BIOAG FINAL REPORT

TITLE: BEYOND BEEF AND BARLEY SOUP: DEVELOPMENT OF NUTRITIONALLY DENSE, HULLESS FOOD BARLEY VARIETIES FOR ORGANIC FARMERS

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ABSTRACT

Barley has well-documented nutritional advantages over other small grains as a source of human food. Researchers from WSU have been breeding and selecting hulless food barley types, a novel and promising market class for Washington growers. For this current project, our goal was to develop and release a new agronomically superior hulless barley variety with enhanced human health attributes. We evaluated 30 advanced lines on organic and conventional farms, and further tested six advanced lines as part of the WSU Variety Testing Program. Traits of interest included days to maturity, grain yield, disease resistance, plant height, tolerance to lodging, test weight, protein content and β-glucan content. We successfully released the new two-row spring barley variety 'Havener' through the official WSU Variety Release process, and we are in the final decision making phase regarding the release, either as germplasm or as a variety, of a second barley cultivar. Both have unique combinations of high yields in dryland systems, high test weight compared to hulled varieties, excellent agronomic qualities, and elevated protein and β-glucan content. Havener is currently being grown by the Washington State Crop Improvement Association as foundation seed, and the seed will be available to seed dealers and farmers beginning in 2017.

OBJECTIVES:

1. Release germplasm and/or varieties of hulless food barley agronomically adapted to dryland farming systems.

2. Release a food barley with superior protein and β-glucan content compared to existing hulled and hulless varieties.

OUTPUTS

I. HAVENER SPRING BARLEY VARIETY DESCRIPTION

Identification:

1. **Crop kind and market class:** Two-row, spring, hulless, food barley
2. **Selection No.:** 09WA-265.5
3. **Name:** Havener
4. **Pedigree:** X04041-T32/X04041-T34

X04041-T32 and X04041-T34 are spring, hulless, waxy barley lines with high β-glucan content that were derived from a cross between 01WA-13862.3, a hulless, waxy barley and Radiant. 01WA-

13862.3 is a hulless waxy spring barley derived from a cross between SH 97110, a hulless barley, and Merlin, a hulless, waxy barley.

General Situation:

1. **Unique Cultivar Characteristics:**
    a. Havener is a hulless, food barley with high β-glucan that is broadly adapted across all rainfall zones of eastern Washington State. Averaged across all rainfall locations and years in the 2013-2014 Variety Testing trials, Havener had yields significantly exceeding Meresse, the hulless control, by 338 lbs/acre. Havener has 5% higher β-glucan content than Meresse, and between 31 and 38% higher β-glucan content than commonly grown hulled cultivars. Havener also has significantly higher test weight than Meresse by 2.9 lbs/bu, and 5 to 8 lbs/bu higher test weight than all commonly grown hulled cultivars tested.

    b. Havener is unique from existing varieties in one or more of several agronomic and morphological characteristics, predominantly for grain yield in a hulless variety, test weight, protein content, and β-glucan content.

2. **Use-type:** Food (see Figure 2)

3. **Description:**
    a. Plant Type – spring
    b. Head Type – two-row

4. **Varieties it is Intended to Replace:** Meresse and Clearwater across all rainfall zones.

Performance Evaluations:

1. Yield/test weight and protein - Breeder trials: Havener was first included in a WSU Preliminary Trial in 2010 and in a WSU Yield Trial in 2011. From 2011 to 2012, Havener had yields statistically equal to the hulled variety Baronesse (Table 1). Test weight was significantly higher for Havener compared to Baronesse each year (Table 1), with a 3-year average approximately7.5 lbs/bu higher in 09WA-265.5. Protein was tested in 2011 and 2012, with no significant difference shown between Havener and Baronesse (Table 1).

Yield - WSU Extension Variety Testing Program: Havener is broadly adapted to different rainfall zones and dryland production systems of eastern Washington. In data summarized over two years (2013-2014) and across all rainfall zones, Havener significantly out-yielded Meresse by 338 lbs/acre. From 2013 to 2014, Havener yielded 378 lbs/acre higher than Meresse (3718lb/a compared to 3340 lb/a) across the high rainfall zone (>20" precip/yr) locations of Pullman, Fairfield and Farmington (Table 2). Over the same time period, Havener yielded 327 lbs/acre higher than Meresse (3490 compared to 3163 lb/a) across the intermediate rainfall zone (16-20" precip/yr) locations of St. John, Mayview, Dayton, Walla Walla, and Reardon. In the low rainfall zone (<16" precip/yr) locations of Almira and Lamont, Havener yielded an average of 255 lbs/acre higher than Meresse (2506 compared to 2251 lb/a) (Table 2).

