

**INCREASING THE RELEVANCE OF BREEDING
TO SMALL FARMERS:
Farmer Participation and Local Knowledge in
Breeding Barley for Specific Adaptation to Dry
Areas of North Africa**

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1. IRESA-TUNISIA

1.1 Introduction

Within the framework of the project, experiments were carried out in the semi-arid regions of Tunisia in farmer fields. Barley material included advanced yield trials, local barley lines, nurseries, and agronomy trials (Table 1). The sites planted were as follows :

- Gafsa** in South Western Tunisia, characterized by low rainfall (<250 mm), early spring drought and high temperatures in spring (sorocco).
Farmer : young, owner of an area of about 10 hectares. Not mechanized and poor management practices.
- Foussana** in Central Tunisia, characterized by low rainfall (250-300 mm), poor sandy soils low winter temperature, high spring temperatures.
Farmer : old, owner of an area of about 20 hectares most of rangeland. Not mechanized and poor management practices.
- Tejerouine** in North Western Tunisia, characterized by low rainfall (250-300 mm), low winter temperatures. The crop production tendency over five years is of one good year (yield >4000 kg/ha) two average years (yield <1500 kg/ha), and two crop failure years (yield 0-500 kg/ha).
Farmer : young, owner of an area of about 500 hectares, mechanized farm and optimum management practices.
- Zaghouan** in North Western Tunisia, characterized by average rainfall (350 mm), moderate temperatures, good soils, and high disease incidence.
Farmer : not chosen this season (1996-97), the experiments were conducted at the college of agriculture of Mograne (ESA.Mograne) as back up research.
- Kef** in North Western Tunisia, characterized by average to low rainfall (<450mm), cold winter temperatures, and high disease incidence.

The climatic conditions during this cropping season were characterized by severe drought during the winter and spring seasons. High winter temperatures and severe hail damaged the crop at many sites in North Western Tunisia. Therefore at the farm level there were total crop failures at all sites of Gafsa, Tejerouine, Foussana, and Zaghouan, and severe hail damage at Le Kef. With the exception of Gafsa, we were able to select among the barley nurseries and yield trials, as well as estimating the yield at Le Kef.

Table 1. Barley Germplasm used for farmer participatory selection at four sites in 1996-1997 crop season.

Yield Trials		No Line	
Elite I	(AYT)	25	Fixed lines. Landrace accessions. Checks
Orge 1	(IYT)	25	Fixed lines. Checks
Orge X	(PYT)	25	Newly introduced lines. Checks
Orge XI	(PYT)	25	Fixed lines. Selected lines from NURMAG 95. Checks
NURSERIES			
SEGMAG 97		Special segregation population (F3) provided by ICARDA targeted for North Africa, six row barleys	
NURMAG 97		Barley lines selected from SEGMAG 96, with emphasis on selection made in Tunisia and Morocco, and showing adequate disease resistance	

^a AYT: Advanced yield trial ; IYT: Intermediate yield trial ; PYT: Preliminary yield trial

Barley breeding material developed by our program was also tested at Foussana, Tejeroine, Le Kef, and Mograne It included four levels of yield trials: three elite yield trials (75 entries), five advanced barley yield trials (125 lines), three preliminary yield trials (75 lines), three special trials (130 lines); and a number of selection nurseries that includes over 3000 lines.

1.2 Results

1.2.1 Yield performance

The performance of the barley yield trials is shown in Tables 2 and 3. Grain yield varied from 1779 kg/ha (Var.# 3 Elite I) to 323 kg/ha (Var.# 18 Orge XI) at Le Kef. The yield range at Mograne was 1283 kg/ha (Var. # 4 Elite I) to 458 kg/ha (Var.#2 Elite I); at Tejeroine the grain yield varied from 811 kg/ha (Var. #8 Elite I) to 105 kg/ha (Var.# 2 Elite I), and at Foussana the range within Elite I was 874 kg/ha to 295 kg/ha. The barley lines within each yield trial are listed in a descending order (Table 2) based on grain yield within each site.

The number of lines that showed an average grain yield higher than that of the check Rihane (Var.#23) is higher at Mograne (17 lines) than at Foussana (11 lines), Tejeroine (5 lines), and lowest at Le Kef (2 lines).

