Survey of Silage Crop Nutritive Value in New Mexico and West Texas

Circular 665

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Cooperative Extension Service • College of Agricultural, Consumer and Environmental Sciences

INTRODUCTION

Various crops are grown in New Mexico for silage preservation to be utilized in animal feeding operations (Figures 1 through 3). When it is not possible or time constraints prevent laboratory analysis of all feeds to be consumed by livestock, tabulated data can be used to give general values of different feedstuffs. In an effort to provide typical ranges and expected nutritive value of the different silage crops grown in eastern New Mexico and West Texas, a survey of commercial laboratory-submitted samples was taken from the region. Knowing common ranges and average nutritional value of crops such as corn, forage sorghum, and small grains is important in determining how certain crops might contribute to local feeding requirements and subsequent management associated with crop selection and ensiling practices. The large databases of commercial laboratories are a valuable and reliable source of crop nutrition information obtained over varying management and growing environments.

***Figure 1*. Forage sorghum being chopped for ensiling near Clovis, NM.**

METHODS

Datasets obtained from near-infrared spectroscopy (NIRS) analyses of corn, sorghum, and small grain (e.g., wheat, triticale) silages were obtained from a National Forage Testing Association-certified laboratory (ADM Laboratories, LLC, Clovis, NM) where samples were submitted from across New Mexico and West Texas. These samples were submitted from 2007 to 2010 and contained a broad range of dry matter (DM) content upon submission. Data were analyzed for mean and range estimates of parameters such as DM, crude protein (CP), relative feed value (RFV), total digestible nutrients (TDN), acid detergent fiber (ADF), neutral detergent fiber (NDF), and the minerals calcium (Ca), phosphorus (P), and potassium (K). For more on the definitions of these nutritive value terms, see Circular 641, *Hay Quality, Sampling, and Testing* (http://aces.nmsu.edu/pubs/_circulars/CR-641.pdf).

No farm management information was available for the samples used in this analysis, and it is likely that both pre- and post-ensiled samples were

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Figure 2. **Triticale being chopped for silage after swathing near Clovis, NM.**

Figure 3. **Leveling and packing of chopped material in a silage bunker prior to covering for ensiling.**

included in this large dataset. However, analyses are broken out by crop species, and three different ranges of DM content were used to give a general, relative maturity at harvest (i.e., Dry, >40% DM; Typical, 25–40%; and Wet, <25%). It should be noted that an "optimum" DM for most silage is not less than 30%, especially for crops such as small grains and sorghums. However, there are instances when these crops are harvested at the proper growth stage (e.g., soft-dough) but have not dried to the proper DM content before ensiling. The National Research Council (NRC) lists a "less than 25%" category for corn silage, but doesn't include data from 25 to 31% in their tables. Since this range accounts for 30% of the small grain and 50% of the sorghum samples submitted from this region, we felt it was necessary to include these samples in the Typical category. For the RFV component only, DM categories were analyzed separately for each crop using the MIXED procedure of SAS (SAS V9.2, SAS Inst., Cary, NC). Differences among means within a crop were separated using Fisher's Protected LSD when F tests were significant ($P \leq 0.05$).

Results from the survey are shown in Tables 1 through 4 and Figure 4. Tables include the mean, maximum, and minimum values, and the standard deviation (SD) for each DM category. Survey results are compared here with dairy cattle nutrient requirements published by NRC (2001). While it is understood that this is not the only resource available to compare means and ranges of common feedstuffs, it is likely the most utilized and referenced resource for dairy cow nutrition requirements and ration formulation. As stated in NRC, locally specific differences from NRC published values can occur for several nutritional parameters presented.

