ICARDA
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Research innovations on dual-purpose barley genotypes for green forage and grain feed

Progress report submitted to
CRP Livestock Flagship 2.1 - Improved feed & forage germplasm and new tools and technologies for breeding

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Progress report on dual purpose barley research program at ICARDA

Crop-livestock integration is a common and efficient pathway for intensification of agriculture in developing countries. Barley is grown mainly as a grain crop (feed, food and malt), although it is grazed (west Asia and north Africa) or harvested during vegetative stage (dry regions of South Asia) for green forage to provide green forage in lean period. Barley grain and straw is globally used as feedstock. The use of barley for human food is most common in regions where other cereals do not grow well because of altitude, latitude, low rainfall, low inputs application or problematic soils. In Morocco, barley is a crop for dry regions with variable rainfall with poor crop management practices by small holder/marginal farmers. They are supporting their livestock for feed with grain and straw as well as for green forage using it like a dual-purpose crop for grazing and harvesting the remainder after regeneration for grain and straw for feed. In addition, it is an important food crop for human being in the region, being utilized in different products.

There is increasing realization that crop improvement of cereals needs to widen target traits beyond the primary trait of grain yield. The growing demand for animal feed and fodder that, at a time when the availability of the natural resource basis for their production becomes more constrained, has increased the importance, and monetary value, of crop residues. The quantity and fodder quality of barley residues can be significantly increased by conventional and molecular breeding as there is significant genotypic variability available in germplasm. Therefore, better targeting of new varieties of barley by improved understanding of current and future preferred whole crop traits demanded by farmers, consumers and industry is imperative. The project on investigation and identification of food-feed trait relationships in existing cultivars and exploring possible trade off effects for the development of full-purpose barley was undertaken at ICARDA Morocco. The ICARDA barley breeding program for feed and forage under the Livestock CRP, targeting global non-tropical dry environments with especial emphasis to the East Africa and WANA region was implemented during 2018-19 crop season at ICARDA Morocco and it's two platforms in Lebanon and India.

The program was implemented under the Feed and Forages flagship of the CRP Livestock under the following two clusters of activities.

2.1: Feed & Forage selection and breeding and development of new tools and technologies for breeding

A. Evaluation of barley genotypes in the breeding program:

The spring barley breeding material in different generations was evaluated for agronomic traits and disease reactions in different generations at Morocco and Lebanon during the crop season 2018-19. The details of the material evaluated, selections made for generation advancement, new crosses made, and the new genotypes bulked for PYTs are given in Annexure 1.

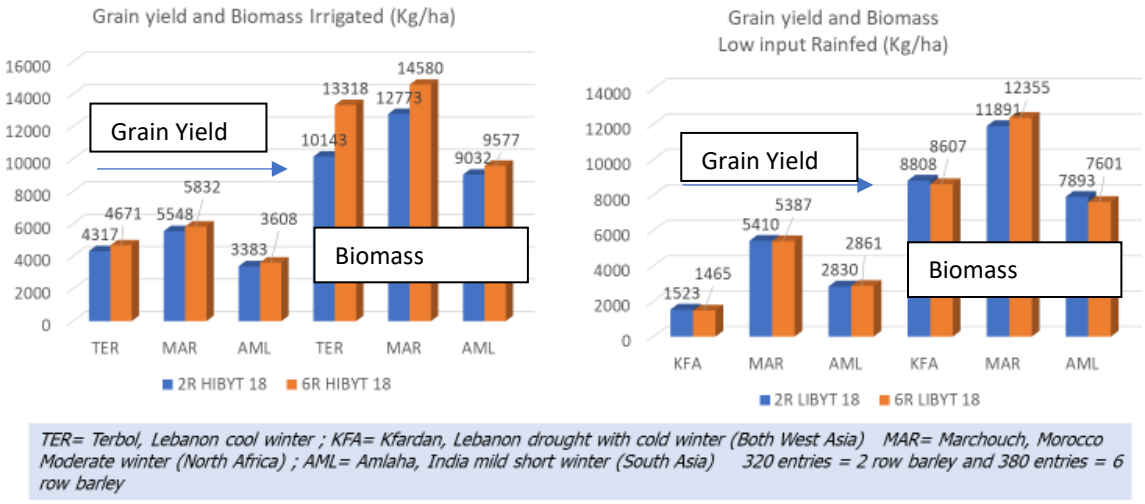
B. Evaluation of barley genotypes in the advanced yield trials:

About 800 advanced genotypes were evaluated under replicated yield evaluation trials at Morocco, Lebanon and India for growth vigour and growth duration, grain yield potential with biomass production. Separate sets of genotypes were taken in trials limited irrigated and rainfed conditions, representing the 2-row and 6-row types of barley. The trials were managed with help of ICARDA staff and supervised periodically by scientist/ barley breeder at important crop stages for observations recording. More sets of

these genotypes were also screened for most important traits like disease resistance under hotspot locations in Morocco and India sometimes under artificial inoculations with help of NARS partners.

