Superstition and science in the fight against stem borers

by Jürg Bürgi

The successful work of the IRMA project so far has mainly been due to collaboration among various groups of experts and researchers. Plant breeders, entomologists, sociologists, economists, and communications specialists are working together on ways of reducing crop losses suffered by small farmers on maize fields in Kenya.

When Joseph Mwangangi Kivuvo discovers the characteristic white feeding tracks left by the stem borer larvae, he sprinkles a handful of humus over them.

Here in the Machakos area, 60 kilometers southeast of Nairobi, in a region regarded by specialists as belonging to the "dry transitional zone", the annual rainfall is never more than 500 millimeters. The fields are terraced to prevent erosion. Kivuvo, a 71-year-old farmer, and his wife cultivate a plot of 10 acres (4 hectares) here, mainly planting maize, with beans sown in the summer.

The trick with the field dust truly works miracles, the sprightly old man assures consultant Josephine Malelu, who has come from the Agricultural Testing Station in Katumani. The agro technician is skeptical, but she doesn't show it - since she is not here to give instructions, but to listen. She has been collecting information about methods and problems in cultivating maize from Kivuvo's family and other farming families in the village for a year now. She is also measuring the losses of crops and stocks caused by pests. As Joseph Kivuvo admits, these can easily amount to one-third of the crop. Instead of having ten 90-kilo sacks, he then only has seven sacks per acre.

1 Recording crop losses

In early November, when the second (or short) rainy season begins, technicians and consultants from the Kenyan Agricultural Research Institute (KARI) mark out test areas of 10 square meters on the small farmers' maize fields, and spray them with the popular insecticide "Bulldok". The standardized procedure makes it possible to assess the crop losses caused by stem borers in the untreated fields fairly accurately. As the research director Hugo De Groote explains, "It's important that we don't disturb the farmers' ordinary everyday life. This is the only way we can find out how they work and what the problems are that they have to deal with in their fields. By providing us with information about their needs, the farmers are contributing to the development of new varieties of maize." A good example of the direct influence they have on the project's work is the extension of the research to storage pests such as the weevil *Sitophilus zeamais*, which add reductions in the harvest to the damage already done by the stem borers.

De Groote, who is from Belgium and works as an economist at the Nairobi branch of the International Maize and Wheat Improvement Center (*Centro Internacional para Mejoramiento de Maiz y Trigo, CIMMYT*), is manages IRMA's socio-economic research program. He has enthusiastic praise for the dedication that KARI's local specialists show in their work on the project. Josephine Malelu, for example, has to leave her apartment on the KARI station's grounds in Katumani before sunrise so that she and her team can meet ten farming families per day. She is "glad that my husband is able to look after our two little children" until she returns to the station late in the evening. On the bad dirt tracks, which are often sodden from downpours during the rainy season, even cross-

country vehicles make only slow progress.

2 Plow, dibble and hoe

The research work, which already started a year ago, has confirmed that only a few farms have more than two hectares of fields, and are mostly tilled by hand. Farmers who can be counted as prosperous - such as Joseph Kivuvo with his six acres, two cows, four goats, five sheep, 20 chickens, and three oxen - use a simple one-share plow. On the first pass, the seed is laid in the furrow, and after turning, the seed is covered. Often a dibble with a long handle is used, too. This tool and an ordinary hoe are also preferred for weeding. Farmers with livestock can fertilize the fields with manure. But there is not much to collect. The animals, roaming freely during the day on fallow land sparsely covered with bushes and thin trees, are not kept in sheds overnight. Joseph Kivuvo does not have any money to spend on chemical fertilizer and his crops remain well below the optimum yield, which agronomists estimate at 1.6 tons per hectare. It is only where farmers are able occasionally to buy and use fertilizer and seed - when they have access to micro-credits as members of self-help groups - that the crops are measurably larger.

The self-help groups have about 20 people in each, almost all women, and they meet twice monthly, with everyone paying in slightly more than 100 Kenya shillings (about € 1.35). About half of the money is available for loans; some 40% are given to members in a rotating fashion. The self-imposed interest rate of 14% per month is very high, but the borrowers did, however, not complain. They appreciate the availability of the money, and explain that the interest doesn't really matter with loans this small and with short repayment periods hardly ever extending beyond six months.

3 Little interest in innovation

Another study by the group of socio-economic researchers shows that a shortage of finance is only one factor tying harvest to substandard levels. The others are ignorance and a lack of interest. The great majority of the farmers stay stubbornly to tried and traditional ways. Newly bred varieties are almost exclusively planted where the farmers are able to produce more than they require for their own needs - in the fertile highlands and in the humid transitional zone.

