regulations.

– S. Mugo and D . Poland

B. Kuria, C. Taracha, C. Ngichabe, W. Songa, J.K. Ngeno, and E. Mukisira at CIMMYT-Mexico biosafety greenhouse.

Dr. E. Mukisira examines the Bt and non-Bt maize infested with stemborer larvae in CIMMYT greenhouses in Mexico.

IRMA Responds to Public's Questions about Open Quarantine Site

Farmers and villagers around the KARI center in Kiboko were curious, and they were starting to talk, and to speculate. What was behind all that secure fencing that went up so quickly on the road by the station? Was it true that GMOs were being grown there? Was the presence of that different kind of maize going to affect their maize? And the locals were not the only ones with questions?

Seizing on the opportunity to build rapport and establish dialog with local farmers, as well as scientists based at the KARI-National Range Research Center (NRRC) Kiboko, the IRMA project conducted a public seminar on December 5, 2002 to explain the presence and uses of the recently constructed open quarantine site (OQS) at Kiboko. The site was built by the project to eventually accommodate Bt maize trials under tight biosafety regimes and security. At this time, it is being used with mock trials to train KARI scientists and staff who will run the actual trials, as well as KEPHIS staff who will oversee them, in the necessary protocols. The mock trials also allow scientists to fine tune the planting regimes.

Aside from explaining the uses of the facility, IRMA scientists took the opportunity to explain the IRMA project in general and various aspects of Bt maize technology. The seminar attracted more than 70 participants, the majority of whom were farmers and local community leaders. Also in attendance were the District Officer, Makindu Division as well as his local chief and assistant chiefs, KARI staff and scientists from Kiboko and Katumani, and local agricultural extension officers.

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(IRMA Responds to Public's cont'd...)

The main presentations were:

1. S. Mugo, J. Songa, B. Odhiambo, W. Muasya, and L. Muhammad gave background information and explained the purpose of the open quarantine site at Kiboko and the IRMA project.
2. S. Mugo and B. Odhiambo gave a presentation on "What is Bt Maize and How Does it Work?"
3. Dr. Kimani, the head of the National Quarantine Center of KEPHIS and Dr. Luta Muhammad, socioeconomist at Katumani participated during the question and answer sessions along with the IRMA scientists.

"We made preparations in a hurry for the seminar to catch up with government officials before they got too engaged with electioneering and Christmas euphoria," says Mugo, "but still all the presenters we invited were not able to attend. Nevertheless, we put together some good sessions and plenty of time was allowed for all present to ask questions and get answers."

"The main points we emphasized, Mugo says, "were that there was no Bt maize growing at the OQS and that planting of such maize will be well publicized in the community. We emphasized that the mock trials were to help us develop methodologies to capably manage the Bt maize trails, once the Bt maize is available in Kenya."

The farmers asked many good questions, among them

- When will the insect resistant maize be available?
- Why was GM maize rejected in southern Africa?
- Why the restricted access to the OQS?
- Will the Bt toxins affect my animals?

KARI and KEPHIS scientists also chimed in with some appropriate questions.

- How are genes engineered into crops?
- How do you plan to control insect resistance by stem borers?
- How do you pla n to control *Busseola fusca*?

The resource persons competently responded to the queries to the satisfaction of the group. Not unexpectedly, questions arose about the rejection of GM maize in southern Africa, specifically Zambia. Fortunately, Mr. Barack Gogo of Picasso Productions was in attendance in order to tape the seminar and interactions. Gogo had just returned from Zambia and provided a first hand account of what he saw there and his assessment of the situation. He attributed the crisis over the distribution of GM maize food aid to a knowledge gap among Zambians and emphasized that efforts to create better awareness, such as the event being held at Kiboko, had not been undertaken in Zambia, and that in his view, the human tragedy there was needless and preventable.

Another item that particularly aroused interest was the moat at the OQS, which some participants found disturbing. They asked if it was there to keep undesirables out of the OQS or to contain undesirables within? Although resource persons explained that it is a set procedure for such level of containment, some farmers still maintained doubts, though some of these were dispelled when they actually toured the OQS.

S. Mugo notes that the success of this seminar was dependent on a number of individuals. Mr. Muasya the head KARI-Katumani Kiboko Sub-Center played a pivotal role in organizing, inviting the participants, and chairing the meeting. Thanks to Mr. Kibet CD NRRC Kiboko for hosting the seminar, Dr. Odhiambo for his presentations, Dr. Muhammad and Dr. Kimani for contributions during discussions. Mr. J. Mbithi and Mr. D. Mutinda prepared the field. Thanks also to the government administration, extension staff and farmers for attending and for enabling such high caliber discussions.

—S. Mugo

Scenes from the public seminar at NRRC-Kiboko.

A Reference Collection for Nontarget Arthropods of Bt Maize in Kenya

Bt maize is one of the most promising technologies available for combating maize stem borers in Kenya. However, before Bt maize can be released into farmers' fields, it is critical that potential ecological impacts be thoroughly investigated. To respond to this need, the IRMA project is generating information and conducting experiments to determine what, if any, impacts the technology has on nontarget arthropods.

During the past two years, IRMA project scientists and collaborators have collected and characterized arthropods from farmers' maize crops in Kenya's five major maize growing regions (Kilifi [Coast], Kakamega [Western], Embu [Eastern], Kitale [Western] and Machakos (semi-arid Eastern). The purpose of this collection is to identify the important arthropods associated with maize to better focus nontarget studies, and to establish a reference collection (RC) to facilitate the monitoring Bt maize for possible impacts on nontarget arthropods.

The RC is comprised of voucher specimens of the various arthropod taxa collected from the different maize growing regions, and will be mainly used as a technical reference during the monitoring phase of Bt maize fields. Its use will not be limited to IRMA, project scientists stress, but it also will serve as a potent resource for other KARI projects. The RC is presented in two formats: (i) preserved arthropod specimens, and (ii) a digital database. The majority of the preserved specimens are kept in a dry form (dry collection), while others are kept in 75% ethanol (wet collection). The dry collection consists of arthropod specimens that have been pinned, dried, and kept in cool dry preservation boxes. Each of the voucher specimens are labeled, including information on the arthropod identity, location of collection, trap type, host crop, and date of collection.

Currently, the team has amassed more than 101,000 arthopod specimens from three of the five major maize growing regions. It comprises several individuals from the different taxa, which have been fully characterized, as well as representative specimens of each of the arthropod groups.

The digital database will greatly expand access to the collection through CD-ROMs, and eventually, the internet. It will enable entomologists to classify insect specimens to family level so as to enable future monitoring of insect diversity and abundance.

The most common and important insect families were photographed using a digital camera attached to a dissecting microscope to obtain the desired resolution.

For most specimens, two digital images were taken (usually a dorsal and transversal image) to facilitate identification. Images were stored in a JPG format using a file size (150K) that strikes a balance between easy downloading and sufficient resolution. Each image is linked to an Excel database containing useful information such as the specimen voucher number, genus, and family to facilitate the search process and location of physical specimens. Additional data columns include location and time of capture, type of trap used, association with maize, biological control agent, temporal distribution curve, and relative abundance.

IRMA entomologists are in the process of completing the specimen classification and pictorial database, thus ensuring that these resources reflect the abundance and diversity found in farmers' fields.

– J.M. Songa, D. Bergvinson, and S. Mugo

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