Corn Silage Processing: Dairy Farm Survey

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Introduction

The digestibility of the starch component of corn silage is influenced primarily by kernel processing and ensiling time (Ferraretto et al., 2014; Ferraretto and Shaver, 2013a; Ferraretto and Shaver, 2012a). Starch digestibility in corn silage is important because about half of its energy value comes from the starch which is provided by the grain fraction. We (Ferraretto and Shaver, 2013b) presented results from a sample survey of commercial testing labs over 2005 to 2012 showing a high percentage of corn silage samples categorized with poor processing (up to 42%) and a low percentage of samples categorized with excellent processing (only 7 to 17%) based on processing score measurements (Ferreira and Mertens, 2005).

Since then different corn silage processing has been implemented on some of the self-propelled forage harvesters (**SPFH**) being used on farms. The changes include shredlage processors, shredder rolls, conventional processors with greater roll speed differential, and inter-meshing disc processors. Additionally, there has been a lot of recent interest, especially with the feeding of higher corn silage diets, about setting the forage harvester for a longer theoretical length of cut (**TLOC**) with the aim of increasing the particle length of corn silage. Further augmenting this interest is the recommendation for longer TLOC when using shredlage processors (http://shredlage.com/harvesting-recommendations/).

The objectives of this field trial were to survey dairy farms about their corn silage harvest, processing and feeding practices, and collect corn silage samples during silo feed-out for determination of processing score and particle length.

Methods

Seventy-six corn silage samples were obtained from 69 dairy farms during farm visits April to August 2014. Farms were located in Illinois (n = 1), Minnesota (n = 15) and Wisconsin (n = 53). One sample was collected from each farm except for 7 farms that were feeding from two silos at the time of our visit. The samples were collected from the pile that had been shaved from the exposed face for feeding.

Dry matter (**DM**) content was determined on corn silage samples by drying at 60°C for 48 h in a forced-air oven. Dried samples were then ground thru a 1-mm Wiley Mill screen for determination of starch content by NIRS. As-fed samples were used to determine particle size distribution using the Penn State manual shaker box (**PSU-SB**) with 3 sieves and a pan (Kononoff et al., 2003). Also, as-fed samples were sieved mechanically using the Wisconsin Oscillating Particle Separator (**WI-OS**) to determine mean particle length (**MPL**; ANSI, 1998). Corn silage processing score (**CSPS**) was determined on dried samples according to Ferreira and Mertens (2005). During each farm visit a survey questionnaire was completed to assess herd demographics, corn silage harvesting practices, feeding practices, and farmer perceptions with regard to animal- and equipment-related responses.

Results and Discussion

Survey farm demographics are in Table 1. There was a wide range in herd size and production parameters. The wide range in milk yield and content of milk fat and protein can be partially explained by the inclusion in the survey of some all-Jersey (n=2) and partial-Guernsey (n=1), -Brown Swiss (n=1) and -Crossbred (n=1) farms in with the remaining all-Holstein farms.

A summary of corn silage harvest practices used by the survey farms is in Table 2. Most farms (61%) harvested corn silage using a Claas SPFH equipped with a Shredlage® processor. Bunkers (95%) and inoculants (87%) were used by most farms. Corn hybrids were solely dual-purpose type for 43% of the farms. Most farmers reported a 22-26 mm TLOC (79%) and a 1.5-2.5 mm roll gap (82%). There was no attempt to verify the reported settings on the equipment.

Descriptive statistics for DM and starch content, particle size, and CSPS are in Table 3. It should be noted that these data are a single snap-shot in time and may or may not be reflective of the corn silage fed on these farms in the months before or the months after our survey was performed.

The content of DM and starch was similar for the shredlage- and all-sample sets. While the average content of DM and starch was indicative of high-quality Midwest-USA corn silage, the range among farms was wide for both at 22%-units and 26%-units for DM and starch, respectively. This likely reflects the challenges of weather conditions and harvest scheduling. Reducing variation in DM content is an area where corn silage quality could be improved.