RESULTS

Sample Dry Matter

While inferences taken from such a diverse dataset with a large degree of management variation are limited, a few generalizations can be made from this survey. First, it is evident that the majority of harvests, whether corn or sorghum, are conducted during the most optimum stage of plant maturity for ensiling (i.e., between 25 and 40% whole-plant DM). This typically coincides with the 1/3 to 1/2 kernel milk line stage for corn and the soft-dough stage for sorghum. For harvests outside of this window, more were taken at drier stages (>40% DM) than at what would be considered too wet (<25% DM). This may indicate delays associated with limited custom harvesting equipment and availability or even weather delays. This may also be indicative of the growers' desire to produce large quantities of forage necessary to meet the high feed demand and to allow the plants to fill as much grain as possible before cutting. Regarding small grains, it is more difficult to

Table 1. Corn Forage Nutritive Value as Determined by NIRS Analysis of Samples from Eastern New Mexico and West Texas Submitted to a Commercial Laboratory from 2007 to 2010

		DM†	ADF	NDF	CP	Ca	P	K	TDN	RFV
Dry Matter		— — — — — — — — — — — — — — — % of DM— — — — — — — — — — — — — — —								
Dry (>40%)	Mean	43.6	27.1	42.6	7.1	0.258	0.223	1.42	64.1	150
n = 595	Max.	61.5	43.8	58.8	13.3	0.448	0.294	2.15	66.4	217
	Min.	40.5	20.1	31.1	3.4	0.101	0.135	0.87	52.4	92
	SD‡	3.4	4.5	4.7	1.2	0.045	0.036	0.22	2.2	23
NRC, 2001	Mean	44.2	27.5	44.5	8.5	0.26	0.25	1.10	65.4	--
Typical (25–40%)	Mean	32.9	26.2	43.1	8.1	0.259	0.215	1.48	69.6	150
n = 3,405	Max.	40.4	42.0	66.5	11.6	0.446	0.288	2.07	73.7	214
	Min.	24.5	20.0	31.3	5.0	0.105	0.104	0.79	59.2	83
	SD	3.7	3.4	4.6	0.9	0.046	0.038	0.25	2.3	20
NRC, 2001	Mean	35.1	28.1	45.0	8.8	0.28	0.26	1.20	68.8	--
Wet (<25%)	Mean	23.8	29.1	47.1	8.8	0.272	0.191	1.44	67.7	134
n = 94	Max.	24.4	42.4	71.2	11.2	0.391	0.270	2.01	73.0	181
	Min.	19.5	21.0	37.1	6.5	0.181	0.140	0.98	58.9	73
	SD	1.2	4.3	6.2	1.2	0.052	0.041	0.31	2.8	22
NRC, 2001	Mean	23.5	34.1	54.1	9.7	0.29	0.24	1.30	65.6	--

†DM = dry matter, ADF = acid detergent fiber, NDF = neutral detergent fiber, CP = crude protein, Ca = calcium, P = phosphorus, K = potassium, TDN = total digestible nutrients, and RFV = relative feed value.

‡SD = standard deviation.

Table 2. Sorghum Forage Nutritive Value as Determined by NIRS Analysis of Samples from Eastern New Mexico and West Texas Submitted to a Commercial Laboratory from 2007 to 2010

		DM†	ADF	NDF	CP	Ca	P	K	TDN	RFV
Dry Matter		— — — — — — — — — — — — — — — % of DM— — — — — — — — — — — — — — —								
Dry (>40%)	Mean	44.8	38.4	60.1	7.2	0.383	0.181	2.42	64.3	94
n = 227	Max.	59.9	54.7	76.2	17.7	0.997	0.320	3.93	69.1	167
	Min.	40.5	23.0	38.0	3.1	0.008	0.056	0.87	59.1	50
	SD‡	4.8	6.2	7.6	3.3	0.196	0.057	0.66	1.9	20
Typical (25–40%)	Mean	31.9	36.3	53.6	8.2	0.637	0.209	2.50	64.9	108
n = 1,925	Max.	40.4	53.2	73.8	18.6	1.246	0.438	4.28	69.2	211
	Min.	24.5	22.6	30.9	3.0	0.011	0.053	0.67	59.7	60
	SD	3.8	6.2	7.0	2.5	0.220	0.068	0.66	1.9	22
NRC, 2001	Mean	28.8	40.7	63.3	10.8	0.64	0.24	2.57	54.4	--
Wet (<25%)	Mean	22.5	37.5	50.4	11.0	0.723	0.247	2.65	64.6	114
n = 192	Max.	24.4	54.7	68.1	19.2	1.276	0.459	4.73	68.8	179
	Min.	10.1	23.8	36.0	4.4	0.274	0.113	1.08	59.3	66
	SD	2.6	7.3	7.0	2.4	0.190	0.079	0.70	2.3	25