Table 3 shows the grain yield of the other trials at Le Kef station. The yield range (kg/ha) was very large within these yield trials: Orge 1 (1518-554), Orge X (1122-376), and Orge XI (1133-323).

Table 2. Average grain yield (kg/ha) in a descending order of Elite Yield trial at four sites.

Le Kef		Mograne		Foussana		Tejeroine	
Var #	Yield	Var #	Yield	Var #	Yield	Var #	Yield
10	1779.3	04	1283.0	06	874.9	08	811.9
03	1776.3	14	1261.3	05	861.3	22	736.1
23	1756.7	25	1226.3	10	728.9	07	652.1
05	1728.3	05	1131.3	24	6888.7	16	590.0
21	1668.3	08	1128.0	18	683.9	04	580.0
24	1626.3	24	1110.3	09	677.0	23	574.2
19	1544.3	10	1101.3	03	661.6	21	547.8
22	1543.0	03	1060.7	04	595.0	24	532.8
07	1517.7	13	1028.0	08	587.8	03	529.0
12	1467.0	20	971.7	13	586.0	01	528.7
08	1402.0	09	930.7	16	562.0	15	511.6
14	1353.3	01	869.7	23	584.0	05	495.4
04	1353.0	06	828.0	21	558.0	19	476.2
15	1339.7	12	803.7	12	553.0	25	446.2
01	1322.1	19	770.0	17	544.0	09	430.0
09	1253.0	17	739.0	19	541.6	17	426.2
17	1241.7	22	722.0	15	535.6	12	420.4
13	1166.3	23	697.7	01	522.6	13	415.6
16	1124.7	21	650.3	14	516.8	10	381.4
18	1116.7	15	608.7	22	495.4	11	359.8
25	1113.7	11	605.3	11	471.8	18	292.1

20	899.7	16	600.7	25	379.6	14	291.5
06	877.0	18	589.3	20	352.5	20	284.9
02	848.7	07	510.0	07	337.5	06	252.3
11	747.3	07	510.0	02	295.3	02	105.0

The number of lines that outyielded the check was higher in the intermediate yield trial than in the preliminary yield trials at Le Kef. Entries in trials Orge X and Orge XI were selected for specific regions and therefore should be tested at the targeted sites next crop season.

1.2.2. Farmers selection criteria

The selection criteria varied in priority among the group of farmers. Table 4 shows the selection criteria set by the group and ranked by each one of the participant farmers.

Table 3. Average grain Yield (kg/ha) in a descending border of Orge 1, Orge X, and Orge XI Yield trials at Le Kef.

Orge 1		Orge X		Orge XI	
Var. #	Yield	Var. #	Yield	Var. #	Yield
17	1790.0	09	1172.3	23	1133.3
14	1528.3	23	1152.3	22	982.0
01	1518.5	18	1149.7	16	885.0
16	1459.3	10	1126.3	07	833.7
18	1454.0	14	1122.3	04	778.7
24	1320.0	17	954.3	14	739.3
23	1314.3	21	937.7	25	717.3
05	1261.7	15	867.0	02	679.3
06	1169.0	20	784.3	15	663.7
09	1162.0	02	747.0	09	653.7
03	1139.0	05	740.3	06	631.7
13	1088.7	07	702.3	01	608.0
02	1086.2	11	699.0	03	605.0
08	1074.0	01	666.3	08	601.3
20	1068.3	19	637.3	20	592.0
10	1055.0	08	626.0	24	582.7
15	1010.3	25	556.0	10	572.0
04	990.3	13	540.7	05	569.7
19	952.3	04	523.0	12	528.7
12	942.3	06	503.7	21	501.7
21	846.0	22	456.3	11	501.0
07	801.0	16	435.3	13	489.7
11	799.3	24	431.0	17	433.0
22	638.7	03	390.7	19	421.3
25	554.0	12	376.0	18	323.7

Grain yield was ranked first by most of the farmers followed by straw yield. Drought resistance was considered as an important criteria for four farmers. Ranking of yield stability, grain quality and resistance to insects and diseases varied among the participating group.

Table 4. Selection criteria as ranked by seven farmers from Le Kef region.

