Evaluating Twin–Row Corn Silage Production

Midwest Forage Association (MFA)
Midwest Forage Research Proposal (MFRP) Project Results

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Situation

Corn silage production is a major part of many forage operations in Wisconsin. As the #1 producing corn silage state in the nation, farmers are constantly looking for ways to increase silage yields and quality. In Outagamie County alone, more than 1/3 (33.9%) of the 85,000 acres planted to corn annually are harvested as silage. Wisconsin leads the nation in corn silage production with an average of 862,500 acres harvested during the 2008 and 2009 growing seasons. The total amount of silage harvested in the state averaged 14,456,500 tons during this two-year span. This resulted in an on-farm yield of 16.76 tons per acre (35% dry matter basis). In an effort to increase yields, row spacing and population are two management factors that may directly affect forage yield and quality. This Midwest Forage Research Proposal (MFRP) submitted on behalf of the Outagamie County Forage Council (OCFC) addressed the following questions…Does twin row corn silage production provide greater returns than traditional single 30-inch rows in Wisconsin? At what population is the greatest return per acre achieved? A combination of forage quality & quantity, (Milk per Ton and Milk per Acre) was used to determine which row spacing method and population producers can expect to see the greatest returns.

Over the last 15 years, row spacing for corn has changed from 38-inch to 30-inch and now to something narrower. A more recent development has been the sale of planters with "30-inch twin" rows (two rows 8 inches apart off the 30-inch centers). As rows become narrower, other equipment modifications often need to be considered. However, in the case with twin rows, producers do not have to change their harvest equipment. Traditional 30-inch row heads can be used to harvest twin rows. Proponents of twin rows claim narrow row yield benefits with minimal or no equipment modification. Popular press articles found in agricultural media have producer testimonials indicating as much as a 25-28% yield increases using twin row planting.

Photo courtesy of Great Plains

Twin Row Corn at Sugar Creek Farm – June 25, 2011

When MFRP proposal was submitted, the price of a bushel of corn had increased $1.78 in Wisconsin from $3.57 in 2009 to $5.35 in 2010. As a result, corn silage prices had seen substantial increases as well, with multiple producers selling high quality corn silage for $45 or more per wet ton in Outagamie & surrounding counties. That was 2010.

During the 2011 growing season while this research project was being conducted, corn silage prices of $78 and $80 per wet ton were being purchased in and around Outagamie County in August of this year. Because a producer has to be able to get comparable value from his silage acres as his corn grain acres, he/she must do everything in their ability to get the greatest return per acre. Row spacing and population are two of those variables, that, seem to receive a great amount of attention from farmers and the popular press. This project examined the effects of row spacing and plant population in the East Central part of the state of Wisconsin, which harvests a much greater percentage (38.1%) of its corn as forage/silage than the rest of the state as a whole (22.5%).

Response

The Midwest Forage Association had identified *Planting populations for corn silage (row spacing, twin-rows*) as one of the *top short term research program* needs, so the organization was hearing the same question from their members as we were – "Is there a difference between 30-inch twin-rows and 30-inch single rows"? As a result, we submitted a MFRP to the Midwest Forage Association and were granted $2,016 to help offset the costs of performing this research.

After some discussion, the following objectives were identified to provide producers with an answer upon project completion. They included the following:

1) The first objective was to determine whether or not there is an increase in yield using twin rows vs. single 30-inch rows. The producers used the same planter to do both twin rows and single 30-inch rows in the plots, so overall yield will be the first variable that can be evaluated comparing twin row yield to 30-inch row yields.

2) The second objective was to determine if there was a quality difference between the treatments by measuring Neutral Detergent Fiber digestibility (NDFd) which will also give us the ability to differentiate the Milk per Ton (MPT) measurements of the differing populations (30,000-40,000) and planting methods, twin versus single rows. This will help us determine at which planting rate (30,000, 35,000, or 40,000) we saw the greatest return per acre. While yield is important, quality needs to be considered as well. If there are differences, then we can calculate the cost of the additional seed used to determine whether or not the observed yield or quality increase was greater than the additional input cost (seed) required to achieve it.

