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.

Mock Trials Planted at Proposed Open Quarantine Site (OQS)

The proposed open quarantine site at Kiboko within the KARI NRRC Kiboko is now operational. The one-hectare area, with restricted access, borders on bush land. However, it is convenient for researchers as the Kiboko field station is very accessible, has facilities for growing food crops, a good water supply, adequate land for isolation by distance, and trained and committed staff on hand. In addition, the Kiboko station is also a short distance between the KARI/NDFRC Katumani insectary, which will supply stem borer larvae and eggs for field infestations.

The facility is equipped with a lockable gate, 2m high chain-linked fences topped with 3 strands of barbed wire, water trough with a disinfectant, irrigation for the entire hectare, troughs for dispersal and burning of plant waste, and soak pits for dispersal of exhausted disinfectant water. The facility is under 24-hour guard service. Areas not used by trials will be planted with Mucuna (*Mucuna pruriens* velvet bean), which will be ploughed under after maturity.

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Entrance (left) and water troughs (right) to the proposed open quarantine field site at KARI NRRC Kiboko.

KARI's Level II Biosafety Greenhouse

An artist's rendering of the Level II Biosafety Greenhouse to be built at KARI's National Agricultural Research Laboratory. The facility, the first of its kind in East Africa, is being funded by the IRMA project and will represent a major development of Kenya's biotechnology capabilities. Bid packages have been completed and are ready to be sent to the contractors. Groundbreaking is anticipated in early 2003.

(Mock Trials Planted cont'd...)

This facility will be used to verify, under field conditions, the results obtained from bioassays carried out at the biosafety level-2 laboratory, which were conducted to identify effective Bt Cry proteins against the five major Kenyan stem borers. The field study will repeat the experiments in which maize containing various *cry* genes, singularly and in combinations, were infested with stem borers (*Chilo partellus* and *Busseola fusca*). Results will promote optimal selection of combinations of genes for resistance to these stem borer species.

The KARI staff at Katumani and Kiboko comprises Mr. Kibet, the Center Director KARI, NRRC Kiboko, Mr. Wilson Muasya, a plant breeder and the overall manager of the KARI-Kiboko sub-center, Mr. Anthony Karuku, an engineer at Katumani, Mr. Duncan Mutinda, a technical officer and farm manager, Mr. Joel Mbithi, a technical assistant, and Mr. Paul Mmtoni, a technical operator. They have played critical roles in the development of the facility and are very excited about its operations. Those involved in the daily management and operations have undergone training by KEPHIS and KARI staff on the concept of quarantine (see KEPHIS Officials Conduct Training on Management of Open Quarantine Field Facilities, Pg. 7), and on the requirements, practical management, and operations of open quarantine site.

Mock trials

As we await approval by the Kenyan authorities for importation of Bt maize seed, it was necessary to calibrate the fields for growing maize and to train staff and collaborators on management of OQS facilities. This is being accomplished by growing mock trials. Two sets of mock trials have been planted. Twenty yellow-endosperm inbred lines of subtropical adaptation will represent transgenic maize in the calibration exercise. Possible dispersal to white maize grown in the border rows will be monitored for gene flow.

The Kiboko staff will receive hands-on training in routine management, including restricted access, disposal of plant and insect tissue, detasseling, irrigation, experimental designs and trial lay outs, and routine activities like rotations, land preparation, and proper handling of implements and equipment.

A formal training will be held there as well as seminars for local staff, scientists, and community leaders. KEPHIS will be invited to these training sessions and a special visit for KEPHIS will be arranged at harvest time to demonstrate capacity to manage a quarantine site. Two plantings will be made, one month apart. Layout for the design may be seen in the accompanying figure. Seed packaging will be undertaken in such a way that exact numbers are brought to the field and any remnant seed is destroyed by burning in the trenches provided in the field.

Infestation will be done in the first row of the inbred lines with 20 black-head eggs of *C. partellus* at the 4-leaf stage. All remnant insect eggs will be disposed by burning and burying the ashes in the trenches provided in the field. Petri dishes will be cleaned thoroughly and disinfected before leaving the field. Every two weeks after infestation, dead hearts in each plot will be counted and leaf damage scored.

All plants in the inbred line rows will be detasseled as the tassels emerge. This is a critical activity in these mock trials, with the aim that no yellow seeds will be produced in the white endosperm border rows. Similarly, all plants in the border rows will be detasseled to ensure that no seed will be produced in the inbred line rows. Training and visits by KEPHIS will be organized three months after planting. The ears will be opened in the border rows and in the inbred