Farmer	SELECTION CRITERIA						
	Yield		Resistance			Quality	Stability
	Grain	Straw	Disease	Insect	Drought	Grain	Yield
Farmer 1	3	4	5	7	6	2	1
Farmer 2	1	3	2	4	5	7	6
Farmer 3	1	2	3	5	7	6	4
Farmer 4	1	2	4	5	3	6	7
Farmer 5	2	3	6	5	4	1	7
Farmer 6	1	4	6	7	2	5	3
Farmer 7	1	2	6	7	3	5	4

Based on the above criteria the farmers selected the best lines within three yield trials. Fourteen farmers participated in the selection (including the above seven), and the lines selected are shown in Table 5: each star represents selection done by one farmer. The selection was conducted at Le Kef. Most of the high yielding lines were selected by at least one farmer. Some of the selected lines have low grain yield but might have high biomass yield. Other criteria beside grain yield will be evaluated in future experiments.

Table 5. Selected lines within each yield trials by individual farmers and variety rank based on grain yield at Le Kef.

Variety #	Elite I	Orge 1	Orge X	Orge XI
1				* (12)
2				* (8)
3	** (2)			
4	* (13)	* (18)		
5				* (18)
6				
7				
8				
9				* (10)
10	** (1)		* (4)	* (17)
11				* (21)
12		* (20)		** (19)
13	** (18)	** (12)	** (18)	* (22)
14	* (12)	* (2)		* (6)
15		*** (17)		* (9)
16		** (4)	* (22)	
17	* (17)	* (1)		
18	** (20)		* (3)	* (25)
19	** (7)			
20				** (15)
21	* (5)	** (21)	* (7)	
22	** (8)	** (24)		*** (2)
23				
24			* (23)	
25	* (21)	* (25)		
Nb. Farmers	4	4	3	3

*. Selected by one farmer ; **. Selected by two farmers ; ***. Selected by three farmers

(-) Variety rank from tables 3,4.

1.2.3. Nurseries

Two nurseries were included in this project in order to be able to evaluate breeding material at the farm level under farmer management. The regional special Maghreb nurseries provided by ICARDA (SEGMAG and NURMAG) were planted at Foussana, Tejerouine, and Mograne. Selection was done only at two sites. Figure 1 shows the frequency of selected lines within each nursery. At Foussana, farmers had a total crop loss. Lines that showed good stand and produced adequate fertile tiller were considered as drought tolerant and were selected. Disease resistance was the main selection criteria at Mograne (Fig. 2).

Fig. 1. Number of lines selected at two sites from two barley nurseries.

Fig. 2. Frequency of lines resistant to powdery mildew selected at Mograne.

2. INRA-MOROCCO

2.1 Introduction

Barley is the most widely grown crop in Morocco due to its adaptation to the prevailing harsh environments and to the multiple functions it plays at the farm level. Barley contributes largely to livestock feeding (almost 30% of the total forage units) through grazing early in the season, dipping at heading and through the use of straw and 80% of the grain production. Barley grain is also used as a human food mainly in the arid and mountain areas.

Barley is considered by most farmers as a risk adverse crop and seldom benefits from additional inputs and its associated agricultural package is reduced to sowing mainly of landraces followed by grazing or harvesting. Under this prevailing farmers attitude, providing seeds of improved varieties might be the first alternative to increase barley production in Morocco since it will not have higher additional costs. During the last twenty years, the National Agriculture Research Institute (INRA) has released 13 barley varieties, some being the result of the ongoing collaboration with ICARDA. Seven of these varieties are of two row types while all the landraces are of six row types. These new cultivars have a yield potential superior to 6.5 t/ha while that of the landraces seldom exceeds 5.0 t/ha. The average grain yield gain over the same period is estimated to more than 50%. These yield gains can be explained by reducing the growing cycle and the plant height and by improving the resistance to major diseases, mainly powdery mildew and net blotch.

In spite of these yield advantages, 80% of farmers fields are still sown to landraces. The survey conducted by Saade et al. (1993) has attributed the low adoption rates of the newly released cultivars to the high price of certified seeds, the predominant belief that two rowed cultivars are of malting quality, their presumed low qualities of grain and straw for animal feeding, and the reduced extension efforts for barley compared to wheat.

The decentralized barley breeding, initiated at the national level in 1983, has been reinforced in 1989 with ICARDA's new approach adopted to better serve the North Africa region. This decentralized breeding has allowed to switch to six row types, preferred by most of the North African farmers and has led to the selection of many promising lines presented for release.

In case of barley in Morocco, further decentralization of barley breeding by involving farmers in the selection process is needed. This participatory approach will combine both selection and the transfer of the technology efforts.