†DM = dry matter, ADF = acid detergent fiber, NDF = neutral detergent fiber, CP = crude protein, Ca = calcium, P = phosphorus, K = potassium, TDN = total digestible nutrients, and RFV = relative feed value.

‡SD = standard deviation.

Table 3. Small Grain Forage Nutritive Value as Determined by NIRS Analysis of Samples from Eastern New Mexico and West Texas Submitted to a Commercial Laboratory from 2007 to 2010 (small grains categorized by DM range)

		DM†	ADF	NDF	CP	Ca	P	K	TDN	RFV
Dry Matter		— — — —	— — — —	— — —	— —	—% of DM—	— — — —	— — — —	— — —	— — —
Dry (>40%)	Mean	44.3	28.6	54.5	15.3	0.316	0.348	3.11	67.3	114
n = 478	Max.	63.0	41.5	69.4	29.5	1.418	0.520	4.90	70.4	147
	Min.	40.5	18.6	43.7	6.4	0.006	0.169	1.52	63.3	81
	SD‡	4.0	5.1	4.3	4.1	0.224	0.094	0.63	1.6	14
Typical (25–40%)	Mean	33.7	31.5	55.2	14.4	0.474	0.355	3.08	66.4	109
n = 1,515	Max.	40.4	44.2	68.9	26.1	1.230	0.581	5.27	71.8	152
	Min.	24.5	14.1	43.2	6.8	0.006	0.207	1.36	62.5	74
	SD	3.8	5.0	3.9	3.0	0.227	0.090	0.50	1.5	13
NRC, 2001 (Wheat)	Mean	33.3	37.6	59.9	12.0	0.38	0.29	2.28	57.2	--
NRC, 2001 (Triticale)	Mean	32.0	39.6	59.7	13.8	0.57	0.33	3.01	57.2	--
Wet (<25%)	Mean	21.1	33.0	53.2	17.0	0.687	0.435	3.54	66.0	112
n = 122	Max.	24.4	48.5	60.9	28.3	1.177	0.732	5.08	71.5	171
	Min.	11.2	15.2	40.6	9.6	0.337	0.291	2.55	61.2	81
	SD	3.8	6.6	4.4	3.9	0.212	0.108	0.63	2.0	17

†DM = dry matter, ADF = acid detergent fiber, NDF = neutral detergent fiber, CP = crude protein, Ca = calcium, P = phosphorus, K = potassium, TDN = total digestible nutrients, and RFV = relative feed value.

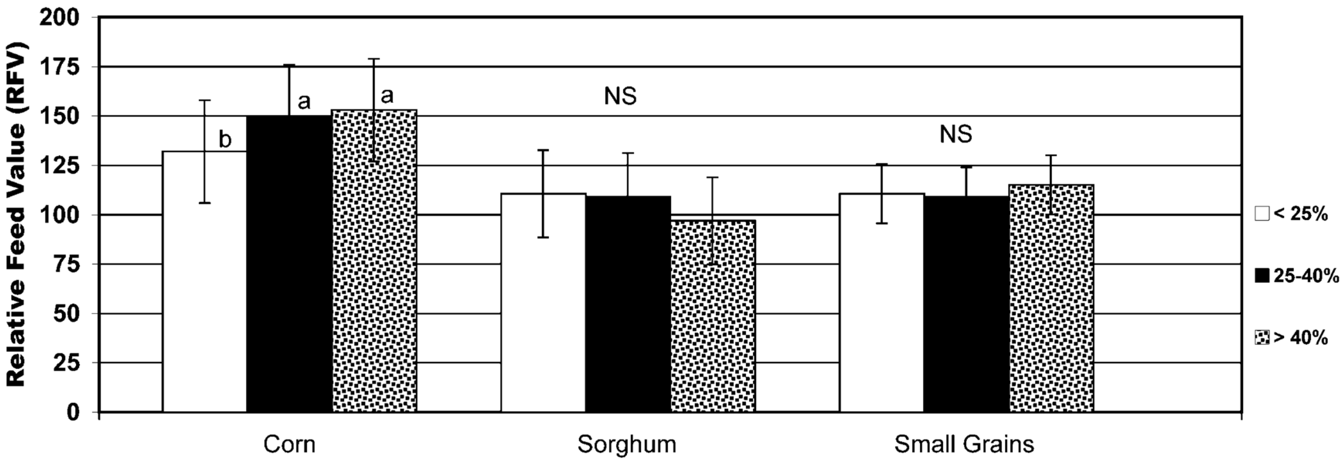
‡SD = standard deviation.