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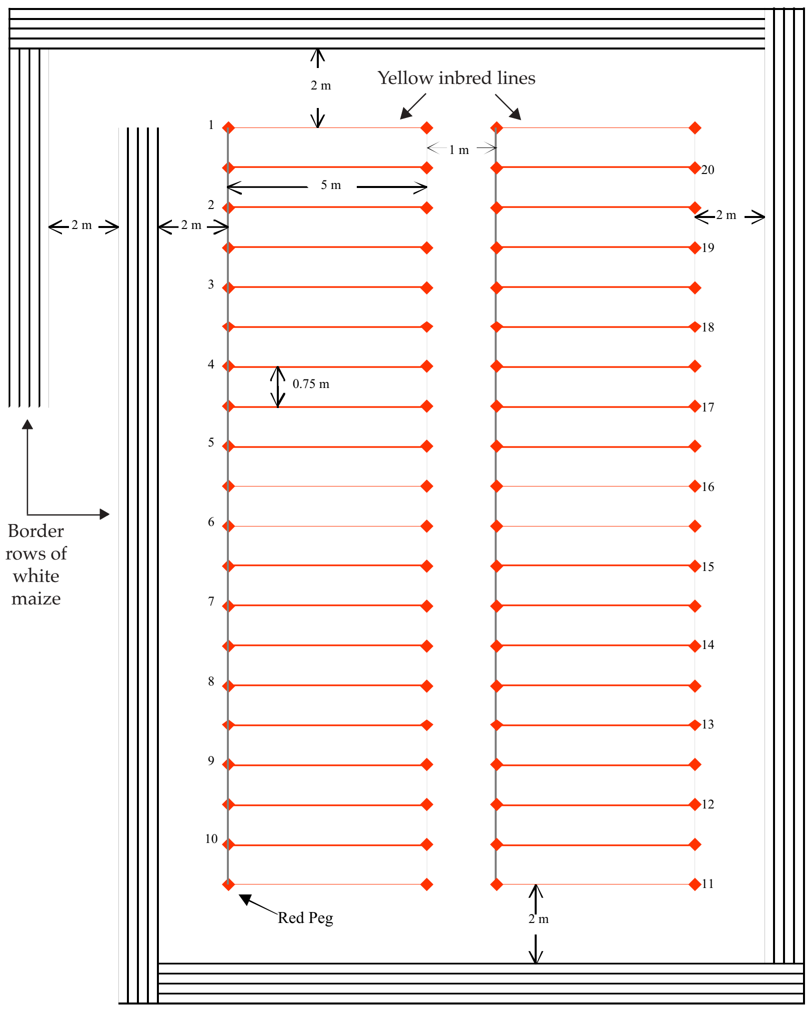

Inbred lines = Yellow endosperm lines of subtropical adaptation
Borders = H513

Layout of mock trials to be grown at the open quarantine field facility at Kiboko during 2003A season.

(Mock Trials Planted cont'd...)

lines to demonstrate that (1) no single seed is recovered from the inbred lines, and (2) no single seed exhibiting yellow xenia is found in the border rows.

Stems will be split from all plants in the first inbred line rows where infestation was undertaken and the number of stem borer tunnels and visible exit holes counted, length of each tunnel measured, and cumulative length for each plant recorded.

After harvesting, all plant material (including pegs) will be dried in the field for one week and later burned in the trenches, and the ashes buried.

—S. Mugo

First set of mock trials planted Sept. 10 2002.

Seminars Inform Extension Staff about Bt Maize Issues

What is Bt maize? Is it safe to eat? Is it safe to grow? What is a refugia and how is it used? Such issues may seem like "old hat" to IRMA researchers who have been involved with these topics for the last four years. But to the extension staff of the Ministry of Agriculture and Rural Development (MOARD), it is new territory.

In July 2002, IRMA coordinated and sponsored a series of seminars for the Kenya extension service that addressed various aspects of Bt maize. More than 120 individuals participated in the seminars, which were made to groups of 20–30 individuals comprising the Director from the respective KARI Center, the Provincial Director of Agriculture and Livestock Extension (PDALE), the Provincial Crops Officer (PCO), the Provincial Livestock Officer (PLO), the District Agriculture and Livestock Extension Officer (DALEO), the District Crops Officer (DCO), and Research Extension Liaison Officers (RELOS) from MOARD and KARI. The seminars were held in the five major maize growing regions of Kenya and each was hosted by the KARI center in the vicinity: Mombasa, Machakos, Embu, Kaka-mega, and Kitale.

The specific objectives of the seminars were to

1. familiarize the extension staff and answer their questions about the IRMA project and Bt maize.
2. discover information areas IRMA needs to address;
3. identify extension staff who are particularly good communicators. They may later be asked to help make video and/or radio productions for use with extension officers and farmers;
4. look for innovative ways to communicate about the technology and effective messages that will resonate with farmers; and
5. help IRMA scientists refine a series of fact sheets on Bt maize through feedback and suggestions from extension staff.

The seminar programs began with an overview, by a local extension officer, on the insect pest problems in their respective region. Presentations by the seminar team followed: The stem borer problem and current control options (M. Mulaa); Economic impacts of borers on maize production systems (O. Okuro); The IRMA Project–goals, objectives,

Resource persons for Machakos extension seminar.

activities and expected outputs (S. Mugo); 'What is Bt Maize?' (S. Mugo); Insect resistance management in Kenya (M. Mulaa); Bt maize and the environment (J. Songa/M. Mulaa); Biosafety regulations in Kenya (J.K. Ng'eno); and Bt maize and food safety (S. Mugo).

Later in the program, extension officers broke into groups to critique one of six fact sheets that IRMA is preparing on key issues related to Bt and insect resistant maize. The fact sheets were prepared in early 2002 and tested and

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(Seminars Inform Extension cont'd...)

refined by IRMA entomologist David Bergvinson with the help of researchers and extension officers from Kitale. In June, revisions were made based on this feedback and refinement continued at the extension seminars.

"The feedback was extremely useful," say IRMA project coordinator Stephen Mugo. "Comments ranged from changing the format and using more bullet points and less text to some very technical but nonetheless important points. They really helped us focus in on creating messages that grassroots extension officers can use."

The final session of the day was the "Star Search" exercise, led by IRMA communicator David Poland. Individual extension staff made five-minute presentations, which were videotaped, on one of three topics: What is Bt maize?; What is a refugia and why do we need to use it with Bt maize?; or Is Bt maize safe to eat? Farmers were the imagined audience for these presentations, and participants could present in English or Swahili. The "Star Search" presentations were judged and a modest prize was given to the winner of each topic (see Table).

This exercise had three objectives, Poland explains. "First, it indicated how well the participants had actually assimilated what they heard. Second, the presenters provided us with unique and entertaining ways of getting these messages across. And third, we identified exceptional communicators that we may use later in our communication work. In addition, we hope to use the video we recorded in various extension and farmer venues."