More typical for Kenyan agriculture is the humid hilly zone in the west of the country. Here, the farmers are struggling against the fiendish *Striga* weed, which causes further reductions to the already modest crops produced on their poor soil. To make things even more difficult, the human population pressure is particularly high in this area, where 40% of all the maize fields are situated. Some 390,000 tons of maize are consumed per year, but the regional production amounts to only 232,000 tons. Studies in the Siaya district have shown an actual yield per hectare of 0.5 to 0.7 tons. If more appropriate varieties were planted and carefully fertilized, estimates indicate that level could be raised to 1.6 tons per hectare. But in western Kenya only one in five farmers is using improved seed, usually in addition to the familiar local varieties - and they can afford neither chemical fertilizers nor insect protection.

In a country with poor transport routes and incomplete statistical data, basic information like the above, which is of fundamental importance to the success of the IRMA project, can only be obtained locally through painstaking and detailed work. The project's directors are lucky to have young, highly qualified specialists such as Josephine Malelu and her colleagues, who are familiar with local conditions and can deal with people in the local dialect. Without them, it would not be possible to carry out the complex project.

4 Insect inventory

The team run by the entomologist Josephine Songa, also based in Katumani, is also playing a key role. They are developing an inventory of the region's insect population. Trained in Canada, Songa and her team set traps on the maize plantations, collecting alls sorts of beetles and moths. Then, after rough sorting, specially trained collaborators catalogue the insects. The task requires great concentration and good training; previous research has been sporadic at best in identifying local insect species and numbers. Josephine Songa often has to request advice from specialists at the

Museum of Natural History in Nairobi.

Research into the beetles and moths, caterpillars and larvae in Kenya's maize fields is an important prerequisite for later testing of plants into which the natural insect toxin *Bacillus thuringiensis* (*Bt*) has been incorporated using genetic technology. The aim is that the transgenic plants should exclusively affect only the dangerous larvae of the stem borer, leaving other species untouched.

The insect station at Katumani supplies the stem borers for controlled feeding tests and experimental pest attacks. In well-lit cages, the moths lay their eggs on strips of paper that are folded flat ("maize leaves") or rolled into tubes ("maize stems"). The larvae then grow in jam jars on a locally developed mixture of maize flour and dried and powdered maize leaves, with yeast, vitamins and agar, and finally they pupate.

5 Uncompromising precautions

For the IRMA project Kenya inherits expertise in science and agronomy, and importantly in regulatory policy at both the legislative and executive level. Precautions applied to Kenyan genetic research correspond precisely, and without any qualifications, to those in force in the industrialized countries. Stephen Mugo, project coordinator at the CIMMYT branch in Nairobi, had to wait nearly a year before the government body responsible gave him permission to import leaves of *Bt* maize plants from Mexico so that he could test the effectiveness of *Bt* on local stem borer species. Previously, in the summer and fall of 2000, a special secure laboratory was constructed in the grounds of the KARI headquarters near Nairobi, with a special team of scientific personnel trained to run the facility. And the further the project develops, the greater will be the challenges faced by the local approval bodies. Their next task will be to consider plans for a security greenhouse, in which pest damage will be artificially induced for both traditional and transgenic maize plants.

The experiments with maize leaves have not yet been completed. Surprisingly, the tests showed that the stem borer species *Busseola fusca* could cope with the Mexican maize leaves relatively well. At best, every second insect survived the diet, and in the worst case as many as four out of five survived - too few to keep the pest under control. For the other stem borers, including the particularly aggressive and widespread *Chilo partellus*, at least one of the *Bt* proteins was fatal. *Busseola fusca* is now to be confronted with other *Bt* genes - known as "events" - from the CIMMYT laboratory in Mexico. In addition, the scientists are attempting to stack genes to enable the plants to resist several species of stem borer.

Stephen Mugo hopes to conduct greenhouse testing of different varieties of *Bt* maize during 2002. The effects of the living plants on both pest insects and the rest of the fauna will be investigated, again in high-security greenhouse conditions. If the tests are successful, further experiments will be carried out in field tests. Although the maize plant has no natural relatives in Africa, pollination will be studied in these experiments.

6 Insect-resistant plants from traditional breeding

Gene technology has attracted the greatest attention in the IRMA project - motivating the scientists and inspiring the imagination of those holding political responsibility - but this is only one aspect of the project for supplying small farmers in Kenya (and later the whole of East Africa, if possible) with insect-resistant maize varieties. It is the increased resistance of the plants that matters, not the technology used to achieve it.

It is no accident that the first concrete result of the project has been the marketing of a traditionally bred maize variety with improved resistance to stem borers. The seed still has to pass the required regulatory approval procedures during the course of the year.

Because farmers traditionally (and for financial reasons) use their own seed set aside from the latest harvest, the IRMA project concentrates on open pollinating varieties. There are only very few small farmers who could afford buying hybrid seed. But even if the project management succeeds in developing open pollinating insect resistant - either conventional or transgenic - varieties it is still an open question how many farmers would ever use them. Until now most of them stick to their local

seed which is slowly improved by careful selection.

Joseph Mwangangi Kivuvo in the fertile hinterland of Machakos also stays skeptical. How much would this newfangled maize cost, he wants to know. When answered that it would meet the price of today's current varieties, he makes things clear: "That's too expensive."

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