Identifying Farmers' Preferences for New Maize Varieties in Eastern Africa

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Abstract

To bridge the gap between breeders and farmers and to ensure that new varieties satisfy farmers' preferences and suit their socioeconomic situations, the International Maize and Wheat Improvement Center (CIMMYT) is developing and adapting participatory methods for identifying farmers' maize variety preferences in East Africa. Several methods are being used: breeding on-station under stress conditions (simulating farmers' conditions); participatory rural appraisals; farmers' evaluation of new varieties on-station; and mother and baby trials. The latter is a new approach consisting of a central researcher-managed "mother" trial comprising all tested varieties, and satellite or "baby" trials, which are farmer managed and test a subset of varieties from the mother trial. The results show that farmers are eager to participate in selecting new varieties but their selection is very different from that of breeders. Moreover, farmers' evaluations and testing on-farm both show very high variance. The methodology used in the study to identify farmers' criteria and to facilitate farmer evaluation of the varieties was very convenient for data collection but not for data analysis. For future trials, sufficient resources need to be made available to assure enough high quality data for statistical analysis. These data will make it possible to adjust the breeders' index in order to make it more responsive to farmers' preferences.

Introduction

Improving communication between farmers and breeders

The purpose of plant breeding is to develop improved genetic material, particularly with higher yield. This is achieved through a more efficient use of resources by the plant, or through increased resistance to pests and other types of stress. In developing new materials and extending them to farmers, classical plant breeding faces two major obstacles. First, new varieties can be disappointing to farmers where undesirable traits go undetected during the breeding process. In Kenya, for example, several late maturing maize varieties have been released over the last 10 years, but none has surpassed the very popular H614D—a hybrid released in 1986 based on H614C, which was released in 1976. Secondly, breeders necessarily discard many crosses and varieties during the selection process because of traits considered undesirable;

however, these traits may actually be of interest to farmers. On the Kenyan coast, for example, a technician brought home a discarded cassava variety and this variety is now being rapidly adopted.

These examples illustrate the communication gap between breeders and farmers, which is also reported elsewhere (Kamara et al. 1996). However, efforts are being made to reduce this gap, in particular by a process called participatory plant breeding (PPB). The aim of PPB is to improve communication between farmers and breeders so that farmers' concerns and preferences are incorporated earlier in the research process; research is accelerated; and the adoption rate improves (Sperling et al. 1993; Eyzaguirre and Iwanaga 1996). Farmers are not only asked for their opinion (the consultative approach; see Biggs 1989 for definitions) and collaboration (collaborative approach), but are actively invited to help set the research agenda (collegiate approach). By inviting farmers to make decisions in the research process, it is assumed that they will not only adopt, but also, and more importantly, adapt the available technology to their own needs and environment (Ashby 1991). For this communication to succeed, new tools are needed, along with a common language that suits both breeders and farmers.

Breeders usually select their material by analyzing large amounts of data, which are systematically obtained from highly controlled situations to reduce variability. Farmers, however, select varieties based on small experiments and observations in the field and from anecdotal evidence, using intuitive multi-factor analysis (Sumberg and Okali 1997). Social scientists play an important role in bridging the gap between farmers and breeders, and this paper presents an interdisciplinary approach applied to maize breeding in East Africa.

Maize is a very important food crop in East Africa, but productivity has not kept up with population growth in the region. Soil fertility is declining and pest pressure is increasing, therefore maize breeding needs to focus on developing varieties tolerant to drought and nitrogen stress (Bänziger et al. 2000). A large number of varieties have been developed and, since 1999, farmers have been invited to collaborate in their evaluation.

Breeding maize for East Africa

Breeding stress tolerant varieties for East Africa started with physiological studies, determining the important traits, and then selecting a large number of promising varieties from the CIMMYT genebank in Mexico. Methods were developed to test these varieties under stress conditions on-station, simulating farmers' conditions as closely as possible. Using these methods, varieties were crossed and further selected and a large number have now been tested in Zimbabwe—CIMMYT's regional center for Southern Africa. CIMMYT tested the varieties using mother and baby trials (described later).

CIMMYT's maize breeding program in East Africa started in 1997. Diagnostic surveys and expert interviews revealed that food security is one of the major problems facing farmers in the region, and that maize production is their main strategy to combat this. The major constraints to maize production, as perceived by farmers, are drought, soil fertility, seed availability, and pests (De Groote et al. 2001b). Generally, the main pests are stem borers and weevils (the major storage pest), while around Lake Victoria the predominant pest is striga, a parasitic weed that attacks maize and sorghum. To deal with these constraints, CIMMYT and its partners have developed various projects. The most important of these are the African Maize Stress (AMS) Project, the Insect Resistant Maize for Africa (IRMA) Project, the Striga Project, the Seed Supply Systems Project, and the Quality Protein Maize (QPM) Project (Table 1). A team of five CIMMYT scientists (two breeders, two agronomists, and one economist) works on the different projects in collaboration with colleagues from the national programs, mostly within the East and Central Africa Maize and Wheat Network (ECAMAW). Social scientists form a working group within this network and focus on participatory research and analysis of the maize sector.

The participatory work involves testing new technologies, particularly varieties, but also cultural practices such as soil and water conservation and pest control. In the maize sector study, an analysis is made of the system to ensure that the new technologies to be introduced are appropriate. This includes studying maize marketing, seed production and distribution methods, fertilizer and pesticide markets, and credit availability.

In the Africa Maize Stress Project, new varieties are being developed for different agroecological zones. For the dry areas, 50 varieties were tested on 4 stations in Kenya in 1999. These materials are usually crosses or double crosses with the most popular improved open pollinated variety (OPV), Katumani Composite B (KCB), an early maturing variety to which all new materials are compared. Farmers were invited to all four stations to evaluate the material. Of the 50 varieties, 16 were retained for testing on-farm in 2000, using the mother and baby methodology. In 2001, four sets of varieties were tested in four different agroecological zones. At the end of the process, successful varieties will be proposed by the Kenya Agricultural Research Institute (KARI) for the National Performance Trials (NPTs) where they will be compared with varieties from other breeding programs and private seed companies. The best of these varieties will be selected for release.

Participatory Methods in Maize Breeding

New materials developed for drought stress and low nitrogen are tested and evaluated using a number of techniques.

Table 1. Constraints to maize production and related projects in East Africa.

Constraints†	Project
Drought, low nitrogen	AMS (Africa Maize Stress Project)
Pests such as stem borers and weevils	IRMA (Insect Resistant Maize for Africa Project)
Striga	Striga Project
Availability of quality seed at an affordable price	Seed Supply Systems Project
Nutrition	QPM (Quality Protein Maize Project)† Identified by farmers and scientists from national program

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Classical breeding took place at four stations in the semi-arid region of Kenya under optimal and stress conditions, the latter to simulate farmers' conditions. In the last stage of the on-station research, 50 varieties were evaluated on 4 stations (Katumani, Kiboko, Kampi Ya Mawe, and Kitui) in 1999 in the dry areas of eastern Kenya. Methods and results of these breeding processes are discussed elsewhere (Bänziger et al. 2000).