"Star Search" participants at each location (Winners are underlined)

Q1. What is a Bt maize plant?

Machakos	Embu	Kakamega	Kitale	Mtwapa
1. B. K. Mureithi	1. Githinji V. N	1. S. O. Ipomai	1. Simanto Oscar	1. Ngunyu P. W
2. A. N. Njaimwe	2. Mwoga G. M	2. Ireri D. N	2. O. T. Adede	2. W. Mureithi
3. B. W. Kamau	3. Mwai George	3. L. Kibisu	3. Makheti N. J. M	3. M. W. Opilo
4. D. K. Wahome	4. Nyaga P. R	4. B. Kingori	4. Felicia N. Ndung'u	4. A. Onyango
5. Kikuri B. M.				5. Wachira J. T

Q2. What is a Refugia and why do we need to use it with Bt Maize?

Machakos	Embu	Kakamega	Kitale	Mtwapa
1. Elizabeth Mwangangi	1. M. N Nduru	1. S. M. Maiko	1. Simanto Oscar	1. Evan Mbinga
2. Jane Otadoh	2. E. K. Magambo	2. J. I. Mose	2. Jared K. Mutai	2. P. A. Odhiambo
3. Mercy Waithaka		3. W. G. Oduori		3. Wachira J. T
4. V. N. Ndetu				

Q3. Is Bt Maize safe to eat (why does it kill borers but not hurt people or animals)?

Machakos	Embu	Kakamega	Kitale	Mtwapa
1. Ruth Mwangi	1. Misheck Kaburu	1. S. O. Ipomai	1. Leonard K. Kubok	1. D. M. Mwamachi
2. T. Mahali	2. J. T. Muchoki	2. J. L. Mbato	2. Oluoch Mbai	2. S. Abdillahi
3. D. K. Mwanga		3. S. K. Muhindi	3. R. K. A. Sargo	3. S. K. Angore
4. Muyu Muindi		4. Ogalo BER	4. Odari N.	4. Chege
		5. B. M. Walela		5. OwiroMbinga Martin

Mugo adds "we learned from write-ups that the participants were asked to bring to the seminars that while many of them thought that biotechnology could contribute to food security, they had considerable apprehension about the technology. Most of those concerns were borne of ignorance—a lack of good scientific information. And so, at the end of the day," he says "it was gratifying to hear the extension agents declare on their own volition that their fears about biotechnology and Bt maize have been 'erased.'"

The seminar organizers and resource persons, Stephen Mugo and Grace Kimani, wish to thank their fellow resource persons Dr. M. Mulaa, Dr. J . Songa, Mr. D. Poland, Mr. J. Ng'eno, and Mr. O. Okuro for the excellent presentations, responses to questions, and the team spirit that they exhibited at all locations. Thanks are also in order for the organizers at each location: Dr. Charles Mutinda at Embu, Mr. James Gethi at Mombasa, Mr. Christopher Mburu at Kakamega, Dr. Kiarie Njoroge at Machakos, and Dr. George Ombakho at Kitale, together with their staff at each location for their excellent logistical support and for organizing field visits.

We also want to especially thank Dr. Ephraim Mukisira, Deputy Director, KARI, for his participation and words of advice he delivered while opening the

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Participants listen keenly during the presentation at Kitale.

Mrs Otadoh (right), a "star", receives her award in Machakos from Mr. J.K. Ng'eno (left) and Ms. Grace Kimani (center).

(Seminars Inform Extension cont'd...)

seminars at Mombasa and Kakamega. The KARI Center Directors (Dr. R. Muinga at Mtwapa, Dr. G. Okwach at Katumani, Dr. M. Gethi at Embu, Dr. Odongo at Kakamega, and Dr. C. Nkonge at Kitale) did us all proud by participating and/or officially opening the seminars at their respective centers.

Finally we thank Mr. J.K. Ng'eno, Deputy Minister of Agriculture and Rural Development for participating in various capacities and above all for allowing his staff to accommodate the seminars within their busy schedules.

—S. Mugo, D. Poland, and G. Kimani

IRMA entomologist David Bergvinson reviews and revises draft fact sheets with Kitale extension officers during May visit.

Study Compares Effects of Bt Biopesticide and Conventional Insecticides on Nontarget Arthropods

All pest management technology, be it biological, cultural or chemical based, may have effects on nontarget arthropods in the environment. There is no risk-free technology, so decisions about using specific pest control methods must be based on analysis of the technology's benefits and risks.

A major purported advantage of Bt maize is that it reduces reliance on conventional broad spectrum insecticides, which have negative effects on nontarget beneficial insects. However, there is little data under Kenyan field conditions to either support or refute this assertion. For Kenyan regulatory agencies to consider the deployment of Bt maize, information must be generated on its effects on nontarget arthopods and how it compares to conventional insecticides.

In response to this need, IRMA scientists conducted a study at the KARI Katumani Field Station during the long rains (LR) and short rains (SR) of 2001, to evaluate and compare the effects of a Bt biopesticide (Thuricide™) and conventional insecticides (Bulldock™ and dimethoate), on target and nontarget arthropods found in a maize/bean cropping system. Because Bt maize currently may not be grown in Kenya, the study used the Bt biopesticide to simulate it because of their similar mode of action and specificity of pest control. Bulldock is used against lepidopteran stem borers, while dimethoate is a broad spectrum insecticide for bean pests. Plots of maize/bean intercrops were established and subjected to three treatments: Bt spray, conventional insecticides, and control (untreated). Three types of traps (pit-fall, sticky, and water traps) were set up in each plot for weekly collection of arthropods from within the maize stand and from the soil surface. Maize plants were sampled three times a season to identify stem borer species, which were then reared in the laboratory for possible parasitoid emergence.