This joint effort between NARS and ICARDA, through the financial contribution of IDRC, aims at developing the participatory breeding approach in order to better serve the barley growers in Morocco.

2.2. Materials and methods

Three farmers, each from Jemaa Shaim (arid zone), Merchouch (semi-arid zone) and Tanant (mountain zone) have participated in this effort during 1996-97 season. At Merchouch and Jemaa Shaim, both NURMAG 97 and MORYT 97 were planted while only MORYT 97 was planted at Tanant. NURMAG 97 is an observation nursery composed of 297 F4 bulks each planted in two rows of 2.5 meters long with 0.3 row spacing with an empty row between adjacent lines. MORYT 97 is a yield trial composed of 112 experimental lines and five checks: Aglou (2R), Tiddas (2R), Rabat 071 (6R landrace), Arig 8 (6R) and Laannoceur (6R). These checks are replicated in four blocks in an augmented design while the experimental lines are not replicated. Each variety is sown in a plot of six rows of 3 meters long with 0.3 m as row spacing. The trial at Tanant was discarded due to insect damage at planting.

The NURMAG 97 and MORYT 97 (with two replications) are also planted at experiment stations of Merchouch and Jemaa Shaim situated within 4-6 km from participating farmers fields. Selections were made at late tillering and at maturity by the participating farmers and their neighbors. In total, three farmers participated in the selection process at Jemaa Shaim and 8 at Merchouch. During the selection, farmers are presenting the reasons for their preferred lines. Breeders (Amii and Ceccarelli) also made their selection both in farmer fields and at the experiment stations.

Plant height and grain yield in the four central rows were measured in the yield trials. Number of selected lines, the frequency of the occurrence of selection criteria, the selection intensity and the correlation between the selections made by the participating farmers with those made by the breeders were calculated using 0 (for line not selected) and 1 (for selected line).

A survey was conducted to determine the uses of barley by the participating farmers, their selection criteria and ideotypes characteristics.

2.3. Results and discussion

The rainfall during the 1996-97 season was more than 20% above the long term averages at Merchouch and Jemaa Shaim stations which received respectively 571 and 466 mm. The rains were abundant from November to January which received 80% of the total rainfall (Table 6). Severe drought occurred during February and March affecting grain yields both in farmer fields and at the experiment stations and delayed the planting of the experiment at Merchouch farmer site. The average grain yields obtained at farmers and experiment stations sites are reported in Table 7. Leaf rust and BYDV were the most developed diseases. Twenty lines were resistant to leaf rust and only seventeen were moderately susceptible to BYDV among the MORYT97 lines

Table 6. Monthly rainfall (in mm) at Merchouch and Jemaa Shaim during 1996-97 growing season

	Merchouch	Jemaa Shaim
September	7.0	1.0
October	26.5	6.0
November	28.0	28.0
December	302.0	264.0
January	123.5	81.0
February	0.0	0.0
March	11.5	21.0
April	72.5	65.0
May	0.0	0.0
June	0.0	0.0
Total	571.0	466.0
Long term average	435.0	320.0

Table 7. Average, minimum and maximum grain yield obtained at farmer fields and the experiment stations during 1996-97 season.

Site	Mean grain yield	Minimum	Maximum
Merchouch station	2077.0	1333.0	3333.0
Merchouch Farmer	2530.0	500.0	6000.0
J. Shaim farmer	994.0	516.7	2067.0
J. Shaim Station	2127.0	516.7	3083.0

2.3.1. Correlations between selections made by farmers and breeders

For the NURMAG 97 nursery grown at farmer sites, the selections rates varied among farmers and with the breeder at both sites. At Merchouch and Jemaa Shaim sites, 113 and 63 lines were discarded by all the farmers and the breeders. At Merchouch, the participating farmer selected 36% of the lines while the neighboring two farmers selected 41 and 11% (Table 8). The barley breeders selected 20%. Among the lines selected by the breeder, 77% were also selected by at least two farmers.

Table 8. Selections by farmers and breeder in the NURMAG97 nursery at Merchouch and Jemaa Shaim.