Although the percentage retained on the top or coarsest PSU-SB sieve was 7%-units greater for shredlage than the other defined (excludes the "unavailable" sample category) sample categories on average, the percentage retained on top 2 PSU-SB sieves and the WI-OS MPL were similar. This suggests that there may not have been much improvement in physically-effective fiber for the shredlage samples compared to the other samples collected in this survey. The average percentage retained on the top PSU-SB sieve for shredlage was substantially lower than that reported by Ferraretto and Shaver (2012b) from their feeding trial (20% versus 32%). It should be noted that the TLOC setting on the SPFH was 30 mm in the study of Ferraretto and Shaver (2012b), while the TLOC was usually 22-26 mm for the shredlage samples in this survey. The ranges for PSU-SB top sieve, PSU-SB top 2 sieves, and WI-OS MPL in the shredlage samples were 32%-units, 21%-units, 6 mm, respectively. Sample frequency distributions for PSU-SB top sieve are in Figures 1 (all samples) and 3 (shredlage samples).

All sample types fell in the adequately-processed category based on CSPS (Ferreira and Mertens, 2005). The CSPS was only 2%-units greater for shredlage than the other sample categories on average. This was achieved, however, coincident with the greatest percentage fibrous-particle retention on the top sieve of the PSU-SB for shredlage. The range for CSPS in shredlage was 33%-units, and both the greatest and lowest CSPS were observed within the shredlage samples. Sample frequency distributions for CSPS are in Figures 2 (all samples) and 4 (shredlage samples).

Farmer responses to feeding-related survey questions are in Table 4. Feeding experience with these new-types corn silages was limited with only 20% of respondents using for over 12 months. Only 22% of respondents had increased total forage content of their diets, while 47% increased the corn silage content of their diets which indicates a greater proportion of corn silage in the total forage DM. With regard to the inclusion of hay or straw in the TMR, 54% of respondents still did so and only 40% of those had reduced the amount fed.

Farmer responses to animal-related survey questions are in Table 5. Increased or no change were the most common responses to all questions, and these were relatively evenly split for milk yield and fat content. Nearly two-thirds of the respondents reported no change in feed sorting, while only about one-third of respondents reported improvements in herd health and manure scores.

Farmer responses to equipment-related survey questions are in Table 6. Processing rolls were relatively new with only 23% of respondents reporting usage on more than 30,000 as-fed tons. Only about 5% of respondents felt that silage packing density had decreased. Most respondents reported either no change or being unsure about tons per hour (57%), fuel usage (64%), and roll wear (76%).

Conclusions

The physical form (PSU-SB, MPL, and CSPS) and DM results indicate considerable opportunity to improve corn silage quality by reducing variation through better process control during harvest for shredlage and non-shredlage type samples. It appears that major changes in feeding programs were not made coincident with the use of new-type corn silages. Because this survey was a single snap-shot in time and most farmers still had very limited experience harvesting and feeding new-type corn silage, a follow-up survey is warranted.

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References

American National Standards Institute. 1998. Method of Determining and Expressing Particle Size of Chopped Forage Materials by Screening. Standards. Am. Soc. Agric. Eng., St. Joseph, MI.

Ferraretto, L., R. Shaver and J. Lauer. 2014. Influence of ensiling on the digestibility of whole-plant corn silage. UWEX Team Forage. Focus on Forage Series - 16:3. http://fyi.uwex.edu/forage/fof/

Ferraretto, L. F., and R. D. Shaver. 2013a. Meta-analysis: Effects of corn silage hybrid type on intake, digestion, and milk production by dairy cows. J. Dairy Sci. 96(Suppl. 1):214 (Abstr.).

Ferraretto, L. F., and R. D. Shaver. 2013b. We can make better corn silage. Hoard's Dairyman. Augsut 25th issue. pg. 537.

Ferraretto, L. F., and R. D. Shaver. 2012a. Meta-analysis: Impact of corn silage harvest practice on intake, digestion and milk production by dairy cows. The Prof. Anim. Sci. 28:141-149.