The stem borers (target pests) that infested maize at Katumani during the LR and SR, 2001, in descending order of abundance were *Chilo partellus*, *Sesamia calamistis*, *Cryptophlebia leucotreta*, and *Busseola fusca*. Infestation was lowest in the Bt-sprayed plots followed by the insecticide treated plots; the untreated maize had the highest stem borer intensity. In both seasons, the control plots had the richest diversity of parasitoids, while the conventional insecticide plot had the least. The parasitoids in the three respective treatments during the LR were control: *Cotesia flavipes*, *C.sesamiae* and *Pediobius furvus*; Bt-spray: *C. flavipes* and *P. furvus*; and insecticides: *C. sesamiae* and *P. furvus*. The parasitoids in the SR were control: *C. flavipes*, *C. sesamiae*, *Chelonus curvimaculatus*, *P. furvus* and *Dentichasmias busseolae*; Bt-sprays: *C. sesamiae*, *D. busseolae*, and *P. furvus*; and insecticides: *C. sesamiae* and *P. furvus*. Of the collections from the traps, the insecticide-treated plots had the lowest number of nontarget (NT) arthropod families and arthropod abundance. NT arthropod families in the control, Bt-spray, and insecticide plots during the LR numbered 55, 47, and 33, and in the SR, 49, 53, and 38, respectively. The abundance of NT arthropods in the control, Bt-spray, and insecticide treated

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(Study Compares Effects cont'd...)

plots in the LR was 1653, 1522, and 976, and in the SR it was 1524, 1816, and 1203, respectively.

Of the recovered beneficial NT arthropods, there were significantly less ladybird beetles (coccinelidae), rove beetles (staphylinidae), and honey bees (Apidae) in the insecticide treated plots as compared to the control and Bt-spray maize crops, during both LR and SR 2001. Although the Bt-spray appeared to have a negative effect on the bees, the effect was less than that found in the insecticide plots. However, there were significantly more rove beetles in the Bt-spray plots than in both the control and in the insecticide plots, in both seasons, suggesting that the Bt-spray had a positive impact on this predator. Ladybird beetles and rove beetles are important predators of stem borer larvae; bees are important as pollinators in the field and for honey production. Ladybird beetles are also predators of other important pests such as aphids.

Dr. Josephine Songa examines insects in the laboratory.

This study shows that the insecticides and Bt-biopesticide spray were very effective in reducing stem borer infestation in maize, but the insecticides appear to have more negative effects on nontarget arthropod diversity (families) and abundance, on beneficial insects, including important parasitoids and predators of stem borers, and on a key pollinator (honey bee). Since Bt-spray and Bt maize have similar modes of action, through the Bt endotoxins, these results may indicate some potential impacts of Bt maize on target and nontarget arthropods, compared to commonly used insecticides. This study also provides a standard protocol that can be used for future field evaluations of nontarget impacts of Bt maize in Kenya. Additional studies will be conducted in other Kenyan maize agroecologies to confirm the findings.

—J. Songa

Pediobius furvus (a pupal parasitoid) adults emerging from a stemborer pupa.

Updates on IRMA Training Efforts

Training of staff is a high priority for the IRMA project, which emphasizes capacity building and technology transfer. The trainings outlined in the strategic plan for 2002 and 2003 were refined to develop the schedule shown in the accompanying table. The areas requiring most immediate attention are transformation, and biosafety in the greenhouse and in the open quarantine field facility.

Transformation: Two scientists from KARI will be trained at CIMMYT-ABC in Mexico in transformation and molecular analysis. Mrs. Catherine Taracha, of the KARI Biotechnology Center at NARL in Nairobi began training in September, and a second scientist is being identified and will soon travel to CIMMYT-Mexico.

Biosafety for greenhouse and field operations: Four scientists from KARI and KEPHIS will undertake training in biosafety in the greenhouse. Mr. Kennedy Onchuru and Mr. Benson Kuria have been nominated by the KEPHIS Director to undergo this training at CIMMYT-Mexico in October 2002.

Training in biosafety in the open quarantine field facility will comprise two parts: (1) training on management of the facility (see KEPHIS Officials Conduct Training on Management of Open Quarantine Field Facilities, Pg. 7) and (2) training for KEPHIS and KARI staff, to be conducted as part of mock trials in early 2003.

Biosafety and institutional management: In October, 2002, representatives from KEPHIS, the Ministry of Agriculture, and KARI will visit key government agencies and institutes in the United States and Mexico to learn first-hand how biotechnology regulations have been developed and implemented, with stress given to the practical aspects of these tasks. The high level delegation will include Dr. Wilson Songa, Assistant Director of KEPHIS, Ms. Jane Wangui Mumo Gathuru of KEPHIS, Mr. Joel Ng'eno, Deputy Director of the Kenya Ministry of Agriculture and Rural Development, Dr. Ephraim Mukisira, Deputy Director of KARI, and Dr. Christopher Ngichabe, Center Director, KARI Biotechnology Center, and Coordinator, Biotechnology Initiatives, ASARECA. They will be accompanied in the United States by Dr. Stephen Mugo, IRMA Project Coordinator and Dr. Scott McLean, CIMMYT, and in Mexico by Dr. David Hoisington, Director of the CIMMYT

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(Updates on IRMA cont'd...)

Applied Biotechnology Center, Mr. David Poland, CIMMYT, Dr. Alessandro Pellegrineshi, Dr. McLean, and Dr. Mugo. The trip will allow those directly involved with biosafety in Kenya to openly interact with officers from the United States Department of Agriculture, the Environmental Protection Agency, the Food and Drug Administration and the Animal and Plant Health Inspection Service. While in the United States, they will also visit the Syngenta Corporation laboratories in North Carolina.

