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Selection of New Varieties through Participatory Research, the Case of Corn in South Mali

A. Kamara*, T. Defoer** & H. De Groote**

Key words : Mali - Corn - Participatory Research - Selection of Varieties - Farmer Criteria

Summary

On-farm trials in South Mali, combined with a survey of farmers' criteria, both men's and women's, show that the properties of the new corn varieties do not correspond well to their selection criteria.

A better understanding of farmers' objectives is therefore essential in selecting new varieties.

Résumé

La réalisation simultanée d'essais variétaux en milieu paysan et une enquête concernant les désidératas des agriculteurs (homme et femme) concernant la diffusion de nouveaux cultivars de maïs, montrent l'inadaptation des derniers génotypes sélectionnés pour le Sud du Mali.

Une meilleure compréhension des objectifs de production des paysans est essentielle pour orienter le choix de nouvelles variétés.

1. Introduction

The development of high yielding varieties is one of the main thrusts of agricultural research programs on cereals. The thematic research approach generally consists of testing new varieties on-station, followed by multi-location researcher-managed on-farm trials. Under these conditions, several high yielding varieties have been selected, creating high expectation for adoption. However, these varieties often fail to perform better than local varieties, under farmer practices (7). The diversity of the local farming systems has been reported to be one of the major reasons for this failure (17). Indeed, the improved varieties normally require management practices which are not appropriate for most of the agro-ecological and socio-economical conditions.

In order to respond to the variability of the local conditions and production objectives, farmers grow varieties with different characteristics (15). Their selection criteria have been reported to be very different from those of the breeders (16). These criteria are often not well known, due to the complexity and variability of farmers' production strategies and objectives. Experience has shown that discovering this complexity and understanding farmers rationality is not an easy task (5). Developing participatory tools and methodologies that facilitate communication between farmers and researchers is therefore urgently needed.

Through promotion by the "Compagnie Malienne pour le Développement des Textiles" (CMDT) in the beginning of the 80s, corn quickly became an important cash crop in South Mali. With the removal of guaranteed prices in 1986 (accompanied with the withdrawal of credit for corn inputs), corn ceased to be a cash crop and farmers rapidly shifted from intensive sole cropping to traditional practices (including reduced fertilization, local varieties, intercropping, etc) (3). However, corn remained one of the most important cereals in the farming systems of South Mali. Since improved corn varieties are expected to increase systems productivity, their development receives continuing priority by the thematic research program of the agricultural research institute (Institut d'Economie Rurale; IER) of Mali. While understanding the variability of farmers' production strategies and objectives has become extremely important, now corn has become a more subsistence crop, the thematic research approach on corn varieties is mainly restricted to on-station trials and multi-location researchermanaged on-farm trials, without structured assess-ment of farmers' selection criteria. To cover this deficiency, the Farming Systems Research (FSR) Team of Sikasso of the IER is developing a participatory research methodology, involving farmers in the design, implementation and evaluation of on-farm variety trials on corn.

The participatory research methodology aims at identifying system parameters that are essential components of selecting and promoting of improved varieties. The complementarity of stability analysis and farmers' assessment to the results, generally obtained by on-station research and multi-location trials, leads to better targeting of extension efforts and in orienting the varietal selection program. First the methodology is described, followed by a brief outline of the importance of corn in South Mali's agro-ecology. The results

