Crop Improvement in Eastern and Southern Africa

Research Objectives and On-Farm Testing

A regional workshop held in Nairobi, Kenya, 20-22 July 1983
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Editor: Roger A. Kirkby
RÉSUMÉ

Un atelier a réuni un petit groupe représentatif de scientifiques travaillant à des programmes d’amélioration des cultures alimentaires en Afrique orientale et australe, pour discuter de la planification, de la conduite et de l’élaboration de ces programmes. Le débat a porté surtout sur les aspects méthodologiques, communs à la majorité des cultures réalisées par les petits fermiers et les plus susceptibles de permettre l’utilisation des résultats de la recherche.

On s’intéresse donc ici aux cultures locales et aux pratiques culturales, à l’organisation de l’aide institutionnelle pour améliorer les cultures, aux objectifs particuliers des programmes et au mode d’établissement de ces objectifs, enfin aux méthodes d’évaluation employées pour formuler une nouvelle recommandation sur les travaux de vulgarisation. On résume aussi la séance de discussion qui a porté sur l’organisation des programmes d’amélioration des cultures, l’établissement des objectifs techniques, l’application des critères de sélection, la méthodologie pour les essais sous terrains et sur les fermes et, enfin, l’orientation de la recherche.

RESUMEN

Este seminario reunió un pequeño grupo representativo de científicos que trabajan en programas de mejoramiento de cultivos alimenticios en Africa oriental y meridional con el ánimo de discutir la planificación, la ejecución y el desarrollo de tales programas. El énfasis de la discusión recayó en aquellos aspectos metodológicos, comunes a la mayoría de los cultivos sembrados por los pequeños agricultores, que tienen la probabilidad de influir más en que los resultados de la investigación sean utilizados por el agricultor.

Entre estos trabajos se encuentran breves recuentos de las variedades locales y las prácticas de cultivo empleadas actualmente, la organización institucional para el fitomejoramiento, los objetivos específicos de los programas y su sistema de establecimiento, así como los procedimientos de evaluación empleados para llegar a las nuevas recomendaciones para los trabajos de extensión. También se incluye en este volumen un resumen de la sesión de discusión sobre la organización de los programas de fitomejoramiento, la fijación de los objetivos técnicos y la aplicación de los criterios de selección y la metodología para las pruebas tanto en fincas como en localización múltiple. Varios temas de política fueron identificados.
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TOWARD A MAIZE PROGRAM RESPONSIVE TO BURUNDI FARMERS

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Averaging 155 persons/km², Burundi is one of the most densely populated countries in Africa, but population densities range from 50-300 persons/km² (Maton 1983a). Over 90% of the populace is rural, villages, as such, being nonexistent (Mertens 1981). The amount of arable land per inhabitant varies considerably, but in the region of Mugamba, a high-elevation area where maize is very important, the average area cultivated is 1.67 ha/homestead and 0.27 ha/person (Maton 1983b). The gross national product per capita is estimated at US$180 annually (World Bank 1981). This low income combined with high population density results in intensive exploitation of the land. Most regions in the country have at least two cropping seasons per year on any given plot.

Maize is the second most important crop in Burundi, after common beans, in terms of area cultivated. The Department of Agronomy estimates that 260 000 ha are cultivated in maize, with an average yield of 1.5 t/ha. Although the crop is grown throughout the country, its importance varies considerably from one region to another. In the highland areas (1700-2200 m), maize is the staple food and, consequently, occupies a large land area -- often more than 50% of the total land under cultivation (ISABU 1979). However, it is almost always interplanted with beans, peas (Pisum sativum), or other crops. Maize becomes less important at lower elevations (800-1200 m), where cassava becomes more important in the diet, and maize plantings become small or very low density in intercropping associations.

Over most of the country, there are two maize crops: rainy-season upland and dry-season bottomland. The former is by far the most important and is planted in late September or early October after the first rains signal the end of the principal dry season. Dry-season bottomland maize, planted in July and August in moist valleys, accounts for only a small portion of total maize production. However, the harvest from these plantings is quite important. The bottomland crop is harvested in December or January and comes at a time of annual food shortages, when the current upland crop is not yet ready and the previous year's harvest has been consumed.

BURUNDI MAIZE PROGRAM

The Burundi maize program is part of the Food Crops Division of the Institut des Sciences Agronomiques du Burundi (ISABU). ISABU is
the main research arm of the Ministry of Agriculture and Animal Husbandry and is composed of four principal research stations and numerous research centres. The headquarters for the program are located at the main ISABU research station in Kiozi. The current professional staff includes one expatriate adviser (IDRC), two university-level agronomists, two technical school-level agronomists, and an administrative assistant. The adviser's expertise is in plant pathology and breeding. The two university agronomists specialize in soil science and rural sociology. One of these agronomists will begin a Master's program in plant breeding in 1983 in Canada.

The broad objectives of the program may be summarized as follows:

1. To develop maize varieties that produce greater yields than the local material presently used and satisfy quality and cropping-cycle requirements within local soil, pest, and pathogen constraints.