2. **Agronomic characteristics:** Results summarized from 2013 and 2014 Variety Testing trials show that Havener has an average heading date 3, 2, and 4 days later than Meresse and 1 day earlier, 2 days later and no difference compared to Baronesse across high, intermediate and low rainfall zones, respectively (Table 3). On average, Havener is 3, 2 and 2 inches taller than Meresse across the high, intermediate and low rainfall zones, respectively, and generally statistically equal to slightly taller than Baronesse across locations (Table 3).

3. **Quality:** Havener is a hulless variety designated as a food type. Havener has shown an average test weight of 58.3 lbs/acre across all rainfall zones (14 location/years), significantly higher than Meresse (55.4 lbs/a), Lyon (51.4 lbs/a), Baronesse (50.9/a), and all other hulled varieties tested (Table 4).

   Havener has an average protein content of 13.5% across all rainfall zones (14 location/years), significantly higher than Champion (12.1%), Lenetah (11.9%), and Lyon (12.5%), and significantly lower than Meresse (15.1%) (Table 4). Comparisons to other commonly grown varieties can be seen in Table 4.

   In our WSU barley breeding trials from 2013 to 2014, Havener has shown an average β-glucan content 36, 38, 35, 34, 31 and 5% higher than Baronesse, Champion, CDC Copeland, Lenetah, Muir and Meresse, respectively (Table 5).

4. **Stripe rust:** Havener has been shown to be moderately susceptible to stripe rust, similar to Meresse. In 2013, barley stripe rust was low and not uniform at all locations it was tested. Barley leaf rust caused by *Puccinia hordei* was very severe at Mount Vernon and therefore no reliable stripe rust data is available for 2013. For barley leaf rust, Havener was shown to have 60% infection, similar to Harrington, CDC Copeland, and CDC Meredith, and less than Champion (80%), Meresse (80%), Bob (90%), AC Metcalfe (80%), Tradition (100%), and Lenetah (80%). Lyon and Baronesse both had 20% leaf rust infection, and Muir had 10% leaf rust infection.

   In 2014, both Havener and Meresse were given a field summary designation of moderately susceptible (MS) to stripe rust, similar to Lyon, AC Metcalfe, Harrington, and Lenetah (Table 6).

Weaknesses: Havener is moderately susceptible to stripe rust similar to Meresse, Lyon, AC Metcalfe, Harrington, and Lenetah. Despite this susceptibility, Havener shows high yield potential for a hulless variety. Though Havener has not suffered major yield decreases due to stripe rust, it is possible this could occur if stripe rust becomes a major problem for barley on the Palouse.

Where did the name come from? Havener is named in honor of Robert and Elizabeth Havener, long-time champions in the effort to eradicate hunger and malnutrition worldwide.

II. ORGANIC VARIETY AND BREEDING LINE TRIALS

Breeding trials were conducted on two organic farms, Finnriver Farm in Chimacum, WA and Harvest Ridge Farm in Lewiston, ID, from 2014 to 2015. Data is also presented here for the organic breeding trials in 2013 at Finnriver Farm. Five breeding lines in particular stood out in the Finnriver trials: X07G12-T111, X06G03-T218, X05013-T151, X05013-T267, and X05013-T273 (Tables 7-9).These five, along with several other promising lines, are currently being considered for expanded variety trials in western

Washington, as well as for potential variety and/or germplasm release for organic farmers in this region. These and other lines are presently in the field again for testing at Finnriver Farm. Seven lines are being considered for germplasm and/or variety release resulting from the Harvest Ridge trials, including: X05013-T151, X06G03-T24, 10WA-117.17, 10WA-118.13, X05013-T273, X07G25-T41, and X05013-T267 (Tables 10-11). Both X05013-T267 and X05013-T273 performed extremely well in terms of yield and agronomic capacity in both organic trial locations.

OUTREACH

We have disseminated the results of our research through numerous field days and farm tours, print materials (see Figure 1 for an example), and a poster presentation. Multiple tours of barley breeding plots were given during the 2014 and 2015 growing seasons. Tours were targeted toward growers, students and other interested stakeholders. Havener barley has been served as the key ingredient in a Clif Bar sponsored dinner highlighting the relationship between plant breeders, chefs, and eaters (Figure 2).

Field Days

Field days with an emphasis on hulless food barley were conducted at nine locations in 2014 (Harvest Ridge Farm, Fairfield, Almira, Mayview, Mount Vernon, Farmington, St. John, Lamont and Pullman) and four locations in 2015 (Lamont, St. John, Farmington, and Pullman).

Presentations

Presentations were delivered at the following conferences and/or to the following groups: Northwest Center for Alternatives to Pesticides, the Greater Spokane Incorporated Agribusiness Council, the Pacific Northwest Organic Plant Breeding Symposium, the Berkeley Food Institute, SOLIBAM Congress (Nantes, France), the Washington State Crop Improvement Association, the Organic Seed Growers Conference, and the Texas A&M Plant Breeding Symposium.