To involve farmers more closely in variety development and selection, and therefore to increase the likelihood of adoption, one sublocation (smallest administrative unit in Kenya) close to each of the stations was selected for study. Participatory methods included participatory rural appraisals (PRAs), farmers' evaluation on-station, mother and baby trials, and community seed production (Table 2).

Initially, a PRA was conducted in each of the four sublocations, consisting of interviews with key informants, and group interviews of men and women on their maize variety preferences and selection criteria. In the second stage, the farmers or their representatives were invited to the station to evaluate the different test varieties, according to their own criteria. Breeders' and farmers' evaluations were then combined to select the varieties to be tested on-farm.

Table 2. Components of participatory methods used in maize breeding in eastern Kenya.

Component	Activities/data collected
Participatory rural appraisals	Farmers' variety preferences Maize selection criteria Perceived problems and pests of maize Interest in variety evaluation and testing
On-station:	Breeders' evaluation Farmers' evaluation
Mother trial	Breeders' evaluation (emphasis) Farmers' evaluation
Baby trials	Breeders' evaluation: yield data, timing of practices, and inputs, only Farmers' evaluation
Community seed production	Comparison of available varieties in mother and baby trials Experimentation with different modes of seed production: individual, community, and commercial

On-farm testing was conducted using the mother and baby trial approach developed in Zimbabwe. Sites for the mother or central trial are located in farmers' fields, schools, or on group farms that are sufficiently large enough to accommodate the trials. The mother trial is researcher or collaborator managed and the data collected are similar to those from on-station trials. This trial usually has a large number of entries grown in two-row plots. The purpose of the mother trial is to generate biophysical data for the breeders, as well as to allow farmers to evaluate all of the test varieties in one location. Subsets of varieties from the mother trial (usually 4-8 varieties) are given to farmers to grow on their farms under their management. These farmer-managed trials are known as baby trials. Their objective is to test the varieties under farmers' conditions and to obtain farmers' opinions on how the varieties perform under those conditions

The final stage of the maize development program is the production of hardy, high performing varieties that meet farmers' and consumers' preferences. However, as farmers often have difficulty in obtaining good quality seed of these new varieties at a reasonable price, CIMMYT has also initiated a project to produce and disseminate improved seed in Kenya. This project is currently in its first stage, which involves the evaluation of a large number of released or about-to-be-released varieties in many locations using mother-baby trials. In the subsequent stages of seed multiplication and distribution, farmers will be included through individual and community participatory methods. Since these stages have not yet begun, they are not discussed in this paper.

In the next sections, we discuss the participatory methods used—PRAs, on-station evaluation, and mother-baby trials—focussing on methodology, applications in the semi-arid zone of Kenya, and results.

Participatory Rural Appraisals

Methodology

To involve farmers in variety selection, PRAs were organized in one sublocation near each of the project sites. Firstly, a literature review was conducted at the district and divisional level for each site, and one sublocation was selected in each of the four sites: Kitanga (Katumani station), Mulaani (Kambi Ya Mawe), Ngumo (Kiboko), and Itoleka (Kitui). With assistance from extension and administration staff, farmers' meetings were organized in December 1999 and January 2000. Separate group interviews were conducted with men and women (except in Kitanga, where it was not convenient to do so), using the same open questionnaire. First the farmers were asked to record the varieties grown and the criteria used to select these varieties. Then they scored the varieties for each of the criteria on a scale of 1 (very bad) to five (very good). Next, farmers were asked to rank the constraints they faced in order of importance and score them on a scale of one (less important) to three (very important).

After the group discussions, farmers were asked if they were interested in evaluating the test varieties. In all four sites farmers were enthusiastic to participate. They expressed preference for evaluating the varieties twice: once around the tasseling stage and once at harvest. Dates were fixed for the farmers' visits on-station.

Results of the participatory rural appraisals

Only the major results of the PRAs are discussed here, i.e., farmers' maize variety selection criteria and farmers' interest in taking part in participatory breeding. The other elements are discussed in more detail by Bett et al. (2000). The different criteria used by farmers to select their maize varieties are presented in order of importance in Table 3. Farmers used a wide range of criteria, and the ranking differed substantially between sites and between groups. For ease of presentation, the table shows only those criteria mentioned by more than one group. Early maturity and yield are clearly the most important criteria as they are the only two mentioned by all groups in all sites.

To gain a general appreciation of the importance of a particular criterion in the area, we combined rankings from different groups and villages into a derived score, devised to represent the number of times a criterion ranks highly. For each group, the criterion receives a value inversely related to its rank, i.e., when a criterion is ranked first, it receives a derived score of 5, when it is ranked second, it receives a score of 4, and so on. The mean derived score (mds) is an indicator of the overall importance of the derived scores, and ranges from 0 (criterion was not mentioned) to 5 (criterion was ranked first by all groups). In Table 3, the criteria are ranked in order of decreasing mds.

According to this analysis, early maturity (mds = 3.4) is by far the most important criterion, followed by yield (mds = 1.9). A second important group (mds >1) comprises yield-related criteria such as cob size and grain size, other grain and cob characteristics, and drought tolerance. Criteria mentioned by at least three groups are pest and disease resistance, taste, and processing characteristics.

Considered less important are plant characteristics such as vigor, flint, and cob length, which were each mentioned twice. Characteristics mentioned only once include red cobs, tolerance to low soil fertility, tolerance to water logging, and cost and availability of seed. No important differences between men's and women's rankings were observed, except that, surprisingly, only men mentioned processing characteristics as a selection criterion.

Drought, soil fertility, and pests are the most important constraints to maize production mentioned by farmers. Weevils are by far the most important pest, followed by stem borers and termites (Table 4). Less important pests are army worms, porcupines, squirrels, and humans (theft in the field is a problem in many areas).

To evaluate the overall importance of each pest, we again calculate the mean derived score. Weevils are easily the most important pest. They were ranked first in all groups, resulting in a maximum score of 5. Stem borers and termites came a distinct second (mds = 2.8).

Table 3. Maize selection criteria used by farmers in four sublocations in eastern Kenya, ranked in order of importance.