Ferraretto, L. F., and R. D. Shaver. 2012b. Effect of Corn Shredlage on lactation performance and total tract starch digestibility by dairy cows. The Prof. Animal Scientist. 28:639-647.

Ferreira, G., and D. R. Mertens. 2005. Chemical and physical characteristics of corn silages and their effects on in vitro disappearance. J. Dairy Sci. 88:4414-4425.

Kononoff, P. J., A. J. Heinrichs, and D. R. Buckmaster. 2003. Modification of the Penn State forage and total mixed ration particle separator and the effects of moisture content on its measurements. J. Dairy Sci. 86:1858-1863.

Table 1. Survey descriptive statistics (mean, standard deviation, minimum and maximum) for herd size (number of milking cows in herd), and milk yield, fat%, protein%, and urea-nitrogen (mg %).

	Herd Size	Milk Yield and Composition			
	n	lb/cow/day	Fat %	Protein %	MUN, mg %
Mean	840	87	3.8	3.2	10.1
Stdev	655	10	0.4	0.2	1.6
Min	66	52	3.3	2.9	6.0
Max	3500	109	5.6	3.9	15.4

Table 2. Summary of silage harvest practices on the survey farms.

Survey Question	% of Surveys
Self-propelled forage harvester/processor	
Claas with Shredlage® processor	61%
Loren-Cut® rolls	7%
Others	32%
Silage Storage	
Bunkers or piles	95%
Bags	5%
Corn Silage Hybrid	
Dual-purpose	43%
Silage-specific	26%
BMR alone or in combination	31%
Use of Silage Inoculant	
Yes	87%
No	13%
Theoretical length of cut[1]	
>26 mm	14%
26 mm	47%
22 mm	32%
≤19 mm	7%
Roll gap[1]	
>2.5 mm	3%
2.5 mm	16%
2.0 mm	48%
1.5 mm	18%
≤1.0 mm	15%

[1]As indicated on the survey form.

Table 3. Survey descriptive statistics (mean, standard deviation, minimum and maximum) for whole-plant corn silage dry matter% (DM; as-fed basis) and starch% (DM basis) , as-fed % retained on top (19 mm) and top 2 (8 and 19 mm) sieves of Penn State shaker box, mean particle length (MPL; mm) on as-fed samples with the WI Oscillating Screen Particle Separator, and kernel processing score on dried samples using a Ro-Tap shaker (% starch passing thru a 4.75 mm sieve).