3) The third objective was to share the findings with other area forage council members, not only those in the Outagamie County Forage Council, but in the East Central region of Wisconsin, including the Midwest Forage Association Symposium/Annual Meeting.

Travis Van De Hey, Caliber Custom Services (owner of the Great Plains 1625 16/32 Twin Row Yield Pro Planter), agreed to cooperate with UW-Extension (Joe Lauer, state corn agronomist, and myself), along with Paul Knutzen, Knutzen Crop Consulting (local professional crop consultant), and the following farm owners – Jeff Handschke and Mike Bruette – Sugar Creek Farm – New London (Outagmie County), Randy Dorow – Dorow Farm – Hortonville (Outagamie County), and Ken Jarek - K&K Dairy – Pulaski (Shawano County) Vic Vosters – Kaukauna

(Outagamie County) established twin row corn silage research plots on their farms in 2011. Fields were selected based on uniformity and ability to harvest at least 0.25 acres for each treatment in each of the replications.

The experimental design was a randomized complete block design with four replications. The treatments for the experiment were as follows:

Row spacing	**Plant Density**
1. 30 inches	30,000 plants/A
2. 30 inches	35,000 plants/A
3. 30 inches	40,000 plants/A
4. Twin rows	30,000 plants/A
5. Twin rows	35,000 plants/A
6. Twin rows	40,000 plants/A

2011 MFA Twin-Row Corn Research Plots																							
Sugar Creek Farm – MFA Plot **Croplan 491 VT3-102 Day YGRW/RR2/YGCB** **S=30-inch Single rows, T=30-inch Twin rows; 30, 35 and 40 = Number x 1000 plants/A**																							
Rep 1						Rep 2						Rep 3						Rep 4					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
30T	30S	40T	40S	35S	35T	30S	30T	35T	35S	40S	40T	35S	35T	40T	40S	30T	30S	35T	35S	30S	30T	40S	40T

2011 MFA Twin-Row Corn Research Plots																							
Randy Dorow Farm – MFA Plot **Pioneer 9910 AM1-99 Day AM1/LL/RR2** **S=30-inch Single rows, T=30-inch Twin rows; 30, 35 and 40 = Number x 1000 plants/A**																							
Rep 1						Rep 2						Rep 3						Rep 4					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
30T	30S	35S	35T	35T	35S	30S	30T	35S	35T	40T	40S	35T	35S	40S	40T	30T	30S	35S	35T	30S	30T	40T	40S

2011 MFA Twin-Row Corn Research Plots																							
K& K Dairy Farm – MFA Plot Masters Choice MC-530- 105 Day Conventional Corn S=30-inch Single rows, T=30-inch Twin rows; 30, 35 and 40 = Number x 1000 plants/A																							
Rep 1						Rep 2						Rep 3						Rep 4					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
30S	30T	40T	40S	35S	35T	30T	30S	35T	35S	40S	40T	35S	35T	40T	40S	30S	30T	35T	35S	30T	30S	40S	40T

Producers planted full season hybrids (defined in Outagamie County as 95 day relative maturity or longer). A full season hybrid uses the entire available growing season to reach physiological maturity before killing frost or cool temperatures end the growing season. Producers fertilized according their crop according to UWEX fertility recommendations based on their current soil test results. Plant stand populations were recorded at harvest. Kevin Jarek measured the exact length and width of each plot at the time of harvest ensuring accurate yield calculations. A zip-lock gallon-sized freezer bag was used to sample each treatment in each replicate. Samples were frozen and delivered to AgSource (WI state certified lab) in Bonduel for Near Infrared (NIR) analysis and then forwarded to the UW Soil and Forage Testing Lab in Marshfield to have 30-hour NDFd testing completed. The NDFD data provided us with the means to determine the Milk per Ton (MPT) results for each of the treatments that are a part of this project. As a result, we have the necessary information to determine what impact, if any, twin rows and population had on overall quality along with total yield.

