

REPORT 1999

This draft report covers two main activities, namely the participatory barley breeding project, and the disease scoring. These were conducted during a number of visits by ICARDA scientists and research support staff which have been reported separately.

Participatory Barley Breeding in Eritrea

Barley is one of the most important crops in Eritrea. It is grown in the Central Highland zone on about 40,000 hectares with an average yield of about 500 kg/ha. Barley production represents 20% of the total agricultural production.

The most important areas for barley are the provinces of Hamassien (nearly 17,000 ha), Akele Guzai (11,000 ha), Seraye (7,800 ha), Sahel (2,500 ha) and Senhit (2,500 ha).

Barley is one of the staple crops in the highlands of Eritrea where it is widely used as human food in a number of recipes such as injera (pancake), kitcha (roasted bread), geat (porridge), siwa (a local beer). In addition, straw is an important source of animal feed, highly valued because of the high digestibility.

Barley is grown not only as a single crop, but also in a mixture with wheat known as "hanfetse". The main reasons given for growing hanfetse are the better taste of the bread and a lower presence of diseases.

During 1999 a new project was started with the long term objective of increasing barley production in the country 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, three villages were identified, one in the south of the country near Senafe, one north east of Asmara, near Embaderho, and one close to the research station of Halale, at Tea Amine.

In each village we planted 100 pure lines derived from the local landraces collected in November 1997 (see Annual Report of the Germplasm Improvement Program for 1997) and 37 populations representing the landraces collected in 37 sites visited during the 1997 collection.

The pure lines were divided in two trials, each containing 50 pure lines and one local check (from seed purchased from the farmer) repeated 5 times. The two trials were planted few hundred meters apart in Senafe and Embaderho, and about three kilometers apart in Tea Amine. They were hosted by two different farmers in each of the three villages. The bulks were evaluated in a different trial together with three improved cultivars, namely Beka, Halker and HB-32. This trial was planted close to one of the two trials with the pure lines. Therefore in each village a total of 137 different types of barley were evaluated.

One set of the two trials with the pure lines and one trial with the bulks were planted in the research station at Halale, at about 35 Km from Asmara.

The trials were unreplicated and arranged in four rows and 10 columns each in the case of the bulks, and in five rows and eleven columns each in the case of the pure lines. In each location a different randomization was used.

Close to maturity, the host farmer and a group of neighbors, ranging from 9 to 12, gave a score to each individual plot either alone or assisted by a researcher when they needed assistance in recording the scores. Farmers were interested in performing the selection, in giving reasons for selecting or discarding and in indicating those that they considered to be the best entries. The farmers did not perform selection on station. At the time of farmers' selection two breeders scored all the plots from 1 (worse) to 5 (best) including the trials on station.

At harvesting, the following traits were measured:

plant height (PH) in cm

spike length (SL) in cm

total biomass (BY) in kg/ha

grain yield (GY) in kg/ha

harvest index (HI)

1000 kernel weight (KW) in g

The trial with the bulks was analyzed with the moving means analysis of variance using AGROBASE. The two methods used were the Quadratic method, which assumes a quadratic approximation with two neighbors on either side, giving more weight to plots close to being adjusted for the trend effects, and the Row x Col method, which adjusts each plot yield by subtracting the mean of the row (or range) and column means.

The trial with the pure lines was analyzed with REML using the entries as fixed effects and all the other sources of variation as random effects. The two models used were the row and column and the autoregression model. The resulting BLUE's (Best linear unbiased estimates) for the entries were then used for the additional calculations including the correlation coefficients. It has to be noted that since we used different randomizations in each location, the correlation coefficients across locations are in effect estimates of genetic correlation coefficients.

Bulks

Table 1 shows the performance of the bulks (mean and range) compared with the three improved checks.

Table 1. Breeder score (AGSC: 1= good - 5 = poor), plant height PH in cm), spike length (SL in cm), biomass (BY in kg/ha), grain yield (GY in kg/ha), harvest index (HI) and 1000 kernel weight (KW in g) of 37 landraces tested as bulks together with three improved varieties in four locations (three farmers' fields and one research station) in Eritrea.