	Rank							
	Kiboko		Kitui		Katumani	Kampi Ya Mawe		Derived
Criteria	Women	Men	Women	Men	W + M	Women	Men	score†
Early maturity	1	3	2	2	4	3	2	3.4
Yield	2	6	6	9	2	6	7	1.9
Cob size	6	5	4	1		2		1.7
Grain size	8	1	1					1.6
Other grain characteristics	5	2			3		9	1.3
Number of lines‡	3	11			1			1.3
Drought tolerance			3	3			6	1.0
Other cob characteristics			5	4			1	1.0
Pests and diseases	4	10		6		4	10	0.7
Taste			6	8	6		12	0.6
Plant characteristics						5	3	0.6
Processing		9		7			11	0.4

† Every time a criterion is ranked first it receives a score of 5, each second ranking scores 4, each third ranking scores 3, each fourth ranking scores 2, and each other ranking scores 1.

‡ Only important for the variety Kinyanya, which means "eight rows" in Kamba, the local language.

Table 4. Ranking of importance of maize pests by farmers in four sublocations in eastern Kenya.

Common pests	Katumani Women	Katumani Men	Kitui Women	Makueni Women	Kiboko Women	Mean derived score†
Weevils	1	1	1	1	1	5.0
Stalkborer	3	3		2	2	2.8
Termites	2	2		3	3	2.8
Army worms	2		2			1.6
Porcupine			3	4		0.8
Squirrel	4	4	6	5		0.8
Man			5	10	5	0.6

† Every time a criterion is ranked first it receives a score of 5, each second ranking scores 4, each third ranking scores 3, each fourth ranking scores 2, and each other ranking scores 1.

The use of derived scores has some conceptual problems. The scores rely on a very subjective appreciation of the value of different ranks, and are therefore hard to generalize. Moreover, their use lacks a theoretical base from which to derive statistical tests. For this reason, it was decided that derived scores no longer be used. Instead farmers would be asked directly whether they perceived a variety to be very important (a score of 3), of medium importance (a score of 2), of low importance (a score of 1), or not important.

On-Station Evaluation

Methodology

The trials were conducted on four KARI research stations in the arid and semi-arid area, namely Katumani (Machakos district), Kambi Ya Mawe and Kiboko (Makueni district), and Kitui (Kitui district). Fifty new entries were tested on each station, usually double backcrosses of new materials with Katumani. The entries were established in small blocks, each in two rows of 3 m (0.75 m between rows, 0.5 m between hills).

The statistical design used in the research is an alpha lattice, and the randomization is generated using Alpha software, produced by CIMMYT. A related software package, Fieldbook, generates forms in a spreadsheet for data entry (Barreti et al. 1997). The variables that can be integrated, depending on the breeders' strategy, are presented in Table 5. The software allows the calculation of a breeders' index, in which the breeder specifies which criteria (from the above variables) he or she finds important and weights each accordingly. The index has a 0-1 scale—the smaller the index, the better the variety is considered in terms of the traits included.

Farmers were invited to the station to evaluate the new varieties, assisted by researchers from KARI and CIMMYT, and Ministry of Agriculture extension staff. Initially farmers used three different colored ribbons to evaluate the varieties shortly before harvest. The green, blue, and red ribbons denoted varieties they appreciated, were moderately interested in, and did not like at all, respectively. The procedure went surprisingly well, and farmers were able to evaluate the 52 varieties in 10 to 30 minutes. Next farmers were given a maize variety evaluation form (Figure 1). For each variety, farmers were asked to make a cross against the qualities for which it was considered good. They were also asked for some personal information such as age and years of farming experience.

In later evaluations, changes were made to the procedure because farmers complained that they had to walk through the varieties twice. The ribbons were replaced by an extra column on the form in which farmers were asked to give a general evaluation (1 = poor, 2 = average, 3 = good) of each variety. Illiterate farmers were assisted by researchers and extension staff, or by students from a nearby secondary school. The evaluation procedure was conducted one or two weeks prior to harvesting and again at harvest. At the end of the evaluation, the participants were asked if they were interested in testing some of the varieties on their farms. They indicated that they had identified several worth testing, and that they would be able to test four or five varieties at a time.

Table 5. Variables used by breeders to evaluate drought tolerant maize varieties.

Variable (unit)	Description
Entry	A consecutive number from 1 to n (the total number of tested materials).
Pedigree	Parental background of the material.
Origin	
Index (0-1)	Breeders' index, derived from a weighted combination of the variables below.
Grain yield (t/ha)	
Ear aspect (1-5)	1 = good uniform cobs with the preferred texture of the area (i.e., flint for E. Africa); 5 = ugly cobs with undesirable texture for the area (i.e., dent).
Anthesis date (d)	Date when 50% of the plants shed pollen.
ASI (d)	Anthesis-silking interval.
Plant height (cm)	Measured from the ground to the first tassel branch on a representative plant.
Ear height (cm)	Measured from the ground to the insertion of the top ear on a representative plant (only for hybrids).
Root lodging (%)	% of plants with root lodging counted before harvest.
Stem lodging (%)	% of plants with stem lodging counted before harvest.
Ears/plant	Number of ears (having at least one grain) per plant at harvest.
Plant aspect (1-5)	1 = short plants with uniform and short ear placement; 5 = tall plants with high ear placement.
Ear rot score (%)	Scale of 1 (clean, no rot) to 5 (completely rotten).
GLS (1-5)	Score for gray leaf spot, a maize disease.
P. sorg (1-5)	Score for *Puccinnia sorghi* (rust, a maize disease).
E. turc (1-5)	Score for *Exserohilum turcicum* (leaf blight, a maize disease).
Leaf rolling score (1-5)	Measured twice before flowering when differences between genotypes are visible using following scale: 1 = unrolled; 2 = leaf rim starts to roll; 3 = leaf is shaped like a V; 4 = 60% dead leaf area; 5 = leaf is rolled like an onion.
Leaf senescence (1-10)	Three scores are taken after flowering when differences between genotypes are visible. Scoring is made on scale of 0 to 10, by dividing the percentage of dead leaf area by 10.
Grain texture (1-5)	Grain texture as preferred in the area.
Grain moisture (%)	Measured from a grain sample by an electronic moisture meter.

Maize Variety Evaluation Questionnaire (CIMMYT/KARI Participatory Breeding)

1. Farmer's name:________________ 2. Farmer's sex: ___________________ 3. Date: _______________
4. Farming experience:______ (years) 5. Formal education: ________________ (years completed)
6. Size of farm: __________ (acres) 7. Area under maize: _______________ (acres)

Evaluation during vegetative stage (1 = poor, 2 = average, 3 = good)

	At tasseling (date: .../.../...)			At harvest (date: .../.../...)			
Variety	Early maturity	Drought tolerance	Overall evaluation	Cob size	Well-filled cob	Yield	Overall
1							
2							
3							
.							
.							
.							
50							
51							
52							

Figure 1. Evaluation form for farmer evaluation of maize varieties on-farm.

Selection from on-station trials for the next cycle

The breeding program calculated the selection index for all varieties, resulting in a rank (Table 6). After a number of varieties had to be discarded because of undesirable traits, a final list was produced of varieties to be continued in the next cycle.