Fig.1 : Important diseases of barley adversely affecting the quantity and quality of the forage/ feed (L to R: leaf and stripe rusts, scald, net blotch, spot blotch and powdery mildew

The trial means for grain yield and biomass at each location under irrigated (HIBYTs) and rainfed (LIBYTs) are given in fig 2 below indicates the wide range of diversity for the performance under two production conditions. The significant genotypic differences were observed for the test genotypes, with 6-row barleys always producing higher grain and biomass yield at all locations.



TER= Terbol, Lebanon cool winter ; KFA= Kfardan, Lebanon drought with cold winter (Both West Asia) MAR= Marchouch, Morocco Moderate winter (North Africa) ; AML= Amlaha, India mild short winter (South Asia) 320 entries = 2 row barley and 380 entries = 6 row barley

Fig.2: Performance of barley genotypes for grain yield and biomass under limited irrigation and rainfed conditions in two-row and six-row barley trials across three countries representing three contrasting environments

A set of 40 promising genotypes (37 test entries and three checks) was shortlisted based on the desired traits for advanced trial for testing their potential as dual-purpose barley with experimentation of cutting and non-cutting treatment. The objective of this trails was to identify the barley genotypes with higher green forage yield at cut with minimum impact on the grain and straw yields of the regenerated crop. The trial was conducted in 5 m long plots of 6 rows at 20 cm apart at Marchouch Station of ICARDA in Morocco. The cut for green forage was taken at 55 days after sowing (following the previous recommendations of optimum cutting dates from India). The fresh weight of the green forage was recorded in kg/plot from 2.5 m length of each plot and the remaining 2.5 m length was left uncut for comparison. Important traits like days to flowering, days to maturity, plant height, spike length, grains per spike, number of productive tillers per m length, biomass and grain yield were recorded on each replication in both the treatments (cut and no cut). The disease incidence powdery mildew and spot form of net blotch were recorded on the trials and the maximum incidence is considered for reporting.

There was significant effect observed on traits like plant height, spikes per square meter for cut treatment over no cut, while spike length and grains per spikes were not affected much (Table 2). Similarly, the incidence of diseases like powdery mildew and SFNB were not much affected by the cut treatment.

Based on over all interpretation entries 1, 6,7,8,13,14, 28,29, 31 35 and checks V Morales were desirable for the use as dual purpose barley with higher green forage yield, biomass and grain yield as well as less reduction in the biomass (straw) and grain yield in cut treatment over no cut treatment. These will be shared with the NARS in Morocco and Ethiopia for further evaluation in the research stations and farmers' fields.