Location		AGSC	PH	SL	BY	GY	HI	KW
Tea Amine	Halker	3.6	72.2	7.6	545	226	0.40	35.4
	Beka	2.3	69.2	7.3	635	235	0.37	34.3
	HB-32	3.6	63.8	6.9	623	235	0.38	37.7
	Mean	3.6	70.8	7.6	675	252	0.38	38.0
	Max	4.6	78.8	8.9	1110	365	0.53	46.3
	Min	1.6	63.8	6.6	244	154	0.24	27.7

Halale Res. St.	Halker	2.7	75.5	7.7	1120	191	0.17	26.1
	Beka	3.2	77.5	9.4	1430	344	0.24	30.2
	HB-32	3.2	81.5	8.4	1311	307	0.24	30.8
	Mean	3.1	78.1	8.7	1294	285	0.22	29.4
	Max	4.3	88.2	11.4	1986	467	0.28	38.5
	Min	1.9	66.2	5.4	830	150	0.12	24.3
Senafe	Halker	2.4	55.1	5.9	751	359	0.47	42.0
	Beka	3.1	51.8	5.9	671	293	0.53	42.7
	HB-32	2.4	56.8	7.2	656	396	0.46	40.3
	Mean	3.4	57.9	6.5	817	373	0.45	40.0
	Max	4.4	67.8	7.9	1086	604	0.56	54.3
	Min	2.4	50.1	4.9	585	173	0.33	29.2
Embaderho	Halker	3.0	59.8	7.2	5175	1736	0.34	42.8
	Beka	1.2	61.8	3.5	4834	1761	0.37	40.3
	HB-32	4.5	70.4	6.2	5207	1811	0.35	42.6
	Mean	3.4	65.5	6.5	4982	1735	0.35	40.6
	Max	6.0	74.4	12.2	6777	2318	0.48	43.7
	Min	1.2	59.8	3.5	3277	1132	0.23	35.3

Average grain yields were the highest in Embaderho (1735 kg/ha), while in the other three locations were below 500 kg/ha. Total biomass yield was also the highest in Embaderho (4982 kg/ha), and between 600 and 1200 kg/ha in the other three locations.

Table 2. Genetic correlation coefficients between agronomic score, plant height, spike length, biomass, grain yield, harvest index and 1000 kernel weight of 37 landraces tested as bulks together with three improved varieties in four locations (three farmers' fields and one research station) in Eritrea in 1999.

		Tea Amine	Senafe	Halale Res. Station
Biomass	Tea Amine	1.000		
	Senafe	0.153	1.000	
	Halale Res. Station	0.001	0.111	1.000
	Embaderho	0.099	0.063	-0.009
Grain Yield	Tea Amine	1.000		
	Senafe	-0.013	1.000	
	Halale Res. Station	-0.048	0.242	1.000
	Embaderho	-0.045	0.127	0.190
Ag. Score	Tea Amine	1.000		
	Senafe	0.067	1.000	
	Halale Res. Station	0.020	-0.091	1.000
	Embaderho	0.257	0.073	0.217
Plant Height	Tea Amine	1.000		
	Senafe	0.099	1.000	
	Halale Res. Station	0.034	-0.075	1.000
	Embaderho	-0.005	-0.003	0.393*
Spike Length	Tea Amine	1.000		
	Senafe	0.158	1.000	
	Halale Res. Station	-0.104	0.121	1.000

Harvest Index	Embaderho	0.002	0.285	-0.058
	Tea Amine	1.000		
	Senafe	0.350*	1.000	
	Halale Res. Station	0.260	0.287	1.000
Kernel Weight	Embaderho	-0.085	0.104	0.303
	Tea Amine	1.000		
	Senafe	0.326*	1.000	
	Halale Res. Station	0.288	0.339*	1.000
	Embaderho	0.361*	0.193	0.190

*P<0.05

There were very weak relationships between the characters measured in different locations (Table 2). In particular, none of the correlation coefficients between yield measurements (grain or biomass) were significant, indicating not only a high degree of specific adaptation, but also that selection in the research station at Halale is not likely to be effective in other locations. Even in those few cases where the correlation coefficients were significant, their value was very low, and the maximum determination coefficient (R^2) was 15% indicating that less than 1/5th of the variability in one variable was due to the variability in the other.

In the three locations (Tea Amine, Senafe and Embaderho), where selection was done by both the breeders and the farmers, we calculated the simple correlations coefficients between the scores given by the breeders and the farmers and the various agronomic characters (Table 3).