	Merchouch	Jemaa Shaim
Farmer 1 alone	25	0
Farmer 2 alone	55	26
Farmer 3 alone	2	3
Farmers 1 and 2	24	5
Farmers 1 and 3	2	1
Farmers 2 and 3	1	35
All three farmers	2	72
Breeder alone	4	0
Breeder + 1 farmer	9	1
Breeder + 2 farmers	16	25
Breeder + 3 farmers	29	46
Not selected	113	63
Selected by farmer 1	105 (36%)	131 (46%)
Selected by farmer 2	118 (41%)	212 (74%)
Selected by farmer 3	32 (11%)	187 (65%)
Selected by breeder	58 (20%)	72 (25%)

At Jemaa Shaim, two farmers selected more than 60% of the lines, the participating farmer selected 46% of the lines, while the breeder selected only 25%. Among the lines selected by the breeder, 98% were also selected by at least two farmers.

Table 9. Total number of lines selected by the farmers and by the breeders, lines in common with the breeder and with selections made on grain yield and number of best selected lines at Merchouch.

Total selections	Common with breeder	Common with grain yield selections	Numb of best selected lines ^a
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Farmer 1	64	31	17	3
Farmer 2	53	25	15	3
Farmer 3	25	22	11	2
Farmer4	14	5	4	1
Farmer5	43	11	8	0
Farmer6	18	5	4	1
Farmer7	42	11	8	1
Farmer8	27	6	5	1
Breeder1	36	36	13	4
Breeder2	21	16	9	5

a number of best yielding lines

These results show that, with the exception of one farmer at Merchouch, most of the farmerstend to select more lines than the breeders who selects with a selection pressures of around 20 to 25%,which is usual for observation nurseries. None of the farmers at both sites selected the winter typesand the two row check replicated three times within the nursery. Plant density, medium cycle and height (tall plants) guided the selection by most of the farmers, and none of them mentioned the reaction to major diseases as an important criterion. Some farmers judged that the number of linestested wastoo large and they can not afford going through this kind of nursery many times. For MORYT97, at Merchouch farmer site, the selection rates varied from 14 to 64 lines out of the 112 lines tested and five checks (Table 9). The two breeders selected respectively 36 (Amri) and 21 (Ceccarelli) lines. Twenty one lines out yielded the best check. Farmers 1 and 2 selected more than 70% of the linesselected on the basis of grain yield. The breeder selected 61% and the rest of farmers selected 50% or less of the lines selected based on grain yield. The breeders were able to select the 4 and 5 linesout of the best six high yielding lines. The farmers 1 and 2 picked up 3 high yielding lines and thiscan be explained by their low selection pressures since they selected respectively 57% and 47% of the tested lines. The rest of the farmers selected only one of the six lines. Only 12 lines were not selected by any of the farmers and breeders, and 26% of the lines were selected by at least four farmers(Table 10). Out of the 36 lines selected by breeder 1, only two lines were not selected by any of the famersand the two lines were among the group selected on the basis of grain yield. 83% of the linesselected by the breeder and 89% of the lines selected on the basis of grain yield were also selected by at least two farmers.

Table 10. Number of lines selected by farmers, breeders and the basis of grain yield at Merchouch in the MORYT97 trial during 1996-97 Season

	Farmers only	Farmers + Breeders	Farmers + Grain yield Selection
One farmer	24	5	2
Two farmers	28	9	2
Three farmers	22	8	7
Four farmers	12	5	2
Five farmers	10	6	2
Six farmers	4	1	2
Seven farmers	3	1	2
Eight farmers	0	0	0
Breeder only	-	2	2
Not selected	14	12	12

The correlations between the selections made by the breeders, the farmers and on the basis of grain yield are presented in Table 11. These correlations confirmed that only the farmers 1, 2 and 3 were able to select most of the lines in common with the breeders and with the lines selected based on grain yield. Farmer 3 was the most efficient in selection since he had the highest correlation coefficient together with the highest selection pressure. His selections were also highly correlated with the selection made by the breeder at the experiment station while only 30% of these lines were in common with the selections made by the same breeder in the farmer field.

Table 11. Correlations between selections made by breeders and on the basis of grain yield with selections made by the farmers within the MORYT97 nursery grown in the farmer field and at the experiment station.

	Amri/farm	Ceccarelli/farm	GYLD/farm	Amri/Station
Farmer1 (64)	0.403 (0.0001)	0.326 (0.0005)	0.231 (0.014)	0.066 (0.487)
Farmer2 (53)	0.343 (0.0002)	0.232 (0.014)	0.186 (0.049)	0.176 (0.061)
Farmer3 (25)	0.641 (0.0001)	0.347 (0.0002)	0.347 (0.0002)	0.249 (0.008)
Farmer4 (14)	0.0289 (0.762)	0.0259 (0.786)	0.095 (0.318)	-0.150(0.115)
Farmer5 (43)	-0.1109 (0.244)	-0.003 (0.975)	-0.003(0.975)	0.0113(0.235)
Farmer6 (18)	-0.041 (0.668)	0.039 (0.684)	0.039 (0.683)	0.09 (0.322)
Farmer7 (42)	-0.099 (0.300)	0.06 (0.951)	0.006 (0.951)	0.124 (0.193)
Farmer8 (27)	-0.120 (0.208)	-0.110 (0.247)	-0.003 (0.972)	0.024 (0.82)

GYLD: Selection on grain yield basis

The results in Table 12 showed significant correlations between selections made by the breeders and also with the selections made on the basis of grain yield in the farmer field. However, the selections at the experiment station were only correlated with selections made by one of the breeders at the farmer field.

Table 11. Correlations between selections made in the MORYT97 trial by breeders with those made on the basis of grain yield obtained at farmer site.

	Amri/farm	Ceccarelli/farm	
Amri/farm	-		
Ceccarelli/farm	0.453 (0.0001)		
GYLD/farm	0.306 (0.001)	0.297 (0.001)	
Amri/Station	0.238 (0.011)	0.104 (0.277)	0.210 (0.026)

For MORYT97 at Jemaa Shaim farmer site, the three farmers and the breeder have the same frequency of selection, ranging from 35 to 39%. Out of the 41 lines selected by the breeder, 23, 27 and 24 were common respectively with the selections made by farmers 1, 2 and 3 (Table 13).

Table 13. Numbers of total selected lines, lines common with the breeder and with selections made on grain yield and number of best selected lines at Jemaa Shaim.

	Total selections	Common with breeder	Common with GYLD	Num. of best selected lines ^a
Farmer 1	44	23	10	2
Farmer 2	39	27	11	1
Farmer 3	43	24	12	1
Breeder	41	41	14	2

^a number of lines with best grain yield.

These farmers selected respectively 10, 11 and 12 lines among the 21 lines that outyielded the best check. The breeder selected 14 lines from the group of high yielding lines and was able to pick up 2 out of 4 best yielding lines. Farmer 1 was also able to select 2 best yielding lines while the other farmers selected only one of the four best yielding lines. Forty three lines were selected neither by the farmers nor by the breeder, or on the basis of grain yield (Table 14). Forty one lines were selected by at least two farmers out of which 25 lines were also selected by the breeder. The results in Table 13 confirmed the significant correlations existing between the selections made by the farmers themselves and by the breeder at the farmer site. The selections in the farmers' fields were not significantly correlated with the selections made by the breeder at the experiment station. However, the selections made by the breeder at the farmer field and at the experiment station were highly correlated with the selections made on the basis of grain yield at the farmer site (Table 15).

Table 14. Number of lines selected by farmers, breeders and the basis of grain yield at Jemaa Shaim in MORYT97 trial during 1996-97 Season.

	Farmers only	Farmers + Breeders	Farmers + Grain yield selection
One farmer	18	6	2
Two farmers	15	7	3
Three farmers	26	18	8
Breeder only	-	10	-
Not selected	53	43	46

Table 15. Correlations between farmers and breeders selections in farmers' fields and the experiment station in Jemaa Shaim.

	Far1.F	Far2.F	Far3.F	A.S	A.F	GYLDF
Number of selections	44	39	43	15	41	21
Far1.F	-	0.448 (0.0001)	0.568 (0.0001)	-0.102 (0.286)	0.2616 (0.005)	0.129 (0.176)
Far2.F		-	0.733 (0.0001)	0.098 (0.305)	0.495 (0.0001)	0.177 (0.06)
Far3.F			-	0.013 (0.89)	0.315 (0.0007)	0.185 (0.051)
A.S				-	0.028 (0.772)	0.281 (0.002)
A.F					-	0.299 (0.001)
GYLDF						-

Farm.F: Farmer selection done at the farmer field

A.F: Selections made by breeder A at the farmer site.

