DEVELOPMENT OF MAIZE INBREDS, HYBRIDS, AND ENHANCED GEM BREEDING POPULATIONS FOR SUPERIOR SILAGE, BIOFEEDSTOCK YIELD, AND COMPOSITIONAL ATTRIBUTES

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Overview:

Corn silage production is the second most important use of corn in the U.S. after grain production. In 2009, approximately 6.6% of the 34.5 million hectares of corn harvested in the U.S. in 2009 were dedicated to silage. Although, the overall number of hectares harvested for corn in the U.S. increased slightly from 2008 (34.2 million hectares), the proportion of those hectares dedicated to silage nationwide has decreased from 7.1% in 2008 (USDA, 2010).

Wisconsin is the major silage-producing state in the U.S. with approximately 345 thousand hectares harvested in 2009. This represents approximately 15% of the total number of corn hectares harvested for silage in the U.S. and approximately 22.5% of the area harvested in the state of Wisconsin in 2009 (USDA, 2010).

In the early 1990's, motivated by the realization of the substantial economic and nutritional benefits of improving forage quality, primarily corn for silage, the University of Wisconsin (UW) Corn Silage Breeding Program was initiated to enhance both nutritional value and forage yield of corn. This was the first corn silage breeding program in the U.S. focused on the development of corn varieties for biomass production, currently used for animal feed and this program remains the only public program of its kind in the country. The UW Corn Silage Breeding Program has been incorporating new sources of germplasm from the GEM project for a number of years as a means to enhance primarily forage yield but also compositional quality of the materials generated.

The biomass quality properties of corn required for animal nutrition have been found to be parallel to the desired traits to be selected for corn to be used as a feedstock for energy bioconversion. Therefore, the high forage yield and highly fermentable cell wall carbohydrate composition of the populations and crosses involving germplasm developed by the UW Corn Silage Breeding Program have shown promise for developing lignocellulosic biofeedstocks for ethanol production.

In 2010, The UW Corn Silage Breeding Program continued to evaluate silage yield and nutritive value of the most productive GEM crosses identified in grain yield evaluations conducted over the past several years by the GEM project throughout the U.S. Corn Belt. If any of these crosses have high dry matter yield and good nutritional quality in our UW trials, the respective GEM parent or breeding population is included in the UW inbred development nursery for further inbreeding and selection. The 2010 trials focused primarily on first testing of some new GEM populations as well as the advancement and re-testing of different GEM materials.

2010 Field Trials:

Six trials involving GEM materials (AR16026, DK212T_2888, GEM0175, GEM0176, GEM0183 and GUAT209) and one involving lines derived from GQS C0 were planted in 2010 at two WI locations, Madison (May 6th and 10th) and Arlington (May 20th and 24th). Trials were planted in triplicates in each of the locations with an average planting density of 32,800 plants/acre. Temperatures throughout the spring and summer were above average for our area. A rapid accumulation of growing degree days was noted throughout the season. No major lodging problems were observed this year. Due to mechanical malfunctions, significant delays occurred during harvesting primarily for the Arlington location. Advancement decisions were done using primarily the West Madison yield and dry matter data. Highlights listed below are based solely on West Madison data.

AR16026

Trial **AR16026** consisted of the silage re-evaluation of seven advanced inbred lines from the GEM program derived from the AR16026:S1719-052-2-B-B-B population testcrossed by Holdens tester LH287 and UW line W604S. Eleven different hybrids (including commercial and internal) were also included as checks (Table 1).

AR16026 highlights (Table 1): Of the 7 hybrids evaluated (in combination with two testers), the forage yield of five of those crossed by W604S and three crossed by LH287 exceeded the average yield of the checks excluding F2F633 (9.10 tons/acre). Dry matter content was acceptable (~35%) for this trial. Hybrids produced using the W604S tended to produce higher yielding hybrids compared to LH287. Quality evaluation will be performed for 8 of the 14 hybrids evaluated for yield. After quality evaluation analysis is completed, decisions will be made as to which lines from AR16026 might be publicly released. It is worthwhile noting that the highest yielding check of this trial was W605S x LH244. Inbred W605S was released by the UW Corn Silage Breeding program in 2004 and was developed from the GEM breeding population AR17026:N1019. Also, other GEM derived lines such as W606S (derived from GEM population SCRO1:N1310-398-1-B), W607S (derived from GEM population BR52051:N04-76-1-B-B) and W609S (derived from GEM population FS8B(T):N11a-322-1-B-B) were among the highest yield hybrids in the trial. These lines, as well as W608S (derived from GEM population CHO5015:N15-8-1-B-B) and W610S (derived from GEM population CUBA164:S2012-235-1-B) have been released through the Wisconsin Alumni Research Foundation and are being distributed to interested parties.

DK212T_888

Trial **DK212T_888** consisted of the silage evaluation of advanced inbred lines from the GEM program derived from DK212T:N11a12-122-1-B-B and DK888:N11a08a:440-001-B. This included 17 inbreds from DK888 and eight inbreds from DK212T, each crossed to Holdens' tester LH244. Eleven different hybrids (including commercial and internal) were also included as checks (Table 2).

DK212T_888 highlights (Table 2): Of the 25 hybrids evaluated, the forage yield of eight DK888 and four DK212T exceeded the average of the experimental crossed, which was higher than the average of the checks as well as the average of the trial. Maturity appears to be an issue with some of these hybrids. Quality evaluation will be performed for 12 of the 25 hybrids evaluated for yield in this trial to determine merit for public release.

GEM0175

Trial **GEM0175** consisted of the first silage evaluation of 15 inbred lines from the GEM program derived from the GEM0175 population testcrossed by Holdens tester LH287. Ten different hybrids (including commercial and internal) were also included as checks (Table 3).