Table 1. Havener compared to Baronesse in breeder trials at Spillman Farm in Pullman in 2010, 2011 and 2012. Grain yield (g/plot), test weight (lb/bu), and protein (%) are shown for each genotype.

Year	Grain Yield		Test Weight		Protein	
	Havener	Baronesse	Havener	Baronesse	Havener	Baronesse
2010	3919	4261	62.6*	53.9	na	na
2011	4626	4593	61.0*	54.4	9.07	9.83
2012	4067	4262	60.2*	52.7	10.27	9.47

*Denotes significant difference (P=0.10)

Table 2. Two-year average (2013-2014) Variety Testing data by location for grain yield (lbs/a). 14 site years total.

Variety	High rainfall				Intermediate rainfall						Low rainfall		
	Fairfield	Farmington	Pullman	**Average**	Reardon*	Dayton	St. John	Walla Walla±	Mayview±	**Average**	Almira±	Lamont*	**Average**
Havener	3280	4080	3800	**3718**	1250	3200	4040	4570	3200	**3490**	3360	1650	**2506**
Meresse	2770	3620	3630	**3340**	930	2900	3450	4070	3070	**3163**	3190	1320	**2251**
CV (%)	11	9	8	**9**	14	8	9	8	5	**8**	7	13	**10**
Lsd (p=0.10)	290	320	260	**165**	190	190	280	460	170	**137**	290	290	**202**

*2014 data only. ±2013 data only.

Table 3. Two-year average (2013-2014) Variety Testing data for heading date (Julian) and plant height (inches) of 09WA-265.5, Meresse and Baronesse.

Variety	High rainfall		Intermediate rainfall		Low rainfall	
	Heading date	Plant height	Heading date	Plant height	Heading date	Plant height
Havener	180	36	168.5	28	172	27
Meresse	177	33	166.5	26	168	25
Baronesse	181	36	166.5	27	172	25

Table 4. Two-year (2013-2014) Variety Testing Summary across three rainfall zones for test weight (lbs/bu), and protein (%). High rainfall (>20”), intermediate rainfall (16-20”), and low rainfall (<16”) data were included.

Variety	High Rainfall Zone (6 loc/yrs)		Intermediate Rainfall Zone (6 loc/yrs)		Low Rainfall Zone (2 loc/yrs)	
	TW	Protein	TW	Protein	TW	Protein
Havener	57.5	13.4	58.8	13.1	58.7	13.9
Meresse	54.7	15.1	56.0	15.1	55.6	15.2
Lenetah	51.6	11.8	52.0	11.7	52.2	12.3
Muir	51.3	12.6	51.3	12.4	51.7	12.7
Lyon	50.9	12.1	51.4	12.6	51.8	12.8
Champion	52.6	12.1	52.9	11.8	53.7	12.4
CDC Copeland	49.3	12.0	50.0	12.0	50.0	12.9
Baronesse	50.8	12.5	51.4	12.5	50.6	13.6
CV (%)	2.5	5.3	1.6	5.1	2.1	6.2
Lsd (0.10)	0.5	0.3	0.3	0.3	0.8	0.6

Table 5. Two-year (2013-2014) data (4 location years) for β-glucan content, with control varieties shown as % β-glucan content of 09WA-265.5.

Variety	**% β-glucan of 09WA-265.5**
Havener	100%
Baronesse	64%
Champion	62%
CDC Copeland	65%
Lenetah	66%
Muir	69%
Meresse	95%

Table 6. 2014 stripe rust readings, including infection type (IT) and percent (%) on cultivars, including Havener(in red, below) at the following locations: Spillman Farm near Pullman (LOC 1); Plant Pathology Farm near Pullman (LOC 3); Whitlow Farm near Pullman (LOC 4); Northwestern Research and Extension Center in Mount Vernon (LOC 5). A field summary and overall rating were also assessed for each cultivar.

Variety	LOC1		LOC3		LOC4		LOC5				Field Summary	Overall Rating
	7/7		7/2		7/9		6/4		7/9			
	Milk		E. Milk		Stem elongation		Seedling		Milk			
	IT	%	IT	%	IT	%	IT	%	IT	%		
Havener	8	10	8	2	8	10	2	10	0	0	MS	6
Meresse	8	10	8	2	8	5	2	5	0	0	MS	6
CDC Copeland	8	30	5	5	8	5	2	10	0	0	S	9
CDC Meredith	8	20	8	2	8	1	2	5	0	0	S	8
AC Metcalfe	8	10	2	1	2	1	2	5	0	0	MS	6
Tradition	8	20	8	2	8	10	8	5	0	0	S	8
Lyon	8	10	8	2	8	1	2	5	0	0	MS	6
Muir	2	1	2	1	2	1	2	2	0	0	R	1
Champion	8	5	8	2	8	5	2	2	0	0	MR	4
Baronesse	8	5	8	2	8	2	2	2	0	0	MR	4
Bob	8	2	2	1	2	1	2	5	0	0	MR	3
Harrington	8	10	5	2	8	2	2	2	0	0	MS	6
Lenetah	8	10	8	2	8	5	2	5	0	0	MS	6

Table 7. 2013 Organic variety trial at Finnriver Farm in Chimacum, WA.