Table 3. Simple correlation coefficients between the breeder's score (B), the farmers' average score (F) and plant height (PH), spike length (SL), biomass (BY), grain yield (GY), harvest index (HI) and 1000 kernel weight (KW) in 37 landraces tested as bulks and three improved varieties grown in farmers' fields in three locations in Eritrea.

Location	Selection done by	B	PH	SL	BY	GY	HI	KW
Tea Amine	B	-	0.158	0.173	0.067	0.438**	0.498**	0.495**
	F	0.573**	0.112	0.367**	0.139	0.397**	0.221	0.316*
Senafe	B	-	0.251	0.285*	0.314*	0.104	0.073	-0.007
	F	0.083	0.024	0.113	0.080	0.033	-0.273	-0.233
Embaderho	B	-	0.665**	0.205	0.514*	0.687**	0.422**	0.132
	F	0.041	0.210	0.145	0.032	0.010	-0.132	-0.085

* P < 0.05; ** P < 0.01

There were differences in the selection criteria both between the breeders and the farmers and between locations. Only in Tea Amine, there was a highly significant and positive correlation between the breeder and the farmer selection; in the other two locations the two selection criteria were unrelated. The correlation coefficients suggest that yield is not the main selection criteria for farmers while the breeder's score was often significantly correlated with either grain yield or biomass or both. There was occasionally a significant correlation between the farmer score and spike length and kernel size, but in general it seems as if there were other characteristics beyond those that we measured that farmers were looking at. The differences in the selection done by the farmers and the breeder is also shown by the frequency of bulks in common among those which were scored as the best (Table

4). In Tea Amine, Embaderho and Senafe, the number of lines included among those which were scored as the best by both the breeder and the farmers were 2, 4 and 4, respectively. Among the lines which were scored as the best by the breeder on station, none was scored among the ten best by the farmers at Tea Amine, while 2 were also scored among the best ten by the farmers at Embaderho and Senafe.

Table 4. Number of lines included among the ten which received the best score by both the breeder and the farmer.

	In common with best scored lines by the farmer at:		
	Tea Amine	Embaderho	Senafe
Tea Amine	2	-	-
Embaderho	-	4	-
Senafe	-	-	4
Halale Res. Station	0	2	2

The highest yielding bulks at each location are shown in Table 5 (for grain yield) and in Table 6 (for total biomass). In each Table the four bulks which were the top yielding in each location are shown in bold (for example entry 8, 15, 30 and 36 in Tea Amine). In each location the figures not in bold are the yields of the bulks which were the top yielding at another location(s). The tables are also giving, in the last three columns, the number of time each entry was indicated by the farmers as one of the most preferred at that location.

Table 5. Grain yield (kg/ha) of the best four bulks (10% of the total) in each location (in bold), their yields in the other locations and number of time they were selected by farmers.

Entry	Name	Tea Amine	Senafe	Halale Res. St.	Embaderho	# farmers selecting*		
						T.A.	Emb.	Sen.
4	Abat	195	424	467	1713	0	0	0
6	Hanfetse	245	489	353	1863	0	0	0
8	Hanfetse	365	440	350	1519	0	0	0
15	Atsa	312	310	269	2005	3	0	3
17	Kontsebe/Tseray	231	443	278	2203	0	0	0
26	Kulih	268	391	365	1984	3	0	0
27	Quonto/Gunaza	238	328	274	2318	0	1	0
29	Quonto	154	484	266	1804	0	0	0
30	Tselimo	318	496	385	1901	0	0	0
31	Tselimo	250	604	266	1511	0	0	0
36	Yeha	293	411	262	1398	0	0	0
37	Yeha	263	457	313	2305	0	0	0
Check								
38	Halker	226	359	191	1736	0	0	0
39	Beka	235	293	344	1761	0	0	0
40	Hb-32	235	396	307	1811	0	0	0

* No of farmers who included the line among the most preferred

The data show that there is a large variability between bulks for both grain yield and total

biomass, and that there is a great potential for improvement over the improved cultivars. In the case of grain yield, the best entries out yielded the best improved cultivar by 55% in Tea Amine, by 52% in Senafe and by 28% in Embaderho. In the case of biomass (Table 6), the best entries out yielded the best improved cultivar by 75% in Tea Amine, by 45% in Senafe and by 30% in Embaderho.