GEM0175 highlights (Table 3): Of the 15 hybrids evaluated, the forage yield of only four of those crosses exceeded the average yield of the trial (8.10 tons/acre) and none of them exceeded the average of the checks excluding F2F633. Dry matter content was acceptable (~35%) for this trial. Quality evaluation will be performed for four of the 15 hybrids evaluated for yield. After quality evaluation analysis is completed, decisions will be made as to which lines from GEM0175 will be further advanced.

GEM0176

Trial **GEM0176** consisted of the first silage evaluation of 15 inbred lines from the GEM program derived from the GEM0176 population testcrossed by Holdens tester LH287. Ten different hybrids (including commercial and internal) were also included as checks (Table 4).

GEM0176 highlights (Table 4): Of the 15 hybrids evaluated, the forage yield of six of those crosses exceeded the average yield of the trial (8.10 tons/acre) and two of them exceeded the average of the checks excluding F2F633. Dry matter content was a bit below ideal (~35%) for this trial, but checks also were a bit wetter than anticipated. Quality evaluation will be performed for four of the 15 hybrids evaluated for yield. After quality evaluation analysis is completed, decisions will be made as to which lines from GEM0176 will be further advanced.

GEM0183_0184

Trial **GEM0183_0184** consisted of the first silage evaluation of ten inbred lines derived from the GEM0184 and 15 inbred lines derived from the GEM0183 populations testcrossed by Holdens tester LH287. Ten different hybrids (including commercial and internal) were also included as checks (Table 5).

GEM0183_0184 highlights (Table 5): Of the ten GEM0184 hybrids evaluated, the forage yield of only two those crosses exceeded the average yield of the trial (7.8 tons/acre) and only one of them exceeded the average of the checks excluding F2F633. For the GEM0183 crosses, 10 of them exceeded the mean of the trial and three of them exceeding the checks excluding F2F633. Dry matter content

was a bit below ideal (~35%) for this trial primarily for the GEM0184 crosses, but checks also were a bit wetter than anticipated. Quality evaluation will be performed for 12 of the 25 hybrids evaluated for yield. After quality evaluation analysis is completed, decisions will be made as to which lines from GEM0183_0184 will be further advanced.

GUAT209

Trial **GUAT209** consisted of the silage re-testing of 17 inbred lines derived from population GUAT209:S1308a-135-001-B and one inbred line derived from population GUAT209:S1308a-013-001-B crossed to Holdens' tester LH287. Ten different hybrids (including commercial and internal) were also included as checks (Table 6).

GUAT209 highlights (Table 6): Thirteen of the 17 GUAT209 hybrids evaluated in this trial exceeded the average forage yield of the trial which was numerically equal to the average of the checks without including F2F633 (9.0 tons/acre). The percentage dry matter content for the GUAT209 testcrosses was well within the ideal conditions for our area (>35%) but below the average of the checks for this trial excluding F2F633. Quality evaluation will be performed for 13 of the 17 hybrids in this trial to determine merit for further evaluation.

09GQSC0

In 2005, a new breeding population derived from GEM-derived sources of germplasm was initiated. This population is designated the GEM Quality Synthetic (GQS). GQS is approximately 75% Stiff Stalk. The aim is to create inbred lines from GQS that produce silage hybrids with high forage yield as well as superior nutritional quality when crossed to inbred lines from our non-Stiff Stalk Wisconsin Quality Synthetic (WQS) breeding population. Trial **GQSC0** consisted of the silage evaluation of 16 advanced inbred lines from the GQS C0 population crossed to Holdens' tester LH287 and W604S, for a total of 32 entries in this trial. Twelve different hybrids (including commercial and internal) were also included as checks (Table7).

GQSC0 highlights (Table 7): Twenty of the 32 GQS C0 hybrids evaluated in this trial exceeded the average forage yield of the trial (8.9 tons/acre) and 11 of them exceeded the average of the checks without including F2F633 (9.4 tons/acre). Thirteen of the 20 crosses that exceeded the trial average were crosses made by W604S. The percentage dry matter content for the GQS C0 testcrosses was well within the ranges observed for the checks. Quality evaluation will be performed for 20 of the 32 hybrids evaluated for yield in this trial to determine merit for public release.

Nutritional evaluations will include assessment of neutral detergent fiber (NDF), *in vitro* true digestibility (IVTD), *in vitro* NDF digestibility (IVNDFD), crude protein (CP), and starch concentration. Based on these values, milk/ton of forage and milk/acre will be estimated based on MILK2006, which uses forage composition (NDF, IVTD, IVNDFD, CP, and starch) to estimate potential milk production per ton of forage. Forage yield is then used to estimate potential milk per acre. Nutritional evaluation will be completed in approximately one month and the results posted on our web site.

2010 Nursery Activities:

The breeding population GQS is being advanced using a second generation (S_2) top-cross selection method. Briefly, inbreds derived from succeeding cycles of improvement are developed and released. Population improvement and inbred development occur simultaneously. S_2 families derived from GQS are initially screened for general agronomic adequacy and are then top-crossed to elite commercial lines from complementary heterotic groups during the following year. The following summer, top-crosses are grown to estimate forage yield and quality of whole-plant compositional characteristics such as fiber, digestibility, protein, and starch at silage harvesting time. Twenty S_2 families are selected based on a performance index (MILK2006) that comprises silage yield and compositional quality.