Table 4. Small Grain Forage Nutritive Value as Determined by NIRS Analysis of Samples from Eastern New Mexico and West Texas Submitted to a Commercial Laboratory from 2007 to 2010 (small grains categorized by NDF range)

		DM†	ADF	NDF	CP	Ca	P	K	TDN	RFV
NDF		— — — —	— — — —	— — —	— —	—% of DM—	— — — —	— — — —	— — —	— — —
Low (<50%)	Mean	35.7	26.8	48.1	18.8	0.522	0.360	3.36	67.9	132
n = 221	Max.	56.2	38.4	49.4	27.5	1.214	0.593	4.89	71.5	171
	Min.	13.5	15.2	40.6	10.6	0.009	0.228	1.86	64.3	113
	SD‡	9.1	3.9	1.7	3.5	0.269	0.078	0.51	1.2	9
Typical (50–60%)	Mean	35.3	30.6	54.9	14.5	0.463	0.366	3.16	66.7	110
n = 1,668	Max.	63.0	48.5	60.4	29.5	1.230	0.732	5.27	71.8	142
	Min.	11.2	14.1	49.5	6.4	0.006	0.173	1.36	61.2	81
	SD	6.6	4.8	2.6	3.1	0.234	0.094	0.51	1.5	10
NRC, 2001 (Wheat)	Mean	33.3	37.6	59.9	12.0	0.38	0.29	2.28	57.2	--
NRC, 2001 (Triticale)	Mean	32.0	39.6	59.7	13.8	0.57	0.33	3.01	57.2	--
High (>60%)	Mean	36.0	37.7	62.1	12.0	0.272	0.292	2.53	64.5	89
n = 226	Max.	53.8	44.2	69.4	17.5	1.418	0.579	4.13	69.0	109
	Min.	16.1	23.3	60.5	6.7	0.006	0.169	1.52	62.5	74
	SD	5.6	3.9	2.0	2.1	0.188	0.078	0.40	1.2	6

†DM = dry matter, ADF = acid detergent fiber, NDF = neutral detergent fiber, CP = crude protein, Ca = calcium, P = phosphorus, K = potassium, TDN = total digestible nutrients, and RFV = relative feed value.

‡SD = standard deviation.



[a,b]Values with the same letter within a crop are not different according to the LSD test ($P > 0.05$). Error bars represent ± 1 SD.

***Figure 4*. Relative feed value (RFV) of corn, sorghum, and small grain forages at Dry (>40%), Typical (>25–40%), and Wet (<25%) dry matter contents. Samples were submitted from eastern New Mexico and West Texas to a commercial laboratory from 2007 to 2010. Values are LSMeans.**

tell from this survey if harvests were made at early or late stages of development since wheat is either cut at boot stage and first swathed into windrows, allowed to dry temporarily, and then chopped at an optimum DM content, or it is direct cut at soft-dough stage when it would naturally be in the optimum range. However, regional observations indicate that most small grain silage crops (e.g., wheat, triticale, blends) are harvested near boot stage, and at soft-dough to a much lesser degree, especially in double cropping situations.