The farmers involved in variety evaluation were typical of the area. Most had completed at least primary education, with only small differences occurring between sites and between men and women. Farmers had, on average, 20 years of farming experience. Men had, on average, 19 acres of land and women had 14 acres. Average area under maize production ranged from 4.1 to 7.1 acres, with little difference between sites (for details see Bett et al. 2000). The farmers evaluated all varieties according to their own criteria. Their scores were averaged over the four sites, resulting in an average score, which allowed the varieties to be ranked and sorted (Table 6). No differences in rankings were found between farmers' preferences, or between farmer characteristics such as gender and farmer size.

Breeders' and farmers' selections in the study were very different. Breeders found 47 varieties to be better than the local check, whereas farmers only found 7. And of these 7, the breeders accepted only 3. Moreover, the breeders wanted to give 13 more varieties a chance in the next cycle, though they were rejected at this stage.

From Table 6 it is evident that there is very little relationship between the breeders' index and the farmers' evaluation. Statistically, the Pearson correlation coefficient (0.18) is not significantly different from zero ($p = 0.287$). Unfortunately, there was no discussion between breeders and farmers after the analysis to determine the cause of this lack of coherence. It is also unclear why the farmers' top three varieties were not retained for the next cycle.

Mother or Central Trial

Methodology

To increase farmer participation in the selection of drought tolerant varieties for eastern Kenya, the mother and baby trial approach was adopted for further variety evaluation (see De Groote et al. 2001a for a detailed description). The mother trials were planted on three KARI substations (Katumani, Kitui, and Kampi Ya Mawe) and on two farms, one

Table 6. Farmers' evaluation of new maize varieties at four research stations in arid and semi-arid eastern Kenya.

	Breeders' selection						Farmers' evaluation				
	Selection index		Yield (3 sites)		Overall		Site (score)				
Entry†	Value‡ (0-1)	Rank	t/ha	Rank	Score§	Rank	Kampi Ya Mawe	Katumani	Kiboko	Kitui	Final selection (breeder)
ECA-EE-43	0.51	27	2.7	35	1.64	1	1.55	1.75	1.57	1.69	
ECA-EE-40	0.40	12	3.2	12	1.62	2	1.44	1.79	1.4	1.85	
ECA-EE-51	0.81	51	2.3	46	1.51	3	1.12	1.75	1.6	1.58	
ECA-EE-45	0.44	17	2.8	29	1.48	4	1.51	1.71	1.17	1.54	Yes
ECA-EE-46	0.77	49	2.5	33	1.48	5	1.31	1.92	0.93	1.77	Yes
ECA-EE-29	0.45	18	3.2	8	1.45	6	1.78	1.42	1.7	0.88	Yes
ECA-EE-42	0.61	39	2.7	29	1.44	7	1.74	1.5	0.87	1.65	
ECA-EE-52	0.76	48	2.2	48	1.43	8	1.21	1.75	1.33	1.42	Yes
ECA-EE-38	0.38	9	3.0	14	1.43	9	1.55	1.46	0.77	1.92	Yes
ECA-EE-44	0.61	38	2.6	40	1.42	10	1.42	1.62	0.93	1.69	
ECA-EE-47	0.59	36	2.7	28	1.38	11	1.21	1.75	0.93	1.62	
ECA-EE-31	0.66	44	2.6	33	1.34	12	1.49	1.62	1.17	1.08	Yes
ECA-EE-30	0.73	47	2.9	22	1.31	13	1.34	1.46	1.50	0.92	
ECA-EE-23	0.67	46	2.7	34	1.30	14	1.67	1.42	0.93	1.19	
ECA-EE-4	0.56	31	3.0	20	1.30	15	1.19	1.26	1.43	1.31	
ECA-EE-37	0.65	42	2.6	35	1.30	16	1.21	1.54	0.67	1.77	
ECA-EE-18	0.43	14	3.0	25	1.28	17	0.84	1.83	1.3	1.15	Yes
ECA-EE-41	0.42	13	3.1	17	1.28	18	1.33	1.33	0.77	1.69	
ECA-EE-33	0.38	10	3.0	11	1.24	19	1.63	1.29	0.60	1.42	Yes
ECA-EE-28	0.59	35	2.7	31	1.23	20	1.58	1.58	0.80	0.96	
ECA-EE-35	0.58	34	2.6	28	1.23	21	1.25	1.5	0.63	1.54	
ECA-EE-21	0.48	23	2.9	19	1.22	22	0.84	1.5	1.40	1.15	Yes
ECA-EE-49	0.46	19	2.7	24	1.20	23	1.1	1.71	0.90	1.08	Yes
ECA-EE-3	0.49	24	2.7	28	1.18	24	0.97	1.17	1.53	1.04	
ECA-EE-20	0.78	50	2.5	32	1.16	25	1.07	1.33	0.73	1.50	

Note: Only the top 25 varieties according to farmers' preferences are shown.
† Code for the variety tested: ECA-EE = East and Central Africa, Extra Early Variety.
‡ The selection index is a weighted index of different desired traits—a lower value indicates good performance for these traits.
§ Scores are evaluations by farmers made on a scale of 0-2 (0 = poor, 1 = average, 2 = good).

belonging to Makindu Children's Home (near Kiboko) and the other to Emali Primary School. The mother trial consisted of 16 new varieties and 2 local checks, Katumani Composite B (KCB) and Dryland Composite 1 (DLC1). Each variety was grown in two rows of 5 m. Two seeds were sown per hill, which were later thinned to one plant per hill. The spacing between rows was 75 cm and between plants was 25 cm, giving a population of about 54,000 plants/ha. These were replicated three times, and grown under both optimal and non-fertilized conditions. Optimal conditions comprised recommended fertilizer rates and other cultural practices. Both farmers and breeders evaluated the varieties at the mother sites using the same methodology as for the on-station evaluation.

Farmers were invited to visit the mother trials at late silking and at maturity. At each evaluation an effort was made to encourage equal participation by male and female farmers. Of the 101 participants, 57 were women. At the beginning of the evaluation, farmers gathered to discuss what they thought were the important criteria for selecting a given variety at a particular development stage. These criteria were ranked and the top three were used for the evaluation. The criteria were translated into the local Kikamba dialect for ease of understanding.

The farmers were taken around the whole trial to get an initial feel for the project. Afterwards, they were divided into groups of five and taken around by the technical staff. Farmers who could not understand the labeling of the trials or English were assisted. Each criterion was scored from 1 to 5 (1 = very poor, 2 = poor, 3 = average, 4 = good, and 5 = very good). Farmers were also asked to give an overall score to each variety, i.e., their opinion of how good each variety was compared to all others. This was not simply an average of each variety's overall score, but a judgment of the variety in its entirety as a typical plant type. Farmers were also asked to select their best three varieties, and these were summarized at the end of the evaluation. Farmers were also requested to make comments on the whole exercise, including suggestions for improvement.