During summer 2007 the top 20 selected families from Cycle 0 (GQS C0) of this population were recombined to give rise to GQS C1. During the winter nursery of 2007/8 20 GQS HS families derived from the intermating process conducted in summer 2007 were sent to our winter nursery in Puerto Rico for selfing. At least 20 self-pollinations were conducted for each of the HS families. Ten S_1 families were derived from each of the 20 HS families. These approximately 200 S_1 families were planted in our summer nursery last year. Later this summer about half of these S_1 families were eliminated based on agronomic appearance. Three to four self-pollinations were done in each row, but only two ears were harvested from each row at the end of the season. This produced a total of 200 S_2 lines. These 200 S_2 lines were testcrossed in 2009 by inbred line W604S. A set of 201 lines were evaluated in a replicated trial at two locations (Madison and Arlington, WI) with two replications per location. From those a subset of the 34 highest forage yielding lines was sent to our winter nursery to be crossed by W604S. Two S_3 per family were included. Those 34 lines will also be analyzed for quality composition. The best 20 S_2 lines based on the quality evaluation will be recombined to form cycle 2 of the GQS population (GQS C2)

In our 2010 breeding nursery, nine GEM families (derived from DKXL370:N11a20-036-002-B wx, CUBA164:S2012-966-001-B wx, AR16021:S0908a-039-001-B-B, BR105:S1612-008-001-B-B, BR105:S1612-057-001-B-B, BR105:S1640-128-001-B-B, CUBA164:S2008dF44-012-001-B-B, FS8A(T):N1804-006-001-B-B, GUAD05:N3215-197-001-B-B) were self-pollinated for further advancement. Advanced lines from these populations will be further advanced and also crossed by appropriate testers in our 2011 summer nursery.

Advanced inbreds from families PASCO14:N0424-078-001-B-B, SCROGP3:N2017-003-001, SCROGP3:N2017-172-001, UR11002:N0308b-086-001, DKXL212:S0912-012-001, DKXL212:S0912-117-001 were sent to winter nursery for further advancement and to cross by appropriate tester for evaluation in our summer trials in 2011.

Table 1. Forage yield evaluation for AR16026 trial in 2010. Forage yield was evaluated at Madison and Arlington, WI. Entries marked with "*" will be analyzed for nutritional quality. Advancement decisions were made based solely on Madison data.

2010 EXPT AR16026								
		Madison		Arlington		Mean		For
		Dry		Dry		Dry		Quality
10No.	Entry	matter	Yield	matter	Yield	matter	Yield	Evaluation
		%	t/a	%	t/a	%	t/a	
1	AR16026:S1719-052-2-B-B-B-3-1-1-1 X LH287	35.1	9.4	58.9	6.7	47.0	8.1	*
2	AR16026:S1719-052-2-B-B-B-5-1-1-1 X LH287	37.0	8.9	64.5	6.7	50.8	7.8	
3	AR16026:S1719-052-2-B-B-B-9-1-1-1 X LH287	33.8	10.3	62.0	6.5	47.9	8.4	*
4	AR16026:S1719-052-2-B-B-B-13-1-1-1 X LH287	35.3	9.2	55.3	7.2	45.3	8.2	*
5	AR16026:S1719-052-2-B-B-B-15-1-1-1 X LH287	36.6	9.9	61.1	6.1	48.8	8.0	*
6	AR16026:S1719-052-2-B-B-B-20-1-1-1 X LH287	36.9	10.0	62.8	5.9	49.9	7.9	*
7	AR16026:S1719-052-2-B-B-B-22-1-1-1 X LH287	35.5	9.0	59.2	6.6	47.4	7.8	
8	AR16026:S1719-052-2-B-B-B-3-1-1-1 X W604S	36.0	9.3	57.8	6.1	46.9	7.7	*
9	AR16026:S1719-052-2-B-B-B-5-1-1-1 X W604S	.	.	.	.	.	.	
10	AR16026:S1719-052-2-B-B-B-9-1-1-1 X W604S	35.1	9.9	54.9	6.1	45.0	8.0	*
11	AR16026:S1719-052-2-B-B-B-13-1-1-1 X W604S	35.6	9.1	56.9	6.9	46.2	8.0	*
12	AR16026:S1719-052-2-B-B-B-15-1-1-1 X W604S	34.8	7.9	56.6	7.0	45.7	7.5	
13	AR16026:S1719-052-2-B-B-B-20-1-1-1 X W604S	36.4	6.9	61.6	6.1	49.0	6.5	
14	AR16026:S1719-052-2-B-B-B-22-1-1-1 X W604S	37.2	8.8	50.0	4.9	43.6	6.9	
15	W604S X LH244	45.8	7.9	58.1	6.6	52.0	7.2	
16	W605S X LH244	35.6	11.7	55.0	6.7	45.3	9.2	*
17	W611s X LH244	39.5	10.0	58.2	6.3	48.8	8.1	*
18	W610S X LH244	36.9	6.1	48.9	4.8	42.9	5.4	*
19	W606S X LH244	40.9	9.9	61.9	6.1	51.4	8.0	*
20	W607S X LH244	39.8	9.5	52.5	7.2	46.1	8.4	*
21	W609S X LH244	37.7	9.6	52.9	6.2	45.3	7.9	*
22	34R67	38.9	8.8	55.3	7.2	47.1	8.0	*
23	F2F633	34.5	7.3	53.5	5.6	44.0	6.5	*
24	N48V8	37.2	8.4	53.4	6.8	45.3	7.6	*
25	36H56	36.5	8.3	49.7	6.1	43.1	7.2	*
	Mean	37.02	9.00	56.71	6.35	46.87	7.67	
	CV (%)	3.96	10.02	5.57	14.07	5.26	11.70	
	LSD (0.05)	2.96	1.82	6.37	1.80	7.17	1.69	
	Mean of all AR16026 testcrosses	35.79	9.12	58.60	6.36	47.19	7.74	
	Mean of experimental entries for quality evaluation	35.56	9.64	58.72	6.42	47.14	8.03	
	Mean of checks (w/o F2633)	38.87	9.02	54.59	6.40	46.73	7.71	
	Entries marked with "*" will be analyzed for nutritional quality							

Table 2. Forage yield evaluation for DK212T_888 trial in 2010. Forage yield was evaluated at Madison and Arlington, WI. Entries marked with "*" will be analyzed for nutritional quality. Advancement decisions were made based solely on Madison data.