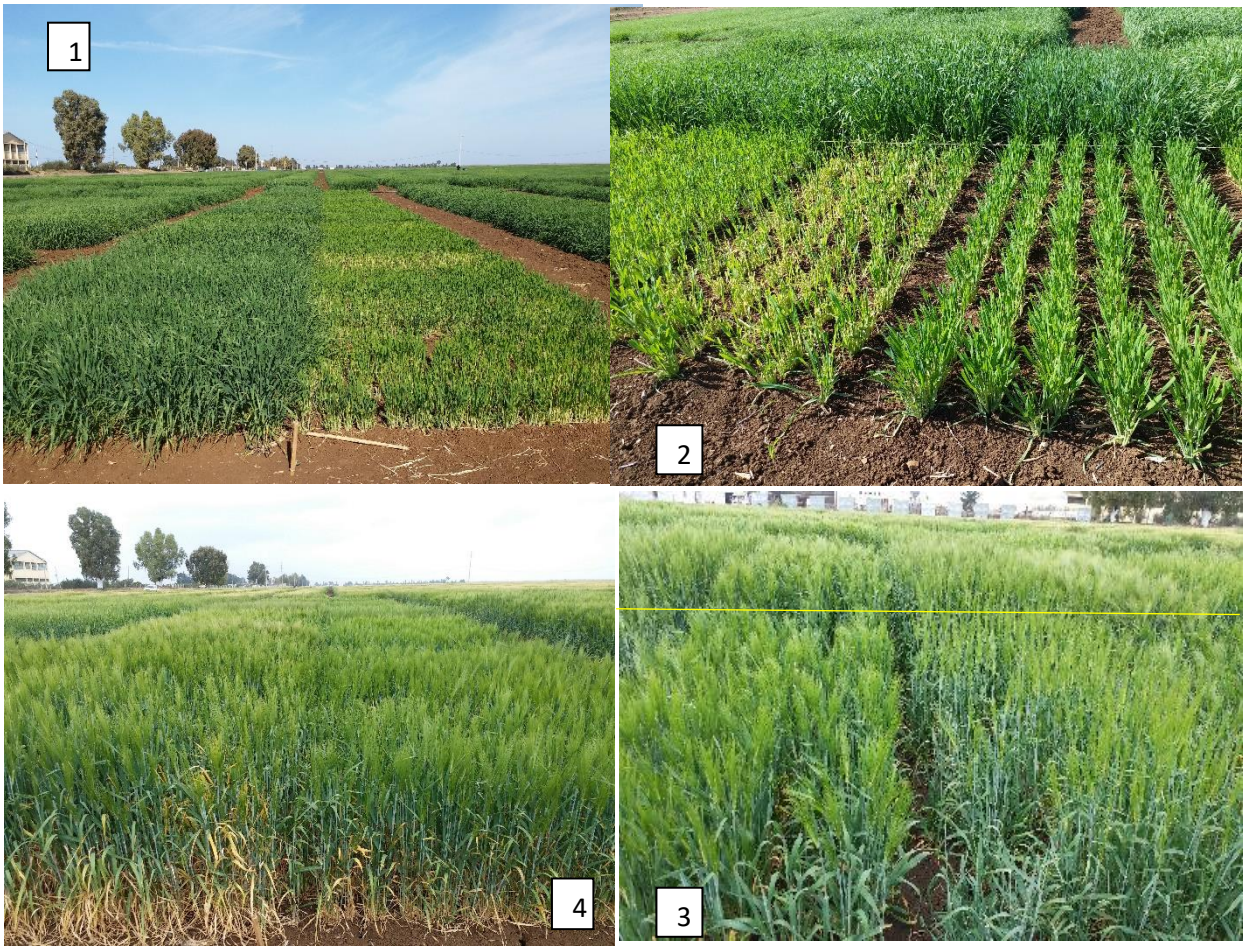


Fig 3: The field trials on dual purpose barley at Marchouch during 2018-19 crop season, 1= Left 2.5m no cut and right 2.5m cut at 55 DAS; 2 & 3 = the genotypes without cut (back ground) and with cut (foreground) indicating regeneration capacity differences at early and late stages and 4= late crop stage left no cut is being almost being caught by cut plots.

Table 1: Barley genotypes included in the dual purpose trial at Morocco 2018-19 crop season.