Results

Three of the four twin-row research plots were harvested successfully (Sugar Creek Farm, Dorow Farm, and K&K), unfortunately, the Vic Voster's plot could not be harvested for silage and was eventually harvested for dry grain. The following tables were derived from Appendix Table 4. Plant Density and Row Spacing Effects on Corn Silage Yield and Quality (Average over all locations, Outagamie County-2011).

Table 1. Row Spacing (RS) Means Over All Three Locations - Sugar Creek Farm-Randy Dorow Farm-K&K Dairy Farm for the MFA Twin-Row Research Project.

Row Spacing (RS) Single vs. Twin	DM Yields – Tons per acre	Mean MPT- lbs milk /T	Mean MPA - lbs milk /A
Single 30-inch	6.2	2,764	17,108
Twin 30 -inch	6.3	2,779	17,638

Table 2. Plant Density (PD) Means Over All Three Locations - Sugar Creek Farm-Randy Dorow Farm-K&K Dairy Farm for the MFA Twin-Row Research Project.			
Target Plant Density - Plants per Acre	**DM Yields – Tons per acre**	**Mean MPT- lbs milk /T**	**Mean MPA - lbs milk /A**
30,000	**6.2**	**2,884**	**17,944**
35,000	**6.3**	**2,745**	**17,436**
40,000	**6.3**	**2,686**	**16,738**

Table 3. Plant Density (PD) X Row Spacing (RS) Means Over All Three Locations - Sugar Creek Farm-Randy Dorow Farm-K&K Dairy Farm for the MFA Twin-Row Research Project.			
RS (Single or Twin) and PD (30, 35, and 40,000 plants per acre)	**DM Yields – Tons per acre**	**Mean MPT- lbs milk /T**	**Mean MPA - lbs milk /A**
30-inch Single Rows 30,000 Planting Rate	**6.2**	**2,879**	**17,701**
30-inch Single Rows 35,000 Planting Rate	**6.2**	**2,770**	**17,298**
30-inch Single Rows 40,000 Planting Rate	**6.2**	**2,643**	**16,326**
30-inch Twin Rows 30,000 Planting Rate	**6.2**	**2,889**	**18,188**
30-inch Twin Rows 35,000 Planting Rate	**6.5**	**2,719**	**17,575**
30-inch Twin Rows 40,000 Planting Rate	**6.3**	**2,729**	**17,150**

Once the field data was collected, a statistical analysis was performed on each of the individual sites evaluating the impact of Row Spacing **–** RS (twin vs. single), Plant Density – PD (30,000, 35,000, and 40,000) and the combined interaction of the two characteristics PD X RS on the final results. The analysis also included a summary of the three combined sites. Means were separated

using Least Significant Difference (LSD) at 0.10 probability level. The following information was derived from Appendix Table 4. Plant Density and Row Spacing Effects on Corn Silage Yield and Quality (Average over all locations, Outagamie County-2011).

Using the mean/average over all three locations, Row Spacing (RS) twin vs. single was statistically significant in only one category – Harvest Plant Density (plants per acre). The 30-inch twin row plantings resulted in 948 more plants per acre at harvest than the same planting population rate for the 30-inch single rows. While this did prove to be a significant difference, it may not be biologically significant to have a significant impact on final yield.

RS did not prove to have a significant impact on the following whole plant measurements: Dry Matter (DM) yield, Moisture (at harvest), Crude Protein (CP), Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), *In vitro* Digestibility, Starch, NDFD, MPT, and MPA. Therefore the conclusion is that twin rows did result in slightly more plants per acre; however, it may not be enough to have a noticeable impact on final yield or quality.

Plant Density (PD), did not statistically significant impact DM yield, NDFD, or MPA, but it did prove to have an influence on other measurements. On average, the 35,000 (65.5%) and 40,000 (65.6%) planting populations were in moisture than the 30,000 (64.4%**)** planting population.