2010 EXPT DK212T_888								
		Madison		Arlington		Mean		For
		Dry		Dry		Dry		Quality
10No.	Entry	matter	Yield	matter	Yield	matter	Yield	Evaluation
		%	t/a	%	t/a	%	t/a	
1	DK212T:N11a12-122-1-B-B-3-1-1-B X LH244	36.8	10.3	52.3	6.0	44.5	8.1	*
2	DK212T:N11a12-122-1-B-B-3-2-1-B X LH244	37.0	11.7	51.1	6.5	44.1	9.1	*
3	DK212T:N11a12-122-1-B-B-7-1-1-B X LH244	38.0	8.4	58.6	6.0	48.3	7.2	
4	DK212T:N11a12-122-1-B-B-7-2-1-B X LH244	37.7	10.0	60.4	5.4	49.0	7.7	*
5	DK212T:N11a12-122-1-B-B-11-1-1-B X LH244	38.4	8.5	55.1	5.6	46.8	7.0	
6	DK212T:N11a12-122-1-B-B-13-1-1-B X LH244	38.6	11.9	55.5	6.1	47.0	9.0	*
7	DK212T:N11a12-122-1-B-B-16-2-1-B-1 X LH244	39.0	8.3	45.9	4.6	42.4	6.4	
8	DK212T:N11a12-122-1-B-B-17-1-1-B X LH244	46.5	9.3	56.7	4.8	51.6	7.0	
9	DK2888:N11a08a:440-001-B-3 X LH244	.	.	.	.	.	.	
10	DK2888:N11a08a:440-001-B-5 X LH244	.	.	.	.	.	.	
11	DK2888:N11a08a:440-001-B-7 X LH244	34.4	10.7	50.9	6.1	42.7	8.4	*
12	DK2888:N11a08a:440-001-B-9-2-1 X LH244	32.8	9.8	52.1	7.1	42.5	8.5	
13	DK2888:N11a08a:440-001-B-10-1-1 X LH244	34.0	10.3	50.5	7.0	42.2	8.7	*
14	DK2888:N11a08a:440-001-B-10-2-1 X LH244	35.4	9.9	53.5	6.1	44.4	8.0	
15	DK2888:N11a08a:440-001-B-11-1-2 X LH244	33.1	9.7	52.3	6.1	42.7	7.9	
16	DK2888:N11a08a:440-001-B-12-1-1 X LH244	32.9	10.9	50.1	7.1	41.5	9.0	*
17	DK2888:N11a08a:440-001-B-12-2-1 X LH244	36.3	10.5	53.6	7.2	44.9	8.8	*
18	DK2888:N11a08a:440-001-B-14-1-1 X LH244	34.0	9.9	53.7	6.8	43.9	8.4	
19	DK2888:N11a08a:440-001-B-14-2-1 X LH244	33.5	10.2	48.8	6.2	41.1	8.2	*
20	DK2888:N11a08a:440-001-B-15-2-2 X LH244	36.6	12.3	49.3	7.2	43.0	9.7	*
21	DK2888:N11a08a:440-001-B-17-1-2 X LH244	36.0	9.9	53.4	6.6	44.7	8.3	
22	DK2888:N11a08a:440-001-B-17-2-1 X LH244	33.6	9.5	50.4	6.6	42.0	8.0	
23	DK2888:N11a08a:440-001-B-19-1-1 X LH244	31.8	11.3	49.0	7.9	40.4	9.6	*
24	DK2888:N11a08a:440-001-B-19-2-1 X LH244	33.4	10.8	53.0	8.3	43.2	9.6	*
25	DK2888:N11a08a:440-001-B-20-1-1 X LH244	32.1	8.5	47.3	8.1	39.7	8.3	
26	W604S X LH244	48.0	5.4	50.7	4.5	49.4	4.9	*
27	W605S X LH244	36.2	11.0	45.0	5.8	40.6	8.4	*
28	W611s X LH244	41.3	9.8	51.4	6.3	46.3	8.1	*
29	W610S X LH244	35.3	6.0	52.3	3.8	43.8	4.9	*
30	W606S X LH244	41.9	9.8	55.2	5.5	48.5	7.7	*
31	W607S X LH244	38.2	10.0	49.8	6.6	44.0	8.3	*
32	W609S X LH244	39.6	9.9	54.1	5.4	46.9	7.7	*
33	34R67	36.6	9.0	47.4	5.4	42.0	7.2	*
34	F2F633	38.2	8.1	52.1	5.0	45.2	6.6	*
35	N48V8	37.9	9.5	51.2	5.1	44.5	7.3	*
36	36H56	35.2	7.4	46.7	4.8	41.0	6.1	*
	Mean	36.8	9.7	51.7	6.1	44.3	7.9	
	CV (%)	4.6	8.8	5.3	13.1	5.2	10.4	
	LSD (0.05)	3.4	1.7	5.5	1.6	5.7	1.4	
	Mean of all DK212T_888 testcrosses	35.7	10.1	52.3	6.5	44.0	8.3	
	Mean of experimental entries for quality evaluation	35.3	10.9	52.0	6.8	43.6	8.8	
	Mean of checks (w/o F2633)	39.0	8.8	50.4	5.3	44.7	7.1	
	Entries marked with "*" will be analyzed for nutritional quality							

Table 3. Forage yield evaluation for GEM0175 trial in 2010. Forage yield was evaluated at Madison and Arlington, WI. Entries marked with "*" will be analyzed for nutritional quality. Advancement decisions were made based solely on Madison data.