2. To orient the selection process to be responsive to the role of maize in the traditional mixed-cropping system.

3. To develop, and include as a routine step in the development of new varieties, a system of on-farm evaluation of promising material.

4. To improve and encourage cooperative research with other ongoing programs in ISABU.

The first objective stems from the observation that there is substantial room for improvement over local varieties. Because maize is not a native crop, there is probably considerable potential for growing exotic material successfully. In the medium and low elevations, some Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) experimental varieties have shown promising results. Although exotic material tested in high-elevation environments has not shown much promise as yet, selections from good local material and, perhaps, subsequent crosses should enable rapid progress to be made.

The other objectives stem from observations that most of the past research on maize has been conducted on experimental stations under conditions that are far removed from those found in farmers' fields (e.g., monoculture with mineral fertilizers, which are almost unavailable in this land-locked country). Little attention has been given to the role of maize in the whole cropping system of an area. Although initial introduction, selection, and improvement must be conducted at the research station, the inclusion of on-farm trials as part of the evaluation process should enable us to identify apparently high-yielding material that is unacceptable to farmers before it is released. Cooperation with other ISABU programs (e.g., legumes) will facilitate evaluation of different improved components of a cropping system.

**METHODOLOGY**

**Selection Methods**

In general, we work with a system of half-sib family selection on population and varietal crosses. In the case of a large population, the best families may be chosen for a diallel cross to form a variety or a bulk of families may be used. At this time, we have no plans for the creation of inbred lines and hybrids due to a shortage of
resources and difficulties in improving infrastructural support in such a mountainous country.

Criteria

Growth Cycles
Among the most important criteria for high-elevation maize is the length of the growth cycle. Any variety that is too late (>190 days) cannot be considered, regardless of yield. Following our multilocational yield trials with the usual second-season crop (peas), we found that late varieties had a negative impact on the second crop. In the subsistence agriculture found in Burundi, coupled with the high population density and intensive land use, it is apparent that farmers work to optimize output per field per year. In a less densely populated area with more market-oriented production, it is possible, or even likely, that farmers would seek to maximize maize production and prefer a long-season variety. In the middle and lower elevations, even the latest varieties permit a second crop, so the growth cycle is not as important in these areas.

Yield
Conversations with farmers have revealed mixed feelings with regard to the importance of yield versus grain quality. At present, our impression is that substantially higher yield will take precedence over most quality considerations. Although detailed field observations are made on pest and disease levels, results of our trials indicate that yield integrates these factors with tolerance of soil and climatic factors to give the overall adaptability or "rusticity" of a variety.

Quality and Storage
The most commonly stated quality requirements are grain size, hardness, and colour. Because most maize for flour production is ground by hand, varieties with large floury (soft) kernels are desired. Yellow kernel colour is associated in local varieties with small flinty kernels and low yield and is, therefore, not desirable. Storage loss of maize is a primary complaint of Burundi farmers and may very well nullify any increase in production. Thus, varieties that show differential susceptibility to field infestation by storage pests are immediately discarded. Likewise, in population improvement, selection for good tip coverage of ears is a high priority.

EVALUATION

On-Station Trials
A certain portion of maize improvement and development must continue to be conducted on research stations. However, we are designing our on-station research to make the selection process as realistic as possible as well as to enable us to test certain hypotheses developed from our farm visits and on-farm trials (e.g., selecting under low input conditions and a mixed-cropping system). Recognizing that maize is but one part of a subsistence system, we evaluate the varieties in terms of yield/hectare/year, including the major component of a typical rotation and a full year's cropping in our evaluation fields. This has suggested to us the reason why a recommended high-yielding late variety of maize has proven unacceptable to farmers -- it does not permit a productive second crop.
Introduction Trials

The majority of material presently received by the program is in the form of CIMMYT experimental varieties for various ecological zones. These are evaluated according to CIMMYT specifications. Varieties with an appropriate growing season and yields exceeding local or released materials by at least 20% are retained. Evaluations are conducted on research stations and, as with all evaluations in the program, receive only cattle manure, if anything, as a soil am­

Multilocational Trials

Those varieties retained are placed in multi­environmental trials at three or four sites with other promising material and local and released varieties. Beginning in 1983, these trials are to be inter­planted with a local cultivar of beans. Maize varieties are evaluated based on whole-plot yield and overall performance of both crops to evaluate for compatibility. Results are analyzed using multienviron­mental analyses of variance, with particular emphasis being placed on varieties showing little interaction with sites (i.e., broadly adapted).

On-Farm Evaluation

On-farm trials now constitute the pivotal point of our evaluation. Introduction and multilocational trials are intended to identify material that has no hope of being useful as well as material that may be of value. No decision for release can be made on the basis of the first two steps regardless of the number of years of evaluation.