In general the highest yielding entries were location-specific such as for grain yield Hanfetse (entry #8), Atsa (#15) and Yeha (#36) in Tea Amine, Quonto (#29) and Tselimo (#31) in Senafe, and Kontsebe/Tseraye (#17), Quonto/Gunaza (#27) and Yeha (#37) in Embaderho.

Table 6. Biomass yield (kg/ha) of the best four bulks (10% of the total) in each location (in bold), their yields in the other locations and number of time they were selected by farmers.

Entry	Name	# farmers						
		Tea Amine	Senafe	Halale Res. St.	Embaderho	T.A.	Emb.	Sen.
2	Hanfetse	768	852	1465	5119	0	0	0
4	Abat	411	836	1652	5321	0	0	0
5	Hanfetse	852	1060	968	5671	0	0	0
8	Hanfetse	1110	809	1785	5107	0	0	0
12	Hanfetse	733	928	1986	5294	2	0	3
13	Hanfetse	1001	670	906	4906	0	0	0
14	Demhay	701	1073	1373	4504	0	1	0
16	Demhay	706	1086	1437	4942	0	0	1
17	Kontsebe/Tseraye	681	738	1193	6777	0	0	0
24	Hanfetse	921	967	1262	6199	0	0	0
27	Quonto/Gunaza	687	877	1150	6065	0	1	0
28	Quonto/Gunaza	574	1085	1456	4402	0	0	0
37	Yeha	708	916	1334	6019	0	0	0
Checks								
38	Halker	545	751	1120	5175	0	0	0
39	Beka	635	671	1430	4834	0	0	0
40	HB-32	623	656	1311	5207	0	0	0

* No of farmers who included the line among the most preferred

However, some entries were among the top yielding ones in more than one location such as Tselimo (#30) in Tea Amine, Senafe and in the research station at Halale, and Hanfetse (#6) at Senafe and in the research station at Halale. Because of moisture stress, yields at Tea Amine, Senafe and in the research station at Halale were of the same order of magnitude, while yields at Embaderho were much higher. The data show that selection for high grain yield would have had limited efficiency in Tea Amine and Senafe, and would have missed all the highest yielding entries at Embaderho.

Similarly to what has been observed for grain yield, most of the bulks with the highest total biomass were location specific, the only exception being the Hanfetse #5 that was the highest yielding in both Tea Amine and Senafe. Of particular interest was that out of eight different Hanfetse tested, six were among the four entries that gave the highest biomass yield in at least one location.

Selection for high biomass in the research station at Halale would have included only one of the highest yielding entries at Tea Amine and Senafe, and none of the highest yielding lines at Embaderho. Farmers were able to identify some of the entries with the highest biomass in Embaderho and Senafe, but not in Tea Amine.

Pure lines

The performance of the pure lines is summarized in Table 7 for the individual farmers' fields in each of the three locations and for the two trials on the research station. In the three locations there were large differences between the two farmers' fields, as indicated not only by grain yield and biomass, but also by plant height and kernel weight.

As already observed in the trial with the bulks, there was a large amount of genetic variation for the set of traits measured in this work. Of particular interest was the variation in grain yield and total biomass with the best line out yielding the grain yield of the local check by between 29-30% in Senafe to between 50 and 100% in Tea Amine and Embaderho, and the biomass yield by about 50-60% in Senafe and Tea Amine to between 70-100% in Embaderho. The number of entries out yielding the local checks by more than 20% in grain yield was 32 in Tea Amine, 31 in Embaderho and 9 in Senafe; in the case of biomass yield the number of entries out yielding the local checks by more than 20% was 40 in Tea Amine, 43 in Embaderho and 15 in Senafe.

This shows the great potential in exploiting the local germplasm to improve barley production.

Table 7. Breeder score (AGSC), plant height PH in cm), spike length (SL in cm), biomass (BY in kg/ha), grain yield (GY in kg/ha), harvest index (HI) and 1000 kernel weight (KW in g) of 100 pure lines from landraces tested with a local landrace as check in four locations (three farmers' fields and one research station) in Eritrea.