2010 EXPT GEM0175								
		Madison		Arlington		Mean		For
		Dry		Dry		Dry		Quality
10No.	Entry	matter	Yield	matter	Yield	matter	Yield	Evaluation
		%	t/a	%	t/a	%	t/a	
1	GEMS-0175-1 X LH287	35.3	8.9	53.3	8.4	44.3	8.6	*
2	GEMS-0175-2 X LH287	33.6	6.2	54.6	8.6	44.1	7.4	
3	GEMS-0175-3 X LH287	34.9	8.8	58.7	7.6	46.8	8.2	*
4	GEMS-0175-4 X LH287	34.9	7.5	56.1	7.6	45.5	7.6	
5	GEMS-0175-5 X LH287	35.5	8.6	60.0	8.0	47.7	8.3	*
6	GEMS-0175-6 X LH287	35.5	7.5	53.7	8.4	44.6	7.9	
7	GEMS-0175-7 X LH287	34.5	5.9	48.7	8.2	41.6	7.1	
8	GEMS-0175-8 X LH287	34.7	4.5	52.2	7.3	43.5	5.9	
9	GEMS-0175-9 X LH287	34.9	7.7	52.6	8.0	43.7	7.8	
10	GEMS-0175-10 X LH287	35.6	8.2	54.4	7.9	45.0	8.1	*
11	GEMS-0175-11 X LH287	33.1	7.2	63.4	9.4	48.3	8.3	
12	GEMS-0175-12 X LH287	34.9	6.9	49.6	8.4	42.2	7.7	
13	GEMS-0175-13 X LH287	33.8	7.5	50.8	8.5	42.3	8.0	
14	GEMS-0175-14 X LH287	35.6	6.8	58.8	7.4	47.2	7.1	
15	GEMS-0175-15 X LH287	34.8	7.0	53.3	7.9	44.0	7.5	
16	W606S X LH244	36.3	8.3	50.0	8.0	43.2	8.2	*
17	W607S X LH244	34.6	9.4	43.5	8.0	39.0	8.7	*
18	W609S X LH244	35.0	7.2	46.9	8.2	40.9	7.7	*
19	W611S X LH244	36.9	9.9	46.0	8.1	41.5	9.0	*
20	W612S X LH244	38.9	11.1	47.9	8.4	43.4	9.8	*
21	W610S X GP245	35.7	8.2	46.7	6.5	41.2	7.3	*
22	35F44	36.4	9.6	47.4	8.2	41.9	8.9	*
23	33T55	35.5	10.4	48.2	9.2	41.9	9.8	*
24	F2F633	33.4	8.4	40.5	6.8	37.0	7.6	*
25	N48V8	37.4	10.0	46.0	8.9	41.7	9.5	*
	Mean	35.3	8.1	51.3	8.1	43.3	8.1	
	CV (%)	3.9	13.4	10.4	10.5	9.0	12.0	
	LSD (0.05)	2.7	2.2	10.8	1.7	8.6	2.2	
	Mean of all GEM0175 testcrosses	34.8	7.3	54.7	8.1	44.7	7.7	
	Mean of experimental entries for quality evaluation	35.3	8.6	56.6	8.0	46.0	8.3	
	Mean of checks (w/o F2633)	36.3	9.3	47.0	8.2	41.6	8.8	
	Entries marked with "*" will be analyzed for nutritional quality							

Table 4. Forage yield evaluation for GEM0176 trial in 2010. Forage yield was evaluated at Madison and Arlington, WI. Entries marked with "*" will be analyzed for nutritional quality. Advancement decisions were made based solely on Madison data.