In Mexico, the Kenyan visitors will meet with CIBIOGEM (Dr. Fernado Ortiz Monasterio), which is the Mexican national biosafety committee. They will also visit CINVESTAV, a polytechnic institute heavily engaged in genetic engineering and biotechnology (Dr. Luis Herrera); INIFAP, the Mexican national agricultural program (Dr. Sebastan Acosta); and Sanidad Vegetal, the agency in charge of plant quarantine and phytosanitary enforcement (Dr. Jorge Hernandez Baeza and Ing. Marco Antonio Cotero, who handles transgenic agriculture plants and products). Visits will also be made to the CIMMYT Maize Program and CIMMYT Applied Biotechnology Center to have an overview of the laboratories, biosafety greenhouses, and other activities.

IRMA project training plans as of August 2002.

Type of Training	Participants	Training Location	Timing and Duration
1.Transformation – Tissue culture – Molecular analysis	1. C. Taracha 2. To be nominated	CIMMYT- Mexico	September 2002: 6-12 months
2. Biosafety • Greenhouse operations	2 KARI scientists 2 KEPHIS officers	CIMMYT- Mexico	October, 2002: 2 weeks
• Field site (management)	10 KARI scientists 5 KEPHIS officers 20 KARI scientists	NARL, Muguga & Embu	Sept. 2002
• Field site (mock trial)	5 from other institutions	NARL, KARI – Kenya	March 2003: 3 weeks
– Management (visits to biosafety facilities)	KEPHIS- Dr. W. Songa KEPHIS -Mrs. Jane M. Gathuru KARI -Dr. E.A. Mukisira KARI -Dr. C. Ngichabe MOARD/NBC – Mr. J. K. Ngeno CIMMYT – Dr. S. Mugo CIMMYT – Dr. D. Hoisington	USA and Mexico	4–19 October 2002: 2 weeks

Maize weevil resistance: In an IRMA-related training, Mr. Paddy Likhayo, a KARI entomologist working with the crop protection research program at Kiboko, visited CIMMYT-Zimbabwe in late August to observe maize weevil resistance breeding project activities conducted by Dr. Kevin Pixley. The objectives were to learn about methods and recent research results from the Zimbabwe work, discuss and identify areas for enhanced collaboration between the two institutions in the development of insect resistant maize varieties, and visit the winter nursery field station at Mzarabani, Zimbabwe.

—S. Mugo and S. McLean

KEPHIS Officials Conduct Training on Management of Open Quarantine Field Facilities

Introduction

With the proposed open quarantine field facility at Kiboko being operational with irrigation and other essential features working well, and having already planted one set of mock trials using yellow endosperm maize inbred lines to stand for Bt maize, the first training was on management of the facility per se. This was done in Nairobi and Embu, 23-24 Sept 2002. Ten KARI scientists (see Table) took part in this training by KEPHIS staff in charge of quarantine services and by KARI staff that are running the field sites where transgenic sweet potato is being evaluated.

The open quarantine site (OQS) facility will be managed by a team at Kiboko; Mr. Wilson Muasya, a plant breeder and the overall manager of the KARI-Kiboko sub-center, Mr. Duncan Mutinda, a technical officer and the farm manager, Mr. Joel Mbithi, a technical assistant, and Mr. Paul Mmtoni, a technical operator. The maize breeders at other KARI centers will take responsibility for IRMA project maize breeding activities at their respective centers and will eventually have activities related to the OQS at one time or other. Dr. Josephine Songa will be very involved with the facility. Everyone needs to be exposed to the proper management of this important facility, and though our scientists are competent and experienced in their disciplines, most have never worked at an operational open quarantine site.

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Participants in a training on management of open quarantine field facility held 23-24 Sept at Nairobi and Embu.

	Name	Title	KARI Center
1	Mr. Benjamin Muli	Agronomist	KARI Mtwapa
2	Dr. Jane Ininda	Maize Breeder	KARI Muguga,
3	Dr. Charles Mutinda	Maize Breeder	KARI Embu
4	Dr. George Ombakho	Maize Breeder	KARI Kitale
5	Mr. Christopher Mburu	Maize Breeder	KARI Kakamega
6	Dr. Josephine Songa	Entomologist	KARI Katumani
7	Mr. Joel Mbithi	Technical Assistant and overall in charge of the operations of the facility at Kiboko	KARI Kiboko
8	Mr. Wilson Muasya	Maize Breeder and the overall manager of the KARI-Kiboko sub-center	KARI Kiboko
9	Mr. Duncan Mutinda	Technical Officer and the farm manager Kiboko	KARI Kiboko
10	Mr. Paul Mmtoni	Technician	KARI Katumani

(KEPHIS Officials cont'd...)

Presentation by KEPHIS

Dr. Wilson Songa, the Assistant Director, Plant Protection Service in KEPHIS, organized the training on quarantine measures. His team of scientists from KEPHIS head office and those at the National Quarantine station at Muguga made presentations. The main presentation on open quarantine status was made by Dr. Anne Kingiri and Mr. Kennedy Onchuru. Participants learned that there are three types of open quarantine: (1) open quarantine status granted for quarantine or restricted/ prohibited imports, (2) open quarantine status granted for biocontrol agents, and (3) open quarantine status for genetically/living modified agents. The IRMA project proposed open quarantine facility falls under the latter category, which requires approvals by the NBC and an inspection by the Kenya Standing Technical Committee for Imports and Exports (KSTCIE). Facilities under this category can be field (including glass houses) or laboratory. The field facility must be well fenced with only one entrance and the following in place:

- A water tap for washing before and after work.
- A 24-hour guard in the facility. The fence should be checked continuously to ensure security.
- A disinfecting trough with disinfectant.
- Trained personnel assigned to the facility.
- Isolation distance is crucial, e.g., 200m for genetically modified sweet potato from any other type of sweet potatoes or members of the same family.
- No permission of unauthorized persons to enter the facility.
- All observations on the plants in the facility to be recorded and made available when needed by KSTCIE, NBC, or KEPHIS.
- Workers in the facility must be in gumboots and hand gloves whenever they are in the facility.
- Impromptu inspections to be done regularly by KEPHIS.