Variety / Breeding Line	Pedigree	Test weight (lb/bu)	Yield (g/plot)
Clearwater	Baronesse*2/pmut882//HB317 (CDC Dawn sib)	50.3	1186
Meresse	Merlin/Baronesse (WPB-BZ-594-35)	26.0	523
Champion	Baronesse/Camas	52.0	1044
Transit	10 / Azhul // HB340	48.5	1227
X05056-T110	WA 9820-98/SH 97110	63.0	817
10WA-130.5	CDC Candle/CDC Alamo	50.1	1156
09WA-265.12	01WA-13862.3/Radiant (X04041-T32)//01WA-13862.3/Radiant	49.4	865
10WA-121.6	CDC Alamo/Merlin	44.0	880
10WA-121.5	CDC Alamo/Merlin	49.2	1233
10WA-130.8	CDC Candle/CDC Alamo	50.0	1887
X06G03-T218	Merlin/Baronesse*2//SH 97110/3/02WNZ-1015	48.0	1488
X07G30-T63	Merlin/Baronesse*2//WA 9820-98/3/03WA-139.4 (X06G07)/3/01WA-13862.3/Radiant (X04041-T34)	50.3	1135
X06G03-T148	Merlin/Baronesse*2//SH 97110/3/02WNZ-1015	51.0	1156
X0626-T229	WA 9820-98/Meresse	52.4	1168
09WA-265.14	01WA-13862.3/Radiant (X04041-T32)//01WA-13862.3/Radiant (X04041-T34)	52.2	1267
X05013-T44	Merlin/Baronesse*2//SH 97110	51.0	1174
X07G26-T35	02WNZ-1015//Bob/03WNZ-249 (X06G01)/3/Pmut-422H/CDC Candle (05WA-344.1)	65.2	1124
X05013-T151	Merlin/Baronesse*2//SH 97110	54.4	1029
X06G11-T90	WA 9820-98/CDC Candle//Radiant/CDC Candle	53.4	1076
X07G31-T120	Radiant/Baronesse/3/WA 10701-99//Baronesse/Harrington (X06G10)/4/Pmut-422H/CDC Candle (05WA-344.1)	67.3	817
X07G12-T111	Radiant//Pmut-422H/CDC Candle (05WA-344.1)	52.6	1667
10WA-130.4	CDC Candle/CDC Alamo	56.9	939
X06G03-T99	Merlin/Baronesse*2//SH 97110/3/02WNZ-1015	51.3	1146
X07G18-T116	01WA-13862.3/Radiant (X04041-T32)/3/Merlin/Baronesse*2//WA 9820-98/3/03WA-139.4	50.0	1050
10WA-121.3	CDC Alamo/Merlin	47.7	1180
10WA-122.10	CDC Candle/WPB-BZ-594-35	53.6	1069
09WA-266.3	01WA-13862.3/Radiant (X04041-T86)//01WA-12501.2/Radiant (X04055-T21)	30.8	820
X05013-T267	Merlin/Baronesse*2//SH 97110	45.0	945
10WA-127.9	HB 335/WPB-BZ-594-35	62.5	1029
10WA-121.7	CDC Alamo/Merlin	50.4	1242
10WA-130.7	CDC Candle/CDC Alamo	47.7	1198
10WA-114.7	SH 97165/Merlin	46.5	969
X06G03-T24	Merlin/Baronesse*2//SH 97110/3/02WNZ-1015	51.5	1073
10WA-107.8	CDC Candle/Merlin	50.7	785
10WA-127.10	HB 335/WPB-BZ-594-35	51.3	1179
10WA-121.2	CDC Alamo/Merlin	52.7	940
X07G25-T41	Pmut-422H/CDC Candle (05WA-344.1) /4/Radiant/ Baronesse/3/WA 10701-99//Baronesse/Harrington (X06G10)	50.5	1139
X07G30-T131	Merlin/Baronesse*2//WA 9820-98/3/03WA-139.4 (X06G07)/3/01WA-13862.3/Radiant (X04041-T34)	50.5	1244
X05013-T273	Merlin/Baronesse*2//SH 97110	49.4	1165
10WA-107.3	CDC Candle/Merlin	52.0	1139

Table 8. 2014 Organic ariety trial at Finnriver Farm in Chimacum, WA.

Variety / Breeding Line	Test weight (lb/bu)	Yield (g/plot)	Yield (lb/acre)	Plump Kernels (%)	Protein Content (%)
09WA-265.12	57.4	3012.3	3614.7	94.7	12.6
09WA-266.3	57.3	3600.7	4320.7	93.7	14.1
10WA-101.13	51.1	3466.0	4159.3	96.7	14.3
10WA-101.24	51.6	4075.7	4890.7	98.3	12.4
10WA-107.8	51.8	3575.7	4291.0	94.7	13.7
10WA-109.18	54.0	2819.0	3382.7	95.3	14.0
10WA-109.6	56.4	3025.3	3630.3	90.3	14.2
10WA-117.17	50.7	3531.3	4237.7	97.3	12.3
10WA-118.13	54.4	3137.3	3764.7	94.3	14.9
10WA-118.16	58.5	2636.0	3163.3	89.3	14.7
10WA-118.7	56.0	3328.3	3994.0	94.0	14.0
10WA-120.4	51.4	3904.3	4685.3	98.7	13.2
10WA-121.3	52.4	2927.3	3512.7	96.3	16.4
10WA-122.12	56.3	3064.3	3677.0	88.7	14.4
10WA-122.9	57.4	2750.0	3299.7	78.0	14.8
10WA-127.10	58.5	3164.3	3797.0	92.7	14.4
10WA-127.11	58.7	2993.0	3591.3	84.3	14.6
10WA-127.9	57.4	3561.7	4274.0	83.7	14.4
10WA-129.7	54.1	2748.7	3298.3	83.7	15.1
10WA-130.5	57.3	2980.7	3577.0	86.3	15.3
11WA-114.5	51.4	2431.3	2917.7	74.0	14.6
Champion	51.2	4104.0	4925.0	98.3	12.2
Meresse	55.3	3347.0	4016.3	95.7	14.0
Transit	52.2	2902.3	3482.7	96.3	14.8
X05013-T151	50.9	3707.0	4448.3	99.0	14.3
X05013-T267	50.2	3416.7	4100.0	99.0	14.2
X05013-T273	50.9	3417.3	4100.7	98.7	13.1
X05013-T44	56.4	3481.7	4178.3	96.3	14.4
X05056-T110	58.4	2075.7	2491.0	94.7	16.9
X0626-T229	56.5	3073.3	3688.0	94.3	15.7
X06G03-T218	51.4	4374.0	5248.7	97.3	12.2
X06G03-T24	51.4	3475.3	4170.0	98.3	13.2
X06G03-T99	50.6	3676.7	4411.7	93.7	12.5
X06G11-T90	56.3	3063.3	3675.7	92.3	14.9
X07G12-T111	50.9	4362.3	5234.7	94.7	12.2
X07G18-T116	54.2	3545.7	4254.7	95.7	14.1
X07G25-T41	51.4	3855.7	4626.7	95.0	13.9
X07G25-T70	50.5	3338.3	4006.0	93.3	12.9
X07G30-T63	55.9	2624.3	3149.3	88.3	15.2
X07G31-T120	55.1	2770.0	3324.3	89.0	14.0

Table 9. 2015 Organic variety trial at Finnriver Farm in Chimacum, WA.