Results of breeders' evaluation

Table 7 shows a typical breeders' evaluation of a multilocational trial. The mean yield from the four sites indicates the extent to which the new varieties surpassed the two local checks. It can be seen that the best varieties yielded a ton more than the better local check (KCB). At the Makindu site, there were significant differences between the local checks and the new varieties, while at Emali, KCB was similar to the new varieties other than ECA-EE-45. At this site, the second local check (DLC1) was comparable in yield only to ECA-EE-45. At Kampi Ya Mawe, DLC1 produced very high yields, outperforming seven varieties including KCB. This was the best site for DLC1, where it produced the highest yield among the four sites. At Kitui, 12 varieties yielded higher than KCB, while the remaining varieties did not show significant yield differences. However, all varieties yielded significantly more than DLC1 at this site.

The selection index was used so that other important aspects were included in the selection. According to this index, the best five varieties were ECA-EE-21, -29, -40, -33 and 16 (Table 7). This ranking mostly reflects yield and ear characteristics.

Results of farmers' evaluation

The farmers who participated in the trial were typical of the area. On average, they had 18 years of farming experience, with the highest being 30 years. Farmers had, on average, 7 years of formal education, which is most likely higher than the regional average. Average farm size was 14 acres, but this was substantially smaller in Emali (7.5 acres) and Makindu (8 acres), the two sites closest to town. Of the sites characterized by smaller farm sizes (Emali, Ithookwe, and Katumani), about half of the farms were planted to maize. In areas with larger farm sizes, the proportion of farms under maize was lower. In general, few differences were observed between male and female farmers. While men's farms were, on average, larger (16.6 acres) than women's (15.1 acres), women's farms were larger in 3 of the 5 sites.

At silking, farmers evaluated the varieties for earliness, and made an overall assessment of each. At this stage, variety ECA-EE-13 was the best across all sites with a mean score of 3.36. It is

Table 7. Breeders' evaluation of 18 new maize varieties compared with two local checks (KCB and DLC1) in mother trials on four research stations in eastern Kenya.

		Grain yield under low N conditions						
Pedigree	Selection index (0-1)	Average	Emali (t/ha)	Kampi YaMawe (t/ha)	Kitui (t/ha)	Makindu (t/ha)	Ear aspect	Anthesis date
ECA-EE-21	0.36	5.10	4.10	6.20	6.20	3.90	3.60	55.00
ECA-EE-29	0.40	5.00	4.20	6.70	5.90	3.30	3.60	54.00
ECA-EE-40	0.40	5.00	4.20	5.80	6.30	3.70	3.50	54.00
ECA-EE-33	0.41	5.10	4.20	6.60	5.60	4.00	3.60	54.00
ECA-EE-16	0.41	4.70	4.10	6.10	5.20	3.40	3.70	55.00
ECA-EE-31	0.44	4.90	3.80	6.30	5.40	4.20	3.40	54.00
ECA-EE-46	0.46	4.90	4.10	6.30	5.70	3.50	3.70	53.00
ECA-EE-8	0.47	4.70	4.00	5.40	5.60	3.90	3.60	54.00
ECA-EE-6	0.48	5.00	4.60	6.00	5.60	3.60	3.50	54.00
ECA-EE-9	0.50	4.70	4.20	5.80	4.90	3.70	3.70	54.00
ECA-EE-13	0.51	5.00	3.70	7.00	5.50	3.90	3.30	53.00
Local check 1	0.53	4.10	4.20	5.20	4.40	2.60	3.00	54.00
ECA-EE-18	0.54	4.60	3.70	5.80	5.10	3.60	4.10	54.00
ECA-EE-38	0.56	4.60	4.20	6.00	4.50	3.40	3.80	54.00
ECA-EE-34	0.59	4.70	3.70	5.80	5.40	3.90	3.50	54.00
ECA-EE-36	0.62	5.00	4.10	6.20	5.90	4.00	3.70	55.00
Local check 2	0.89	3.90	3.30	6.10	4.00	2.30	2.70	52.00
ECA-EE-45	0.93	4.40	3.40	5.30	5.50	3.20	3.30	54.00
Mean			4.00	6.00	5.40	3.60	3.50	54.00
LSD			0.70	1.10	1.00	0.80		
CV			10.80	10.60	11.00	12.90		
Min			3.30	5.20	4.00	2.30	2.70	52.00
Max			4.60	7.00	6.30	4.20	4.10	55.30

important to note that two varieties, ECA-EE-13 and ECA-EE-6, were considered by farmers to be earlier than the local check (DLC1). In addition, another four varieties (-16, -33, -34, -46) were considered to be earlier than KCB. The remaining varieties matured later than the two local checks. In the overall assessment at silking, variety ECA-EE-13 was still considered to be the best. Variety EAC-EE-31, perceived by farmers to be later than the two local checks, scored more highly than KCB, while variety ECA-EE-6, ranked second for earliness, was considered comparable to KCB. Furthermore, variety ECA-EE-33, which was considered comparable to DLC1 for earliness, was ranked higher in the overall assessment. Overall, six varieties were considered to be better than or comparable to KCB.

For the evaluation at harvest, farmers developed the following criteria for all sites: cob size, cob fill (grain filling), and yield. Farmers were also asked to make an overall assessment of each variety independently. Based on cob size, seven varieties were considered to be better than or comparable to KCB. Variety ECA-EE-31 was perceived to have the best cob size, while DLC1 was considered least desirable for this criterion. Two varieties considered to be better for earliness (ECA-EE-6 and -18), were rejected, while four other entries (ECA-EE-8, -21, -25, -31, and -36) were ranked better than or comparable to KCB for cob size but not for earliness.

The next criterion was grain filling. Again variety ECA-EE-31 scored highly. Using this criterion, nine varieties were considered better than or comparable to KCB, while variety DLC1 was ranked the lowest. As observed earlier, the ranking of the varieties changed, with some remaining superior to KCB, while others that had not been considered better for cob size were ranked lower for grain filling, e.g., ECA-EE-25.

The top five varieties according to yield were the same as those ranked by yield components (cob size, grain filling). However, of the 11 varieties considered better than or comparable to KCB, only 7 were perceived to be higher yielding. Again, all varieties were considered to be higher yielding than DLC1.

In the overall assessment (Table 8), the top four varieties for cob size, grain filling, and yield were retained. About 10 varieties were considered to be better or comparable to KCB. This clearly indicates that farmers effectively use yield components for evaluating yield, and attach appropriate weightings to each component.

Comparison of breeders' and farmers' evaluations

It is important to know how closely breeders' and farmers' evaluations correspond and how they are linked in order to predict future adoption of new technologies. In the on-station evaluation, there was no correlation between farmers' and breeders' selections. In the mother trials, there was a small, though not significant, correlation of 20% (Pearson correlation coefficient = 0.2, $p = 0.068$).

