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MEMORANDUM

FROM: Greg Lutgen and Jamie Sherman, Spring Barley

DATE: January 4, 2023

RE: Release of MT Boy (MT16F02902) spring forage barley

Pedigree: LAVINA/CDC COWBOY

Recommendation: Public, protected **Name:** MT Cowgirl (MT16F02902)

Summary:
MT16F02902 is well-suited for production across all forage barley growing regions of Montana and is being released due to forage yield performance.

Agronomic Strengths

- High performing forage line
- Taller plant height
- Longer grain fill period
- Higher percentage of plump seed

Quality Strengths

- Potential improvement of forage quality with lower NDF and ADF

Selection history:

MT16F02902 is a spring, 2-row, hulled, hooded barley developed for forage barley production in Montana. MT16F02902 has a tall, erect growth habit, lax head type, white aleurone and long rachilla hairs. MT16F02902 is an F4 derived selection from Lavina by CDC Cowboy cross made in 2015. 'Lavina' (MT981397), one of the top barley forage producers in the state, is a two rowed hooded spring barley and is a cross between 'Haybet' and 'Baronesse'. 'Haybet'(PI 533600), was developed by USDA-ARS and the Montana Experiment Station, while 'Baronesse (PI 568246)was developed in Germany and both released in 1989. CDC Cowboy, originating from the cross TR320 x SB91709, is a dual-purpose feed forage line with awns and produces well across environments in the Great Plains. MT16F02902 was advanced by single seed descent from the F1 thru F4 generations. It was increased from a F4 plant to produce seed for preliminary yield testing in 2016. MT16F02902 was tested for agronomic and forage traits beginning in 2012.

Purification/seed stocks:

We purified MT16F02902 in 2020 by planting 100 F9-derived F10 headrows at Bozeman Post farm. We evaluated for phenotypic uniformity before bulking all headrows. The 2021 breeder strips appeared uniform and were regularly rogued by barley breeding employees and Foundation staff. MT16F02902 was in Foundation seed in 2022.

Agronomic performance and characteristics:

Table 1 compares MT16F02902 to control varieties Haymaker, Hays and Lavina. Note that Cowgirl's mean performance across locations where it coincided with the control is reported in column 3, while each controls mean performance is reported in column 4. Across all environments, MT16F02902 was equal to or better than controls for forage yield and grain yield. MT16F02902 is taller than the controls, which likely supports forage yields. When MT16F02902 is compared to commonly grown lines it tends to head earlier and mature later such that it has a longer grainfill. The extended grainfill likely increases plump seed and might extend harvest flexibility. Seed size stability under dryland conditions could be important to seed production stability. MT16F02902 is not significantly different in percent grain protein and tends to have better quality with lower ADF and NDF although not significant.

Table 1: Comparison of MT16F02902 with Varietal Controls

TRAIT	CONTROL VARIETY	MT16F02902 MEAN	Control MEAN	MT16F02902/ CONTROL (%)	NUMBER OF OBSERVATIONS
FORAGE YIELD (TONS/ACRE)	Haymaker	3.81	3.53	107.7	12
	Hays	3.72	3.41	109.0*	21
	Lavina	3.72	3.59	103.7	22
GRAIN YIELD (BUSHELS/ACRE)	Haymaker	99.68	96.85	102.9	4
	Hays	87.94	91.97	95.6	13
	Lavina	87.94	89.05	98.7	13
HEADING DATE JULIAN	Haymaker	179.84	180.69	99.5*	10
	Hays	181.15	182.93	99.0***	19
	Lavina	181.83	181.71	100.1	23
MATURITY DATE JULIAN	Haymaker	201.48	200.56	100.5	5
	Hays	207.64	208.37	99.7	9
	Lavina	207.18	205.59	100.8**	10
HEIGHT (CM)	Haymaker	73.49	69.8	105.3**	12
	Hays	76.19	68.07	111.9***	21
	Lavina	73.79	69.25	106.6***	30
GRAIN PROTEIN (%)	Haymaker	12.74	13.2	96.5	6
	Hays	12.52	12.49	100.2	11
	Lavina	13.63	13.62	100.0	16
ADF	Haymaker	31.98	33.19	96.4	11
	Hays	34.07	33.61	101.4	19
	Lavina	33.92	33.98	99.8	20
NDF	Haymaker	57.72	59.67	96.7	11
	Hays	57.52	57.78	99.5	19
	Lavina	57.53	58.13	99.0	20
Plumps (% 6/64)	Haymaker	84.9	72.1	117.8	1
	Hays	84.9	80.6	105.3	1
	Lavina	64.6	58.27	110.9*	7