Sample[1] (n)	Descriptive Statistics	DM%	Starch%	% PSU Top Sieve	% PSU Top 2 Sieves	WI-OS MPL (mm)	Processing Score
All (76)	Mean	34.2%	33.7%	17.9%	76.6%	11.8	66.2%
	Stdev	3.8%	5.7%	8.1%	5.1%	1.4	5.7%
	Min	25.6%	17.1%	3.3%	65.1%	8.6	49.5%
	Max	47.1%	42.6%	43.7%	85.9%	14.8	82.7%
Shredlage (46)	Mean	34.5%	33.6%	19.6%	75.7%	11.9	67.2%
	Stdev	4.0%	6.2%	7.8%	5.4%	1.4	5.9%
	Min	25.6%	17.1%	7.2%	65.1%	9.0	49.5%
	Max	47.1%	42.6%	39.9%	85.9%	14.8	82.7%
Loren-Cut (5)	Mean	33.6%	33.3%	14.7%	76.0%	10.9	66.0%
	Stdev	4.1%	4.7%	6.5%	6.4%	1.9	9.0%
	Min	27.8%	24.2%	3.3%	66.1%	8.6	55.0%
	Max	38.4%	36.9%	21.6%	82.4%	13.5	76.3%
Conventional (6)	Mean	33.2%	33.6%	16.1%	79.9%	12.1	62.2%
	Stdev	0.8%	3.4%	5.8%	2.9%	1.0	5.1%
	Min	31.6%	27.4%	7.8%	74.8%	10.5	53.2%
	Max	34.0%	39.0%	24.5%	83.8%	13.6	69.4%
JD-32% (5)	Mean	34.0%	35.1%	12.3%	78.4%	11.4	65.1%
	Stdev	1.4%	2.0%	3.6%	3.5%	0.8	8.9%
	Min	31.5%	31.2%	8.1%	73.7%	10.1	52.1%
	Max	35.7%	36.6%	17.0%	82.7%	12.4	76.3%
Horning-32% (2)	Mean	34.7%	40.3%	6.3%	73.6%	9.7	69.8%
	Stdev	0.7%	0.1%	2.0%	2.6%	0.5	2.4%
	Min	34.0%	40.2%	4.3%	71.0%	9.2	67.4%
	Max	35.4%	40.3%	8.2%	76.1%	10.1	72.1%
Intermeshing Disc (5)	Mean	31.4%	34.3%	14.6%	80.1%	12.5	64.1%
	Stdev	2.7%	4.2%	5.6%	4.1%	0.7	4.0%
	Min	27.0%	27.4%	8.1%	73.2%	11.5	57.4%
	Max	35.1%	40.6%	22.0%	85.2%	13.5	69.3%
Unavailable (7)	Mean	35.0%	31.7%	20.7%	77.4%	12.1	64.7%
	Stdev	4.8%	6.1%	10.8%	1.9%	1.3	2.3%
	Min	27.0%	21.4%	7.1%	75.3%	10.4	60.9%
	Max	44.3%	38.8%	43.7%	81.1%	14.4	67.5%

[1]Shredlage (Claas self-propelled forage harvester (SPFH), Shredlage® processor); Loren-Cut (varied SPFH, Loren-Cut® rolls); Conventional (varied SPFH, conventional processor); JD-32% (John Deere SPFH, conventional processor, 32% speed differential); Horning-32% (varied SPFH, Horning rolls, 32% speed differential); Intermeshing Disc (varied SPFH, varied disc processors); Unavailable (SPFH and processor type not indicated on survey).

Table 4. Summary of responses to feeding-related survey questions.

Survey Question (# of farms responding)	**% of Surveys**
Time feeding new-type silage (65)	
≤6 months	35.4%
6-12 months	44.6%
>12 months	20.0%
% forage in diet DM (62)	
≤50%	58.1%
50-60%	33.9%
>60%	8.1%
% forage in diet DM (63)	
Increased	22.2%
Same	68.3%
Reduced	9.5%
% new-type silage diet DM (59)	
≤30%	35.6%
30-40%	40.7%
>40%	23.7%
% corn silage in diet DM (64)	
Increased	46.9%
Same	50.0%
Reduced	3.1%
Use hay or straw (65)	
Yes	53.8%
No	46.2%
Hay or straw reduced (35)	
Yes	40.0%
No	60.0%

Table 5. Summary of responses to animal-related survey questions.

Survey Question (# of farms responding)	% of Surveys
Milk yield (66)	
Increased	45.5%
Reduced	6.1%
No change	39.4%
Unsure	9.1%
Fat % (66)	
Increased	43.9%
Reduced	7.6%
No change	42.4%
Unsure	6.1%
Feed sorting (67)	
Increased	14.9%
Reduced	14.9%
No change	67.2%
Unsure	3.0%
Herd health (66)	
Increased	31.8%
Reduced	1.5%
No change	54.5%
Unsure	12.1%
Manure scores (65)	
Improved	33.8%
Worse	7.7%
No change	47.7%
Unsure	10.8%

Table 6. Summary of responses to equipment-related survey questions.

Survey Question (# of farms responding)	% of Surveys
Wet tons thru rolls (56)	
≤20,000	58.9%
20,000-30,000	17.9%
>30,000	23.2%
Silage pack density (65)	
Increased	40.0%
Reduced	4.6%
No change	43.1%
Unsure	12.3%
Tons per hour (63)	
Increased	19.0%
Reduced	23.8%
No change	41.3%
Unsure	15.9%
Fuel usage (63)	
Increased	28.6%
Reduced	7.9%
No change	47.6%
Unsure	15.9%
Roll wear (62)	
Increased	19.4%
Reduced	4.8%
No change	53.2%
Unsure	22.6%

Figure 1. Frequency distribution for % on the top screen of the Penn State shaker box on all samples.