Nutritive Value

Selected corn nutrient composition results are shown in Table 1. When compared to values listed in NRC, there were some differences observed in regionally harvested crops. For example, the components ADF, NDF, CP, Ca, and P were lower in general than those reported in NRC for similar DM ranges. In contrast, K was higher in survey samples and TDN tended to be comparable or higher. For survey data, RFV was analyzed further (ANOVA) to assess any differences among the DM contents submitted to the lab. Typical and Dry did not differ in RFV; however, Wet was significantly less than both (Figure 4). This was due to lower ADF and NDF proportions in the Typical and Dry DM samples (Table 1), likely a result of increased starch (data not shown). Corn usually increases in starch with grain fill at later maturities. Most of the corn in the region is adequately fertilized and well-irrigated, which often leads to high yields and excellent nutritive value, the latter of which is supported by the RFV values presented from this survey.

Results for sorghum samples submitted are presented in Table 2. Large differences existed between results from the survey and those published in NRC. The most representative category for comparison in NRC was “Sorghum, Sudan Type – Silage” (avg = 28.8% DM); however, values listed in this category for silage may not adequately represent and may underestimate the average nutritive value of sorghum grown for silage in eastern New Mexico and West Texas. The NRC category corresponds closest to the Typical DM grouping (avg = 31.9% DM) in the survey. Components such as ADF, NDF, and CP were considerably lower in the survey; however, TDN was over 10% higher, likely due to the lower fiber composition. These differences could be due to several factors, including variation in sorghum types selected by producers (e.g., forage sorghum, sorghum sudangrass hybrids, grain sorghum), increased use of brown midrib (BMR, low lignin) sorghums, and the high variability associated with grain contribution of forage sorghum varieties grown in different regions. Calcium, P, and K were comparable between the two sources. When LSMeans were compared for sorghum in the survey, differences among DM contents were not significant for RFV (Figure 4).

Small grain survey results are presented in Tables 3 and 4. Similar to sorghum, small grain nutritive value was higher than that of NRC ("Wheat/Triticale silage – headed or early head"), and results were closer to those values reported for pre-ensiled small grain silage crops by Marsalis et al. (2008). The survey showed lower ADF and NDF and higher CP and TDN estimates, likely due to the fact that most small grains grown for forage in the region are commonly harvested prior to heading. Survey Ca, P, and K estimates were greater than those reported for wheat, but were similar to those reported for triticale. LSMeans of the small grains indicate that RFV was similar regardless of DM content at time of submission. Due to varying harvest practices on the small grains (e.g., wilting times), greater DM content does not necessarily mean that plants were harvested at later maturity. In fact, minimum RFV (<82) and maximum ADF (>40%) and NDF (>60%) values suggest that mature samples were submitted in all DM categories. As such, NDF may be a better indicator of maturity than DM with the small grains. Hence, small grain data are also presented based on range of NDF of the samples submitted (Table 4). When indexed by NDF, survey results in the High (>60% NDF) category were closest to those reported in NRC (2011) for ADF, NDF, CP, and TDN.

CONCLUSIONS

Nutrient information from this survey gives a more regionally specific estimate of nutritional value of crops commonly grown in New Mexico and West Texas for silage than other publications that have a broader dataset of estimates. NRC states that regional growing conditions and varying management can lead to values different from those published. The largest differences observed between these two sources came with sorghum and wheat estimates. Discrepancies could be due to the number of samples represented by both sources and the variability in crop variety and management associated with different regions of the U.S., as well as differences in laboratory procedures used. As a result, the potential for more sorghum silage crops to be grown in the region in the future necessitates that more localized results be utilized when determining representative values for predicting nutritive value at harvest and ultimately balancing dairy rations. This survey provides producers and nutritionists information on crop contributions going into and feed coming out of ensiling facilities, as well as what can be expected when crops are harvested at different stages of maturity and the magnitude of the change in nutritive value due to maturity. Having any forage tested prior to feeding is recommended because nutritive value of individual samples may vary from those presented here.

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Notes

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