Trait	Locations								
	L1F1	L1F2	L2F1	L2F2	L3F1	L3F2	H1	H2	
AGSC	mean	3.97	3.56	4.06	3.29	2.2	3.8	3.01	2.73
	check	3.5	3.04	3.95	2.4	1.7	3.8	3.33	3.69
	range	1.96-5.04	1.43-5.48	2.00-5.00	0.95-5.03	0.40-4.90	1.00-5.89	1.50-4.82	0.59-5.09
PH	mean	72.3	69.6	82.2	65.6	52.9	63.1	80.6	77.6
	check	67.0	64.6	82.0	64.6	54.2	60.9	84.1	75.7
	range	61.0-81.3	55.2-83.0	65.0-95.8	53.2-82.9	33.0-83.7	52.0-75.6	66.0-92.3	58.1-99.2
SL	mean	7.2	7.4	6.9	6.5	6.7	6.6	8.9	8.9
	check	7.4	7.4	7.2	6	7.2	6.8	8.7	9.2
	range	5.0-9.1	5.1-9.8	4.1-9.2	4.1-9.0	4.8-9.1	4.9-9.1	5.9-12.0	3.3-17.8
BY	mean	4437	3982	9023	4587	3772	5670	7896	7510
	check	4052	3268	7638	4231	3661	5403	8475	7619
	range	3395-6073	2577-5341		3054-7209	2667-5815	4305-8051		
GY	mean	1736	1397	3283	1694	1627	2528	2150	1435
	check	1683	1168	2913	1533	1684	2480	2174	1823
	range	811-2492	534-2128	1744-5912	1111-2432	1202-2172	1895-3224	537-3893	0-2975
HI	mean	0.39	0.35	0.36	0.37	0.44	0.45	0.23	0.19
	check	0.42	0.36	0.39	0.36	0.47	0.46	0.25	0.23
	range	0.28-0.47	0.21-0.59	0.28-0.46	0.27-0.46	0.28-0.53	0.37-0.52	0.04-0.41	0.0-0.37
KW	mean	44.6	37.6	44.6	41.5	35.4	40.7	30.5	27.8
	check	44.6	39.2	44.6	41.3	36.6	42.6	33.7	28.4
	range	28.3-57.5	25.1-45.2	28.3-57.5	32.9-47.1	26.0-43.2	26.4-47.4	19.1-45.1	17.7-36.9

L1 = Tea Amine, L2 = Embaderho; L3 = Senafe; H = Halale Res. Station; F1 and F2 = Farmers 1 and 2.

The genetic correlation coefficients between biomass and grain yield measured in the four different environments (three farmers fields and one research stations) show that in the case of biomass none of the genetic correlation coefficients was significant (Table 8). In the case of grain yield, of the three correlation coefficients that were significant, two were negative, and the one which was positive was low with a determination coefficient of just over 12%.

As already found in the trial with the bulks the relationships between yield measured in different locations is so weak that it is not possible to count on sizeable correlated responses to selection.

Table 8. Genetic correlation coefficients between, biomass and grain yield of 100 pure lines from landraces tested in four locations (three farmers' fields and one research station) in Eritrea in 1999.

Trait	Location	Tea Amine	Embaderho	Senafe
Biomass	Tea Amine	1.000		
	Embaderho	-0.052	1.000	
	Senafe	-0.021	0.204	1.000
	Halale Res. Station	0.172	-0.115	0.015
Grain yield	Tea Amine	1.000		
	Embaderho	-0.267**	1.000	
	Senafe	0.042	0.123	1.000
	Halale Res. Station	0.357***	-0.334**	0.024

** P < 0.01; *** P < 0.001

Both the farmers' preference and the breeders' score were positively and significantly correlated with biomass yield and grain yield at the same location (Table 9), with the only exception of the correlation coefficient between the farmer preference and grain yield at Embaderho. In three cases either the farmers' preferences or the breeders' score in one location were negatively and significantly correlated with biomass or grain yield in a different location. In particular, the breeders' score at the research station (Halale) was not correlated with the biomass yield at any of the other locations it was significantly and positively correlated with the grain yield at Tea Amine, but significantly and negatively correlated with grain yield at Embaderho.

Table 9. Simple correlation coefficients between the farmers preference (the highest the most preferred), the breeders average score and biomass and grain yield in 100 pure lines from landraces tested in farmers' fields in three locations in Eritrea and in one research station.