Difference indicated by Ttest at *p<0.05,**p<0.01, ***p<0.001

Forge yield, height, grain yield and heading date are reported by location in Tables 2 (2020-2021) and 3 (2018-2019). The trials in 2020 and 2021 were lattice square designs with 25 entries and 3 replications. Due to planting issues in several locations in 2018 and 2019 the trials had to be analyzed with a randomized complete block design that consisted of 16 entries and 3 replications. Due to the difference in design the trials are averaged over the years with similar design. Therefore, the tables below report agronomic data by location averaged across 2020 and 2021 (Table 2), as well as 2018 and 2919 (Table 3). The more powerful lattice square design indicates MT16F02902 has more tons/acre in most environments. In most environments where the difference is not significant, MT16F02902 trends equal to or better than most lines. Across environments MT16F02902 trends taller and earlier heading. The greater height in some part explains the greater tons/acre. The earlier heading may explain the more plump seed reported in Table 1. Importantly, the dataset is not balanced with some locations being lost for a variety of reasons, particularly for grain yield. MT16F02902 tends to be equal in grain yield to Lavina and Hays, while in some environments better than Haymaker. Improved grain yield performance in Bozeman suggests the best environment for seed production.

Forage Yield 2020-2021 Forage Intrastate Trial

Lattice square design, 25 entries, 3 replications

	Tons/Acre						
Variety	Bozeman	Conrad	Havre	Kalispell	Moccasin	Sidney	All Locations
loc years	2	1	2	2	1	1	9
Hays	4.54	3.05	1.87	4.87	4.69	1.61	3.76
Haymaker	4.72	3.32	2.03	4.94	4.83	**1.92***	3.61
Lavina	4.98	3.02	1.98	5.84	4.77	**1.96****	3.78
MT Cowgirl	4.71	3.12	**2.91****	**7.85****	**5.76****	**1.86***	**4.19****
LSD (0.05)	0.82	0.55	0.24	1.50	0.14	0.31	0.38
	Height						
Variety	Bozeman	Conrad	Havre	Kalispell	Moccasin	Sidney	All Locations
loc years	2	1	2	2	2	1	10
Hays	68.4	63.3	55.1	75.0	59.6	72.1	66.2
Haymaker	71.8	66.8	58.9	**82.3****	66.3	**76.3***	**71.52***
Lavina	72.1	64.5	56.8	**79.3***	64.0	74.8	**69.3***
MT16F02902	72.8	67.6	**66.6****	**80.5***	**71.5****	**81.1****	**74.1****
LSD (0.05)	5.2	5.7	4.0	6.4	4.4	5.7	6.0
	Grain Yield						
Variety	Bozeman	Conrad	Havre	Kalispell	Moccasin	Sidney	All Locations
loc years	2	1	1	2	1	1	8
Hays	**113.6****	**66.8***	34.0	**101.0****	83.7	62.6	87.8
Haymaker	102.6	49.0	32.9	**97.6***	84.5	49.6	80.6
Lavina	**104.2***	**67.6****	**46.2****	**98.2***	**90.3****	**79.7****	90.0
MT16F02902	**110.4***	**60.6***	30.2	85.9	68.9	**75***	83.3
LSD (0.05)	10.0	14.3	3.1	11.3	3.0	7.2	12.8

** indicates highest value within a column, if significantly different from other selected varieties

* indicates value equal to highest value within a column based on Fisher's Protected LSD (p=0.05)

No designated values within a column indicates that there is no significant difference between selected varieties

	Heading						
Variety	Bozeman	Conrad	Havre	Kalispell	Moccasin	Sidney	All Locations
loc years	2	1	2	1	1	1	8
Hays	179.0	191.7	177.3	194.3	187.2	181.1	184.8
Haymaker	178.5	**190****	176.0	191.8	**186.0***	177.9	184.4
Lavina	**177.5***	191.0	**172.5****	194.2	**184.4****	**175.9****	**183.3***
MT16F02902	**177.3****	**190.3***	**173.16***	192.2	**185.7***	**176.6***	**182.93****
LSD (0.05)	0.86	0.94	1.28	5.47	1.76	1.74	0.79