Entry	Cross name	Sel. History
1	CompCr229//As46/Pro/3/Srs/4/RWA-M47/5/Carbo/Hamra/4/Rhn-08/3/ DeirAlla106//DL71/Strain205	ICB08-0057-18AP-0AP-025AP-5AUB-0KF
2	CompCr229//As46/Pro/3/Srs/4/RWA-M47/5/Carbo/Hamra/4/Rhn-08/3/ DeirAlla106//DL71/Strain205	ICB08-0057-20AP-0AP-025AP-4AUB-0KF
3	Rum/6/JLB70-01/5/DeirAlla106//DL70/Pyo/3/RM1508/4/Arizona5908/Aths //Avt/Attiki/3/Ager	ICB08-0134-18AP-0AP-025AP-5AUB-0KF
4	Rhn//Bc/Coho/3/DeirAlla106//Api/EB89-8-2-15-4/5/CM67/3/Apro//Sv02109 /Mari/4/Carbo/6/Beecher	ICB08-0287-9AP-0AP-025AP-1AUB-0KF
5	Rhn//Bc/Coho/3/DeirAlla106//Api/EB89-8-2-15-4/5/CM67/3/Apro//Sv02109 /Mari/4/Carbo/6/Beecher	ICB08-0287-20AP-0AP-025AP-5AUB-0KF
6	Rhn//Bc/Coho/3/DeirAlla106//Api/EB89-8-2-15-4/5/CM67/3/Apro//Sv02109 /Mari/4/Carbo/6/Lignee527/NK1272//JLB70-063/3/Rhn-03	ICB08-0292-4AP-0AP-025AP-5AUB-0KF
7	Rhn//Bc/Coho/3/DeirAlla106//Api/EB89-8-2-15-4/5/CM67/3/Apro//Sv02109 /Mari/4/Carbo/6/IPA7	ICB08-0294-6AP-0AP-025AP-2AUB-0KF
8	Rhn//Bc/Coho/3/DeirAlla106//Api/EB89-8-2-15-4/5/CM67/3/Apro// Sv02109/Mari/4/Carbo/6/IPA7	ICB08-0294-17AP-0AP-025AP-5AUB-0KF
9	Rihane-03/3/As46/Aths*2//Aths/Lignee686/6/Rhn-03/Eldorado /5/Rhn-03// Lignee527/NK1272/4/Lignee527/Chn-01/3/Alanda	ICB08-0303-4AP-0AP-025AP-3AUB-0KF
10	Sara/4/H.Spont.96-3/3/Roho//Alger/Ceres362-1-1/5/ROBUR-BAR/J126// OWB753431D/SL3/4/GLORIA-BAR/COPAL//BEN.4D/3/SP-B	ICB08-0590-20AP-0AP-025AP-9AUB-0KF
11	Rhn//Bc/Coho/3/DeirAlla106//Api/EB89-8-2-15-4/5/CM67/3/Apro //Sv02109/Mari/4/Carbo/6/Hma-02//11012-2/CM67/3/Alanda/5/ Rhn-03//Lignee527/NK1272/4/Lignee527/Chn-01/3/Alanda	ICB08-0291-1AP-0AP-025AP-5AUB-0KF
12	ENCINO/TOCTE/6/Rhn//Bc/Coho/3/DeirAlla106//Api/EB89-8-2-15-4/5/CM67/3/Apro//Sv02109/Mari/4/Carbo	ICB10-0023-0AP-0AP-0MR-0MR
13	Lignee527/NK1272//JLB70-063/3/Alanda/Zafraa//Gloria'S'/Copal'S' /4/Gloria'S'/Copal'S'//As46/Aths/3/Rhn-03	ICB10-0257-0AP-0AP-0MR-0MR
14	Coho/Zy//Mazurka/3/Alanda/4/Centinela/2*Calicuchima/6/Rhn-03 /Eldorado/5/Rhn-03//Lignee527/NK1272/4/Lignee527/Chn-01/3/Alanda	ICB10-0364-0AP-0AP-0MR-0MR
15	Lignee527/NK1272//JLB70-063/3/Bda/4/Momtaz	ICB10-0783-0AP-0AP-0MR-0MR
16	Avt/Attiki//M-Att-73-337-1/3/Aths/Lignee686/4/M-Att-73-337-1 /3/Mari/Aths*2//Avt/Attiki/5/Manel	ICB09-0108-0TR-0MC
17	Carbo/Hamra/4/Rhn-08/3/DeirAlla106//DL71/Strain205/5/Aths/ Lignee686/4/Avt/Attiki//Aths/3/Giza121/Pue	ICB09-0524-0TR-0MC
18	Rihane-03/3/As46/Aths*2//Aths/Lignee686/6/Rhn//Bc/Coho/3/ DeirAlla106//Api/EB89-8-2-15-4/5/CM67/3/Apro//Sv02109/Mari/4/Carbo	ICB09-0649-0TR-0MC
19	Rhn//Bc/Coho/3/DeirAlla106//Api/EB89-8-2-15-4/5/CM67/3/Apro //Sv02109/Mari/4/Carbo/6/Momtaz	ICB09-1108-0TR-0MC
20	M126/CM67//As/Pro/3/Alanda/4/Ssn/Bda//Arar/3/F2CC33MS/CI07555/5/ Lignee640/Lignee527//Lignee527/Rihane/6/Alanda/Hamra//Alanda-01	ICB09-1129-0TR-0MC
21	Rhn-03//Lignee527/NK1272/3/Aths/Lignee686/5/Baca'S'/3/AC253//CI08887/ CI05761/4/Cen/Bglo'S'	ICB07-0169-29AP-0AP-0AP-7AP-0MR
22	Lignee527/Chn-01//Gustoe/5/Alanda-01/4/WI2291/3/Api/CM67//L2966-69/6/IPA7	ICB07-0928-14AP-0AP-0AP-7AP-0MR
23	DRUMMOND/M97.77/6/P.STO/3/LBIRAN/UNA80//LIGNEE640/4/BLLU/5/PETUNIA1	F09170 09/D30070-0AP-0TR-14MR-0MR
24	P.STO/3/LBIRAN/UNA80//LIGNEE640/4/BLLU/5/PETUNIA1/6/M111	F09247 09/D30147-0AP-0TR-7MR-0MR
25	P.STO/3/LBIRAN/UNA80//LIGNEE640/4/BLLU/5/PETUNIA 1/6/ M111	F09247 09/D30147-0AP-0TR-9MR-0MR
26	P.STO/3/LBIRAN/UNA80//LIGNEE640/4/BLLU/5/PETUNIA 1/6/M111	F09247 09/D30147-0AP-0TR-13MR-0MR
27	H03006//PENCO/CHEVRON	G03050007 09/4S0020-0AP-0TR-9MR-0MR
28	P.STO/3/LBIRAN/UNA80//LIGNEE640/4/BLLU/5/PETUNIA_1	CBSS97M00850T-G-2M-1Y-2M-0Y-0AP-21MR-0MR
29	ANCA/2469/AJO 44	ICB09-1530-0AP-0TR-0AP-8MR-0MR
30	ANCA/2469/AJO 44	ICB09-1530-0AP-0TR-0AP-18MR-0MR
31	SICH84.80/BISON 191	ICB09-1535-0AP-0TR-0AP-7MR-0MR
32	ATAH92/GOB//KEEL	ICB09-1385-0AP-0TR-0AP-1MR-0MR
33	ATAH92/GOB//KEEL	ICB09-1385-0AP-0TR-0AP-7MR-0MR
34	CALI92/ROBUST/6/P.STO/3/LBIRAN/UNA80//LIGNEE640/4/BLLU/5/PETUNIA 1	ICB09-1416-0AP-0TR-0AP-3MR-0MR
35	BGCLM 157.MBV/ND20493	ICB09-1437-0AP-0TR-0AP-11MR-0MR
36	TOCTE//CALI92/ROBUST	ICB09-1454-0AP-0TR-0AP-2MR-0MR
37	TOCTE//CALI92/ROBUST	ICB09-1454-0AP-0TR-0AP-9MR-0MR
38	Alanda 01	Check 1
39	Rihane 03	Check 2
40	V Morales	Check 3

Table 2: Observation on different phenological traits on barley genotypes in the dual purpose trial at Morocco 2018-19 crop season.