Trait	Loc.	Farmer preference			Breeder score			
		L1	L2	L3	L1	L2	L3	H
Biomass	L1	0.468***	0.029	0.028	0.399***	0.164	0.085	0.057
	L2	-0.150	0.226*	0.165	-0.180	0.336**	0.175	0.135
	L3	0.045	0.023	0.414***	0.027	-0.099	0.309**	-0.039
	H	0.302**	0.071	0.116	0.215*	0.037	-0.056	0.303**
Grain yield	L1	0.665***	0.029	-0.049	0.575***	0.073	-0.027	0.356***
	L2	-0.299**	0.162	0.056	-0.291**	0.229*	0.194	-0.378***
	L3	-0.018	0.003	0.365***	0.039	-0.120	0.361***	0.001
	H	0.313**	-0.075	0.087	0.186	-0.076	-0.093	0.696***

L1 = Tea Amine, L2 = Embaderho; L3 = Senafe; H = Halale Res. Station.

* P < 0.05; ** P < 0.01; *** P < 0.001

Therefore, the visual selection by both the farmers and the breeder has the highest efficiency in the location in which it was made, and a much lower efficiency in other locations.

Table 10. Simple correlation coefficients between the breeder's score (B), the farmers' average score (F) and plant height (PH), spike length (SL), biomass (BY), grain yield (GY), harvest index (HI) and 1000 kernel weight (KW) in 100 pure lines from landraces tested in farmers' fields in three locations in Eritrea.

Location	Selected by	B	PH	SL	BY	GY	HI	KW
Tea Amine	F	0.743***	0.421***	0.482***	0.422***	0.613***	0.440***	0.569***
	B	-	0.476***	0.516***	0.559***	0.736***	0.459***	0.558***
Embaderho	F	0.429***	0.589***	0.162	0.489***	0.503***	-0.051	0.308**
	B	-	0.551***	0.099	0.437***	0.406***	-0.157	0.231*
Senafe	F	0.462***	0.428***	0.204	0.394***	0.346***	-0.221*	0.365***
	B	-	0.678***	0.035	0.655***	0.655***	-0.081	0.393***

* P < 0.05; ** P < 0.01; *** P < 0.001

There was a high and positive correlation between the score of the breeder and the farmers' preferences indicating that in the case of the pure lines there was a much stronger agreement between farmers and breeders that in the case of the bulks (see Table 3). Also, the selection by both the breeder and farmer was positively correlated in all locations with plant height, biomass yield, grain yield, and kernel weight. There were also positive correlations with both spike length and harvest index, but these were not consistent across locations.

The results obtained with the pure lines confirmed those obtained with the bulks in suggesting that the research station at Halale is not a good selection sites for a number of target environments in the case of grain yield, the 10 best lines on station included only one of the 10 best lines in Tea Amine and none of the 10 best lines in the other locations. What was even more interesting was that the ten lines with the lowest grain yield in the research station included four of the highest yielding lines in Embaderho, and two of the highest yielding lines in Senafe. Similarly, in the case of total biomass yield, the 10 best lines on station included only one of the 10 best lines in Tea Amine and none of the 10 best lines in Embaderho, and two of the ten best lines in Senafe. The ten lines with the lowest biomass yield in the research station included three of the highest yielding lines in Senafe and one each of the highest yielding lines in Tea Amine and Embaderho.

The highest yielding pure lines at each location are shown in Table 11 (grain yield) and in Table 12 (total biomass) together with their yield in the other locations and with the farmers' score.

Table 11. Grain yield (in % of the check) of the best five pure lines (5% of the total) in each location (in bold), their yields in the other locations and the score they were given by farmers.

