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Nutritional evaluation of corn and sorghum crop residues

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NUTRITIONAL EVALUATION OF CORN AND SORGHUM CROP RESIDUES^{1,2,3}

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Summary

Crop residue samples from 22 grazed and nongrazed corn and sorghum residue fields across Kansas were collected every 2 weeks during the 1997/98 winter feeding season to evaluate quality and yield. Corn residue averaged about 2 ½ tons of total dry matter (DM)/acre, with the leaf fraction (attached and unattached) constituting about 60% of that residue. Unattached leaves represented 85% of the total leaf DM. Yield estimates for sorghum residue averaged over 2 tons/ acre. The stem component represented 55 to 60% of the total DM collected, and about 58% of the leaves remained attached to the stem.

(Key Words: Crop Residues, Forage Quality.)

Introduction

Tillage and fertilization practices and crop varieties have changed dramatically

since the 1970's when the vast majority of crop residue research was conducted by Midwest universities. Moreover, today's harvesting equipment is much more efficient, so less grain is left in the field. The objective of this demonstration project was to obtain yield and quality estimates of corn and sorghum residue from across Kansas.

Experimental Procedures

Twenty-one County Extension Agents from across the state each identified a progressive livestock producer willing to participate in the study. At the onset of the grazing season, approximately ½ acre at each location was excluded from active grazing to evaluate the effects of weathering on residue nutrient content.

Residue was collected at 2-week intervals throughout the grazing season. For each sampling period, the residue in the grazed and nongrazed areas was collected from four different areas of the residue field in 8-foot

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row lengths and separated into attached leaves (manually removed from stem), unattached leaves, and stems (harvested above the brace root). After each sampling period, the collected samples were allowed air dry. All subsamples from each plant part and sampling period were weighed individually to estimate lbs DM/ acre and ground through a lawn chipper. The replicated samples were composited and sent to a commercial forage testing laboratory for analysis of DM and crude protein (CP) content. In addition, neutral detergent fiber (NDF) and acid detergent fiber (ADF) levels were determined, and the ADF concentrations were used to estimate TDN (see footnote in tables). To arrive at district averages, data from individual counties were composited by crop. Only counties with multiple sampling periods were included in this compilation. Means and standard deviations are presented for each residue type by plant part, as well as by grazed versus non-grazed.

Results and Discussion

Statewide averages for DM yield/acre and nutrient content of corn and sorghum residues are shown in Tables 1 and 4, respectively. Corn residue in the west averaged over 4 tons total DM/acre (Table 2). This value was almost double that from the central area and considerably higher than that from northeast Kansas. Corn leaves (attached and unattached) constituted 50 to 60% of residue DM. Unattached leaves represented almost 85% of the total leaf DM weight and 50%

of the total plant DM collected. These observations are consistent with earlier reports citing the vulnerability of corn residue to wastage from trampling and snow. Total CP content of corn residue averaged about 5% and ranged from 4.60 to 5.60% across the state (Table 5). CP contents averaged about 5% in the leaf fraction and close to 4% in the stem fraction. The TDN content of the leaf fractions (unattached and attached) ranged from 48 to 51% throughout the state, whereas that of stems was close to 44%.

The DM yields of sorghum residue for central Kansas averaged about 2.0 tons per acre and is consistent with previous research reporting lower residue production per acre for sorghum than corn (Table 3). The stem component represented 55 to 60% of the total DM collected from the grazed and ungrazed locations. Stem percentage (as a percent of total DM) increased and leaf fractions declined as residue grazing progressed. In contrast to corn, about 58% of the sorghum leaves were attached.

Total CP contents of sorghum residue in the central area averaged 5.6% for grazed and 6.8% for the ungrazed areas (Table 6). CP contents in the leaf fractions averaged 8.0% in the nongrazed and about 7% in the grazed fields. The TDN for both sorghum stem and leaf fractions was near 50%. CP and TDN values obtained from the collected samples are comparable to values from other published reports.