To analyze the relationship between the farmers' and breeders' order of preference, we mapped each evaluated variety in a two-dimensional diagram, where the horizontal axis represents the farmers' rank and the vertical axis represents the breeders' rank (Table 9). The table shows, for example, how

Table 8. Overall assessment by farmers at harvest of 18 new maize varieties compared with two local checks (KCB and DLC1) in mother trials on four research stations in eastern Kenya.

Entry		Total mean score		Emali		Kitui		Kampi Ya Mawe		Katumani		Makindu	
number	Pedigree	Total	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank	Score	Rank
8	ECA-EE-31	3.70	1	2.87	12	4.08	1	3.45	8	4.25	6	3.87	1
9	ECA-EE-33	3.66	2	3.24	3	3.69	3	4.03	1	4.21	8	3.11	7
7	ECA-EE-21	3.59	3	3.03	7	3.50	6	3.83	3	4.39	2	3.21	6
10	ECA-EE-34	3.48	4	2.95	10	3.61	4	3.53	6	3.93	11	3.37	3
16	ECA-EE-36	3.43	5	3.29	2	2.61	13	3.41	9	4.21	9	3.61	2
12	ECA-EE-46	3.40	6	3.16	5	3.39	7	3.33	12	4.39	3	2.71	14
5	ECA-EE-16	3.35	7	3.21	4	2.94	11	3.28	14	4.26	4	3.05	9
13	ECA-EE-25	3.32	8	2.95	11	3.89	2	3.55	5	3.81	12	2.42	15
4	ECA-EE-13	3.27	9	3.08	6	2.86	12	3.34	11	3.75	13	3.34	4
3	ECA-EE-9	3.27	10	2.82	14	3.17	10	3.22	16	4.25	7	2.89	12
17	KCB	3.22	11	3.03	9	3.33	9	3.47	7	4.26	5	2.00	17
2	ECA-EE-8	3.16	12	2.82	13	3.53	5	3.31	13	3.07	18	3.08	8
6	ECA-EE-18	3.13	13	2.71	16	2.19	16	3.28	15	4.57	1	2.89	11
1	ECA-EE-6	3.09	14	3.34	1	2.50	14	3.40	10	3.48	15	2.74	13
15	ECA-EE-38	3.05	15	2.71	17	2.42	15	3.67	4	3.43	16	3.00	10
11	ECA-EE-45	3.04	16	3.03	8	2.14	17	3.21	17	3.57	14	3.24	5
14	ECA-EE-29	2.99	17	2.76	15	1.97	18	3.95	2	3.96	10	2.29	16
18	DLC1	2.83	18	2.63	18	3.33	8	3.19	18	3.07	17	1.95	18

variety EE-EAC-31 was selected first by farmers, but only sixth by breeders. Varieties acceptable to both groups can be found in the top left corner of the table. There are clearly three varieties appreciated by both: EE-EAC-31, -33, and -21. Two more acceptable, but not outstanding, varieties are EE-EAC-16 and -46.

We can also express the correspondence of breeders' and farmers' preferences by calculating the overlap between the two. For example, farmers and breeders have no common variety in their first two choices. Comparing their first 3 choices, however, they have 1 variety in common (ECA-EE-21), or a 33% overlap. In their first 4 choices, there is a 50% overlap. Figure 2 shows the evolution of the overlap. It can be seen from the figure that among the first 10 choices, the overlap is still only 60%.

Satellite or Baby Trials

Methodology

A village close to each of the four mother sites was selected for each satellite or baby trial (Table 10). Farmers from these villages were asked to select 10 participants from among themselves to test a subset of varieties from the mother trials. Each of the 10 randomly selected farmers were given 250 g of each of 4 new varieties, ensuring that each variety was grown by at least 2 farmers. The 4 varieties were chosen randomly using an alpha lattice design with blocks of 4, and each of these blocks of 4 varieties was given to 1 or more farmers. Furthermore, farmers were given a local check (either KBC or DLC1) and were also asked to plant an additional plot of their own local maize. The latter variety differed between sites and farms. The checks were replicated twice, so most farmers had 8 plots, of which 4 were new varieties. Farmers were requested to manage all plots equally. Overall, the varieties tested were the same as those grown in the mother trial, and the same randomization process was used, i.e., an alpha lattice design.

Unfortunately the sample size of the trial was greatly reduced due to poor rains and resulting crop failure on all farms at Kitui, on 6 farms at Katumani, and on 3 farms at Kampi Ya Mawe and Kiboko. Moreover, only yield data from Kampi

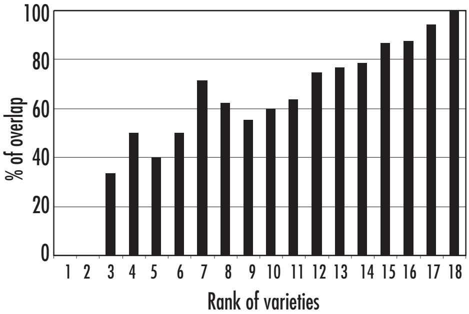

Figure 2. Comparing farmers' and breeders' variety evaluations.

Table 9. Ranking of maize varieties according to farmers and breeders.

Breeders' rank	Farmers' rank																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1			21															
2																	29	
3																		
4		33																
5							16											
6	31																	
7						46												
8												8						
9														6				
10										9								
11									13									
12											KCB							
13													18					
14															38			
15				34														
16					36													
17																		DLC1
18																45		

Note: Numbers in the table refer to varieties tested in the mother trial; KCB and DLC1 are two local checks. The variety that ranked third in breeders' assessment did not even appear among the first 18 varieties ranked by farmers.

Table 10. Sample size of the mother-baby trial established in eastern Kenya.

Location of mother trials	Location of baby trials	Initial no. of farmers	No. of farmers at sites where harvest was measured	No. of plots evaluated at tasseling	No. of plots evaluated at harvest
Katumani	Kitanga	10	4	24	64
Kampi Ya Mawe	Mulaani	10	7	56	88
Kiboko	Nguumo	10	10	52	0
Kitui	Kitui	10	0	0	0
Total		40	21	132	152

Ya Mawe and Kiboko were obtained—a transport problem stopped field workers visiting all other sites at harvest. Yields of 85 plots were measured, and the adjusted yield was calculated as:

Adjusted yield = cob weight*0.8*(100-moisture content)/((100-15)*area)*10000

where:

adjusted yield	=	estimated yield (kg/ha), adjusted for grain coefficient (grain weight/cob weight, assumed to be 80%) and moisture content (measured from three samples) and then calibrated to 15%
cob weight	=	weight of the harvested cobs (kg)
moisture content	=	mean moisture content of three samples
area	=	area harvested (m^2)

Farmers evaluated the varieties at tasseling and at harvest. At tasseling, farmers scored each variety for earliness; at harvest varieties were scored for cob size, cob fill (grain filling), and yield. Again, scores were given on a scale from 1 (very poor) to 5 (very good). At both tasseling and harvest, farmers were asked to give an overall assessment of each variety, using the same scale. This overall assessment, not to be confused with the mean score of the other criteria, can be considered to be similar to the selection index developed by the breeder during data analysis. The index takes into consideration more plant aspects at the given development stage than the criteria of importance. To analyze the overall evaluation and assess the weightings of individual criteria, regression analysis was performed. The overall evaluation was used as the dependent variable and the scores for the individual criteria were used as independent variables.