** indicates lowest value within a column, if significantly different from other selected varieties

* indicates value equal to lowest value within a column based on Fisher's Protected LSD (p=0.05)

No designated values within a column indicates that there is no significant difference between selected varieties

Table 3: Agronomic data 2018-2019 Forage Intrastate Trial
Randomized Complete Block Design, 16 entries, 3 replications

	Tons/Acre					
Variety	Bozeman	Conrad	Havre	Moccasin	Sidney	All Locations
loc years	2	1	2	2	2	9
Hays	5.70	3.16	3.65	2.34	2.29	3.46
Lavina	5.63	3.29	3.89	2.40	2.43	3.56
MT16F02902	5.93	**4.43****	3.64	2.22	2.22	3.72
LSD (0.05)	0.96	0.93	0.61	0.40	0.50	0.90

	Grain Yield					
Variety	Bozeman	Conrad	Havre	Moccasin	Sidney	All Locations
loc years	2	1	1	2	2	8
Hays	**137.6****	94.1	**11.47****	58.8	**99.3***	85.6
Lavina	121.9	73.5	8.6	64.6	**105.2****	86.2
MT16F02902	**128.7***	75.9	9.6	60.7	92.2	77.7
LSD (0.05)	11.1	45.6	1.7	9.8	10.4	10.6

	Height					
Variety	Bozeman	Conrad	Havre	Moccasin	Sidney	All Locations
loc years	2	1	2	2	2	9
Hays	84.0	65.2	62.4	68.3	70.7	70.1
Lavina	84.1	74.5	**69.01****	**70.7***	73.0	**75.2***
MT16F02902	**91.8****	**82.1****	65.2	**74.0****	**80****	**79.5****
LSD (0.05)	2.5	7.0	3.5	4.6	4.8	4.8

** indicates highest value within a column, if significantly different from other selected varieties
* indicates value equal to highest value within a column based on Fisher's Protected LSD (p=0.05)
No designated values within a column indicates that there is no significant difference between selected varieties

	Heading					
Variety	Bozeman	Conrad	Havre	Moccasin	Sidney	All Locations
loc years	2	1	2	2	2	9
Hays	185.5	188.0	**174.8****	189.3	178.0	183.1
Lavina	**184.2****	188.0	**175***	**187.2****	**176.0****	185.6
MT16F02902	**184.5***	**181.3****	177.8	**188.3***	177.7	**179****
LSD (0.05)	0.84	6.60	1.07	1.26	1.52	1.92

** indicates lowest value within a column, if significantly different from other selected varieties
* indicates value equal to lowest value within a column based on Fisher's Protected LSD (p=0.05)
No designated values within a column indicates that there is no significant difference between selected varieties

Disease resistance:

MT16F02902 was susceptible to stripe rust and moderately susceptible to stem rust (Table 5).

Table 4: Cowgirl Stem Rust Data

2020 Study / Location / Org. / Date	Njoro, Kenya KALRO/CIMMYT 4/20	Njoro, Kenya KALRO/CIMMYT 4/27	Debre Zeit, Ethiopia EIAR 5/22	Debre Zeit, Ethiopia EIAR 5/30	Debre Zeit, Ethiopia EIAR 6/8
Entry name	Stem Rust	Stem Rust	Stem Rust	Stem Rust	Stem Rust
MT16F02902	**1 MS**	**5 M**	**5 MS**	**15 S**	**20 MS**
Hays	5 MS	10 MS	5 MS	15 S	30 MS
Lavina	1 MS	5 M	10 MS	20 S	30 MS
AC Metcalfe	10 MS	15 M	0	5 MS	10 MS
ABI Voyager	15 MS	20 S	5 M	20 MS	60 S
MT16F02910	1 MS	10 M	1 MS	10 S	20 MS
MT16F02903	5 MS	10 M	10 MS	20 S	30 MS

R = Resistant

MR = Moderately Resistant

M = Intermediate

MS = Moderately Susceptible

S = Susceptible

MSU Barley Breeding Program:

Jamie Sherman, PI

MSU Breeding Staff – Greg Lutgen, Traci Hoogland, Joe Jensen, Jessica Williams, and Trevor Palone. With special thanks to Ron Ramsfield.

MSU Malt Quality Laboratory - Hannah Turner, Sarah Olivo

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