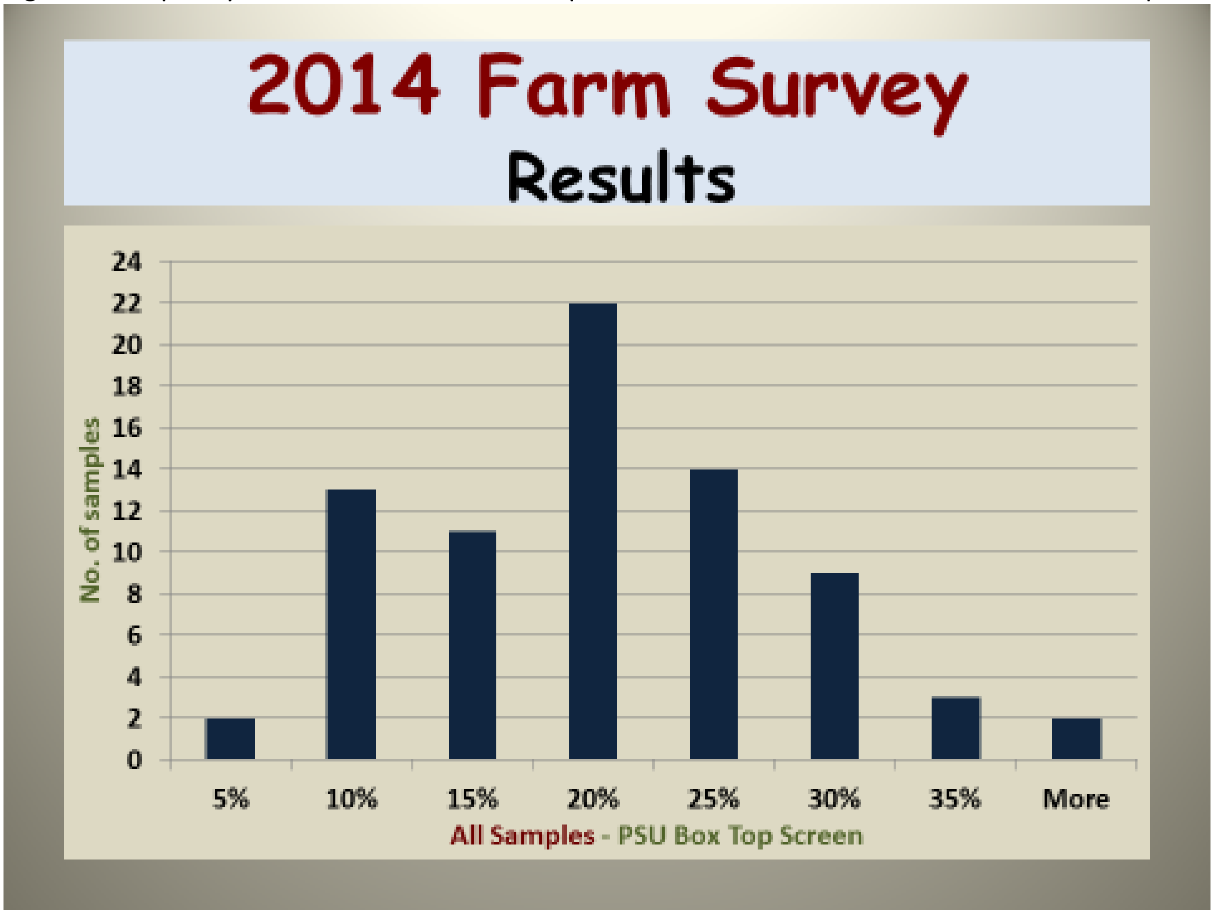

Figure 2. Frequency distribution for processing score on all samples.