Entry	PH	PH	SL	SL	G/S	G/S	Spike m2	Spike m2	Score	Score	RGS	PM	PM	SFNB	SFNB
	NC	Cut	NC	Cut	NC	Cut	NC	Cut	NC	Cut	Cut	NC	Cut	NC	Cut
1	90	64	5	6	59	71	61	82	3	3.5	3	1	1	4	3
2	100	71	6	7	55	52	93	76	2.5	2.5	3.5	4	4	3	3
3	101	75	5	6	49	53	97	86	3	1.5	2.5	2	2	3	2
4	92	77	5	5	50	47	108	91	3	2.5	3	1	1	3	3
5	86	76	5	5	49	50	80	72	2	2.5	3	2	2	3	3
6	93	75	6	11	55	62	89	89	3.5	4	4	1	1	2	2
7	89	73	7	6	62	61	86	70	3	3	4	2	2	2	2
8	95	69	5	7	53	64	79	82	3	3.5	4	1	1	2	2
9	87	65	6	5	59	52	87	76	3.5	4	4	2	2	2	2
10	99	75	8	8	66	66	107	91	4	3.5	2.5	1	1	2	2
11	85	67	7	6	73	67	90	79	2.5	3.5	4	1	1	4	4
12	88	73	7	7	61	72	94	75	2.5	2.5	4	3	3	3	3
13	89	71	5	5	50	53	126	101	3	3	4	0	0	2	2
14	96	67	5	5	54	59	79	81	3	3	2.5	2	2	3	3
15	79	69	7	6	58	53	109	103	2.5	2.5	3.5	1	1	2	2
16	97	79	7	7	50	56	103	106	3	3	3	1	1	3	2
17	81	67	6	6	51	55	64	80	2.5	3	3.5	2	2	3	3
18	97	83	6	5	56	56	104	109	3	3	4	2	2	3	3
19	99	67	7	7	56	64	80	67	3.5	2	2	1	1	3	3
20	91	61	5	4	57	55	97	73	4	2.5	2	0	0	3	3
21	100	75	5	6	48	55	86	76	3	3	2	1	1	2	2
22	91	73	5	5	55	56	93	122	3	3	3.5	3	3	2	2
23	94	77	8	9	63	76	83	82	3	2	2.5	3	3	2	1
24	86	67	8	8	65	72	79	59	4	2	2	4	4	2	1
25	91	63	9	8	74	71	78	61	3.5	1.5	1.5	4	4	2	2
26	87	67	8	8	70	75	73	91	4	2	1	4	4	2	2
27	100	81	8	8	65	71	80	60	4	2.5	2	4	4	2	2
28	92	74	6	6	64	62	110	95	4	4	4	4	4	2	2
29	85	60	5	6	62	60	76	96	4	4	3	3	3	2	2
30	88	65	6	6	67	64	86	76	4	4	3	3	3	2	1
31	91	63	6	6	64	64	93	93	4	4	2.5	3	3	3	2
32	88	65	6	6	67	65	96	107	4	4	3.5	4	4	2	2
33	90	70	6	6	68	68	89	107	4	4	3.5	3	3	2	2
34	92	75	7	7	74	70	99	86	3	3	3	2	2	2	2
35	92	66	7	6	67	59	101	69	3.5	3	2.5	2	2	3	3
36	85	67	6	7	65	70	107	84	2.5	2.5	3.5	2	2	3	3
37	87	72	6	6	52	59	83	89	3	3	3.5	3	3	3	2
38	88	70	7	7	67	63	75	72	2.5	3	3	1	1	2	2
39	92	77	5	5	50	61	109	99	2.5	3	4	3	3	3	2
40	89	69	6	6	67	64	105	97	4	4	2.5	4	4	3	3
Mean	91.1	70.5	6.3	6.4	59.9	61.8	90.9	85.3				2.3	2.3	2.5	2.3

PH=Plant height (cm), SL= Spike length (cm), G/S= Grains per spike, Spike m2= spikes per square meter, VS= visual Score, VRS= visual score regeneration, PM= powdery mildew incidence (1-9 scale), SFNB = spot form net blotch (1-9 scale)

Table 3: Biomass, green forage and grain yield (Kg/ha) of barley genotypes in the dual purpose trial at Morocco 2018-19.