Application for open quarantine status

Open Quarantine Status is granted through KSTCIE, a specialized committee established under the provisions of Cap. 324. The membership of the committee includes

(a) Director of Agriculture (Chairman);
(b) Managing Director, KEPHIS, (Secretary);
(c) Director, KARI;
(d) Pathologist, KARI;
(e) Entomologist, KARI;
(f) Head, Crop Protection Branch, Ministry of Agriculture and Rural Development;
(g) Assistant Director, Plant Protection Services (KEPHIS);
(h) Officer-in-charge, Plant Quarantine Station (KEPHIS);
(i) Secretary, National Biosafety Committee (NBC), National Council for Science and Technology (NCST);

The committee considers applications for importation of plant, plant products, biological control organisms, genetically modified products, seeds, and biopesticides, that are not otherwise eligible for importation under Cap 324. The Open Quarantine Status required for use of these products is considered as a prerequisite before approval for importation of these materials is granted. The meetings of the committee are convened by the secretariat in consultation with the Director of Agriculture and Livestock Production.

Dr. Simon Gichuki explains the biosafety greenhouse where transgenic sweet potatoes are grown.

Application procedures for open quarantine status

1. All requests for Open Quarantine Status consideration must be made to KSTCIE.
2. The application/requests is discussed by KSTCIE.
3. Decision by KSTCIE where inspection of the facility is recommended.
4. Inspection is done by KEPHIS (for status I) and KSTCIE (for status 2 81 3).
5. Inspection report is discussed during the subsequent KSTCIE meeting.
6. Upon satisfactory inspection reports, permits stipulating conditions set out by KSTCIE/KEPHIS are issued by KEPHIS.
7. Plant Import Permit for status I.
8. Biological Import Permit for status 2.
9. Genetically Modified Import Permit for status.

During discussions, KEPHIS indicated that they could only be involved in IRMA's mock trials if we have a quarantine status. The advice was for us to apply for an ordinary quarantine status indicating intention to upgrade the facility to the level required for GMOs. An application will be made and presented to the KSTCIE soon.

KEPHIS National Plant Quarantine Station in Muguga

Dr. Kimani, the center director briefed the group on the functions of the center and its purpose: to facilitate introduction of germplasm and isolate diseases, in short to enable access to germplasm but keep disease away. The center was established in the 1930s, but acquired by KEPHIS in 1996. The materials handled include those requiring permits, the various quarantine types, and the prohibited materials. Other activities include virus testing of imported materials, seed testing for disease, importation of biological agents, and setting GMO regulations.

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(KEPHIS Officials cont'd...)

KARI sweet potato glass house and field facility at NARL Kabete

The group was shown the KARI Biotechnology Center laboratories for tissue culture and for animal biotechnology research, as well as the biosafety level 2 laboratory by Dr. Benjamin Odhiambo and Dr. Simon Gichuki. The contribution of the IRMA project in the design of the laboratories and the proposed greenhouse complex were mentioned.

The sweet potato glass house and field facilities were visited. The glass house is small but meets all requirements for an open quarantine facility. There is a moat and restricted access where sweet potato vines are grown. The sweet potato fields are planted with transgenic potato while the border crop is a bean. Four staff members are designated to work there.

KARI sweet potato glass house and field facility at RRC Embu

The group visited the OQS facility for evaluating sweet potato at Embu. The structure is modest in form and function. Dr. Linus Muriithi and Dr. Mutinda showed the group around the facility. Muriithi explained how they have improvised to meet the necessary requirements.

The team then visited IRMA project activities in Embu including evaluation of 60 inbred lines against *Chilo partellus*, evaluation of elite germplasm from Harare for resistance to stem borers and for adaptation, evaluation of insect resistant single cross and three-way cross hybrids, and the IRM studies. CEB trials by Dr. Mutinda and other KARI Embu-CIMMYT collaborative trials including the MSV screen house were also visited.

The team expressed that they learnt a lot about managing OQS facilities. The Kiboko team believes that we need to do the following:

- Install a water tank to provide water for washing at all times in the OQS at Kiboko.
- Designate four regular staff to work in the facility.
- Purchase gumboots for use while at the center.
- Purchase a good amount of disinfectant for use in the water trough.
- Provide adequate training for individuals working inside the facility and information for all concerned.

We are grateful to Dr. Wilson Songa of KEPHIS and his staff for their presentation. We also wish to thank Dr. Odhiambo and Dr. Gichuki of KARI Biotechnology Center and Dr. Macharia Gethi, Dr. Muriithi and Dr. Mutinda, all of Embu, for conducting us through their centers.

—S. Mugo

Dr. Linus Muriithi conducts the team on a tour in the OQS facility at KARI, RRC Embu.

Maize Diversity Studies Initiated

The rapid development and dissemination of new varieties, including those produced through genetic engineering, can make established landraces obsolete. When farmers adopt the improved varieties, they often stop growing the landraces, leading to an overall decrease in genetic diversity and biodiversity. This carries a double risk. First, the landraces might be lost forever. Genes carrying traits of interest, in particular, resistance to pests and diseases, might be lost to future generations. Second, a narrowing of the genetic base in a particular crop makes it more vulnerable to pests.