* I.E.R. - B.P. 186, Sikasso, Mali.
** KIT (Royal Tropical Institute), Mauritskade 63, 1092 AD Amsterdam, The Netherlands.
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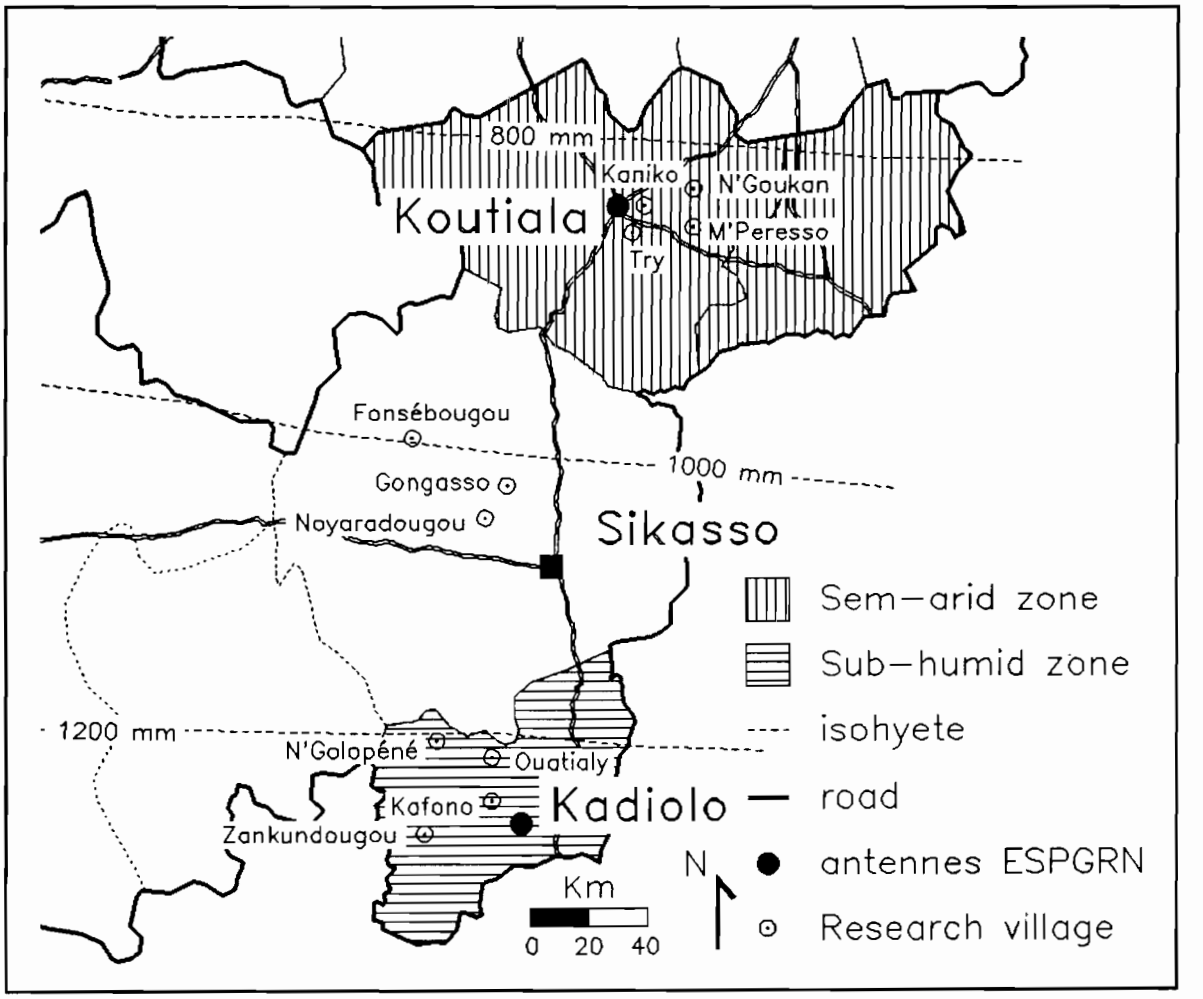

Figure 1 · Localization of agro-ecological zones in South Mali

of a test comparing several improved varieties with a local variety consist the main body of the paper. The conclusion supports the need of a farming systems perspective and involving farmers in the selection process of improved varieties (4, 6)

2. Methodology

The research consists of field tests of new varieties, conducted with farmers under their own conditions, to check adaptability to agro-ecological environment and farmer management practices, followed by preference evaluation. During a village meeting of interested farmer-experimenters organized in the four research villages in each of the two agro-ecological zones of South Mali, a number of improved corn varieties are presented for on-farm testing in comparison with the common local variety. The trial design is discussed and mainly consists of obtaining consensus on a simple block design in which varieties are disposed in parallel strips of the same dimension. No recommendations on agricultural practices are given, and farmers are asked to grow all the varieties according to their traditional practices for corn growing. A demonstration of the field lay-out is given for all the farmer-experimenters of the village, on one of the farmer fields. After the demonstration farmers are given 1 kg of seed of each variety they want to try.

A later visit is made by the research staff to help the farmer mapping the location of the varieties of the trial on a hard board, which is left with the farmer for monitoring purpose.

Since facilitation of communication between researchers and farmers is central in this test, priority is given to evaluate farmers' opinions, preferences and ideas. These preference evaluations are conducted on different occasions: (1) during the growth cycle, (2) just after harvesting, (3) at transformation and (4) at degustation. Using the hardboard with the location of the varieties, farmers are asked to do pair-wise comparisons, during individual field visits. These comparisons result in a preference ranking of the tested varieties reflecting socio-economic conditions. For each pair-wise ranking farmers are asked to express the reasons for the choice. Additionally, farmer visits are organized between farmers of the same village, between villages and between zones. This allows farmers and researchers to exchange information on variety preference and general corn management practices.

3. Characteristics of the Research Area

The FSR Team of Sikasso covers the administrative region of Sikasso, in South Mali. This region is divided into two major agro-ecological zones: a Sub-Humid zone in the South and a Semi-Arid zone in the North. To

contrast these two zones, four research villages were selected in each of the two zones (Figure 1). The villages represent the agro-ecological diversity of the zones.

The climate of the region is dominated by one pronounced rainy season. The yearly rainfall is 800-900 mm in the North and more than 1100 mm in the South. The region has mostly poor sandy soils in a gently rolling landscape.

4. Corn in the farming system of South Mali

Traditionally, South Mali has a slash and burn farming system based on cereal crops: after a few years of cereal cultivation, the land is left in fallow for several years, in order to regenerate soil fertility. In the drier part of the north, millet and sorghum dominate, while in the wetter part of the South, corn is more suited and becomes important. Although livestock and small ruminants are part of the system, they were until recently not integrated: no fodder crops were grown, and organic fertilizer was rarely used. The system was basically closed and self-reliant.

This closed system has now been subject to two major changes: a substantial population growth and the introduction of cotton. Cotton, a cash crop, brought the traditional system in contact with the international market. Cash income (combined with credit facilities) made investments in fertilizers and animal traction possible, heavily increasing the demand for land. At the same time the population has grown dramatically in recent years, increasing the demand for cereals and for the land to grow them. The result has been a rapid decrease in fallow, and an increased need for inputs and crop-livestock integration, to avoid soil degradation.

The two zones under study can be seen as two stages in this development. The Sub-Humid zone in the South has a smaller population increase (0.78%), in-fluenced by more emigration possibilities to Ivory Coast, and a higher level of endemic diseases as onchocerciasis. These factors resulted in a lower population pressure (Table 1). In this zone, cotton has only recently been introduced, and animal traction is not so well developed. Corn which forms the base of the cereal nutrition is more suitable to this zone, and it takes 34 % of the cultivated area (Figure 2). Apart from self-sufficiency, the early harvest of corn also helps to bridge the shortage period before the new harvest.

Table 1 : Population and land in two zones of South Mali

	Semi-Arid zone (North)	Sub-Humid zone (South)
population density (N/km2)	13 - 49	11 - 22
population growth (%/year)	3.47	0.78
people per household, present	17	15
people per household, absent	2	8
arable land (%)	55	73
land cultivated (% of arable land)	69	<20
cultivated land per household (ha)	12	14
cultivated land per active member (ha)	1.4	1.1

The Semi-Arid zone in the North, on the other hand, is

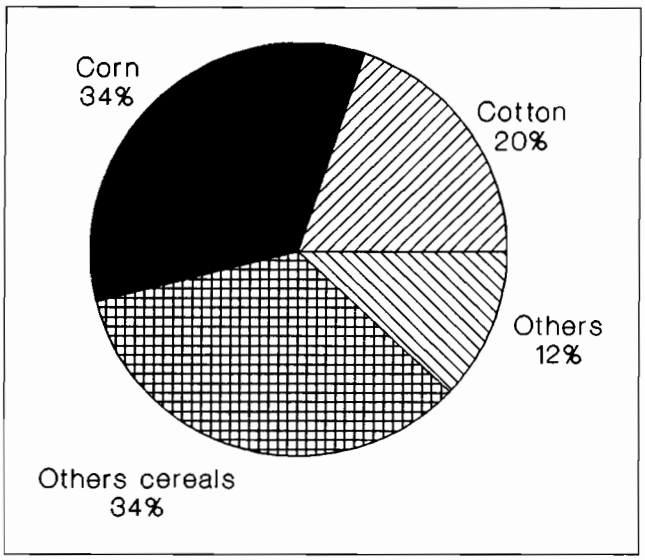

Figure 2 . Use of cultivated land in the Sub-Humid zone (Source · ESPGRN 1992)

subject to a relatively high population pressure, resulting in a higher level of arable land under cultivation (Table 1). The agriculture of this zone is based on a cotton-cereal rotation; corn represents only 7% of the cultivated area (Figure 3). Corn is often sold fresh or as grain.

South Mali is particularly well suited for corn production (10). Corn, however, is more susceptible to pests such as Striga, and is more demanding in inputs and rainfall than other cereals such as millet and sorghum. Striga is a parasitic weed causing high losses, especially when fallow becomes rare and soils are overexploited, but its importance decreases with improved soil fertility management (1). Given the right economic incentives, market information and availability of inputs, these constraints are not insurmountable.

The population in South Mali has a preference for the consumption of millet and sorghum to corn, resulting in a lower price for the latter. Given the increasing population and the increase of prices of imported cereals, a large market for corn is, however, opening up in Mali and in West-Africa. Some major constraints remain, concerning prices, access to markets, exten-

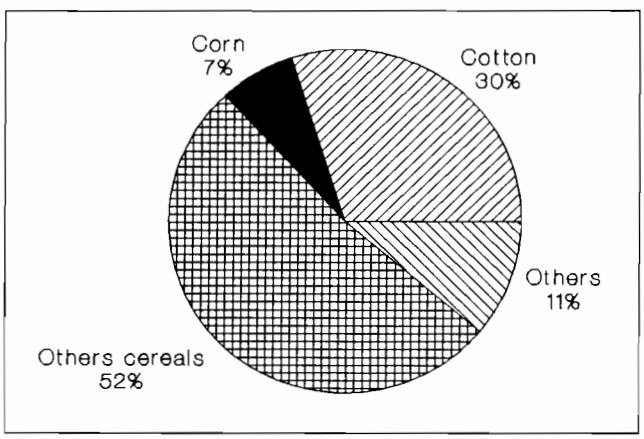

Figure 3 Use of cultivated land in the Semi-Arid zone (Source ESPGRN 1992)

sion services and credit. The Structural Adjustment Program, executed in collaboration with the World Bank, brought a liberalization of cereal markets and a decrease of subsidies, causing a drop in prices, especially for corn. The devaluation of 1994, however, pushed prices up again, starting in 1995 (11). Markets are still not very well developed, and it is at the moment hard to buy large quantities of corn. Finally, extension and credit services are mostly concerned with the cash crop, cotton, neglecting the potential for corn production.

5 Comparing Corn Varieties

5.1 Overview of Varieties Currently in Use

About 80% of the Malian corn is produced in South Mali. Next to local varieties such as Kafougoun and Zafien, the principal improved varieties used in this zone are Tuxpéno, Tiémantié, and TZESRW. The pedigree of these varieties is presented in Table 2.

Table 2 : Pedigree of improved varieties used in Mali

variety	origin	selection specifications
Tiémantié	Mali	mass selection in Mali
EV8422SR	pop. 22 CIMMYT	x streak resistance (IITA)
Tuxpéno	pop. 21 CIMMYT	
Niéléni	Western yellow 096E	x mildew and streak resistance
TZESRW	IB32 IITA (resistant to streak)	x Asian early varieties

Kafougoun in the Sub-Humid zone and Zafien in Semi-Arid zone are both local varieties with a long cycle, appreciated for their productivity and their characteristics for transformation, consumption and conservation. Tuxpéno and TZESRW are both varieties introduced in the beginning of the 80's. Tuxpéno is a very productive late variety, the first one to be widely promoted, but is hard to pound manually and has a high bran content. TZESRW, on the other hand, has a short cycle and is very appreciated for cultivation in combination with millet. It helps to spread the risk of erratic rainfall and its timely harvest helps to bridge the shortage period.

EV8422SR and Niéléni are new varieties recently released. EV8422SR is a late variety, and logically quite productive. Niéléni is of short cycle and therefore more appreciated for its early harvest, but also very appreciated by consumers for it superior taste as charcoal grilled corn-on-the-cob. Moreover, the varieties EV8422SR, TZESRW and Niéléni have been selected for Streak virus resistance (Streak origin IITA). All varieties are adapted for a yearly rainfall of more than 600 mm as in South Mali.

5.2 Appreciation of Varieties by Thematic Research

Table 3 shows the major results of on-station experimentation and researcher-managed on-farm trials by the thematic research (1). The on-station trials were laid out under Randomised Complete Block (RCB) design with 4 replications. The on-farm experiments consisted of simple blocks of 4 varieties without replication, laid out on 10 farms in each of three representative zones.

Table 3 : Characteristics of the principal varieties in extension in South Mali.

Varieties	Cycle (days)	Grain	Yield (T/ha)	CV%	Years in extension	1000 grains weight (g)
Tuxpéno	115-1120	White convex	5-6	17.2	15	238
EV8422SR	115-120	White qu.convex	5-6.5	17.2	2	235
TZESRW	80-90	White concave	3-5	13.9	8	235
Niéléni	80-90	Yellow Concave	4-5	13.9	1	231

The test results are as expected: late varieties are more productive then early ones and the more recent varieties are more productive then the older ones.

5.3 Appreciation of Varieties through Participatory Research

The field tests have allowed to compare the productivity under farmers' conditions. The yield, results of one plot for each of 65 farmers from 8 different villages (see Figure 1), shows that the improved varieties do indeed perform better than the local ones, but at less than half the yields of the thematic research (Table 4). Moreover, the variability is so high that there are hardly any significant differences between the varieties.

Table 4 : Yields under farm conditions and farmers' management practices

Varieties	Sub-Humid zone			Semi-Arid zone		
	Yields (kg/ha)	C.V.	n	Yields (kg/ha)	C.V.	n
Tuxpéno	2313	58	24	1934	53	41
EV8422SR	2169	73	24	1698	71	41
TZESRW	1708	47	24	2253	60	41
Niéléni	1880	62	24	1973	58	41
Locale	1861	41	17	1272	89	26

The stability of the varieties is analyzed by regressing the yield on the environmental index (EI), which is the average yield of all varieties at one given farm. The value of EI is representative for the level of conditions for crop production (8). (Figure 4 and 5). The stability analysis consists of plotting the EI against the yield of each variety of the farm. The relative height of the line represents the general yield of the variety, while the slope is an indication for its adaptability to changing environments. These graphs are interpreted as follows: the local varieties have a low slope, indicating a very stable yield; improved varieties have generally a higher yield (look at Tuxpéno and TZESRW for example) but their slope is also a lot higher. The yields of the local varieties are higher at low environmental index, indicating that they perform better under less favorable conditions. This can clearly explain partly why new varieties are not very widely adopted (4).

Unfortunately for thematic researchers, productivity is not the only criterium that farmers use to select their varieties. Preference evaluations with farmers have enabled tabulation of criteria for their choices. Table 5 presents the analysis by zone and globaly.

Table 5 : Variety selection criteria (as % of farmers interviewed declaring this criteria)

Principal criteria	Sub-Humid zone	Semi-Arid zone	Total
yield	73	49	65
organo-leptic characteristics	54	80	63
length of cycle	58	46	54
agro-ecological conditions (a)	37	67	47
transformation	49	31	43
pest resistance	19	39	25
commercialization	0	72	24
vegetative growth	22	26	23
consumption as objective	19	23	20
conservation of grains in storage	13	5	10
cultivation characteristics (b)	5	0	3
use as animal feed	4	0	3
number of farmers	39	79	118

(a). /ex: drought resistance, shelding, logging..
(b) /ex: fertilizer requirement

Although yield is the most popular criterium, it is closely followed by taste quality and by length of cycle, all three mentioned by more than half of the farmers. Two more criteria are chosen by a third of the people: suitability to environment (especially in the Semi-Arid zone) and ease of transformation. Commercialisation is only found to be important in the Semi-Arid zone, which is more oriented toward marketing. The results (scores) of pair-wise comparisons of the tested varieties with individual farmers were aggregated by zone (Table 6).

Table 6 : Farmers' preferences of varieties after harvesting by men (1), at transformation by women (2) and at degustation by both men and women (3).

Zone	Sub-Humid zone			Semi-Arid zone		
Varieties	1	2	3	1	2	3
Tuxpéno	11.7	9.2	7.9	29.0	0	15.4
TZESRW	12.3	9.8	8.2	18.6	20.0	9.0
EV8422SR	10.3	13.0	9.6	18.8	13.3	16.6
Niéléni	10.3	13.4	11.2	5.4	26.6	19.2
Local	14.1	16.2	15.3	15.5	6.6	7.7

N.B: Figures represent the sum of the scores obtained per variety (by pair-wise comparison) divided by the number of the total scores (not all compared varieties are represented).

In both zones, late varieties are preferred. In the Semi-arid zone of the North, preference is given to the improved varieties (Tuxpéno, EV8422SR), while in the Sub-humid zone of the South, local varieties are preferred by men. Women do not like Tuxpéno because of its difficulty to pound. As men, women of the Sub-humid zone prefer the local variety. Tuxpéno and TZESRW are less appreciated for consumption.

The results of the different approaches are now combined in Table 7. The figures in the table represent the ranking for the column criterium, where 1 has the highest rank, 5 the lowest. We see that only the ranking by the criterium yield follows the preferences of the thematic research, but ranking by stability or by farmers preferences gives dramatically different results.

In general, high yields come at the cost of other qualities, and the two are rarely compatible. Local varieties, often less productive, are clearly more stable, while the newly released varieties (EV8422SR and Niéléni) are distinctly unstable. Analysis according to farmers' preferences produce also quite different results, and also show marked difference between sexes. Men prefer varieties with high yield or varieties with which they have experience, and surprisingly not early varieties, even not in the Semi-Arid zone. Women, on the other hand, prefer varieties that are easy to pound and to cook with. In taste tests, both sexes prefer varieties with higher sugar content, usually yellow in color.

The results of this participatory research, comparing varieties in tests established with farmers, under their conditions and evaluated according to their criteria, show that adoption decisions on new varieties depend mainly on production objectives. Farmers aiming to market fresh corn ears or those who fear an early stock depletion will prefer early varieties. However, this seems to be less important than expected. Farmers who aim to sell grains will benefit more from late and more productive varieties. Finally, the majority of farmers, those who grow corn for home consumption give major importance to consumption and transformation characteristics.

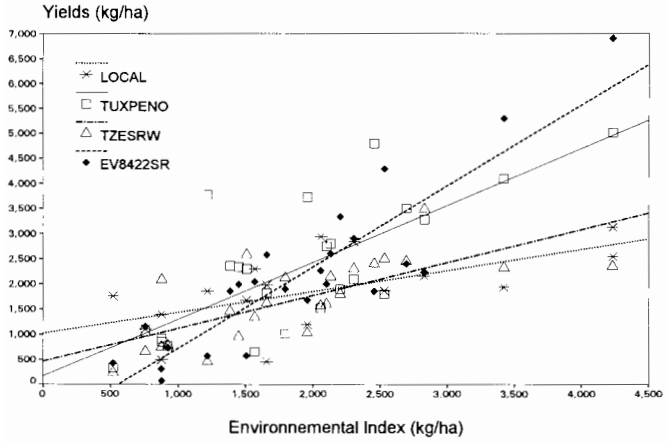

Figure 4 . Yield response to the environmental index in the Sub-Humid zone (original SPSS-graph).

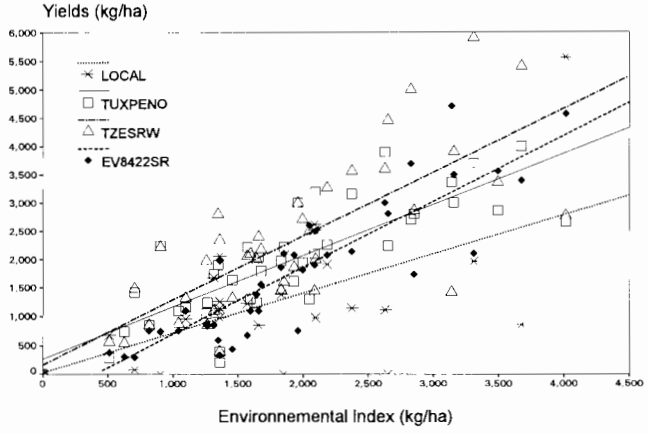

Figure 5 Yield response to the environmental index in the Semi-Arid zone (original SPSS-graph).

Table 7 : Ranking of corn varieties according to yield, stability and farmers' preferences

Varieties	Yield	Stability	Farmers' preferences		
			at harvest (men)	at pounding (women)	at degustation (both)
Sub-Humid zone					
Tuxpéno	1	3	2	5	5
EV8422SR	2	5	5	3	3
TZESRW	5	2	5	4	4
Niéléni	3	4	2	2	2
Locale	4	1	1	1	1
Semi-Arid zone					
Tuxpéno	3	2	1	5	4
EV8422SR	4	5	2	3	3
TZESRW	1	4	3	2	5
Niéléni	2	3	5	1	2
Locale	5	1	4	4	1

NB numbers indicate ranking, 1 = highest, 5 = lowest

6. Conclusion

The results show that thematic research, with its criteria of yield and ecological adaptability, can not be sufficient for selecting suitable varieties for extension. It is necessary to combine this research with participatory research in order to assess the varieties in the less hospitable village environment, and especially to take into account the farmers' criteria of choice.

The example of corn in South Mali has shown that there are a wide range of other criteria and that they differ substantially among farmers. The participatory approach has been shown to be able to account for those criteria, and thus to help thematic research to a better selection. The results can mean a better service to farmers with a range of varieties that respond to their needs in a rapidly changing ecological and socio-economic environment.

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A. Kamara, Mali, Agronomist, IER, CRRA, ESPGRN/Sikasso - Mali.
T. Defoer, Belgian, Agronomist, KIT (Royal Tropical Institute), Mauritskade 63, 1092 AD Amsterdam - The Netherlands.
H. De Groote, Belgian, Agronomist, KIT (Royal Tropical Institute), Mauritskade 63, 1092 AD Amsterdam - The Netherlands.