Results of breeders' evaluation of the baby trials

Because of the small sample size, no extensive analysis was performed other than a yield comparison (Table 11). Five varieties outperformed the best local check (KCB), although only one variety achieved this in more than one site. Since the sample sizes are very small (1-3 repetitions per variety), statistical analysis is not really possible.

Results of farmers' evaluation of the baby trials

Farmers' evaluation of earliness and overall value at tasseling are shown in Table 12. Results indicate that 13 varieties scored higher, on average, than the best local check, indicating an appreciation of breeding for extra early material. The relationship between the scores for overall evaluation and early maturity is highly significant, but the low correlation coefficient (0.271, $p = 0.002$) indicates that many other factors play a role here.

At harvest, 11 varieties outscored the best local check overall, and 7 scored higher than the local check in more than one location (Table 13). This indicates that factors other than yield are important to farmers.

The three varieties (ECA-EE-29, -45, -46) preferred by farmers and retained by breeders from the on-station evaluation also performed well in the farmers'

Table 11. Maize yield (adjusted for water content) from baby trials at two sites in eastern Kenya.

	Kiboko			Kampi Ya Mawe			Total		
Variety	Mean	Std dev	N	Mean	Std dev	N	Mean	Std dev	N
9	5,890	528	2			0	5,890	528	2
29	5,499		1				5,499		1
26	4,917		1				4,917		1
38	4,829	1,110	2			0	4,829	1,110	2
43	4,770		1				4,770		1
18	5,074	1,243	2	4,053		1	4,734	1,058	3
49	4,571	670	2	4,985		1	4,709	530	3
37	5,249	641	2	3,106		1	4,534	1,318	3
KCB	4,392	1,494	15				4,392	1,494	15
13	4,364		1				4,364		1
31	4,169	1,340	2				4,169	1,340	2
33	4,820	1,666	2	2,721		1	4,120	1,690	3
36	4,704	1,364	2	2,923		1	4,110	1,410	3
42	5,181	829	2	1,480		1	3,947	2,216	3
45	4,764	536	2	1,700		1	3,742	1,809	3
6	3,669		1				3,669		1
LOCAL	4,234	614	14	2,207	1,247	6	3,626	1,255	20
21	4,529	969	2	1,091		1	3,383	2,100	3
46	4,580	1,070	2	667		1	3,276	2,382	3
8	5,658		1	309		1	2,984	3,782	2
16	3,246		1	911		1	2,078	1,651	2
DLC1				1,365	313	6	1,365	313	6
34	1,118		1	417		1	768	496	2
Total	4,510	1,114	61	1,908	1,251	24	3,775	1,644	85

Table 12. Farmers' evaluation of baby trials at tasseling in three sites in eastern Kenya.

	Katumani		Kiboko		Kampi ya Mawe		Overall	
Variety	Overall evaluation at tasseling	N	Overall evalation at tasseling	N	Overall evaluation at tasseling	N	Overall evaluation at tasseling	N
46	5.00	1	4.00	1	5.00	2	4.67	4
29	4.00	1	5.00	2			4.50	3
42			5.00	1	4.00	2	4.50	3
45			5.00	1	4.00	0	4.50	1
49	5.00	1	3.00	1	5.00	2	4.33	4
9	4.00	2	4.00	1	3.50	2	3.83	5
36	3.00	1	3.50	2	5.00	1	3.83	4
26			3.50	2			3.50	2
37			3.00	1	4.00	2	3.50	3
16	3.00	1	4.00	3	3.00	2	3.33	6
21	2.00	1	5.00	1	3.00	2	3.33	4
13	2.5	2	4.00	2			3.25	4
18			4.5.0	2	2.00	2	3.25	4
LOCAL	2.75	4	2.86	14	3.92	12	3.18	30
33			.	0	3.00	1	3.00	1
38	2.50	2	.	0	3.00	2	2.75	4
KCB	2.50	4	2.93	14			2.72	18
8			3.00	2	2.00	2	2.50	4
31	3.00	2	2.00	1			2.50	3
DLC1					2.29	14	2.29	14
34	1.00	1	3.00	2	2.50	2	2.17	5
6	1.00	1	2.50	2			1.75	3
43			1.00	1			1.00	1
Mean	2.88	24	3.27	56	3.25	52	3.13	132

overall evaluation (Table 12), although the latter two yielded lower than KBC. In the mother trial, however, only ECA-EE-46 scored higher in the overall evaluation at harvest. Further analysis by variety is not really feasible, however, due to the very small sample size.

On-farm evaluation most likely best represents farmers' conditions and predicts future adoption of technologies, therefore it is important that it is analyzed and understood. The overall evaluation of individual varieties can be seen as the farmers' selection index. To analyze this index, the overall score at harvest was regressed on the score of the individual criteria, i.e., yield, well filled cob (grain filling), cob size, and vigor (Table 14). Yield had the highest coefficient (0.5), followed by vigor (0.2) and grain filling (0.2). Cob size was not significantly different from zero. The results show that the model predicts a large amount of the variation (R2 = 62%), but also that the individual criteria do not capture a number of elements. This highlights the importance of including

Table 14. Regression analysis of the overall evaluation of varieties.

Independent variables	Coefficient	Std error
Yield	0.526	0.098***
Vigor	0.191	0.088*
Well filled cob	0.189	0.083*
Cob size	0.034	0.099
Constant	0.191	0.310
R2	0.624	
Std error of estimate	0.659	
N	84.000	

Note: * significant at the 5% level; ** significant at the 1% level; *** significant at the 0.1% level.

Table 13. Farmers' evaluation of baby trials at harvesting in two sites in eastern Kenya.