In studying the potential impact of insect resistant maize varieties in Kenya, it is therefore important to include the potential impact of such varieties on the genetic diversity and biodiversity of maize, in particular on local varieties (landraces). A first analysis of maize biodiversity in Kenya, based on the PRA results, showed that although agricultural intensification decreased the number of local varieties, it does not decrease the biodiversity, since farmers grow a wide range of improved varieties (De Groote et al. 2002). Only the highlands had less biodiversity, basically because the overwhelming popularity of the veteran variety H614 does not leave much area for planting other varieties.

In August 2002, IRMA initiated a baseline data survey to measure biodiversity in much more detail. While visiting farmers to collect socioeconomic data, the IRMA Economics team began acquiring samples of the varieties farmers are currently growing. The baseline survey was launched in the transitional zone around Embu, where 10 farmers were visited in each of 20 sublocations. Samples of each of their local varieties were taken. In collaboration with IPGRI and the National Genebank of Kenya, samples of interest will be planted out for morphological characterization and sent to the lab for molecular characterization.

(cont'd on page 10...)

(Maize Diversity cont'd...)

By the end of the survey, the team hopes to have all the local maize varieties they collected described and characterized. This data will promote the analysis of factors bearing on changes in biodiversity and genetic diversity. In addition, it will provide a host of accessions to be stored and maintained for future use.

De Groote H., J. O. Okuro, C. Bett, L. Mose, M. Odendo, E. Wekesa. 2002. Using Participatory Methods To Quantify Biodiversity In Maize. Poster presented at the 10th Congress of the European Association of Agricultural Economics (EAAE), Zaragoza (Spain), 28-31 August, 2002

—H. De Groote, G. Owuor, O. Okuro, and S. Mugo

Socioeconomists survey farmers and collect varietal samples to determine maize biodiversity in key study areas.

Field Trials and Surveys to Address Insect Resistance Management Issues

Insect resistant plants containing a gene from the common soil bacterium *Bacillus thuringiensis* (Bt) are becoming increasingly important for pest management in maize. However, since resistance to Bt toxins has been reported in more than 11 insect species in laboratory studies, there is a risk of resistance developing in transgenic maize and hence the need to look for insect resistance management strategies to prolong the efficacy of Bt maize for Africa.

Most of the available guidance on strategies for managing insect resistance to Bt toxins is theoretical and lacking supporting experimental data. Generally, resistance management strategies are based on three principles: (1) diversifying mortality sources (such as incorporating conventional resistance), (2) reducing selection pressure from each mortality factor to the target pest, and (3) maintaining susceptible pest populations. Insect resistance management strategies have largely focused on the third principle.

The best way to maintain susceptible pest populations and slow development of resistance is to provide "refugia," which are suitable host plants located in close proximity to Bt plants. Refugia can be further defined as a food source in time or space that does not impose a selection pressure so as to maintain a susceptible population base to mate with resistant individuals, thereby delaying the development of highly resistant individuals.

In North America, the refugia recommendation is that 20% of the crop is planted to non-Bt maize. However, in some parts of Kenya, farmers may not be willing to plant susceptible maize plants, in which case alternate hosts for stem borers may serve as a refugia. The most important alternative hosts of the four major Kenyan stem borers are reported to be cultivated sorghum, *Sorghum versicolour, Sorghum arundinaceum*, napier grass (*Pennisetum purpureum*), and *Hyperrhenia rufa.*

As part of the IRMA project, a team of scientists headed by Dr. Margaret Mulaa is investigating suitable refugia for maize stem borers. Trials have been conducted in Kitale (highland), Embu (midaltitude), and Mtwapa (lowland tropical) to identify oviposition (egg-laying) preference, survivorship, and economically viable alternate hosts to serve as refugia.

Results to date show that several local sorghum varieties are highly attractive to stem borers and produce four times as many stem borers as commercial (non-Bt) maize varieties. Napier grasses, a popular forage, are also a preferred host for stem borer oviposition, but only produce 50% as many larvae as commercial maize varieties. This means that a 10% area of sorghum or a 40% area of napier grass would be required to provide suitable refugia. The economic return per unit area of these alternate hosts is also being examined as farmers are increasingly diversifying their production to include cattle and milk production and napier grasses will play a key role.

During May 2002, a survey was developed, in collaboration with Kitale extension officers, to define the availability of alternate hosts and farmers' preferences for different grass species that could serve as economically viable refugia. Once tested and refined, the survey was taken to farmers in four major maize growing ecologies in Kenya. Surveys were stratified to include large-scale commercial farmers through intermediate and small-scale farmers. These surveys have already identified the need for structured refugia in the Kitale region, which is the

(cont'd on page 11...)

(Field Trials and Surveys cont'd...)

maize belt of Kenya. Once the survey data has been analyzed, maize ecologies can be classified into those with adequate refugia and those areas where a structured refugia will be required. These regions should be identified by the end of 2002.

With this information, training of extension officers can focus on regions where structured refugia will be essential. In conjunction with this effort, fact sheets are being developed to equip extension officers with the tools to explain how Bt-maize works, the concept of insect resistance management, refugia, and tactics to reduce production and storage losses.

— M. Mulaa, S. Mugo, and D. Bergvinson

Dr. Margaret Mulaa guides visitors through the insect resistance management (IRM) strategy trials at KARI-RRC Kakamega.

Recycling of Maize Seed in Eastern Kenya

The development and dissemination of hybrid maize varieties in Kenya is one of the success stories of agricultural research and development in Africa. The first varieties were released in the 1960s and spread very rapidly. They were first adopted by large-scale farmers in the high potential areas, followed by the small-scale farmers in the high potential areas. The popularity of hybrids is based on their desirable characteristics, most of all, yield, derived from the hybrid vigor that comes from crossing two very different lines. This hybrid vigor, however, disappears in following generations and therefore recycling of hybrid seed is not recommended.