Lower populations often result in improved quality. The 30,000 planting population had greater CP (7.0%) than both the 35,000 (6.8%), and 40,000 (6.7%). For ADF, the 35,000 (23.6%) and 40,000 (23.9%) were both statistically higher than the 30,000 (22.5%). For NDF, the 40,000 planting population (44.6%) was statistically higher than both the 30,000 (42.1%) and 35,000 (43.1%). So, as planting population increases, NDF should increase. For *in vitro* digestibility, the 30,000 planting population proved to be statistically higher (77.4%) than either the 35,000 (75.4%) or 40,000 (75.7%) planting rates. For starch content, the 30,000 planting population proved to be statistically higher (33.5%) than the 35,000 (32.1%) or the 40,000 (31.0%).

For MPT, the 30,000 planting population was statistically higher (2,884 lbs milk/T) than both the 35,000 planting population (2,745 lbs milk/T) and the 40,000 planting population (2,686 lbs milk/T). For MPA, there was no statistical significance noted separating the means using LSD (0.10) probability level. The 30,000 planting population (17,944 lbs milk/A) was very close to being statistically different from the 40,000 planting population (16, 738 lbs milk/A). The higher MPT means observed with the lower planting populations suggest producers consider the yield and quality trade-off between MPT and MPA.

Few PD X RS interactions were detected for forage yield and quality measurements.

In summary, RS has very little effect on corn silage yield and quality, while PD is a major factor in corn silage yield and quality.

Acknowledgements

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Appendix Table 1. Plant Density and Row Spacing Effects on Corn Silage Yield and Quality.
Randy Dorow Farm, Outagamie County - 2011

	Target	Harvest	Whole Plant									
Row	plant	plant	Dry Matter		Crude			*in vitro*			Milk(2006) per	
spacing	density	density	yield	Moisture	protein	ADF	NDF	Digest	Starch	NDFD	Ton	Acre
inches	plants/A	plants/A	Tons/A	%	%	%	%	%	%	%	lbs/T	lbs/A
30-inch Single		31428	5.9	60.4	6.1	21.5	39.5	78.6	38.2	46.4	2923	17392
30-inch Twin		32583	6.0	60.9	6.3	21.4	38.3	79.1	38.1	45.6	2967	17909
	30000	25750	5.9	61.0	6.5	20.6	37.5	80.4	38.2	48.2	3057	18096
	35000	32600	6.1	61.6	6.2	21.5	38.3	77.6	38.5	41.6	2898	17599
	40000	37667	6.0	59.3	5.8	22.4	40.8	78.6	37.8	48.2	2879	17257
30-inch Single	30000	24750	5.9	61.3	6.5	21.1	38.7	80.7	37.3	50.6	3069	18293
30-inch Single	35000	32200	6.0	61.3	6.1	21.0	38.6	78.3	39.6	44.0	2936	17592
30-inch Single	40000	37333	5.9	58.6	5.7	22.4	41.2	76.9	37.9	44.6	2763	16292
30-inch Twin	30000	26750	5.9	60.7	6.6	20.1	36.3	80.1	39.2	45.7	3046	17900
30-inch Twin	35000	33000	6.2	61.9	6.3	21.9	38.0	76.9	37.4	39.3	2861	17606
30-inch Twin	40000	38000	6.1	59.9	5.9	22.3	40.4	80.2	37.7	51.7	2995	18222
Mean		32006	6.0	60.6	6.2	21.5	38.9	78.8	38.2	46.0	2945	17651
Probability(%)												
Plant Density (PD)		0.0	76.8	0.5	0.6	7.4	6.8	9.6	77.7	5.3	10.0	70.7
Row Spacing (RS)		18.5	62.9	34.4	24.5	91.8	25.0	67.4	86.0	72.5	51.8	51.6
PD x RS		77.0	86.9	24.8	94.9	35.5	73.4	18.9	12.9	11.5	20.3	49.4
LSD(0.10)												
Plant Density (PD)		1785	NS	1.0	0.3	1.2	2.2	2.2	NS	5.2	151	NS
Row Spacing (RS)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
PD x RS		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Appendix Table 2. Plant Density and Row Spacing Effects on Corn Silage Yield and Quality.
K and K Dairy Farm, Outagamie County - 2011