In 1982, we set up preliminary trials with farmers at one site to identify potential difficulties in on-farm work. At planting time, we contacted several farmers near the home of one of our agronomists. Our plan was to compare the local maize variety with the released variety recommended for the region and to compare station methods (monoculture, in rows) with the local planting practice (simultaneous planting of maize/bean with traditional spacing) followed by the farmer. Thus, there were four treatments: local variety and released variety each planted according to experimental station methods and each planted according to the local practices. The farmers planted the "traditional" plots and we planted "station" plots. Each treatment was only represented once on each of the farms.

As we were preparing seed with the farmers, it became clear that good quality local seed was scarce because planting was well under way. This was borne out by the very poor stand of the local material planted at a known density. As the season progressed, it became obvious that our trials were on some of the farmers' worst fields. One field was so poor that there was essentially no yield from any treatment. We also found that our plot markers were often displaced. Toward harvest, one farmer harvested all the local variety early -- believing that we were only interested in the performance of the released variety.

Several lessons were learned from these initial on-farm trials:

(1) Farmers should be selected well in advance of the growing season so that the researcher can become acquainted with the farmer
and clearly explain the objectives and select a field that is relatively homogenous and not extremely fertile or infertile (this can be accomplished by observing the current crop). During the first visit, contact should be made with local government officials and extension agronomists, who usually will assist in farmer selection. Each farmer should be visited at least two or three times before planting begins.

(2) We should supply the experimental variety seed, but the farmers should plant all trials in their usual manner as well as supply all the labour and seed for local varieties and selected cropping mixtures. This should help ensure that the farmer will take an active interest in the trial and cooperate accordingly. Most importantly, we can be more confident that the conditions of our trials will approach those of a "typical" farm.

(3) Plot sizes should be kept small (<300 m²) so that they can fit within a farmer's field. Also, they would require less labour. Plots should be marked with perennial plants (e.g., cassava or Colocasia) with cycles longer than maize to ensure that they will remain undisturbed. Farmers tend to leave all crops in place regardless of what has been planted.

(4) Planting must be done at the same time as other plantings in the area, as results will be more reliable. It is then more likely that the farmer-supplied seed will be of reasonable quality than if plantings are done later than normal for the area. This will also permit comparisons to be made within the experimental field as well as, informally, with neighbouring fields.

(5) Farmers do not seem to mind contributing land if they are assured that they can keep all of the harvest and that the land will not revert to the government (ISABU) permanently. We have also found that good rapport is established quickly if we bring an instant colour-photo camera to the field and give the farmer and his family a few pictures of themselves. This also helps overcome farmer resistance to photographing routine fieldwork.

Because the on-farm aspect of our maize program is still in the early implementation and development period, only general plans can be outlined. For the time being, the country is divided into two maize producing zones -- middle/low and high elevations. In 1983, we have contacted about 30 farmers at five well-distributed sites over the middle/low elevation zone, for which we believe we have potentially good material. The three new promising varieties will be compared with the local material and a released variety each year. We expect that a minimum of 2 years will be required to demonstrate that a promising variety merits release.

Our approach to on-farm trials for varietal evaluation is not, strictly speaking, a "farming systems research (FSR)" approach. We have decided to accept the present system as a given and a not particularly well understood one and to force our "improved" material to fit within its constraints. Thus, rather than study a particular system with the purpose of understanding it and with the ultimate objective of providing a package of improvements, we are trying to work with only one component within the major constraints (cycle, soil, pests, and pathogens) and observe how the material is accepted, i.e., how our new material functions within the present system. We leave it to the farmer to make whatever adjustments are deemed appropriate. We
believe that FSR is appropriate and valuable to our program; however, our personnel constraints are such that we cannot undertake the large effort necessary to implement a FSR program. What we can do is to try to have as much contact as possible with farmers in their fields to remain sensitive to their needs and the requirements of their systems. It is likely that ISABU will be beginning a FSR program within the next 2 years and we plan to cooperate very closely with this program.

MAIZE STREAK DISEASE

In high-elevation bottomland maize culture, maize streak disease (MSD) has become a serious problem within the last few years. The program is currently evaluating International Institute of Tropical Agriculture (IITA) streak resistant (SR) material. These materials are being planted in farmers' fields in areas with a history of high MSD levels. In addition, we are developing the facilities and methodology to conduct controlled inoculations to determine if SR varieties hold up under our conditions.

SUMMARY

The Burundi maize program is in a state of rapid change. The major emphasis in its reorganization has been to take into account the constraints and demands of local traditional maize culture. This is being achieved by duplicating on the experiment station, as much as possible, the conditions found on the farm. This includes no longer using mineral fertilizer or phytosanitary products, as well as evaluating material under mixed-cropping systems. The most fundamental change, however, is the inclusion of on-farm trials with active farmer participation as an integral and routine part of the selection and evaluation process. It has become apparent, however, that research must continue to be conducted on the experiment station (e.g., MSD evaluation and preliminary screening of crosses and introduced varieties). The program is working toward an optimum balance between essential on-station and on-farm research.