Table 1. Statewide Dry Matter Yield (lbs DM/acre) of Crop Residue by Crop Type and Plant Part

Plant Part	Corn		Sorghum	
	Grazed	Nongrazed	Grazed	Nongrazed
Leaves				
Unattached	2655 ± 1084	2787 ± 1148	636 ± 754	778 ± 711
Attached	486 ± 329	581±326	867 ± 551	1100 ± 541
Stem	2388 ± 1181	2544 ± 1309	2507 ± 1026	2412 ± 1064

Table 2. Corn Dry Matter Yield (lbs DM/acre) by Crop Reporting District and Plant Part

Plant Part	Central		West		East	
	Grazed	Nongrazed	Grazed	Nongrazed	Grazed	Nongrazed
Leaves						
Unattached	2434 ± 688	2415 ± 753	4204 ± 579	4516 ±	1928 ± 448	2047 ±
Attached	499 ± 425	431 ± 421	640 ± 253	880 ± 126	389 ± 169	522 ± 242
Stem	2707 ± 589	2952 ± 782	3943 ± 345	4146 ±	1272 ± 207	1256 ±

Table 3. Sorghum Dry Matter Yield by Cropping District and Plant Part

Plant Part	Central		East	
	Grazed	Nongrazed	Grazed	Nongrazed
Leaves				
Unattached	660 ± 550	868 ± 798	556 ± 294	506 ± 210
Attached	898 ± 580	1170 ± 545	715 ± 385	791 ± 443
Stem	2513 ± 1006	2447 ± 1117	2482 ± 1207	2258 ± 875

Table 4. Statewide Nutrient Contents of Corn and Sorghum Crop Residues by Plant Part

Plant Part	Corn		Sorghum	
	Grazed	Nongrazed	Grazed	Nongraze
Leaves				
Unattached				
DM ¹	88.6 ± 3.4	86.9 ± 5.2	87.1 ± 4.8	87.5 ± 3.9
CP	5.18 ± .55	5.15 ± .68	6.54 ± 2.4	7.4 ± 2.6
ADF	49.9 ± 1.9	50.6 ± 2.9	48.4 ± 4.2	47.6 ± 4.7
NDF	76.2 ± 1.9	74.9 ± 4.4	66.1 ± 8.1	67.0 ± 8.6
TDN ²	49.5 ± 2.3	49.0 ± 2.3	50.7 ± 3.3	51.3 ± 3.7
Attached				
DM	87.4 ± 7.7	87.5 ± 6.1	86.6 ± 5.3	87.3 ± 3.1
CP	5.17 ± .74	5.13 ± .98	6.96 ± 2.7	8.17 ± 2.7
ADF	50.25 ± 3.5	49.7 ± 2.1	47.2 ± 4.1	45.1 ± 4.2
NDF	77.1 ± 2.9	77.0 ± 2.2	66.0 ± 4.2	64.4 ± 4.7
TDN	49.5 ± 2.8	49.0 ± 1.7	51.6 ± 3.2	53.3 ± 3.3
Stem				
DM	89.1 ± 3.5	88.9 ± 3.7	70.0 ± 18.4	68.3 ± 18.4
CP	4.05 ± .76	4.14 ± .47	4.20 ± 1.6	4.43 ± 1.6
ADF	57.2 ± 3.5	56.7 ± 2.4	50.7 ± 3.2	50.3 ± 3.7
NDF	79.3 ± 4.0	79.1 ± 2.2	72.8 ± 4.1	72.1 ± 4.6
TDN	43.7 ± 2.8	44.1 ± 1.9	50.2 ± 7.1	49.1 ± 2.9

¹DM= % dry matter; CP= % crude protein; ADF = % acid detergent fiber; NDF = % neutral detergent fiber; TDN = % total digestible nutrients.

²% TDN = 88.9 - (.79 × % ADF).