	Target	Harvest	Whole Plant									
Row	plant	plant	Dry Matter		Crude			*in vitro*			Milk(2006) per	
spacing	density	density	yield	Moisture	protein	ADF	NDF	Digest	Starch	NDFD	Ton	Acre
inches	plants/A	plants/A	Tons/A	%	%	%	%	%	%	%	lbs/T	lbs/A
30-inch Single		32889	5.9	63.8	6.8	22.6	42.9	74.5	35.6	40.5	2713	16074
30-inch Twin		33222	6.0	63.9	6.7	22.7	43.9	75.7	36.0	44.6	2757	16574
	30000	26500	5.8	62.7	6.8	21.9	42.3	74.5	37.5	39.6	2694	15760
	35000	33667	5.9	65.4	6.9	23.3	43.6	75.3	34.4	43.3	2768	16253
	40000	39000	6.2	63.5	6.7	22.8	44.3	75.5	35.5	44.7	2743	16959
30-inch Single	30000	26333	5.8	63.0	6.9	20.7	40.8	74.7	39.0	38.0	2727	15773
30-inch Single	35000	33333	5.8	64.8	6.9	23.5	43.6	73.4	33.8	39.0	2665	15493
30-inch Single	40000	39000	6.2	63.6	6.7	23.7	44.4	75.4	34.0	44.5	2747	16955
30-inch Twin	30000	26667	5.9	62.4	6.6	23.1	43.8	74.3	36.0	41.2	2662	15747
30-inch Twin	35000	34000	5.9	65.9	6.8	23.1	43.6	77.2	34.9	47.6	2871	17013
30-inch Twin	40000	39000	6.2	63.3	6.7	22.0	44.3	75.6	37.0	44.8	2739	16963
Mean		33056	6.0	63.8	6.8	22.7	43.4	75.1	35.8	42.5	2735	16324
Probability(%)												
Plant Density (PD)		0.0	1.3	1.3	66.1	43.8	35.0	49.2	28.1	12.6	32.8	10.4
Row Spacing (RS)		57.6	47.5	88.5	34.4	90.3	39.5	14.4	81.9	5.7	27.5	25.1
PD x RS		89.6	94.3	46.8	66.1	21.2	45.7	7.8	29.3	24.0	3.9	26.2
LSD(0.10)												
Plant Density (PD)		1282	0.2	1.3	NS	NS	NS	NS	NS	NS	NS	NS
Row Spacing (RS)		NS	NS	NS	NS	NS	NS	NS	NS	3.4	NS	NS
PD x RS		NS	NS	NS	NS	NS	NS	1.3	NS	NS	121	NS

Appendix Table 3. Plant Density and Row Spacing Effects on Corn Silage Yield and Quality.
Sugar Creek Farm, Outagamie County - 2011