	Kiboko		Kampi Ya Mawe		Total	
Variety	Overall evaluation at harvest	N	Overall evaluation at harvest	N	Overall evaluation at harvest	N
36	5.0	2	5.0	1	5.0	3
45	4.0	2	5.0	1	4.5	2
37	3.5	2	5.0	1	4.3	3
49	3.5	2	5.0	1	4.3	3
13	4.0	1			4.0	1
29	4.0	1			4.0	1
31	4.0	2			4.0	2
43	4.0	1			4.0	1
18	3.5	2	4.0	1	3.8	3
33	3.5	2	4.0	1	3.8	3
46	3.5	2	4.0	1	3.8	3
LOCAL	2.9	16	4.3	6	3.6	22
9	3.5	2	.	0	3.5	2
21	3.0	2	4.0	1	3.5	3
42	3.5	2	3.0	1	3.3	3
KCB	3.2	16	.	0	3.2	16
6	3.0	1			3.0	1
8	5.0	1	1.0	1	3.0	2
26	3.0	1			3.0	1
34	4.0	1	2.0	1	d3.0	2
DLC1				2.8	6	
2.8	6					
16	2.0	1	3.0	1	2.5	2
38	2.5	2	.	0	2.5	2
Mean	3.3	64	3.7	24	3.5	88

an overall evaluation score. The individual coefficients represent how much the overall evaluation increases with an increase in score of an individual criterion. For example, when a variety's score for yield increases by 1, its overall score increases by 0.5; when its score for vigor increases by 1, its overall score increases by 0.2, all other factors being equal. Thus, the coefficients can be seen as the weights in a selection index. The non-significance of the large cob criterion comes as a surprise after the group discussions, but it does make sense since larger cobs do not necessarily equate to more or better quality food for a household.

These results show how a farmers' selection index can be approximated and then compared to the breeders' index to make the breeders' index more responsive to farmers' needs.

Discussion and Conclusion

Two major points need to be discussed. Firstly, did we identify new and promising varieties through this process? And secondly, did the participatory methods contribute to the process? If so, how can they be improved?

In answer to the first question, the results are ambiguous. Although some promising materials were identified, the methodology resulted in a large body of often inconsistent data that are difficult to interpret. Few of the varieties consistently outscored the local checks. Two major factors make it difficult to identify promising material: the poor correlation between farmers' and breeders' evaluations, and the high variability in the farmers' evaluation and in performance in farmers' fields.

On the second point, the participatory methods clearly showed how classical breeding has problems responding to farmers' variety preferences. So far, the two approaches have not converged to form a method compatible to both. Scientists like to control for many factors so that they can accurately state that, under their very controlled circumstances, a limited number of traits have improved. A problem here is that these highly controlled circumstances are not often representative of farmers' conditions, and the limited number of traits might not represent farmers' preferences. This is highlighted by the very poor correlation between farmers' and breeders' evaluations in the study. The exercise, however, provides very useful insights into how to bring the two evaluations together by improving their respective methodologies.

In the study, the main classical breeding tool—the breeders' index—does not seem to represent farmers' preferences well. It could be improved through changes to the functional form, as well as to the variables included and/or the weights attached to different variables. The linear function is not always an appropriate form since some materials should be rejected when they do not pass certain levels. This, however, can be achieved through a multiplicative or multistage index, and there should be no problem in programming this into the existing software. Secondly, the selection process should be transparent so that the pathway of choice can be retraced, analyzed, and improved. Thirdly, an effort should be made to try alternative formulations, including different variables with different weights, to try to better match farmers' evaluations. Finally, and most importantly, breeders should have more frequent discussions with farmers to compare their respective preferences.

From the farmer's perspective, the PRA methodology and the evaluation used on-station and in the mother trials are well developed, although some modifications could be made. The baby trials, however, need serious work. The basic system of asking farmers to define their selection criteria, and to score new varieties on a scale of 1 to 5, was very convenient for data collection but cumbersome for analysis. The criteria collected during the PRAs need to be more concordant so that farmers' responses can be classified into a number of categories. This would simplify the analysis of farmers' evaluations of new varieties. The high variability associated with farmers' evaluation on-station or in mother trials needs to be managed by increasing the number of farmers (preferably to more than 50) participating. Sufficient resources need to be made available to make a rapid analysis possible. The people conducting the analysis will need to have appropriate software installed and have sufficient training, since proper statistical analysis differs from conventional methods. The analysis should then be included in the selection of varieties for the next cycle, and an attempt be made to include the farmers in that selection. An index to combine the evaluations at tasseling and at harvest still needs to be developed.

The baby trials need some serious thought. In the study the data are not very useful: the variance is high, the sample size is small, and a lot of data were lost due to bad weather and poor organization. The experience indicates that enough resources have to be made available to allow for regular site visits to assure the quality and quantity of data collected, and rapid data entry and analysis. The process could be improved by increasing the amount of data collected by the farmer. This could be achieved through well structured questionnaires, combined with proper training to enable farmers to fill them unassisted. A simplified yield measurement taken by farmers should also be tested. Farmers could include more evaluation criteria in the baby trials than is possible in the mother trials, and these data would be very useful for improving the selection index.

Finally, the experience revealed that farmers are eager to participate in selecting new varieties. The methodology still needs work, but it clearly demonstrates the potential for bringing together breeders' and farmers' selection indices. The collaboration between breeders, farmers, and social scientists shows promise for improving the selection procedure by taking into account farmers' preferences early in the process.

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Discussion Summary

The discussion following the presentation centered on two themes: trial design and farmers' evaluation of the trials. The design of the baby trials included controls and, though these trials were evaluated in the same way as the mother trial, the control variety only performed better than other varieties in the mother trials. This could be due to variations in the management of the baby trials. Mother trials are intensively managed and this may influence variety performance. Baby trials provide contrasting management conditions, i.e., low management intensity. Mother trials can be used for testing agronomic practices, but may not be as useful for breeding purposes. Measuring yields in baby trials is difficult, prompting the question of whether farmers' yield scores could be used instead of yield measurements. This point was discussed in several presentations and merits further investigation. It was noted that yields from mother trials and baby trials may not correlate well, and this may be an important reason to have both, i.e., to provide different information.

In terms of farmers' evaluation of baby trials, the point was made that the farmer participants should ideally be selected randomly. As this is usually not possible, there is a risk of bias in the evaluation. While there is little that we can do about this, we need to be aware of the problem. A question was asked on how farmers in the case study ranked the varieties. The answer was that a group process was used to reach an agreement on the order of importance. It was then pointed out that group discussions are useful but may impose consensus when there is not necessarily agreement among farmers, and that there may be high variation in scores among farmers because they select for different purposes. Some farmers, for example, select for storage, while others select for selling properties, and these differences may influence the variability of scores. It was pointed out that farmers can be more precise than breeders when scoring varieties. It was also noted that care should be taken when using an index that combines farmers' opinions on different traits. Such an index can be misleading because it makes assumptions that one trait may compensate for another, when not all traits have the same importance to farmers. An alternative scoring method asks farmers to accept or reject varieties, as breeders do. The point was raised that it would be better if farmers evaluated trials 3-4 weeks before harvest as well as at harvest, but this may be location specific. For example, among maize farmers in Mexico, evaluations before harvest are not considered useful.