Entry	Name	Tea Amine	Senafe	Halale Res. St.	Embaderho	T.A.	Emb.	Sen.
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7	Abat	1.43	0.79	1.63	1.07	1.50	2.14	0.43
9	Abat	1.20	0.96	1.79	0.86	2.17	2.64	1.00
15	Abat	1.14	1.08	1.63	0.84	1.83	2.07	0.57
16	Abat	0.88	1.00	1.65	1.00	1.58	2.36	1.86
21	Abat	1.68	0.93	1.29	1.09	1.67	2.36	1.71
24	Abat	1.68	0.86	0.69	1.01	2.50	2.36	0.29
35	Abederay	1.82	1.05	0.87	0.96	2.83	2.43	0.57
46	Atsa	1.41	1.16	0.33	1.85	2.83	2.57	2.86
55	Kulih	1.68	1.18	1.08	1.22	2.33	2.00	1.57
61	Kulih	1.68	1.18	1.08	1.22	2.17	1.86	1.29
67	Quonto/Gunaza	0.99	1.30	0.74	1.09	1.00	2.00	1.14
68	Quonto/Gunaza	0.87	1.29	0.13	1.37	0.67	2.57	1.14
75	Quonto/Gunaza	0.70	0.96	0.00	1.58	1.33	2.29	0.29
77	Quonto/Gunaza	0.86	0.73	0.49	1.63	1.50	2.50	0.71
78	Quonto/Gunaza	0.60	1.27	0.49	1.59	0.17	2.00	1.29
83	Quonto	0.79	1.04	0.37	2.03	0.50	2.50	0.86
95	Yeha	0.93	1.30	1.04	1.02	1.67	1.29	1.14
99	Yeha	1.16	1.29	0.85	1.15	2.08	2.43	1.14
100	Yeha	1.27	1.02	1.70	1.05	1.80	2.14	1.14

In both tables yields are expressed as percent of the check in that particular location. In the case of the grain yield, there was little in common between the top yielding lines in the different locations and in the research station. In fact, and with the only exception of entry #78 (Quonto/Gunaza) which was among the top yielding 5% both at Senafe and Embaderho, all the others were specifically adapted to one location. It is also interesting that a number of lines which were among the top yielding at one location, yielded less than the check in the research station (see for example all the top yielding lines at Embaderho, one of which failed to produce any grain on station, lines #24 and 35 at Tea Amine, and lines #67, 68, 78, and 99 at Senafe). By contrast, the highest yielding lines on station were often inferior or marginally better than the check elsewhere. Occasionally they yielded substantially more than the check, such as entries #7 and 100 in Tea Amine, but they were never among the best 5% for grain yield.

A similar situation was observed for total biomass with the top yielding lines at any one location not performing equally well at other locations. Two lines, both belonging to the landrace Abat (entries #11 and 28), were among the best 5% on station and were also among the best 5% in Senafe (entry #11) and in Tea Amine (entry #28). However, some of the lines performing poorly (yield lower than the check) on station, and therefore likely to be discarded, were among the best 5% at other locations. Examples are entries #5, 32, 35, 61, 80 and 87. The contrast is particularly evident in the case of Embaderho where four of the five highest yielding entries yielded less than the check on station.

Table 12. Biomass yield (in % of the check) of the best five pure lines (5% of the total) in each location (in bold), their yields in the other locations and the score they were given by farmers.
farmers's score

Entry	Name	Tea Amine	Senafe	Halale	Res. St.	Embaderho	T.A.	Emb.	Sen.
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5	Abat	1.13	1.59	0.71	1.29	1.58	2.14	1.14
8	Abat	1.01	0.99	1.45	1.43	2.67	2.07	1.57
11	Abat	1.11	1.40	1.61	1.41	2.83	2.29	1.86
15	Abat	1.12	1.13	1.40	0.91	1.83	2.07	0.57
28	Abat	1.49	0.74	1.64	1.33	2.33	2.21	0.14
30	Abat	1.07	0.89	1.09	1.70	2.00	2.00	1.86
32	Abat	1.50	1.03	0.66	0.96	2.83	2.43	0.57
35	Abederay	1.63	1.09	0.97	1.22	2.83	2.43	0.57
43	Atsa	1.42	1.12	1.73	1.26	1.75	1.86	2.57
46	Atsa	1.27	1.35	0.56	1.97	2.83	2.57	2.86
48	Atsa	1.04	1.36	1.11	1.08	1.83	1.93	2.71
61	Kulih	1.54	1.13	0.89	1.43	2.17	1.86	1.57
67	Quonto/Gunaza	0.89	1.41	1.29	1.03	1.00	2.00	1.29
70	Quonto/Gunaza	1.06	0.96	0.79	1.62	0.33	2.57	0.71
80	Quonto	1.56	0.88	0.85	1.09	2.00	2.43	1.71
83	Quonto	0.95	1.01	0.58	2.01	0.50	2.50	0.86
84	Quonto	0.98	1.14	0.94	1.62	0.17	1.86	1.14
87	Tselimo	0.84	1.49	0.90	1.29	2.00	2.57	1.57

From discussion during and after selection it emerged that grain filling is one of the major selection criteria (entries with marked different phenology were given an equally good score because they showed a good grain filling), followed by spike length and in some case plant height. Although the presence of diseases (particularly scald and net blotch) was widespread and very serious (in the majority of the plots) the flag leaf had no green tissue left, farmers did not think that this will cause a yield reduction.