Variety / Breeding Line	Test weight (lb/bu)	Yield (g/plot)	Yield (lb/acre)	Plump Kernels (%)	Protein Content (%)	Plant Height (in)	Heading Date
09WA-265.12	45.1	1735	2082	40	16.7	28.5	174
09WA-266.3	39.8	1773	2128	61	17.9	29	164
10WA-101.13	48.7	1148	1378	79	19.1	27	164
10WA-101.24	48.8	1885	2262	63	15.4	28	170
10WA-107.8	42.5	1767	2120	39	17.2	27.5	167
10WA-109.18	49.5	1615	1938	65	16.2	27.5	164
10WA-109.6	46.5	1428	1714	44	16.5	26	170
10WA-117.17	47.9	1766	2119	63	16.9	23.5	171
10WA-118.13	42.7	1820	2184	68	17.8	24	162
10WA-118.16	44.4	1747	2096	35	17.3	25.5	165
10WA-118.7	44.8	1736	2083	49	16.8	26	163
10WA-120.4	47.7	1901	2281	59	16.9	26.5	163
10WA-121.3	44.2	1564	1877	44	17.6	26.5	165
10WA-122.12	45.6	1433	1720	66	20.5	24.5	168
10WA-122.9	44.9	1657	1988	31	18	29	170
10WA-127.10	46.7	1503	1804	42	16.8	24	165
10WA-127.11	47.9	1666	1999	32	17.4	26.5	163
10WA-127.9	49.5	1875	2250	35	17.2	28.5	163
10WA-129.7	46.9	1409	1691	36	18.7	25	170
10WA-130.5	46.2	1355	1626	49	18	28	170
11WA-114.5	51.2	1026	1231	33	20.5	21	173
Champion	49.4	2338	2806	69	16.8	30	162
Meresse	45.8	1756	2107	81	18.4	27	163
Transit	45.1	719	863	44	22	26.5	170
X05013-T151	47.3	1972	2366	73	17.11	26.5	162
X05013-T267	46.5	2065	2478	69	15.9	29	162
X05013-T273	48	2033	2440	68	15.6	28.5	170
X05013-T44	49.4	1588	1906	57	18.8	26.5	164
X05056-T110	46.6	1635	1962	66	18.4	30.5	162
X0626-T229	41.8	1583	1900	52	16.5	27.5	163
X06G03-T218	47.9	1722	2066	76	17.8	23.5	164
X06G03-T24	53.3	1881	2257	45	15.3	26.5	165
X06G03-T99	44.7	1777	2132	31	15.7	23	170
X06G11-T90	43.7	1490	1788	60	18	25	162
X07G12-T111	47	1921	2305	52	16.8	28.5	168
X07G18-T116	40.6	1289	1547	49	16.5	27	170
X07G25-T41	46.8	1661	1993	51	18.3	28	164
X07G25-T70	44.2	1463	1756	22	17.8	26.5	164
X07G30-T63	50.7	1248	1498	40	19.2	25.5	165
X07G31-T120	44.6	1883	2260	43	17.4	26	163

Table 10. 2014 Organic variety trial at Harvest Ridge Farm in Lewiston, ID.

Variety / Breeding Line	Test weight (lb/bu)	Yield (g/plot)	Yield (lb/acre)	Plump Kernels (%)	Protein Content (%)
09WA-265.12	54.4	1290.7	1548.7	42.0	16.8
09WA-266.3	51.7	1394.3	1673.0	29.0	18.3
10WA-101.13	51.9	1462.3	1755.0	80.3	16.7
10WA-101.24	51.6	1451.0	1741.3	76.7	17.7
10WA-107.8	51.9	1129.3	1355.3	31.7	19.0
10WA-109.18	57.3	1455.0	1746.0	61.7	15.8
10WA-109.6	41.5	643.0	771.7	51.7	18.7
10WA-117.17	52.6	2126.7	2552.3	74.0	13.2
10WA-118.13	46.3	1232.7	1479.0	39.3	16.8
10WA-118.16	43.3	731.7	878.3	13.7	14.9
10WA-118.7	53.2	1131.0	1357.3	31.7	18.8
10WA-120.4	52.2	1579.3	1895.3	61.3	14.3
10WA-121.3	51.5	1563.0	1875.7	44.0	18.5
10WA-122.12	56.3	1629.3	1955.3	32.3	17.3
10WA-122.9	60.0	1278.7	1534.3	33.0	15.2
10WA-127.10	59.1	1585.7	1902.7	46.7	16.8
10WA-127.11	45.9	943.0	1131.7	7.3	19.3
10WA-127.9	55.5	982.3	1178.7	34.3	16.8
10WA-129.7	55.7	1320.7	1585.0	12.3	20.7
10WA-130.5	45.1	680.7	817.0	18.0	20.9
11WA-114.5	58.4	1209.7	1451.7	31.0	19.5
Champion	51.8	1493.0	1791.7	55.0	15.6
Meresse	47.8	941.3	1130.0	35.7	16.2
Transit	74.9	625.3	750.7	43.3	20.4
X05013-T151	51.1	1723.3	2068.3	73.7	17.5
X05013-T267	48.8	1579.7	1895.7	42.0	17.8
X05013-T273	51.0	1512.3	1815.0	63.0	17.9
X05013-T44	59.6	969.3	1163.3	56.0	19.4
X05056-T110	61.2	933.7	1120.3	36.7	19.3
X0626-T229	47.6	944.0	1132.7	22.7	18.0
X06G03-T218	51.6	1122.0	1346.7	65.0	18.0
X06G03-T24	50.3	1681.3	2017.7	61.0	16.8
X06G03-T99	49.7	1325.3	1590.3	44.0	18.5
X06G11-T90	53.4	1427.7	1713.3	23.3	17.5
X07G12-T111	56.4	922.3	1107.0	43.3	17.4
X07G18-T116	46.9	1053.3	1264.0	30.0	17.3
X07G25-T41	49.8	1488.7	1786.3	49.0	17.9
X07G25-T70	49.5	1460.7	1753.0	45.3	16.0
X07G30-T63	58.0	1230.7	1476.7	37.3	20.6
X07G31-T120	51.6	1576.0	1891.3	15.7	18.2

Table 11. 2015 Organic variety trial at Harvest Ridge Farm in Lewiston, ID.