Table 5. Corn Residue Nutrient Content by Crop Reporting District and Plant Part

Plant Part	Central		West		East	
	Grazed	Nongrazed	Grazed	Nongrazed	Grazed	Nongrazed
Leaves						
Unattached						
DM ¹	92.6 ± 1.4	92.4 ± 1.4	88.4 ± .58	84.8 ± 4.8	85.8 ± 2.2	84.0 ± 4.0
CP	5.27 ± .77	4.58 ± 5.4	5.1 ± .36	5.23 ± 2.8	5.18 ± .53	5.56 ± .69
ADF	51.3 ± 3.5	51.8 ± 3.8	50.6 ± 1.4	52.1 ± 1.55	48.5 ± 2.7	48.6 ± 1.7
NDF	77.2 ± 2	77.9 ± 2.0	76.4 ± 1.3	75.4 ± 2.9	75.4 ± 2.1	72.3 ± 5.1
TDN ²	48.4 ± 2.8	48.0 ± 3.0	48.9 ± 1.1	47.7 ± 1.2	50.6 ± 2.1	50.5 ± 1.31
Attached						
DM	92.4 ± 1.2	91.5 ± .88	88.9 ± 1.3	88.1 ± .98	83.1 ± 10.2	84.0 ± 8.2
CP	5.76 ± .67	5.78 ± 4.2	4.61 ± .28	5.75 ± .79	5.07 ± .72	4.24 ± .72
ADF	51.3 ± 3.0	51.0 ± 2.9	47.9 ± 8.4	49.2 ± .32	50.9 ± 4.39	49 ± 1.84
NDF	75.5 ± 2.9	75.9 ± 1.4	79.3 ± 1.39	75.7 ± 1.9	76.9 ± 2.9	78.7 ± 1.9
TDN	48.4 ± 2.3	48.6 ± 2.3	51.1 ± .67	50 ± .25	48.7 ± 3.47	50.2 ± 1.5
Stem						
DM	93.3 ± 1.4	92.6 ± .82	88.3 ± 3.2	89.6 ± .71	86.5 ± 1.4	85.5 ± 2.8
CP	3.4 ± .73	3.87 ± .56	4.16 ± .44	4.12 ± .13	4.45 ± .67	4.36 ± .48
ADF	58.8 ± 4.5	57.9 ± 2.5	55.5 ± 3.7	55 ± 1.49	57.0 ± 2.7	56.6 ± 2.4
NDF	78.7 ± 4.7	78.8 ± 1.14	77.9 ± 5.4	77.1 ± 3.23	80.6 ± 2.8	80.5 ± 1.3
TDN	42.4 ± 3.5	43.2 ± 2.00	45.0 ± 2.9	45.4 ± 1.18	43.9 ± 2.1	44.2 ± 1.9

¹DM= % dry matter; CP= % crude protein; ADF = % acid detergent fiber; NDF = % neutral detergent fiber; TDN = % total digestible nutrients.

²% TDN = 88.9 - (.79 × % ADF).

Table 6. Sorghum Residue Content by Crop Reporting District and Plant Part

Plant Part	Central		East	
	Grazed	Nongrazed	Grazed	Nongrazed
Leaves				
Unattached				
DM ¹	86.4 ± 5.2	86.8 ± 4.2	89.8 ± 1.1	89.7 ± 1.12
CP	6.92 ± 2.6	8.0 ± 2.6	5.04 ± .31	5.26 ± .63
ADF	47.1 ± 3.4	46.02 ± 4	53.6 ± 2.4	53.4 ± 1.5
NDF	64.1 ± 8.0	64.3 ± 7.6	73.9 ± 1.2	77 ± 1.9
TDN ²	51.7 ± 2.7	52.5 ± 3.2	46.5 ± 1.9	46.7 ± 1.21
Attached				
DM	86.1 ± 5.6	86.7 ± 3.1	89.7 ± 1.6	89.9 ± 1.43
CP	6.9 ± 2.8	8.2 ± 2.9	7.32 ± 1.7	7.91 ± 1.71
ADF	46.9 ± 4.2	44.4 ± 4.3	49.2 ± 2.9	48.1 ± 1.6
NDF	65.7 ± 4.5	63.5 ± 4.7	68 ± .77	68.4 ± 1.8
TDN	51.9 ± 3.3	53.9 ± 3.4	50 ± 2.32	50.9 ± 1.3
Stem				
DM	68.5 ± 19.8	65.6 ± 18.7	79.7 ± 14.2	80 ± 12.6
CP	4.21 ± 1.6	4.5 ± 1.6	4.16 ± 1.21	4.01 ± 1.14
ADF	50.2 ± 3.2	49.9 ± 3.7	53.3 ± 1.74	52.3 ± 3.26
NDF	72.7 ± 4.4	71.9 ± 4.8	73.7 ± 2.2	73.1 ± 3.62
TDN	50.7 ± 7.5	49.5 ± 2.9	46.8 ± 1.4	47.6 ± 2.58

¹DM= % dry matter; CP= % crude protein; ADF = % acid detergent fiber; NDF = % neutral detergent fiber; TDN = % total digestible nutrients.

²% TDN = 88.9 - (.79 × % ADF).