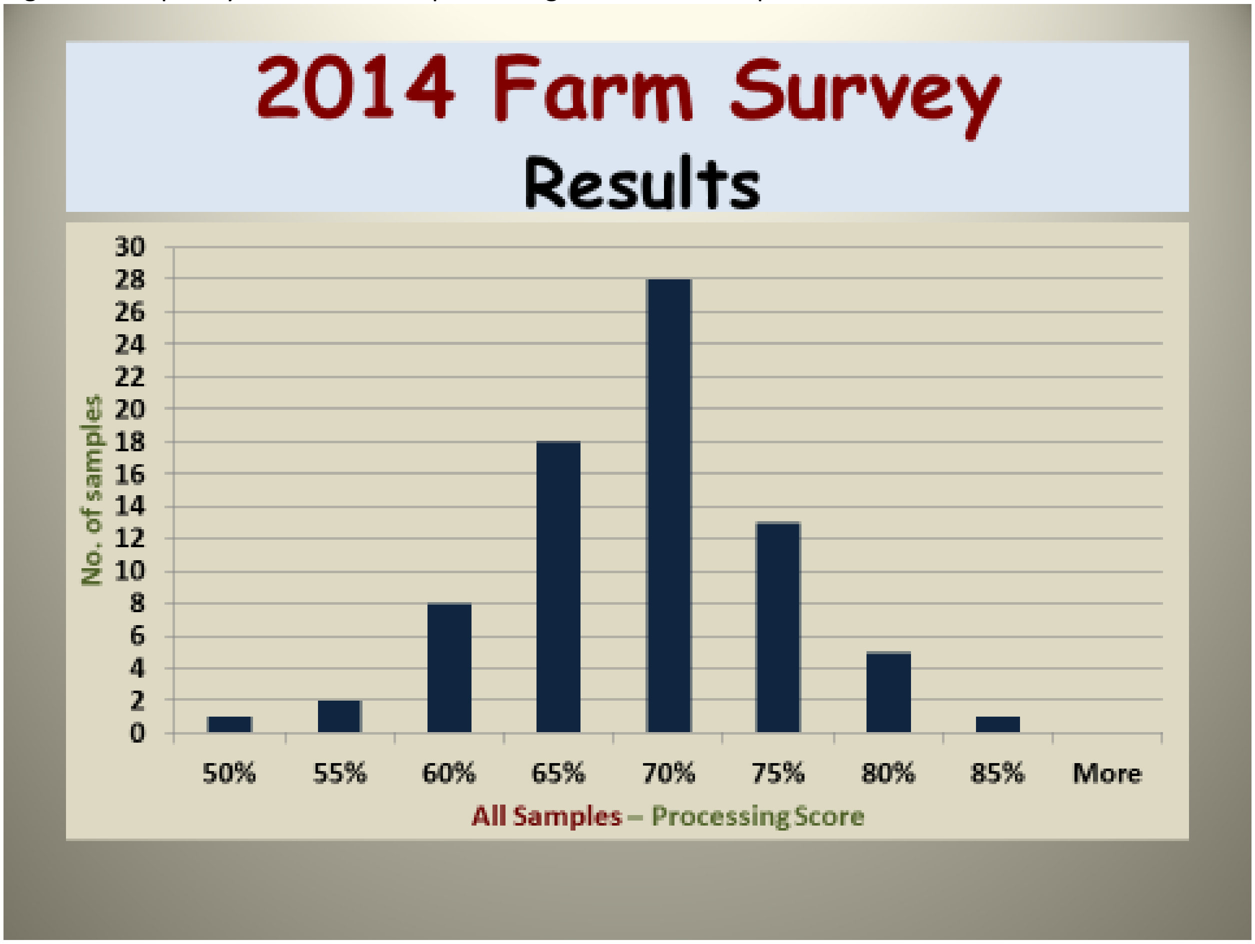

Figure 3. Frequency distribution for % on the top screen of Penn State shaker box on shredlage samples.