	Target	Harvest	Whole Plant									
Row	plant	plant	Dry Matter		Crude			*in vitro*			Milk(2006) per	
spacing	density	density	yield	Moisture	protein	ADF	NDF	Digest	Starch	NDFD	Ton	Acre
inches	plants/A	plants/A	Tons/A	%	%	%	%	%	%	%	lbs/T	lbs/A
30-inch Single		32250	6.8	70.3	7.5	25.8	47.3	74.1	23.3	45.3	2624	17806
30-inch Twin		33500	7.1	70.8	7.5	26.3	48.1	74.5	22.1	46.9	2601	18641
	30000	27750	7.0	69.1	7.6	25.2	46.6	76.4	24.9	49.2	2815	20063
	35000	33000	7.0	69.9	7.5	26.2	47.7	73.5	22.9	44.5	2591	18121
	40000	37875	6.8	72.7	7.4	26.6	48.8	73.0	20.1	44.7	2432	16487
30-inch Single	30000	26750	6.8	69.2	7.5	25.3	47.0	75.3	25.0	47.3	2766	18952
30-inch Single	35000	32250	6.8	69.7	7.5	25.5	46.5	75.1	24.1	46.4	2697	18284
30-inch Single	40000	37750	6.7	72.1	7.6	26.5	48.5	72.0	20.7	42.3	2409	16182
30-inch Twin	30000	28750	7.1	68.9	7.7	25.1	46.3	77.4	24.9	51.1	2864	21174
30-inch Twin	35000	33750	7.2	70.2	7.4	26.9	48.9	71.9	21.8	42.6	2484	17957
30-inch Twin	40000	38000	6.8	73.3	7.3	26.8	49.2	74.0	19.6	47.1	2455	16791
Mean		32875	6.9	70.6	7.5	26.0	47.7	74.3	22.7	46.1	2613	18223
Probability(%)												
Plant Density (PD)		0.0	58.2	0.0	67.8	0.9	3.1	11.6	0.0	37.9	0.5	1.0
Row Spacing (RS)		5.1	15.5	27.2	71.4	16.3	20.2	82.1	14.3	61.2	78.1	31.2
PD x RS		47.7	70.4	33.8	42.1	14.4	13.1	20.4	48.2	45.5	26.9	45.1
LSD(0.10)												
Plant Density (PD)		1266	NS	0.8	NS	0.7	1.3	NS	1.6	NS	172	1716
Row Spacing (RS)		1034	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
PD x RS		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Appendix Table 4. Plant Density and Row Spacing Effects on Corn Silage Yield and Quality.
Average over all locations, Outagamie County - 2011

	Target	Harvest	Whole Plant									
Row	plant	plant	Dry Matter		Crude			*in vitro*			Milk(2006) per	
spacing	density	density	yield	Moisture	protein	ADF	NDF	Digest	Starch	NDFD	Ton	Acre
inches	plants/A	plants/A	Tons/A	%	%	%	%	%	%	%	lbs/T	lbs/A
30-inch Single		32148	6.2	65.0	6.8	23.3	43.3	75.9	32.4	44.5	2764	17108
30-inch Twin		33096	6.3	65.3	6.8	23.5	43.4	76.4	32.0	45.7	2779	17638
	30000	26699	6.2	64.4	7.0	22.5	42.1	77.4	33.5	46.5	2884	17944
	35000	33051	6.3	65.5	6.8	23.6	43.1	75.4	32.1	43.0	2745	17436
	40000	38115	6.3	65.6	6.7	23.9	44.6	75.7	31.0	45.8	2686	16738
30-inch Single	30000	25927	6.2	64.6	6.9	22.4	42.3	77.1	33.6	46.2	2879	17701
30-inch Single	35000	32551	6.2	65.2	6.8	23.3	42.9	75.7	32.8	43.5	2770	17298
30-inch Single	40000	37965	6.2	65.2	6.7	24.1	44.6	74.8	30.8	43.7	2643	16326
30-inch Twin	30000	27472	6.2	64.1	7.0	22.6	42.0	77.6	33.5	46.7	2889	18188
30-inch Twin	35000	33551	6.5	65.9	6.8	24.0	43.4	75.0	31.4	42.4	2719	17575
30-inch Twin	40000	38265	6.3	65.9	6.7	23.7	44.7	76.6	31.2	47.8	2729	17150
Mean		32622	6.3	65.2	6.8	23.4	43.3	76.1	32.2	45.1	2772	17373
Probability(%)												
Plant Density (PD)		0.0	61.6	2.7	2.8	0.5	0.2	4.5	1.0	17.2	0.4	11.8
Row Spacing (RS)		2.1	16.8	42.1	98.2	60.3	84.8	45.5	54.0	47.0	74.8	24.5
PD x RS		46.0	72.2	36.2	95.9	42.5	77.5	33.0	49.2	41.1	49.1	88.1
LSD(0.10)												
Plant Density (PD)		817	NS	0.8	0.2	0.7	1.1	1.4	1.3	NS	96	NS
Row Spacing (RS)		665	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
PD x RS		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS