How Much do Corn Silage Hybrids Vary Across Fields and Farms?

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In nearly every field, farmers observe corn plant variability within the field. They also see variability from field to field. Dairy farmers are concerned about the effect of this variability on corn silage yield/quality and wonder whether this variability will have an impact on milk production.

Corn hybrids interact with their environment and the result is a plant (phenotype) that expresses various traits. Traits are measurable and include such things as plant height, tassel and cob color, yield, and forage quality characteristics. Environmental factors include weather, soil, management, and abiotic and biotic stresses. Agronomists often describe the effects of these factor interactions as GxExM (Genetics x Environment x Management) effects on yield and quality. This article describes the range in corn silage phenotype variability measured within a field, between farms within a single year and between years, and to discuss implications of what it may mean for dairy producers. Forage yield, moisture, NDF, starch content, NDFD, and Milk 2006 performance indices will be evaluated.

Since 1995, the University of Wisconsin corn evaluation program has conducted a forage evaluation program at ten locations in Wisconsin. Between 1995-2012, this program has evaluated 8,295 hybrids in 276 trials using 25,515 plots. Within a trial, each hybrid is replicated three times providing an estimate of *field (soil) variability* under the same environment and management factors. To simulate *farm variability* within a year, each set of hybrids is grown at two to four locations. These locations differ for management, soil, and environment factors. Finally, many hybrids are grown two or more years, thus providing an estimate of *year variability.* Variability is estimated using a statistic called standard deviation. Describing field, farm, and year variability for one hybrid, Pioneer 33F88 will be the starting point.

Between 2009-2012, Pioneer 33F88 was grown at Arlington, Fond du Lac, Galesville, and Lancaster. Forage yield results of individual replicates are shown in Table 1. The minimum and maximum plot of a replicate was 6.0 and 11.4 tons DM/ac. The minimum and maximum field average was 6.6 and 11.2 tons DM/ac, while the minimum and maximum farm average was 9.0 and 10.4 tons DM/ac.

The average (mean) is important to know, but understanding variability around an average is also important. Another name for variability is risk. Standard deviation is a commonly used estimate for risk.

In the Table 1 example, minimum and maximum field variability estimates were ±0.1 and ±1.9 tons DM/ac with an average of ±0.7 tons DM/ac. When looking at a number of fields within a year for a farm, minimum and maximum farm variability estimates were ±0.7 and ±1.8 tons DM/ac with an average of ±1.3 tons DM/ac. Farm variability was nearly twice that of field variability. Farm variability was about the same as year variability of ±1.5 tons DM/ac.

Table 1. Forage yield (tons DM/ac) data of an individual hybrid (Pioneer 33F88) derived from the UW hybrid evaluation program and used to simulate field, farm, and year variability (standard deviation). Year variability = ± 1.5 tons DM/ac.

Year	Field	Rep 1	Rep 2	Rep 3	Field Average	Field Variability	Farm Average	Farm Variability
2009	ARL	9.8	11.0	11.0	10.6	±0.7		
2009	FON	7.2	7.3	6.5	7.0	±0.4		
2009	GAL	9.9	9.7	9.9	9.8	±0.1		
2009	LAN	8.4	7.8	10.6	8.9	±1.5	9.1	±1.6
2010	ARL	9.6	9.1	10.2	9.7	±0.6		
2010	FON	7.2	6.8	6.0	6.6	±0.6		
2010	GAL	12.0	8.1	9.9	10.0	±1.9		
2010	LAN	8.8	9.0	11.1	9.7	±1.3	9.0	±1.8
2011	ARL	10.2	10.3	10.2	10.2	±0.1		
2011	FON	10.1	9.6	9.1	9.6	±0.5		
2011	GAL	11.4	11.0	11.1	11.2	±0.2		
2011	LAN	11.4	10.3	9.7	10.5	±0.9	10.4	±0.7
2012	ARL	8.7	8.9	8.1	8.6	±0.5		
2012	FON	7.7	9.4	8.9	8.7	±0.8		
2012	GAL	11.0	10.7	10.8	10.9	±0.2		
2012	LAN	7.9	8.0	7.5	7.8	±0.3	9.0	±1.3
Average					9.3	±0.7	9.3	±1.3

Variability for Pioneer 33F88 yield and quality traits were calculated (Table 2). Field variability was about half of farm and year variability for nearly all traits. Looking at variability in relation to the mean, the most variable traits were forage yield (7-16%), starch content (8-14%), and milk per acre (8-16%). All involve yield, especially grain yield. The least variable were forage moisture, NDF, NDFD, and milk per ton.

Table 2. Summary of field, farm, and year variability (± standard deviation) of an example hybrid (Pioneer 33F88).

	Forage Yield *(tons DM/ac)*	Forage Moisture *(%)*	NDF *(%)*	Starch *(%)*	NDFD *(%)*	Milk 2006	
						(lb milk/ton)	*(lb milk/ac)*
Mean	9.3	66.4	47.7	29.5	57.1	3,092	28,900
Field Variability	±0.7	±1.6	±2.0	±2.4	±1.6	±83	±2,380
Farm Variability	±1.3	±3.2	±2.5	±2.9	±2.3	±91	±4,260
Year Variability	±1.5	±4.3	±3.6	±4.0	±4.8	±168	±4,730
Ratio (%) = Variability/Mean							
Field	7	2	4	8	3	3	8
Farm	14	5	5	10	4	3	15
Year	16	6	8	14	8	5	16

Table 3. Summary of field, farm, and year variability (± standard deviation) of all hybrids evaluated in the UW hybrid evaluation program.

	Hybrids *(N)*	Forage Yield *(tons DM/ac)*	Forage Moisture *(%)*	NDF *(%)*	Starch *(%)*	NDFD *(%)*	Milk 2006	
							(lb milk/ton)	*(lb milk/ac)*
Mean	25,515	8.2	63.6	46.5	30.8	58.7	3,218	25,620
Field Variability	8,295	±0.8	±2.3	±2.5	±2.9	±1.6	±95	±2,730
Farm Variability	2,899	±1.2	±4.4	±3.5	±4.4	±2.3	±133	±4,210
Year Variability	577	±1.5	±5.6	±4.1	±5.1	±3.3	±164	±4,860
Ratio (%) = Variability/Mean								
Field		10	4	5	9	3	3	11
Farm		15	7	8	14	4	4	16
Year		18	9	9	17	6	5	19

Finally, the above approach can be used to estimate the field, farm, and year variability of each hybrid tested in the UW hybrid evaluation program. A total of 8,295 hybrids have been evaluated in a field (Table 3). For forage yield, the average was 8.2 tons DM/ac with field variability of ±0.8 tons DM/ac. These same hybrids were evaluated at multiple locations to estimate farm variability within a year which was 8.2 ± 1.2 tons DM/ac. For a field, the ratio of the variability to the mean was 10%, while the farm and year variability was 15 and 18%. For most traits, field variability is about half of the farm or year variability indicating that if consistent silage quality is desired it is best to handle corn silage field by field.

The impact of variability is less on stover or quality traits (NDF, NDFD, and milk per ton) than on traits involving grain and yield (forage yield, starch content, and milk per acre). Thus, the repeatability of traits involving starch and yield is more difficult to estimate and farmers need to be careful when selecting hybrids based upon these traits. Stover quality traits have less variability, are more repeatable, and would take fewer plots (locations and replications) to measure accurately.