Entry	BY NC	BY cut	BY Difference	GF	GY NC	GY cut	GY Difference
1	7516	5769	1746	16118	3133	2523	610
2	7506	5373	2133	13112	2960	2180	750
3	6956	4873	2083	14222	2773	1900	773
4	8372	5719	2653	12845	3423	2426	887
5	7269	5666	1603	14065	2820	2013	747
6	7949	6159	1790	15568	3490	2833	740
7	7723	6216	1507	14769	3183	2800	590
8	8263	5686	2576	14642	3393	2753	723
9	6473	6289	183	13749	2896	2763	457
10	7636	5086	2550	16152	3033	2156	797
11	6709	7116	-407	13789	2890	2996	347
12	7423	5206	2216	13425	2926	1890	860
13	8159	6243	1916	13682	3273	2393	820
14	7496	5689	1806	15668	3033	2280	743
15	7513	5369	2143	13469	2936	1893	863
16	8499	5819	2680	13179	3223	2410	787
17	6939	5633	1307	12439	2866	2540	540
18	7046	5643	1403	14645	2726	2096	660
19	6939	5349	1590	14532	2903	1836	870
20	6966	4906	2060	14929	2836	1886	813
21	6626	6139	487	13529	2733	2520	477
22	6599	5533	1067	15138	2486	2046	557
23	7439	5049	2390	13572	3113	2213	817
24	7109	4416	2693	14339	2913	1647	960
25	6999	4846	2153	15078	2803	1716	870
26	7189	4340	2850	14659	2896	1577	983
27	8206	5223	2983	13379	3670	2350	1050
28	8039	5693	2346	14929	3456	2780	743
29	7733	5689	2043	16732	3316	2600	750
30	7499	5276	2223	13412	3193	2306	817
31	7756	5326	2430	16005	3363	2686	737
32	7686	5329	2356	14055	3456	2460	890
33	7166	5653	1513	13212	3086	2733	570
34	7233	5000	2233	14065	2743	2073	680
35	6549	5859	690	14349	2886	2730	467
36	7573	5169	2403	14055	2770	1790	823
37	6819	5116	1703	13365	2666	1893	720
38©	6743	5776	967	12669	2783	2190	650
39©	6969	6323	647	12962	2883	2420	603
40©	7516	5419	2096	15018	3350	2583	777
Mean	7369	5526	1843	14239	3033	2296	733
LSD	1490	1457	33	4203	783	747	1067
CV	10	13	62	15	13	17	74
H2	0.61	0.63	0.57	0.49	0.61	0.73	0.32

BY= Biological yield, GY= Grain yield, GF= Green forage yield, NC= No cut, highlighted entries selected for sharing with NARS partners in Morocco and Ethiopia.

2.2: Development of food-feed-crops with high nutritive value and feed biomass and development of new tools and technologies

In addition to selecting dual-purpose barley with higher regeneration capacity (crop stand after cut) and grain yield, the evaluation of the straw quality of the barley genotypes was undertaken in order to address the activity of "Development of food-feed crops with high nutritive value and feed biomass". The NIR analyses of barley straw for several straw quality traits was undertaken on the samples from the dual-purpose barley trial representing the no-cut and cut treatments (Table 4). Also, more than 900 samples from association mapping panels were analysed with NIR model DS2500 to develop NIRS prediction equations for barley from these 1000 plus samples. The GWAS analysis will be done for individual traits using the AM panel genotyping data. In addition, a set of more than 500 lines from fixed generations (F6 Onwards) was evaluated for their potential as dual-purpose barley with screening for grain / straw biomass yield in advanced trials of spring barley breeding trials. Around 50 genotypes from these test entries will be selected for conduct of a new set of dual-purpose barley trial during ensuing crop season of 2019-20 at ICARDA Morocco.

Table 4: Straw quality traits of barley genotypes in the dual purpose trial at Morocco 2018-19 (NIR DS2500).