Variety / Breeding Line	Test weight (lb/bu)	Yield (g/plot)	Yield (lb/acre)	Plump Kernels (%)	Protein Content (%)	Plant Height (in)	Heading Date
10WA-109.18	30.4	734.25	881.5	29.5	16.85	29	157
10WA-117.17	43.325	1341.5	1609.75	37	14.775	28.5	157.5
X05013-T151	43.75	1773.25	2128	29.75	17.7	27.5	157
X06G03-T24	40.25	1381	1657.25	10.5	17.1	27.125	156.5
10WA-122.12	43.05	1171.5	1406	9	18.175	28.25	156.25
10WA-127.10	46.775	1153.75	1384.5	18	16.925	27.375	156.25
X05013-T267	43.025	1637	1964.25	52.25	15.875	25.125	156.75
10WA-120.4	41.725	1477.5	1772.75	44.5	16.575	24.375	156.25
X07G31-T120	39.25	1062.25	1275	23.25	18.2	28.375	156.25
10WA-121.3	42.4	1363	1635.25	42.75	16.4	28.625	157.25
X05013-T273	42.2	1509.5	1811.75	24	17.3	28.125	156.25
X07G25-T41	41.5	1456.5	1747.75	21.5	17.275	28.625	156.25
X0626-T229	39.7	1416	1699.25	9.5	17.85	26.375	155
X05056-T110	50.825	1321	1585	24.75	17.5	30.875	155.5
10WA-107.8	41.75	1424	1709	17.5	17.175	29.25	156.25
10WA-118.13	39.55	1445.5	1734.5	23.25	17.5	24.625	156.25
10WA-130.5	45.55	1108.5	1330	20.5	18.3	30.125	156.5
Transit	42.975	938	1125.5	23.5	11.35	33.375	157
Meresse	43.85	1101	1321	28.25	17.075	26.75	157
Champion	42.35	1410.75	1693	7.25	15.65	29.125	156.5

FIGURES

Figure 1. A spring 2-row barley variety, 'Havener', was released in 2015. As quoted in the information card below "Havener, developed specifically for human consumption, contains 50 to 75% higher β-glucan (a heart healthy soluble dietary fiber) than common Washington-grown varieties Lyon, Muir, Champion, Bob, and Baronesse. Havener has higher yields and test weights across all eastern Washington rainfall zones than the hulless variety Meresse."

