FARMER PARTICIPATION IN BARLEY BREEDING IN EGYPT

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Introduction

Barley is estimated to cover about 50,000 ha in the North-West Coast of Egypt. The area is divided in five regions; Ras El-Hekma, Marsa Matrouh, El-Negeila, East Barrani, and West Barrani; each region is served by a SubRegional Support Center (SRSC). Each region is divided in three zones or strips; the coastal or first zone, the second zone, and the third zone. The production systems include different combinations of barley, orchards, horticultural crops, and livestock. Only 6-row barley is grown in the area; some farmers were exposed in the past to a 2-row variety distributed by a development project, but the variety was very poorly adapted to the region.

The major use of barley is feed, mainly for small ruminants (barky sheep). The use of barley grain for food preparation is widespread, although in small amounts in each household. Barley flour is mixed with wheat flour for bread making or used for the preparation of sweets, (the most famous is called beggina, barley flour mixed with sugar and then cooked in milk). A barley soup (made of cracked grains), is also common, and some farmers mentioned a sort of couscous (kisk) made out of barley and cooked in milk.

Farmers do not grow different varieties for feed and food; they usually grow one or two varieties, one of them being the local and the other being Giza 126. The latter has been distributed by MRMP and has been quickly adopted and appreciated in the area.

Planting is always done by hand, with seed rate varying from 45 to 75 kg/ha. Continuous barley is common; some farmers have already adopted barley-lentil or barley-vetch rotations introduced by MRMP. The crop is grown without inputs such as fertilizers, herbicides, or pesticides. When asked about the reasons for not using fertilizers and any other inputs, the answer was always; 'they are not available', intending both the unavailability on the market and the unavailability of cash.

Some farmers keep the seed for planting the following season; some buy the seed from neighboring farmers or from the local market.

The most desirable attributes for a barley variety are drought tolerance, high tillering ability, long spikes, white seed, and resistance to smut and leaf rust. One farmer in El-Negeila is interested in early heading but (relatively) late maturing barley.

Methodology

During 1999/2000, a new project was started with the long term objective of increasing barley production in the area, and with the short term objective of assessing the possibility of using a participatory approach in the development of new cultivars. After consultation with farmers, eight locations were identified; El-Karamis and El-Hebella in Ras El-Hekma SRSC, El-Shawaier and Ghout Rabbah in Marsa Matrouh SRSC, El-Magroun and El-Dawaia in El-Negeila SRSC, West Barrani, and East Barrani.

In each location, we planted 53 barley entries and one local check (from seed obtained from the farmer), repeated seven times, for a total of 60 plots. The trial was unreplicated and arranged in six blocks of 10 plots each. Selection was conducted in each farmer's field by the host farmer and by a group of five expert farmers.

At tillering stage and at maturity, a group of five expert farmers, including the host farmer, gave an agronomic score to each plot in each farmer's field. A score from 0 (worst) to 5 (best) was used in all locations. In each region, the same five farmers scored the two trials planted in that area. Selection was conducted in such a way as to reveal the criteria being used by the farmers in making their choices. At the end of the selection, we sat with farmers to discuss about the trial, to have their impression about the germplasm, and to decide which entries to select for the next year. In all locations, farmers decided to use only the score given at maturity for final selection and to keep the entries that received the top scores (5 or 4) by the majority of the group. One barley breeder scored the trials at maturity.

The following traits were measured: plant height (ph) in cm; spike length (sl) in cm; number of spikes per m2 (ssm); biomass (by) in kg/ha; grain yield (gy) in kg/ha.
The data were analyzed by fitting different models of the residual maximum likelihood method (REML) using the ASREML software. The environmentally standardized data were used to analyze genotype x environment interactions using clustering and ordination procedures (using the software GEBEI). Eventually, a similarity analysis was used to compare the score given in different locations by the individual farmers and the breeder, and the final selection in the eight locations. These analyses were done using the program NTSYS-PC version 2.02 (Numerical Taxonomy System, Applied Biostatistics, N.Y.).
Plant height, spike length, number of spikes per m2, grain yield, and biomass of the 53 entries are shown in Table 15 together with the values of the local check.

Results

Yields varied widely both between and within locations. The average yield of grain varied from about 200 kg/ha in West Barrani (WB) to more than 1000 kg/ha at El Magroun (El-N). The highest yielding entries out-yielded the local check by two to three folds. Similarly, the average total biomass yield varied from about 700 kg/ha at El Hebella to nearly 4000 kg/ha at El Magroun. The highest yielding entries out-yielded the local check by between 30% to three times. In three locations (El Karamis, El Shaweir, and El Dawaia), farmers were able to identify the top yielding line.

Table 15. Mean and range of biomass yield (by in kg/ha), grain yield (gy in kg/ha), plant height (ph in cm), spike length (sl in cm), number of spikes per m2 (ssm) of 53 barley entries and one local check tested in eight farmers fields in the northwest coast of Egypt.

Location		by	gy	ph	sl	ssm
El Hebella	Mean	734.5	335.2	39.5	14.4	49.4
	Max	1485.9	669.2	50.1	16.5	73.0
	Min	201.9	86.1	32.1	12.4	28.4
	Loc check	791.0	264.0	35.2	13.9	45.4
El Karamis	Mean	928.5	294.5	35.3	12.3	32.8
	Max	1605.9	734.1	46.1	14.8	65.0
	Min	485.8	45.7	26.5	9.6	18.1
	Loc check	778.4	289.0	34.0	11.6	23.7
El Shawaier	Mean	1412.5	436.4	22.4	9.6	52.7
	Max	2029.7	1079.3	40.0	15.1	69.7
	Min	891.2	0	10.1	6.3	35.0
	Loc check	1515.0	484.9	17.9	8.4	53.6
Ghout Rabbah	Mean	1574.2	370.0	29.2	12.4	43.5
	Max	3228.0	1124.9	45.7	15.8	57.4
	Min	707.8	12.3	17.6	9.1	28.2
	Loc check	1281.0	263.2	24.4	11.7	47.2
El Dawaia	Mean	1883.1	919.1	52.1	15.8	46.6
	Max	2851.0	1439.5	71.0	21.3	65.4

	Min	1043.5	484.4	38.9	11.4	27.9
	Loc check	1750.0	962.3	45.9	14.7	47.2
El Magroun	Mean	4068.4	1063.2	62.9	14.7	56.8
	Max	6933.0	1752.7	78.4	19.1	81.3
	Min	2193.0	566.0	44.5	10.3	27.9
	Loc check	3341.0	1146.0	53.4	13.2	69.6
East Barrani	Mean	1084.2	304.2	37.7	12.3	54.1
	Max	2011.9	659.2	52.0	14.7	74.4
	Min	306.0	20.4	18.2	9.9	31.2
	Loc check	859.9	232.3	33.4	12.6	49.6
West Barrani	Mean	1326.9	249.2	33.1	14.0	48.8
	Max	2343.0	632.3	48.4	20.6	72.3
	Min	716.5	0	22.7	10.6	32.7
	Loc check	1016.0	230.3	33.6	14.2	49.1

Genotypes x Environment (GE) interactions explained about 76% and 82% of the variance of environmentally standardized data for grain yield and biomass, respectively.
The biplot of grain yield (Figure 2) shows that El Hebella (E1) and El Magroun (E6) are closely correlated, like El Shawaier (E3), El Dawaia(E5), El Karamis (E2), East barrani (E7), and West Barrani (E8). By contrast, Ghout Rabbah (E4) is dissimilar from all other locations.

The correlation coefficients (Table 16) show that in general, farmers gave a higher score to tall plants. The farmers' scores were positively and significantly correlated with biomass and grain yield, with the exception of biomass in El Hebella and West Barrani and biomass and grain yield in El Magroun. There was occasionally a significant correlation between the farmer's score and spike length and number of spikes per m2.

Table 16. Correlation coefficientsa between the visual score given by the group of farmers and biomass yield (by), grain yield (gy), plant height (ph), spike length (sl), and number of spikes per m^2 (ssm) of 53 barley entries and one local check grown in 8 farmers' fields in the northwest coast of Egypt.

Location	by	gy	ph	sl	ssm
El Hebella	-0.094	0.323	0.488	0.303	0.110
El Karamis	0.424	0.359	0.346	0.222	0.088
El Shawaier	0.512	0.485	-0.007	0.057	-0.233
Ghout Rabbah	0.349	0.327	0.293	0.520	-0.111
El Magroun	0.138	0.057	0.443	0.228	0.203
East Barrani	0.465	0.519	0.446	0.039	0.162
West Barrani	0.235	0.372	-0.208	-0.384	-0.053

[a] underlined (significant at P< 0.05), bold (significant at P< 0.01)

The similarity analysis of the selections of the breeder and the farmers shows that each location tends to cluster separately, with each cluster including both the farmers' and the breeder's selections. In general, there was a clear effect of the location, with higher similarity between the score of farmers and the breeder in the same site, with the exception of Barrani (Figures 3 to 6).

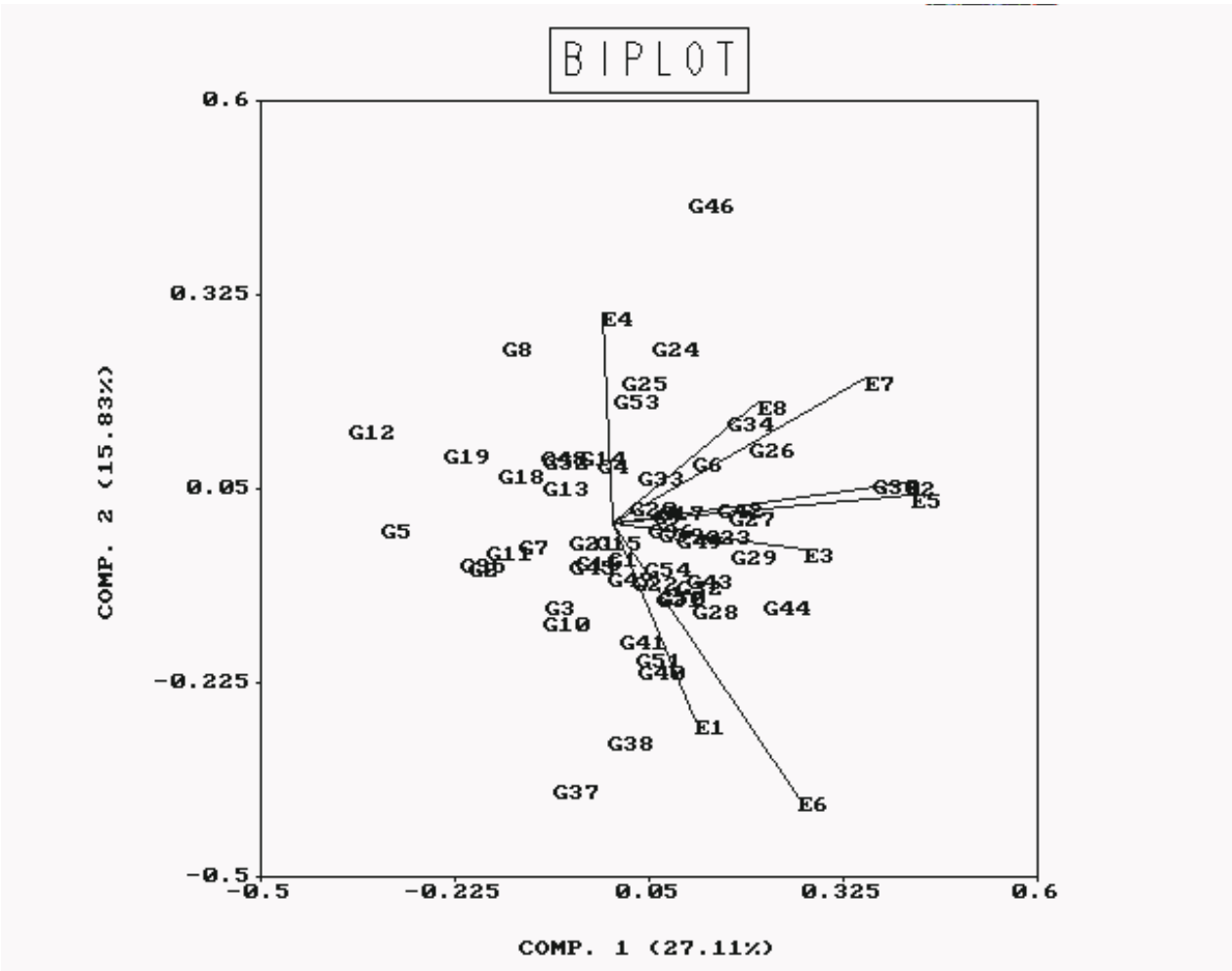

Fig. 2. Biplot of the first two components of grain yield of 54 barley entries grown in 8 farmers' fields in the northwest coast of Egypt (E1=El Hebella, E2=El Karamis, E3=El Shawaier, E4=Ghout Rabbah, E5=El Dawaia, E6=El Magroun, E7=East Barrani, E8=West Barrani).