Entry	DM (%)	DM (%)	Ash (%)	Ash (%)	OM (%)	OM (%)	CP (%)	CP (%)	NDF (%)	NDF (%)	ADF (%)	ADF (%)	ADL (%)	ADL (%)	IVOMD (%)	IVOMD (%)	ME (MJ/kg)	ME (MJ/kg)
	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C
1	86.1	85.8	11.0	10.1	89.0	89.9	7.4	7.9	69.8	67.1	41.2	46.2	5.7	6.6	60.7	54.2	7.7	8.9
2	86.6	84.3	10.6	10.0	89.4	90.0	7.4	8.1	70.2	66.7	40.6	45.8	5.3	6.5	60.1	54.5	7.7	8.8
3	87.4	84.2	10.0	9.1	90.0	90.9	7.6	8.2	69.7	66.2	39.5	44.7	5.2	6.3	62.7	57.7	8.3	9.4
4	86.6	84.7	11.3	10.3	88.7	89.7	7.5	7.3	69.1	66.2	41.5	45.5	5.4	6.4	60.4	54.8	7.7	8.9
5	86.1	83.3	9.7	8.5	90.3	91.5	7.1	8.3	67.5	63.3	37.9	43.3	4.7	5.9	64.7	58.9	8.5	9.7
6	85.7	85.0	10.6	10.4	89.4	89.6	7.0	7.2	70.2	68.7	43.0	45.5	5.9	6.8	58.0	54.8	7.8	8.4
7	85.0	84.9	10.5	10.3	89.5	89.7	7.8	7.8	67.4	65.8	40.2	42.4	5.3	5.9	61.1	58.9	8.5	8.9
8	85.9	85.8	11.2	11.6	88.8	88.4	6.9	7.9	70.3	67.2	40.6	46.1	5.2	6.8	60.3	55.2	7.9	8.7
9	86.8	86.5	11.0	10.6	89.1	89.4	7.4	7.2	70.3	68.2	43.3	46.3	5.5	6.6	58.9	54.7	7.8	8.6
10	87.6	86.1	10.7	9.5	89.3	90.5	7.3	7.8	71.3	68.3	41.9	47.1	5.7	6.9	60.1	54.4	7.8	8.9
11	85.6	85.7	10.2	10.1	89.8	89.9	7.8	7.6	68.0	67.5	42.3	42.8	5.6	6.0	58.7	58.2	8.4	8.5
12	86.7	85.1	9.9	8.3	90.1	91.7	7.7	7.9	69.7	65.5	39.5	44.0	5.0	6.0	62.9	56.8	8.2	9.3
13	86.3	85.2	10.6	9.7	89.4	90.3	7.1	8.0	68.4	65.5	40.0	44.7	5.1	6.4	62.9	57.1	8.2	9.3
14	85.6	85.4	9.8	9.6	90.2	90.4	6.8	8.1	69.7	66.4	40.6	45.8	5.1	6.6	61.4	55.5	8.0	9.0
15	86.1	85.7	9.2	8.4	90.8	91.6	7.6	8.2	67.0	62.3	37.3	42.8	4.4	5.6	66.9	58.8	8.5	9.9
16	86.4	85.3	9.6	8.7	90.4	91.3	7.2	7.1	69.0	66.7	41.4	44.0	5.5	6.2	61.5	57.7	8.4	9.1
17	85.4	85.0	9.7	10.1	90.3	89.9	7.8	7.5	67.4	67.6	41.3	41.9	5.3	5.9	59.5	58.9	8.5	8.7
18	85.8	84.4	10.2	9.8	89.8	90.2	7.6	7.9	69.4	67.5	41.3	44.3	5.3	6.4	59.8	56.6	8.2	8.8
19	86.4	84.6	10.2	8.6	89.8	91.4	6.5	9.1	71.4	62.4	36.9	47.6	4.6	7.2	66.2	52.9	7.5	9.9
20	87.2	85.7	10.7	9.0	89.3	91.0	6.5	8.0	72.1	65.4	40.1	49.2	5.5	7.6	63.3	51.4	7.2	9.4
21	86.3	85.5	10.6	9.9	89.4	90.1	6.9	7.7	71.8	68.4	42.1	47.7	5.5	7.1	60.2	52.6	7.6	8.9
22	86.5	85.7	10.6	10.5	89.4	89.5	7.6	7.7	68.2	68.3	42.8	43.5	5.7	5.9	58.1	58.0	8.3	8.5
23	85.6	85.7	10.4	9.7	89.6	90.3	7.3	9.7	70.5	63.1	36.3	45.7	4.2	6.6	66.5	55.0	7.9	9.8
24	84.7	83.9	9.6	8.7	90.4	91.3	7.5	8.2	69.1	66.3	39.8	44.6	5.1	6.6	62.5	56.4	8.2	9.3
25	85.0	85.0	9.2	8.6	90.8	91.4	7.2	9.4	68.5	63.5	36.4	44.1	4.2	6.3	65.9	58.5	8.6	9.8
26	85.0	84.2	9.5	8.7	90.5	91.3	7.4	8.6	69.0	63.6	37.2	44.5	4.3	6.6	65.6	56.6	8.2	9.8
27	85.9	83.9	10.9	11.1	89.1	88.9	6.8	7.1	73.5	73.6	46.1	48.5	6.7	7.2	51.8	50.4	7.1	7.5
28	87.8	86.6	11.0	11.8	89.0	88.2	7.4	8.2	71.1	70.0	44.1	47.2	6.1	6.7	55.1	53.2	7.5	7.8
29	87.1	86.1	11.1	11.7	88.9	88.3	7.8	8.6	69.7	69.6	42.9	46.1	5.7	6.1	56.7	53.7	7.5	8.0
30	87.2	86.4	11.4	11.5	88.6	88.5	7.7	7.8	70.8	70.6	44.8	46.8	6.3	6.5	55.2	53.0	7.4	7.9
31	87.5	87.3	11.1	11.5	88.9	88.5	7.7	7.3	71.0	71.2	46.0	46.7	6.4	6.8	55.0	53.7	7.5	7.8
32	86.7	86.6	11.1	12.0	88.9	88.0	7.2	8.0	72.2	70.7	45.2	47.2	6.3	6.8	54.6	53.0	7.5	7.7
33	87.2	86.5	11.1	11.2	88.9	88.8	7.3	7.2	71.2	71.0	45.7	47.1	6.4	6.8	54.6	53.2	7.5	7.8
34	87.1	86.1	10.6	10.5	89.4	89.5	7.7	8.1	69.9	68.2	41.3	45.4	5.5	6.5	59.4	54.8	7.7	8.5
35	86.4	87.1	10.9	11.4	89.1	88.6	6.8	7.3	73.0	71.2	45.4	47.7	5.8	6.5	54.9	52.8	7.6	7.8

36	86.7	85.1	9.5	8.5	90.5	91.5	7.2	7.5	68.0	65.3	39.3	44.1	4.9	5.7	64.0	57.7	8.4	9.6
37	86.6	86.0	9.5	9.1	90.5	90.9	7.7	8.0	67.1	66.4	39.8	42.5	4.9	5.4	62.3	59.3	8.6	9.2
38	86.8	86.1	10.7	9.8	89.3	90.2	7.4	8.6	70.1	66.1	39.9	45.7	4.9	6.1	62.8	55.6	8.0	9.3
39	86.4	85.8	10.2	9.8	89.8	90.2	7.5	7.6	68.0	67.4	41.8	44.1	5.4	5.7	59.7	56.9	8.2	8.7
40	87.3	86.6	11.5	11.6	88.5	88.4	7.7	7.6	70.5	71.7	45.1	46.5	6.3	6.5	55.1	53.4	7.5	7.9
Mean	86.4	85.5	10.4	10.0	89.6	90.0	7.3	7.9	69.8	67.3	41.3	45.4	5.4	6.4	60.3	55.5	7.9	8.8

Organization of the Farmers Day:

In order to communicate the results to the ultimate clients "The farmers" spring barley ICARDA program, organized the "Farmers day" at ICARDA Research Station, Marchouch in Morocco on 28 April 2019, to make them aware about the research innovations of the barley program especially about the dual-purpose genotypes in the yield trials where the cut for green forage has been practiced. The promising genotypes with higher green forage yield and better regeneration capacity were shown to the farmers. More than 100 farmers from Romani and Oued Zem region, which represents the major barley area around participated in the farmers day and many of them have shown keen interest in such dual-purpose barley varieties to get them cultivated. They were willing either to use them in grazing or stall feeding to their livestock especially in the dry areas where there is an acute shortage of the green forage. The resistance to the common foliar diseases of the region in the new genotypes in the demonstration plots was highly appreciated by farmers. There was a great demand for the seed of these cultivars indicated by the farmers to make use and the involvement of INRA barley scientists would be helpful who are working in close cooperation with ICARDA.

Fig 2: Farmers from different villages visited ICARDA Marchouch Station, in Morocco and were shown the field trials on dual purpose barley

Summary

ICARDA is having the global mandate for barley for the Dry Areas, where it is used commonly as feed and food crop for livestock and human being, respectively. The barley program at ICARDA under CRP Livestock is involved in improvement of dual-purpose barley for combination of green forage with grain and straw yield as feed. Incorporation of resistance to foliar disease and tolerance to abiotic stresses like drought, heat and cold to prevent the possible loss of quantity and quality of the forage, grain and straw. The genetic improvement of straw quality is also an important objective of the program. From 2018-19 trials a set of 10 genotypes (entries 1, 6, 7, 8, 13, 14, 28, 29, 31 and 35) and check V Morales have been identified as promising genotypes for sharing with NARS at Morocco, Ethiopia and India for further evaluation at research stations and farmer's fields to release best ones for commercial cultivation.

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Note: Personal information including Name, Business Title, Email, Phones, Images and GPS points included in this report have been authorized in writing or verbally by the data subject.

Annexure 1:

Summary of barley breeding material evaluated at Morocco and Lebanon during 2018-19

SN	Generation/ Item	Morocco		Lebanon	
		Sown	Harvested	Sown	Harvested
	Crossing Block (Marchouch/ Terbol)	525	525	497	497
	Crosses made (F1 Morocco & Lebanon)	272	272	933	882 (513 HI),(369 LI)
	F_2	1126		300	300
	F_3	842		301	299
	F_4	279+101+640		7760	7760 Spikes
	F_5	754 families	741 (2R), 543(6R)	5960	1216 (688 2R+528 6R)
	F_6 (Ryd2+Ryd3 BYDV pyramiding)	72	72		
	F_7 (All LI)	741 (2R) 931 (6R)	237 (2RLIPYT), 194 (6RLIPYT) 60(NPYT)	741 (2R) 931 (6R)	
	Doubled Haploids	Cross 1=390; Cross 2=102; Cross 3=129 and DH Cross 4=192			
	H. bulbosum derivatives evaluation	155	155		
	H. spontaneum Derivatives (HEB25) for drought screening	Brittle (512) Non brittle (880)	1392		