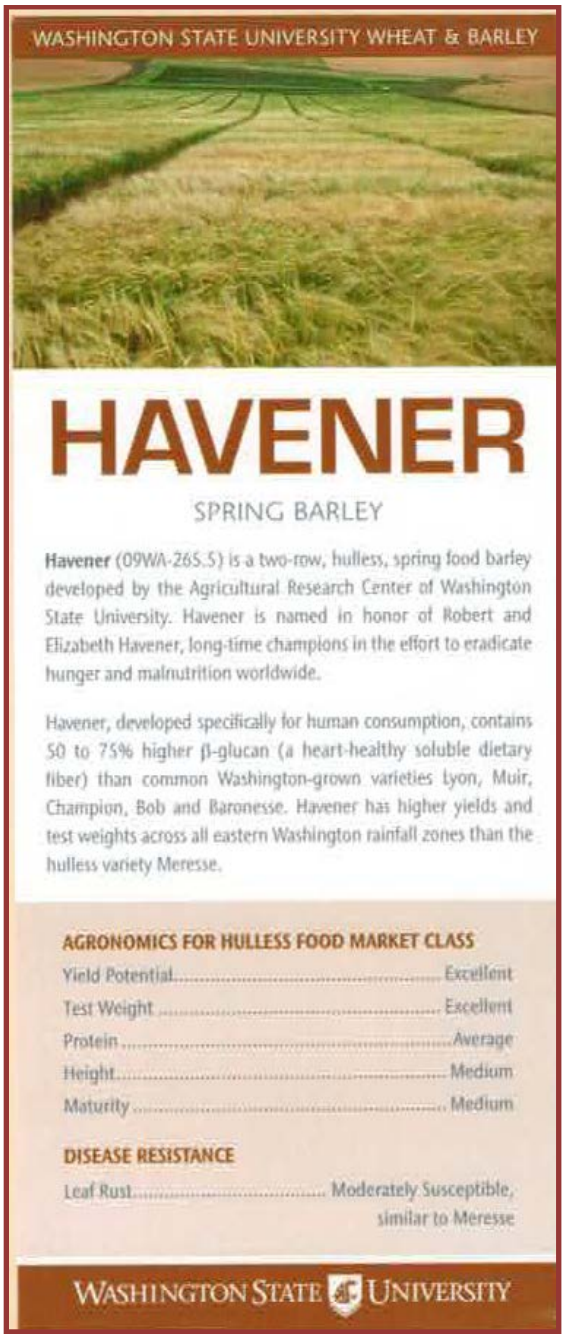
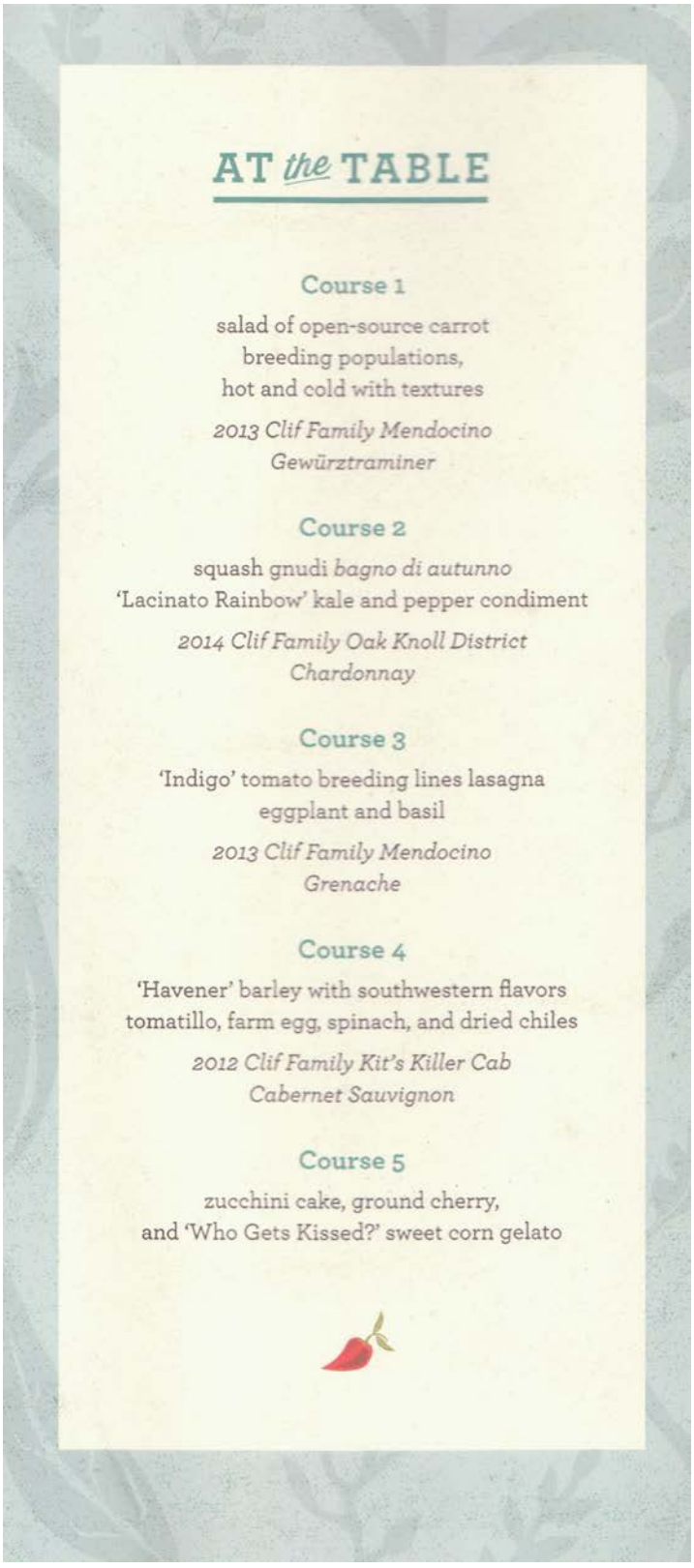


Figure 2. Havener barley highlighted in Course 4 of a Clif Bar sponsored 'plant breeder – chef –eater' inspired dinner.



AT *the* TABLE

Course 1

salad of open-source carrot
breeding populations,
hot and cold with textures

2013 Clif Family Mendocino
Gewürztraminer

Course 2

squash gnudi *bagno di autunno*
'Lacinato Rainbow' kale and pepper condiment

2014 Clif Family Oak Knoll District
Chardonnay

Course 3

'Indigo' tomato breeding lines lasagna
eggplant and basil

2013 Clif Family Mendocino
Grenache

Course 4

'Havener' barley with southwestern flavors
tomatillo, farm egg, spinach, and dried chiles

2012 Clif Family Kit's Killer Cab
Cabernet Sauvignon

Course 5

zucchini cake, ground cherry,
and 'Who Gets Kissed?' sweet corn gelato