2010 EXPT GEM0176								
		Madison		Arlington		Mean		For
		Dry		Dry		Dry		Quality
10No.	Entry	matter	Yield	matter	Yield	matter	Yield	Evaluation
		%	t/a	%	t/a	%	t/a	
1	GEMS-0176-1 X LH287	28.0	7.5	44.6	8.2	36.3	7.8	
2	GEMS-0176-2 X LH287	29.1	6.2	44.9	7.7	37.0	7.0	
3	GEMS-0176-3 X LH287	28.8	9.2	46.1	7.6	37.4	8.4	*
4	GEMS-0176-4 X LH287	27.0	7.2	45.1	9.0	36.1	8.1	
5	GEMS-0176-5 X LH287	29.0	6.1	46.9	8.9	38.0	7.5	
6	GEMS-0176-6 X LH287	27.6	5.4	41.7	7.5	34.6	6.5	
7	GEMS-0176-7 X LH287	28.6	5.5	42.7	8.8	35.7	7.2	
8	GEMS-0176-8 X LH287	30.7	8.8	40.9	8.1	35.8	8.5	*
9	GEMS-0176-9 X LH287	29.3	7.3	42.3	9.2	35.8	8.2	
10	GEMS-0176-10 X LH287	28.5	8.2	43.4	8.9	36.0	8.6	*
11	GEMS-0176-11 X LH287	30.4	8.0	44.6	7.6	37.5	7.8	
12	GEMS-0176-12 X LH287	27.6	8.2	39.1	8.8	33.3	8.5	*
13	GEMS-0176-13 X LH287	29.5	9.4	43.5	8.4	36.5	8.9	*
14	GEMS-0176-14 X LH287	29.2	7.8	44.2	9.5	36.7	8.6	
15	GEMS-0176-15 X LH287	27.3	8.1	46.0	8.9	36.7	8.5	*
16	W606S X LH244	30.0	7.9	50.2	8.5	40.1	8.2	
17	W607S X LH244	32.9	10.1	48.1	9.5	40.5	9.8	*
18	W609S X LH244	32.3	6.3	45.5	7.9	38.9	7.1	
19	W611S X LH244	32.8	8.9	50.4	7.8	41.6	8.3	*
20	W612S X LH244	33.8	10.5	53.4	8.7	43.6	9.6	*
21	W610S X GP245	35.3	7.8	47.4	6.9	41.4	7.3	
22	35F44	31.7	9.4	48.1	7.9	39.9	8.7	*
23	33T55	31.9	10.0	50.0	9.3	40.9	9.6	*
24	F2F633	27.8	8.4	43.6	6.8	35.7	7.6	*
25	N48V8	32.9	9.9	45.2	8.2	39.1	9.0	*
	Mean	30.1	8.1	45.5	8.3	37.8	8.2	
	CV (%)	6.6	10.4	5.1	8.4	5.7	9.4	
	LSD (0.05)	4.0	1.7	4.7	1.4	3.8	2.2	
	Mean of all GEM0176 testcrosses	28.7	7.5	43.7	8.5	36.2	8.0	
	Mean of experimental entries for quality evaluation	28.7	8.6	43.2	8.5	35.9	8.5	
	Mean of checks (w/o F2633)	32.6	9.0	48.7	8.3	40.7	8.6	
	Entries marked with "*" will be analyzed for nutritional quality							

Table 5. Forage yield evaluation for GEM0183_0184 trial in 2010. Forage yield was evaluated at Madison and Arlington, WI. Entries marked with "*" will be analyzed for nutritional quality. Advancement decisions were made based solely on Madison data.

2010 EXPT GEM0183_0184								
		Madison		Arlington		Mean		For
		Dry		Dry		Dry		Quality
10No.	Entry	matter	Yield	matter	Yield	matter	Yield	Evaluation
		%	t/a	%	t/a	%	t/a	
1	GEMS-0184-1 X LH287	27.5	5.5	36.2	8.6	31.9	7.0	
2	GEMS-0184-2 X LH287	27.7	7.4	40.2	9.3	34.0	8.4	
3	GEMS-0184-3 X LH287	28.4	7.1	38.9	8.8	33.7	7.9	
4	GEMS-0184-4 X LH287	28.9	6.1	38.5	8.5	33.7	7.3	
5	GEMS-0184-5 X LH287	28.7	3.0	42.7	8.6	35.7	5.8	
6	GEMS-0184-6 X LH287	27.9	8.9	39.0	9.3	33.4	9.1	*
7	GEMS-0184-7 X LH287	29.0	4.3	35.7	9.1	32.4	6.7	
8	GEMS-0184-8 X LH287	28.3	3.8	41.4	8.8	34.8	6.3	
9	GEMS-0184-9 X LH287	29.4	5.8	38.1	8.7	33.7	7.2	
10	GEMS-0184-10 X LH287	28.9	8.1	38.4	7.9	33.7	8.0	*
11	GEMS-0183-1 X LH287	29.5	8.1	37.3	7.9	33.4	8.0	*
12	GEMS-0183-2 X LH287	28.2	8.2	38.0	8.7	33.1	8.5	*
13	GEMS-0183-3 X LH287	29.4	6.8	39.3	8.8	34.4	7.8	
14	GEMS-0183-4 X LH287	30.6	7.9	38.9	9.2	34.8	8.5	*
15	GEMS-0183-5 X LH287	29.9	8.1	37.9	9.2	33.9	8.6	*
16	GEMS-0183-6 X LH287	29.4	7.7	38.7	8.9	34.0	8.3	
17	GEMS-0183-7 X LH287	30.0	7.5	38.7	8.6	34.3	8.1	
18	GEMS-0183-8 X LH287	30.6	7.9	41.1	8.4	35.8	8.2	*
19	GEMS-0183-9 X LH287	29.7	7.2	39.7	8.3	34.7	7.7	
20	GEMS-0183-10 X LH287	29.9	8.4	39.0	7.9	34.5	8.1	*
21	GEMS-0183-11 X LH287	30.8	8.4	40.5	7.8	35.7	8.1	*
22	GEMS-0183-12 X LH287	30.6	8.1	40.5	8.2	35.6	8.1	*
23	GEMS-0183-13 X LH287	27.8	7.2	38.3	8.9	33.1	8.1	
24	GEMS-0183-14 X LH287	30.0	8.5	40.2	8.8	35.1	8.6	*
25	GEMS-0183-15 X LH287	28.5	7.9	39.3	8.1	33.9	8.0	*
26	W606S X LH244	31.8	9.1	46.9	9.2	39.4	9.1	*
27	W607S X LH244	31.2	10.3	45.4	8.6	38.3	9.5	*
28	W609S X LH244	31.1	7.8	43.9	8.2	37.5	8.0	*
29	W611S X LH244	32.2	9.4	45.9	8.5	39.1	8.9	*
30	W612S X LH244	33.5	9.4	51.3	8.6	42.4	9.0	*
31	W610S X GP245	32.5	8.7	46.2	7.9	39.4	8.3	*
32	35F44	33.4	10.8	46.0	9.3	39.7	10.1	*
33	33T55	33.6	11.2	46.2	9.5	39.9	10.4	*
34	F2F633	26.1	8.4	42.5	6.3	34.3	7.3	*
35	N48V8	33.9	9.9	44.3	8.6	39.1	9.3	*
	Mean	30.0	7.8	41.0	8.6	35.5	8.2	
	CV (%)	3.6	10.2	5.2	7.2	4.7	8.7	
	LSD (0.05)	2.2	1.6	4.2	1.2	3.6	2.7	
	Mean of all GEM0183_0184 testcrosses	29.2	7.1	39.1	8.6	34.1	7.9	
	Mean of experimental entries for quality evaluation	29.6	8.2	39.2	8.5	34.4	8.3	
	Mean of checks (w/o F2633)	32.6	9.6	46.2	8.7	39.4	9.2	
	Entries marked with "*" will be analyzed for nutritional quality							