"During our participatory rural appraisals (PRAs) and in other discussions with farmers, breeders, and stockists, we realized that recycling of hybrids by farmers is very common in Kenya," says IRMA socioeconomist Hugo De Groote. "Farmers told us that indeed there is a decrease in yield, but not a large one. Consequently, given the high cost of seed, recycling hybrids is often economical, especially when the farmer faces a cash constraint.

In searching the literature, the IRMA economics team found little empirical information on yield reduction in recycled hybrid seed. Consequently, they decided to go out and measure the yield reduction themselves, in order to subject the practice of recycling to economic analysis.

Their study began with the long rains of 2002, in areas surrounding the KARI experiment stations at Embu and Kitale. In Kitale, yield changes were only measured on-farm, while in Embu the effect was also followed in a more controlled on-station environment with controlled outcrossing of the varieties. As of late September 2002, the on-station plots had not been harvested, but on-farm plots harvested earlier in September provided some very interesting results. During the season, scientists and field extension visited farmers in eight villages and selected plots in established fields with pure maize stands. The team found that the farmers planted two hybrid varieties, H513 (an older variety from the Kenya Seed Company) and PHB3253 (more recently introduced by Pioneer), and one open pollinated variety (OPV). Plots of 10 x 10 m were marked in maize fields planted with fresh seed, and once or twice recycled hybrid seed.

At harvest time, officers went back to the farmers to measure the harvest of the plots. Results show that fresh H513 seed produces 3.5 t/ha, but the yield decreases to 3 t/ha after recycling, and remains roughly the same for the third cycle (see Table). The yield of PHB3253, on the other hand, does not change significantly between fresh seed and once recycled, 3.2 and 3.1 t/ha, respectively. At the second recycling (third generation), however, it drops dramatically to 1 t/ha. The OPV also had a yield of 3 t/ha, but the farmers could not recall the number of times this variety had been recycled.

What are the costs and benefits when farmers recycle hybrid seed? IRMA scientists went on-station and to the field to get an answer to this key question.

For the economic analysis, the economists multiplied the yield by the maize price, currently about KSh 8,000/t (about US$ 100). Thus, the economic loss of recycling ranges from KSh 400 to KSh 4,000 per ha in the first season,

Mean maize yield from different generation seeds.

Generation	Variety	Mean yield t/ha
Fresh seeds	H513	3.54
	PHB 3253	3.24
Second generation	H513	3.01
	PHB 3253	3.07
Third generation	H513	2.99
	PHB 3253	1.01
Unknown	OPV	3.03
Mean		***2.84***
CV		***28.3***
LSD		***1.02***

(cont'd on page 12...)

(Recycling of Maize cont'd...)

and between KSh 40 and KSh 8,000 for the second season. This is then compared with the cost of seed, currently KSh 2,750/ha. Clearly, the economic benefit of purchasing fresh seed every year is small compared to the cost in the first year and, for H513 at least, even in the second year. Recycling PHB3253 more than once, however, is not economical.

The researchers are looking forward to getting more results with the completion of the harvest in Kitale, as well as the results of the on-station trials in Embu. Given the high variability of on-farm yields, it will be necessary to increase the sample size. Therefore, the trials will be extended to more regions and more farmers in upcoming seasons. The KARI station in Njoro has already agreed to collaborate in this work.

— H. De Groote, C. Muriithi, S. Mugo, and J. Gethi

IRMA Project Annual Project Meetings: 18–22 November 2002, Nairobi, Kenya

The Third Annual Meeting for the Insect Resistant Maize for Africa (IRMA) Project will be held 18–22 November 2002 at the Hilton Hotel, Nairobi. Following is the schedule of meetings:

Sunday, 17 November	Arrivals to the Hilton Hotel
Monday, 18 November	IRMA planning meetings
Tuesday, 19 November	IRMA planning meetings
Wednesday, 20 November	Visit to proposed quarantine field sites at Kiboko.
Thursday, 21 November	IRMA Steering Committee Meeting (SC members), follow-up planning meetings for other IRMA project participants
Friday, 22 November	IRMA Stakeholders' Conference, departures in the evening or following morning

On Wednesday, 20 November, there will be site visits to the mock trials underway at the quarantine field site in Kiboko.

On Thursday, 21 November, the Steering Committee meeting will take place at KARI headquarters. Those not involved in the Steering Committee meeting, will hold follow-up team meetings at the Hilton Hotel.

All are invited to participate in the Stakeholders' Conference that will take place on the afternoon of Friday, 22 November. We expect the Stakeholders' Conference to be concluded by 5 p.m., therefore, you may plan your departure for that evening or Saturday morning.

As in previous years, each project team is required to meet and discuss each team scientist's activities for 2002 and proposed work plan and budgets for 2003. These discussions will take place on Monday, 18 November. The Team Leader will then present a summary of the entire team's 2002 activities and proposed 2003 work plan and budget to the entire project group on Tuesday, 19 November. The reports/plans can be finalized on Thursday, 21 November by those not attending the Steering Committee meeting.

All project scientists are expected to prepare a draft annual report similar to what has been prepared in previous years. These should be sent to your team leader who will forward them to Dr. Stephen Mugo, the IRMA Project Coordinator, for compilation and circulation prior to the start of the annual meeting. The report will form the basis for each team's discussion and planning. There are many exciting things happening in the IRMA project and we are looking forward to sharing them as a group.

— S. Mugo

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Do you have a question or comment about the IRMA project or the quarterly newsletter articles? Or perhaps you have an article you would like to contribute. If so, please contact the IRMA Quarterly Newsletter editor at d.poland@cgiar.org or IRMA Coordinator Stephen Mugo (s.mugo@cgiar.org).