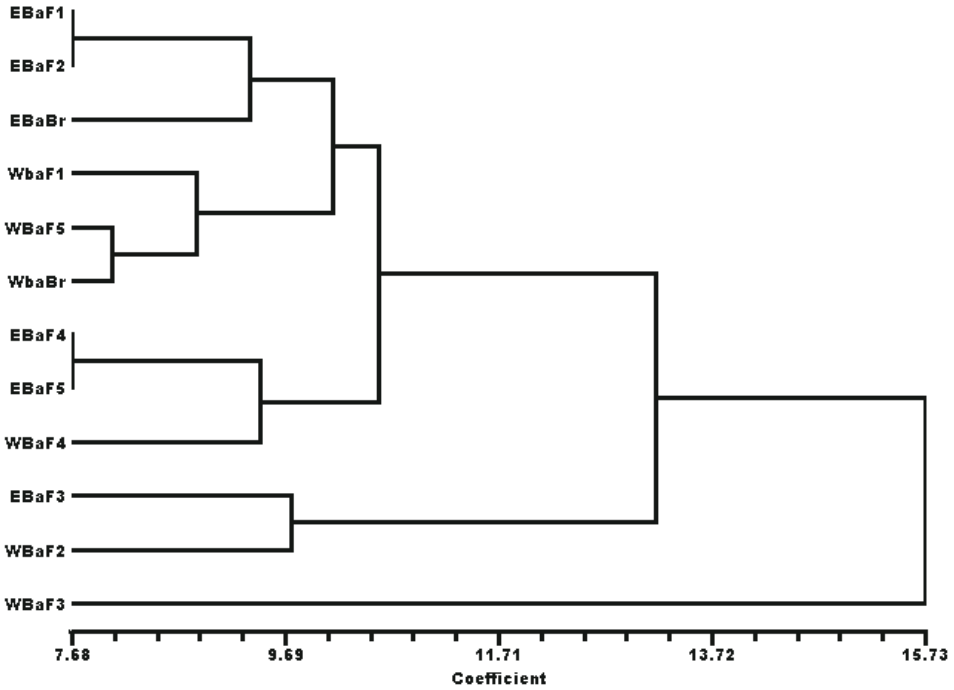

Fig. 3. Dendrogram based on cluster analysis of the selection score of five farmers (F1 to F5) and one breeder (Br) in 54 entries (53 new entries and 1 local check) at El Hebella (ElH) and El Karamis (ElK).