Table 6. Forage yield evaluation for GUAT209 trial in 2010. Forage yield was evaluated at Madison and Arlington, WI. Entries marked with "*" will be analyzed for nutritional quality. Advancement decisions were made based solely on Madison data.

2010 EXPT GUAT209								
		Madison		Arlington		Mean		For
		Dry		Dry		Dry		Quality
10No.	Entry	matter	Yield	matter	Yield	matter	Yield	Evaluation
		%	t/a	%	t/a	%	t/a	
1	GUAT209:S1308a-135-001-B-1-1 X LH287	35.7	7.4	52.7	5.9	44.2	6.7	
2	GUAT209:S1308a-135-001-B-1-2 X LH287	33.0	9.7	45.9	8.1	39.5	8.9	*
3	GUAT209:S1308a-135-001-B-4-1 X LH287	33.3	9.2	45.9	7.3	39.6	8.2	*
4	GUAT209:S1308a-135-001-B-4-2 X LH287	33.4	9.9	45.6	7.5	39.5	8.7	*
5	GUAT209:S1308a-135-001-B-5-1 X LH287	32.2	8.6	49.3	7.6	40.7	8.1	
6	GUAT209:S1308a-135-001-B-5-2 X LH287	33.6	9.7	46.3	7.8	39.9	8.7	*
7	GUAT209:S1308a-135-001-B-6-1 X LH287	31.9	9.3	47.0	8.0	39.5	8.7	*
8	GUAT209:S1308a-135-001-B-6-2 X LH287	32.8	9.2	47.0	7.0	39.9	8.1	*
9	GUAT209:S1308a-135-001-B-8-1 X LH287	33.8	6.9	49.0	7.9	41.4	7.4	
10	GUAT209:S1308a-135-001-B-8-2 X LH287	33.5	8.5	49.4	8.3	41.4	8.4	
11	GUAT209:S1308a-135-001-B-13-2 X LH287	32.1	9.1	44.9	7.6	38.5	8.4	*
12	GUAT209:S1308a-135-001-B-14-1 X LH287	32.7	9.1	46.6	7.3	39.6	8.2	*
13	GUAT209:S1308a-135-001-B-14-2 X LH287	32.6	9.0	46.7	7.9	39.7	8.5	*
14	GUAT209:S1308a-135-001-B-15-1 X LH287	34.0	9.6	51.0	6.7	42.5	8.2	*
15	GUAT209:S1308a-135-001-B-15-2 X LH287	33.4	9.9	49.8	7.7	41.6	8.8	*
16	GUAT209:S1308a-135-001-B-22-1 X LH287	33.7	10.3	44.8	7.7	39.2	9.0	*
17	GUAT209:S1308a-135-001-B-22-2 X LH287	32.8	9.3	47.8	7.2	40.3	8.2	*
18	GUAT209:S1308a-013-001-B-4-2 X LH287	32.4	8.5	48.0	8.1	40.2	8.3	
19	W604S X LH244	45.5	9.4	50.2	7.7	47.9	8.5	*
20	W605S X LH244	36.0	11.5	47.9	7.8	42.0	9.7	*
21	W611S X LH244	42.4	9.9	53.3	8.1	47.8	9.0	*
22	W610S X LH244	36.4	6.4	49.6	5.4	43.0	5.9	*
23	W606S X LH244	38.3	8.8	56.5	7.8	47.4	8.3	*
24	W607S X LH244	39.5	9.9	48.1	7.8	43.8	8.8	*
25	W609S X LH244	39.8	9.5	54.8	7.7	47.3	8.6	*
26	W609S X GP245	36.9	7.3	54.5	7.3	45.7	7.3	*
27	34A20	33.9	9.4	49.3	8.1	41.6	8.7	*
28	F2F633	37.9	7.8	44.4	6.3	41.2	7.0	*
29	N48V8	37.9	9.4	49.1	7.5	43.5	8.4	*
30	36H56	36.3	7.9	46.4	6.4	41.3	7.1	*
	Mean	35.3	9.0	48.7	7.5	42.0	8.2	
	CV (%)	4.6	8.8	4.8	9.5	4.8	9.1	
	LSD (0.05)	3.2	1.6	4.7	1.4	4.6	1.3	
	Mean of all GUAT209 testcrosses	33.2	9.1	47.6	7.5	40.4	8.3	
	Mean of experimental entries for quality evaluation	33.0	9.5	46.9	7.5	39.9	8.5	
	Mean of checks (w/o F2633)	38.4	9.0	50.9	7.4	44.7	8.2	
	Entries marked with "*" will be analyzed for nutritional quality							

Table 7. Forage yield evaluation for GQSC0 trial in 2010. Forage yield was evaluated at Madison and Arlington, WI. Entries marked with "*" will be analyzed for nutritional quality. Advancement decisions were made based solely on Madison data.