A.S: Selections made by breeder A at the experiment station

GYLDF: Selections made on the basis of grain yield at farmer field

The results obtained at Merchouch and Jemaa Shaim showed clearly that only few farmers are as good as the breeders in identifying the high yielding lines. But, these farmers tend to apply low selection pressure compared with the breeders. The results also show the difficulty of identifying useful material for farmers conditions by selecting visually at the neighboring experiment stations. However, the efficiency of selection in the farmer field will depend on the quality of the trials conducted with the help of the participating farmers.

2.3.3. Selection criteria

At Merchouch most of the farmers based their visual selection on plant density, grain and straw yields and on long spikes (Table 16). Only few lines were selected on the basis of tillering ability, earliness, diseases and lodging resistance. None of the farmers used grain size or straw color. Farmer 3, the most efficient, selected his lines based on plant density, long spikes and straw yield. The breeder selected the lines on the basis of plant height (semi-dwarf and tall), disease resistance, overall agronomic score and grain size.

Table 16. Selection criteria used by farmers at Merchouch and Jemaa Shaim and their occurrence number.

Selection criteria	Merchouch				Jemaa Shaim			
	Farmer1	farmer2	farmer3	breeder	Farmer1	farmer2	farmer3	breeder
Tillering	1	0	0	3	0	3	2	16
Plant density	48	20	25	0	17	9	20	0
Plant height (tall)	10	13	0	25	15	5	10	30
Earliness	10	1	0	10	7	18	7	22
Long spike	31	4	17	10	23	15	19	15
Lodging Resist.	0	2	0	0	0	1	0	0
Disease Resist.	3	2	0	27	0	0	0	23
Grain yield	25	43	0	0	2	12	26	0
Straw yield	12	17	7	0	5	16	26	0
Straw color	0	0	0	0	4	9	7	0
Large kernel	0	0	0	12	0	3	1	9
Overall aspect	1	0	0	31	11	4	1	36
Local adaptation	0	0	0	0	1	2	5	0
Total selected lines	64	53	25	36	43	39	43	41

At Jemaa Shaim, the farmers mainly used long spikes, plant density, plant height, and earliness along with the visual estimation of grain and straw yields as selection criteria. Few farmers used the tillering ability, lodging resistance and kernel size and some of the farmers selected few lines on the basis of local adaptation (phenotypic similarity with the landraces) and on the overall agronomic aspect. The white colored straw was mentioned by all farmers during the selection of few lines. For the breeder, the selections were mostly guided by the agronomic score, disease resistance, earliness and plant height (tall). Some of the lines were also selected on the basis of long spikes, tillering ability, kernel size and the visual estimation of straw yield.

At both locations, the farmers used mainly yield components such as plant density and spike length that are not very often correlated with grain yield. Farmers seldom mentioned disease as a factor in their selection pressure even though leaf rust and BYDV infections were abundant. Earliness was mentioned at the semi-arid site of Jemaa Shaim, while only one farmer selected early genotypes at Merchouch. All the farmers ignored the two-row types even though some of them were good. The breeders used mainly the overall agronomic score and disease resistance and included the two-row types in their selections.

2.3.4. Farmer survey

The age of the participating farmers at Merchouch ranged from 30 to 76 years and their agricultural acreage ranged from 10 to 17 ha (Table 17). Cereals were sown over 50% of the land, 10 to 30% were sown to food legumes and the rest left as fallow. Two farmers did not grow barley during this season and the others planted barley on 0.5 to 4 ha mainly to feed their animals as forage, straw and

grain production. Only two farmers used part of their barley grain for human consumption. Regarding the seed source, 3 farmers bought part of their barley seeds from SONACOS (Government Agency selling seeds) and one of them saved part of his seeds from the harvest of the demonstration trial conducted at his farm. These farmers used the cultivars released by INRA such as ACSAD 176 (6R), ACSAD 60 (2R), Arig 8 (6R), and Laannoceur (6R). Three farmers use seeds of the landraces after seed cleaning and fungicide treatment. The two remaining farmers use the seeds of landraces with no seed processing.

Table 17. Agricultural land and uses of barley products of surveyed farmers at Marchouch.

Name	Age	SAU	Wheats	Barley	Barley uses
Bounaga Abdellah	49	15	10	2	Animal feeding, grazing
Hajjaji Abdellah	49	12	10	0	--
Slimani Abdellah	30	15	10	1.5	Animal feeding, grazing
Anbar Ali	52	17	6	2	0.4 tons food, rest animal feed
Benlmalam Abdeslam	70	10	6	0.5	Grazing
Ferkous Miloudi	70	16	6	4	Grazing, animal feed
El Hadi Mohamed	55	14	6	0	--
Mbrouki Driss	36	13	6	3	0.4 tons food, grazing, animal feed

SAU: Total agricultural land

Regarding the ideotype characteristics, six farmers prefer tall varieties and two prefer medium stature and lodging resistant genotypes. Only one of the farmers would like to have early cultivars with long spikes. All farmers like to have varieties with white grain and two farmers mentioned their preference for white colored straw as well (Table 18). None of the farmers mentioned early vigor and disease resistance among their preferred traits. The ideotypes of barley breeders for this region are mainly of short stature to medium tall with lodging resistance, of medium cycle (95-105 days to head), with resistance to major diseases, early vigor and with medium to large kernels with white aleurone.

Table 18. Farmers ideotype characteristics and sources of seeds at Merchouch region.

	Ideotype characteristics	Source of seeds
Farmer1	6 rows, medium height, lodging resistance, white grain and straw	Local, treated and cleaned
Farmer2	2 or 6 rows, tall,	SONACOS
Farmer3	6 rows, tall, long spikes, early and white grain	SONACOS and local not treated
Farmer4	6 rows, tall and white grain	Local treated and cleaned
Farmer5	2 or 6 rows, medium height, white grain and straw	Local treated and cleaned
Farmer6	6 rows, tall and white grain	SONACOS and demonstration trials
Farmer7	6 rows, tall and white grain	Local not processed

At Jemaa Shaim, the three farmers were 55 to 70 years old with 18 to 31 ha of agricultural land. Approximately 2/3 of the farm acreage is sown to cereals, 1/5 to food legumes and the rest is left as weedy fallow (Table 19). Barley occupies each year between 4 to 6 ha out of which 0.5 to 1 ha is reserved for grazing. The grain production is mainly used or stored for animal feeding (3 to 6 tons), 0.6 to 0.7 tons are used as human food and the surplus is sold to neighbors or at the market. The farmers in this region prefer six-row types, early and tall varieties with white grains. The breeders are searching for tall, medium early, drought tolerant and disease resistant genotypes.

Both the survey and the participation of farmers to selection process showed that most of the farmers are not aware of the importance of diseases and would discard any good two-row variety. Their selection criteria did not include the grazing quality and they are satisfied with the landraces known as forage types. Apparently, the breeders are including most of the concerns of farmers in their selections.

In the past, some farmers have been asked to judge the newly released varieties during their evaluation in the demonstration trials. The participatory approach initiated by this project has allowed to know better the traits preferred by farmers through their participation to the selection process in their site. Such a methodology provides additional experiment sites for the breeders since no correlations were found between grain yields obtained at farmer fields and those obtained at the neighboring experiment stations (Table 20). It also allows to advance lines approved by most of the farmers which will be easily adopted by farmers in the region. The approach should be extended to allow farmers to select within heterogeneous populations (F4 or F5 bulks) but the participating farmers should be aware of the effects of the remaining genetic segregation and soil heterogeneity.

Table 19. Agricultural acreage and barley uses of participating farmers at Jemaa Shaim site.

Farmers name	Age	SAU	Acreage Cereals	Acreage Barley	Barley uses
Hajjaj M'zani	70	20	14	5	0.7 tons human consumption, rest animal feeding (5.0 t)
Razim Larbi	65	18	11	4	0.6 tons human consumption, 3.0 t animal feeding, rest sold
Lagharbi Ahmed	55	31	22	6	0.7 tons human consumption, 6.0 t Animal feeding, rest sold

SAU: Total agricultural land

Table 20. Correlations between grain yields at farmer sites and at the experiment

stations				
	GYLDM S	GYLDM F	GYLDJS S	GYLDJS F
GYLDM S	-----	0.070 (0.459)	0.1756 (0.064)	0.102 (0.886)
GYLDM F		-----	-0.102 (0.284)	0.115 (0.228)
GYLDJS S			-----	-0.007 (0.944)
GYLDJS F				-----

GYLD: Grain yield, M: Merchouch region, JS: Jemaa Shaim

F: Farmer site, S: Experiment station