Cereal Disease Assessment

In Eritrea, wheat and barley development during this crop season was less than optimal due to the delay and insufficient rainfall. Cereals were stressed at early growth stages, hence poor stand was observed in farmer's fields and at the experimental station. The late rains associated with relatively high temperatures favored rust, bacterial and blotch diseases development at the main station. At farmer fields, high levels of leaf rust (*Puccinia recondita*) incidence on wheat were observed. On barley, *Helminthosporium* diseases were well developed particularly barley net blotch "net and spot forms" (*Pyrenophora teres*), spot blotch (*Bipolaris sorokiniana*), and scald (*Rhynchosporium secalis*) were recorded. Incidence of bacterial leaf streak (*Xanthomonas translucens*) and septoria (*septoria passerinii*) were observed on barley respectively at Halale and Embaderho.

The disease level observed on barley and wheat in Eritrea causes relatively high yield losses. Most of Hanfetse entries showed adequate resistance level to rust (on wheat) and to scald net and spot blotch (on barley), indicating that one of the reasons given by farmers to grow the mixture is well founded.

The barley nurseries grown on station (1723 entries) were composed of local material and breeding materials from the ICARDA barley-breeding program. All the material was planted at the

main station (Halale).

The wheat nurseries (mostly material from CIMMYT and from CIMMYT/ICARDA) were planted at the main experimental station and advanced lines (200 entries) were tested on-farm in the three locations. A collection of local wheat was planted only at the main station.

All disease notes were recorded on the experimental station field books and will be used for selection of breeding lines for next season. Two types of selections were recommended. Highly resistant breeding lines and/or landrace accessions will be included in the crossing block. Moderately resistant lines will be advanced if the agronomic traits meet the selection criteria and the objectives of the program. Highly susceptible breeding lines will be discarded. Landrace accessions could be maintained for evaluation for other traits than disease resistance.

At Halale station, the level of resistance was very low in the lines selected from the landraces. About 12 % of the lines showed moderate resistance to net blotch while only 4% of the accessions showed moderate resistance to spot blotch and over 30% of the lines were susceptible to bacterial stripe. In the breeding nurseries, 29 lines from the 226 tested showed tolerance to net blotch, nine entries were tolerant to spot blotch, and about 53% of the entries were susceptible to bacterial stripe. An adequate level of resistance was observed in the 8THEMBON nursery. About 25 and 44% of the entries were moderately resistant to net and spot blotch respectively.

Among the bulks (described earlier), about 30% showed moderate resistance to net blotch at the three stations (Halale, Tea Amine, and Embaderho). The level of resistance to spot blotch was lower and varied from station to station: 30% at Halale, 35% at Tea Amine, and 16% at Embaderho. Scald was recorded at Embaderho, where 32% of the pure lines showed tolerance or resistance compared with about 15% found in the bulks.

Wheat nurseries were evaluated for leaf rust resistance. Very low level of resistance was observed in the wheat collection. Selection within population was recommended. Resistant to tolerant lines were marked and will be considered for testing for a second cropping season while some lines could be included in crossing block. About five bread wheat entries from CIMMYT/ICARDA wheat project showed good tolerance to drought as well as leaf rust. These lines were recommended for testing in on-farm trials next season.

At present, there is no Eritrean research staff working on cereal diseases. Based on the status of disease development in the cereal growing area, pathology work has to be strengthened. Special disease nurseries will be dispatched from ICARDA base program to Eritrea. The main research station, at Halhale, can be a good site for screening for resistance to net blotch "net and spot forms" of this leaf blotch disease. The spot form of net blotch does not occur in Syria, hence screening for resistance could be realized in Eritrea provided that the National Program assigns a research staff to work on cereal pathology.