2010 EXPT GQSC0								
		Madison		Arlington		Mean		For
		Dry		Dry		Dry		Quality
10No.	Entry	matter	Yield	matter	Yield	matter	Yield	Evaluation
		%	t/a	%	t/a	%	t/a	
1	50072-1-1-2-1 X W604S	35.6	10.0	51.3	5.5	43.4	7.8	*
2	50072-1-1-2-2 X W604S	.	.	.	.	.	.	
3	50072-1-1-4-1 X W604S	37.0	10.2	50.6	5.2	43.8	7.7	*
4	50072-1-1-4-2 X W604S	38.8	8.9	53.0	4.7	45.9	6.8	*
5	50072-1-1-5-1 X W604S	38.2	10.0	53.9	5.9	46.1	7.9	*
6	50072-1-1-5-2 X W604S	37.8	9.9	.	.	.	.	*
7	50120-1-1-1-1 X W604S	35.7	8.9	50.0	6.2	42.8	7.5	*
8	50120-1-1-1-2 X W604S	35.8	8.1	53.0	5.7	44.4	6.9	
9	50156-1-1-3-1 X W604S	39.7	10.3	48.6	5.3	44.1	7.8	*
10	50156-1-1-3-2 X W604S	41.1	9.8	55.1	5.3	48.1	7.6	*
11	50159-1-1-2-1 X W604S	38.4	10.1	53.6	4.5	46.0	7.3	*
12	50159-1-1-2-2 X W604S	39.1	10.0	55.8	5.2	47.5	7.6	*
13	50159-1-1-3-1 X W604S	38.0	9.2	53.6	5.3	45.8	7.3	*
14	50159-1-1-3-2 X W604S	37.1	8.6	57.4	6.2	47.3	7.4	
15	50197-1-1-2-1 X W604S	35.5	9.5	48.0	5.9	41.8	7.7	*
16	50197-1-1-2-2 X W604S	36.3	11.1	44.4	4.8	40.4	8.0	*
17	50072-1-1-2-1 X LH287	34.6	9.5	49.9	6.2	42.2	7.9	*
18	50072-1-1-2-2 X LH287	32.6	9.3	50.1	6.1	41.3	7.7	*
19	50072-1-1-4-1 X LH287	34.7	9.9	47.8	5.0	41.3	7.4	*
20	50072-1-1-4-2 X LH287	34.9	9.3	56.5	5.6	45.7	7.4	*
21	50072-1-1-5-1 X LH287	34.4	9.3	52.4	5.3	43.4	7.3	*
22	50072-1-1-5-2 X LH287	32.7	10.5	48.0	5.7	40.3	8.1	*
23	50120-1-1-1-1 X LH287	33.2	9.1	49.1	4.9	41.2	7.0	*
24	50120-1-1-1-2 X LH287	32.7	8.7	58.5	6.7	45.6	7.7	
25	50156-1-1-3-1 X LH287	35.8	6.5	57.6	5.4	46.7	6.0	
26	50156-1-1-3-2 X LH287	35.3	6.3	54.2	4.3	44.7	5.3	
27	50159-1-1-2-1 X LH287	36.1	6.7	58.4	4.2	47.2	5.4	
28	50159-1-1-2-2 X LH287	35.8	7.5	61.8	5.3	48.8	6.4	
29	50159-1-1-3-1 X LH287	36.1	7.9	51.8	5.1	43.9	6.5	
30	50159-1-1-3-2 X LH287	36.2	5.3	48.0	3.1	42.1	4.2	
31	50197-1-1-2-1 X LH287	33.7	6.4	52.4	6.7	43.0	6.5	
32	50197-1-1-2-2 X LH287	30.9	3.2	47.2	5.8	39.0	4.5	
33	W604S X LH244	38.5	8.6	45.8	5.2	42.2	6.9	*
34	W605S X LH244	33.7	10.8	47.1	7.3	40.4	9.0	*
35	W611S X LH244	38.3	10.3	52.6	7.1	45.4	8.7	*
36	W610S X LH244	36.1	9.3	45.0	6.2	40.5	7.7	*
37	W606S X LH244	34.7	10.2	.	.	.	.	*
38	W607S X LH244	35.7	10.4	50.5	6.0	43.1	8.2	*
39	W609S X LH244	34.3	10.6	49.1	5.6	41.7	8.1	*
40	W609S X GP245	33.5	6.1	56.4	6.5	44.9	6.3	*
41	34R67	36.4	8.9	47.5	5.3	41.9	7.1	*
42	F2F633	31.9	8.6	50.8	5.3	41.4	7.0	*
43	N48V8	35.8	10.2	50.8	6.2	43.3	8.2	*
44	36H56	35.1	7.7	48.7	4.9	41.9	6.3	*
	Mean	35.8	8.9	51.6	5.5	43.7	7.2	
	CV (%)	3.8	10.0	8.3	18.1	7.3	13.0	
	LSD (0.05)	2.7	1.8	8.6	2.0	5.9	2.4	
	Mean of all GQSC0 testcrosses	35.9	8.7	52.4	5.4	44.1	7.0	
	Mean of experimental entries for quality evaluation	36.4	9.7	51.1	5.4	43.7	7.6	
	Mean of checks (w/o F2633)	35.6	9.4	49.3	6.0	42.5	7.7	
	Entries marked with "*" will be analyzed for nutritional quality							

Reference:

USDA - United States Department of Agriculture. National Agricultural Statistics Service. 2010. Crop Production 2009 Summary. (http://usda.mannlib.cornell.edu/usda/current/CropProdSu/CropProdSu-01-12-2010.pdf)