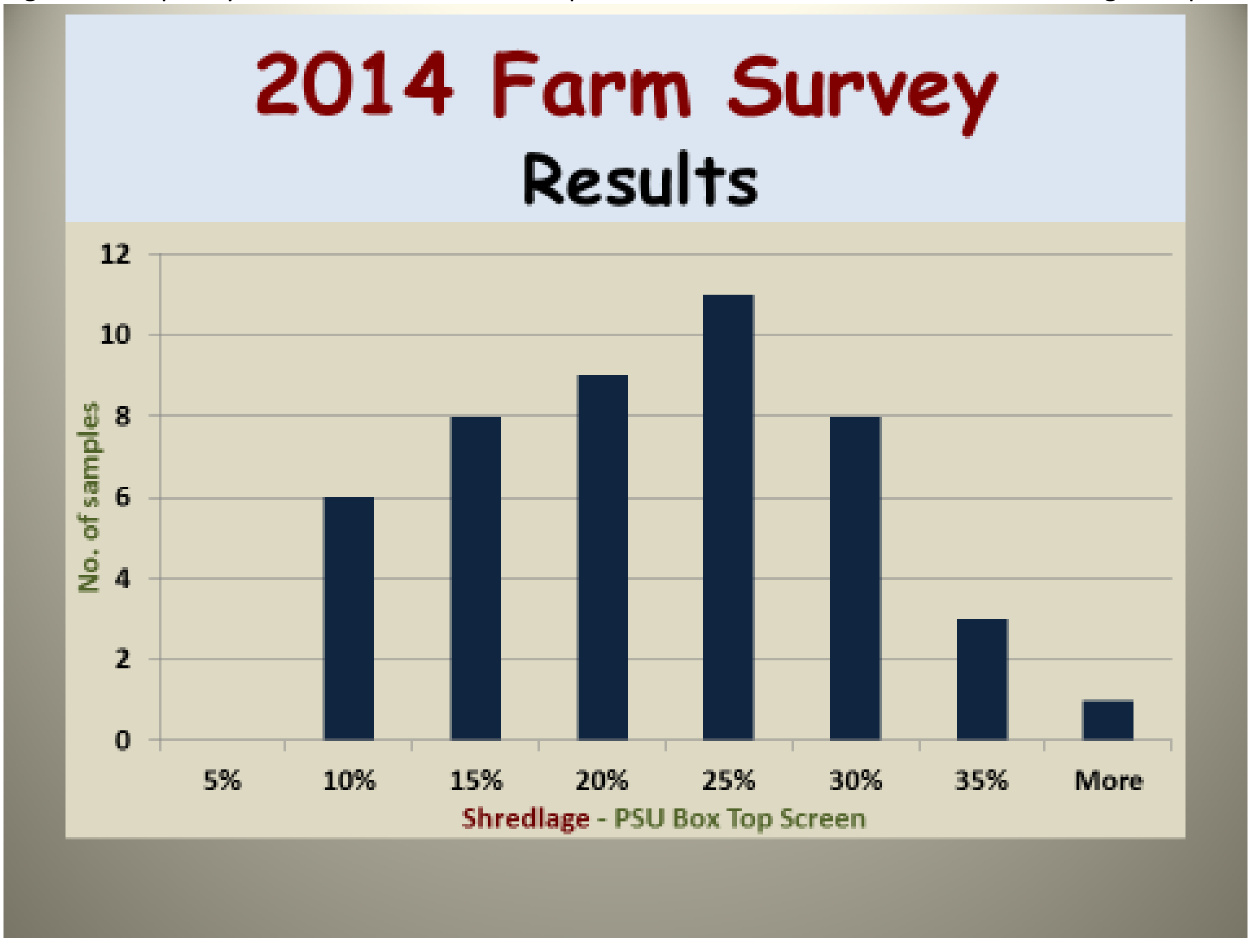

Figure 4. Frequency distribution for processing score on shredlage samples.