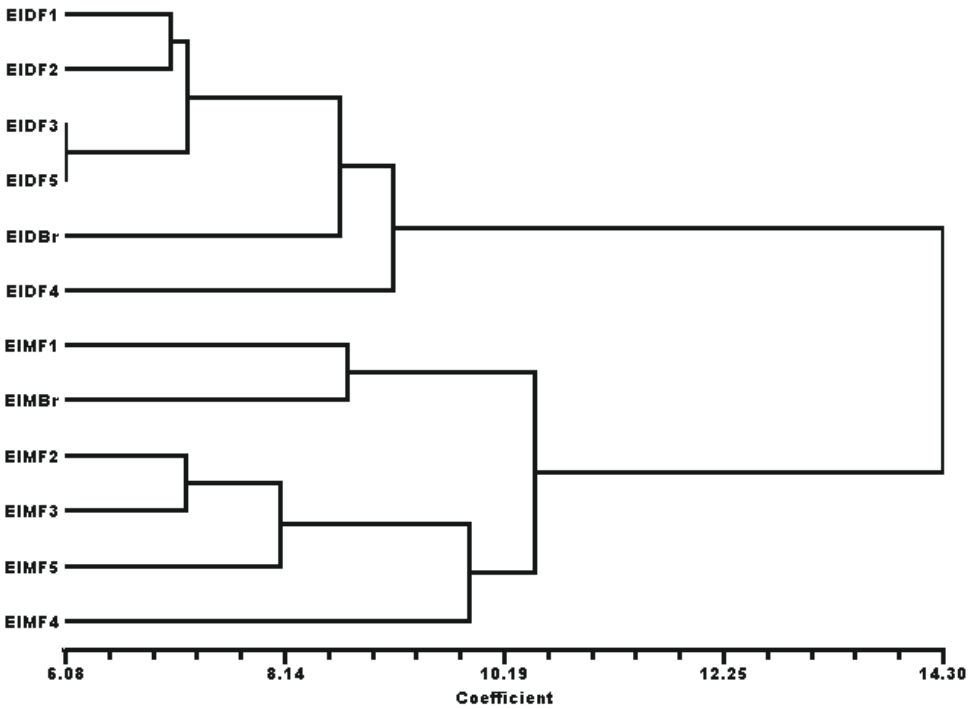

Fig. 4. Dendrogram based on cluster analysis of the selection score of five farmers (F1 to F5) and one breeder (Br) in 54 entries (53 new entries and 1 local check) at El Shawaier (ElS) and Ghout Rabbah (GhR).

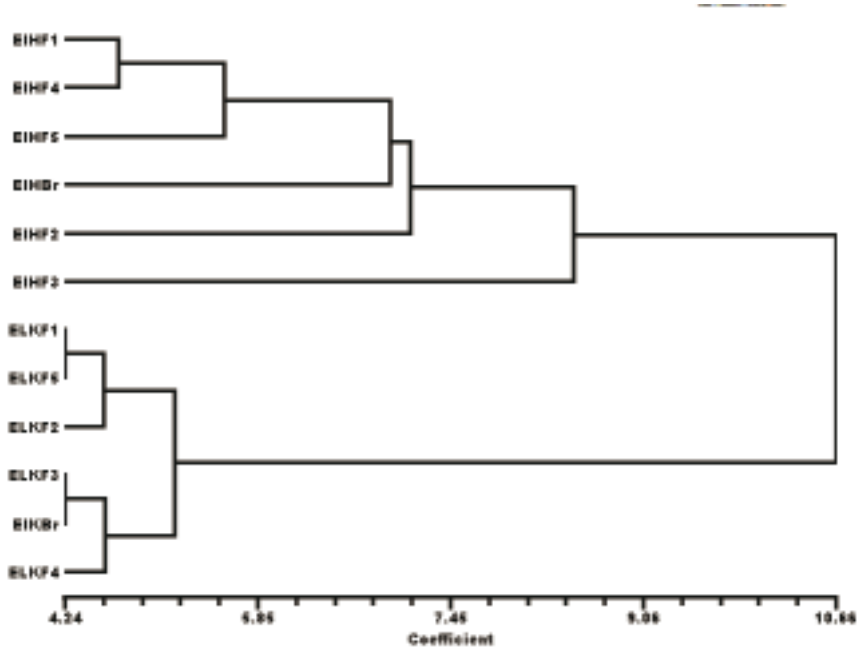

Fig. 5. Dendrogram based on cluster analysis of the selection score of five farmers (F1 to F5) and one breeder (Br) in 54 entries (53 new entries and 1 local check) at El Dawaia (ElD) and El Magroun (ElM).

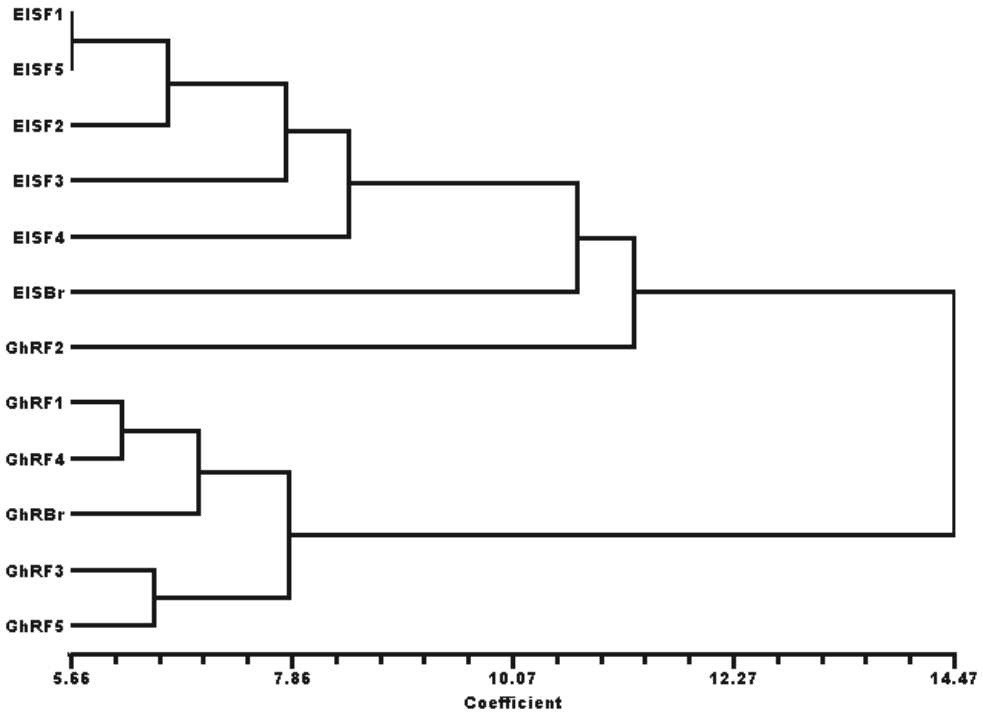

Fig. 6. Dendrogram based on cluster analysis of the selection score of five farmers (F1 to F5) and one breeder (Br) in 54 entries (53 new entries and 1 local check) at East Barrani (EBa) and West Barrani (WBa).

Farmers selected a total of 28 entries; of those, one was selected in five locations, two in four locations, one in three locations, and three in two locations. The list of entries selected in each location is reported in Table 17, while Table 18 shows the most frequently selected entries.

Table 17. Entries selected in 1999-2000 season by farmers in eight locations in the North West Coast of Egypt.

SubRegional Support Center	Location	Number of entries selected	Entry selected
Ras El-Hekma	El-Karamis	3	28-33-48
	El-Hebella	3	32-34-35
Marsa Matrouh	El-Shawaier	8	28-31-32-34-41-43-48-54
	Ghout Rabbah	3	28-29-32
El-Negeila	El-Magroun	11	9-33-37-42-45-52-55-56-57-58-59
	El-Dawaia	7	6-15-17-18-26-32-33
Sidi Barrani	East Barrani	3	18-28-33
	West Barrani	5	6-7-8-32-48

Table 18. Entries selected in more than one location.

Entry	Name	Number of locations
32	Aw Black/Aths//Arar/3/9Cr.279-07/Roho/4/Aths	5
33	Acc # 116131 - Coll # 89013-44/Giza 123	4
28	Aw Black/Aths//Arar/3/9Cr.279-07/Roho/4/DD-14/Rhn-03	4
48	Alanda/5/Aths/4/Pro/TolI//Cer*2/TolI/3/5106/6/Aths	3
34	IPA7/4/Aw Black/Aths//Arar/3/9Cr.279-07/Roho	2
18	JLB70-01/5/Deir Alla 106//DL70/Pyo/3/RM1508/4/Arizona5908/Aths//Avt/Attiki/3/Ager	2
6	Aw Black/Aths//Arar/3/9Cr.279-07/Roho/6/Alanda-01/5/CI 01021/4/CM67/U.Sask.1800//Pro/CM67/3/DL70	2

The entries selected by the participants have been planted in three fields in each of the sites where selection was done in 2000, for a total of 24 trials.

The participatory barley trials generated a large interest between farmers, researchers, and extensionists. All farmers except one did not find the number of entries too large, and they proposed to go up to one hundred plots in the next season. Some farmers (not hosting the trial this year), were interested in having a trial in their fields next season. Farmers were also interested in getting the seed of the selected entries to be increased in their farms.

Farmers were very enthusiastic about the trials and showed interest in continuing the work. They also gave suggestions on how to improve the layout of the trials.

The selection conducted by farmers has resulted in different lines selected in different sites, showing that farmer participation in selection is very powerful in maintaining genetic diversity. The positive and significant correlations between the farmers' scores and grain yield indicate the ability of farmers to identify the high-yielding entries under stress conditions.

The World Bank end-of-year review mission visited one of the sites while farmers were doing selection, and the review members were very positive about the participatory barley improvement activities.