Effect of Harvest Method on Residue Quality

Tasha M. King, Robert G. Bondurant, Jana L. Harding, Jim C. MacDonald and Terry J. Klopfenstein

Summary

A growing study was conducted to evaluate the effect of residue quality due to harvest method and inclusion of supplemental rumen undegradable protein on performance of growing steers. The residue harvested with an alternative method to minimize stem increased gain and improved efficiency compared to conventionally harvested corn residue. Inclusion of rumen undegradable protein increased gain and improved feed efficiency compared to diets without supplemental rumen undegradable protein.

Introduction

The use of corn residue as a roughage source has proven to be economical for producers. As the amount of corn produced has steadily increased over the past 60 years, the quantity of corn residue available has also increased. Previous research has shown that quality of the residue depends on which plant parts are harvested, with the husk having greater digestibility compared to the stalk, which is lowest in digestibility (2012 *Nebraska Beef Report*, pp. 11–12). Advancements in harvest method technology are allowing producers to harvest a bale containing less stalk than conventional baling methods. With residues being low in CP and energy, supplementation is often necessary to meet the nutrient needs of the calf to reach sufficient gains (2016 *Nebraska Beef Report*, pp. 31–32). Even with higher quality residues, metabolizable protein supplementation is still needed to achieve the desired performance of the growing calves. The objective of this trial was to determine the effect of harvest method on quality of residue in growing diets and the effect of supplemental rumen undegradable protein (RUP) to residue based growing diets.

Procedure

An 84-d growing trial was conducted utilizing 60 crossbred steers that were individually fed with the Calan gate system. Steers were limit-fed a diet of 50% alfalfa and 50% Sweet Bran® at 2% of BW for 5 days prior to start of trial to reduce variation in gut fill, then 3 consecutive day weights were collected, utilizing the average as initial BW. Steers were blocked by initial BW, and assigned randomly to 1 of 5 treatments with 12 steers per treatment in a randomized complete block design. Steers were implanted with Ralgro® on day one of the trial. Two harvest methods were utilized to obtain residue samples for the trial. The New Holland Cornrower Corn Head was used to obtain bales containing 2 or 8 rows. The Cornrower head allows the producer to adjust the number of stalks cut from 0 to 8 (8-row head) and windrows the residue (leaves and husks) on top of the stalks. Harvest method utilizing the Cornrower head was previously discussed in detail (*2015 Nebraska Beef Cattle Report*, pp. 62–63). Conventional bales were harvested in the traditional method of baling cornstalks to be used as a comparison, by raking all residue expelled through the combine and baling. The study consisted of 5 treatments. Both the 8 row and conventional corn residues were used to provide diets containing additional RUP and diets without added RUP, allowing for comparison of the effect of supplemental RUP. Due to the limited availability of 2 row corn residue bales, only a diet containing additional RUP was included to ensure RUP requirements of cattle were being met. The three harvest methods were compared using the three diets with additional RUP. Supplemental RUP was added to treatment diets through the addition of a 50:50 blend of SoyPass® and Empyreal 75® (Table 1). The 50:50 blend provided a balanced supply of amino acids in RUP. All diets were formulated to provide 200 mg/steer daily of

Table 1. Composition of growing diets (DM basis)

Ingredient, % of DM	Treatments				
	2-Row + RUP	8-Row	8-Row + RUP	Conventional	Conventional + RUP
2-Row Corn Residue	64.5	—	—	—	—
8-Row Corn Residue	—	64.5	64.5	—	—
Conventional Residue	—	—	—	64.5	64.5
Distillers Solubles	30	30	30	30	30
Supplement	5.5	5.5	5.5	5.5	5.5
Supplement Composition, %					
SoyPass®[a]	36	—	36	—	36
Empyreal 75®[b]	24	—	24	—	24
Soyhulls	—	60	—	3.0	—
Limestone	33	33	33	33	33
Tallow	2.6	2.6	2.6	2.6	2.6
Salt	2.8	2.8	2.8	2.8	2.8
Trace Minerals	1.0	1.0	1.0	1.0	1.0
Vitamin ADE	0.4	0.4	0.4	0.4	0.4
Rumensin®[c]	0.2	0.2	0.2	0.2	0.2

[a]SoyPass® is a branded soybean meal source high in RUP.
[b]Empyreal 75® is a branded corn gluten meal source high in protein.
[c]Diets were formulated to provide 200 mg/steer daily of Rumensin® at 16 lb DM consumption.

Rumensin®.

Feed samples and refusals were collected weekly, weighed, and then dried in a 140° F forced air oven for 48 hours to calculate individual DMI. At the conclusion of the trial, steers were limit fed the same diet (50% alfalfa and 50% Sweet Bran®) as the beginning limit-fed period for 5 days. Steers were weighed for 3 consecutive days with the average used to determine accurate ending BW.

Table 2. Main effects of supplemental RUP in corn residue based diets fed to growing steers[a]

	No RUP	Supplemental RUP	SE	*P*-Value
Initial BW, lb	617	618	4.9	0.91
Ending BW, lb	724	740	7.5	0.14
ADG, lb	1.27	1.45	0.07	0.08
DMI, lb/d	13.8	12.7	0.52	0.14
Feed:Gain[b]	10.50	8.65	—	0.02

[a]Interaction between residue harvest method and supplemental RUP was not statistically different ($P > 0.12$).
[b]Statistics calculated on Gain:Feed.

In Vitro *and* In Situ

An *in vitro* procedure was performed for 48 h to obtain *in vitro* organic matter digestibility (IVOMD) on the corn residues using the Tilley and Terry method with the modification of adding 1 g of urea to the buffer. Residues were filtered through non ash filters and ashed at 1112°F for 6 h.

An *in situ* study was conducted to determine the proportion of RUP in the three residue types, and the RUP digestibility of the RUP in the small intestine. Dacron bags (Ankom Technology, Fairport, NY) were filled with 1.25 g (as-is) of each corn residue. Four bags per residue were placed in mesh bags and incubated in the ventral rumen of 2 ruminally fistulated steers for 30 h. The bags were evenly divided with half being rolled and frozen until insertion in duodenum. The remaining *in situ* bags were washed and refluxed in neutral detergent solution using the ANKOM Fiber Analyzer (Ankom Technology).

In situ bags previously set aside were preincubated in a pepsin and HCL solution (1 g of pepsin/L and 0.01 *N* HCl) for 3 h at 98.6°F and agitated every 15 min to simulate abomasal digestion. Bags were inserted directly in the duodenum of 2 cows at the rate of 1 bag every 5 min for a total of 6 bags per cow. Once the bags were excreted they were rinsed and frozen until all bags were collected. Bags were washed and refluxed using the ANKOM Fiber Analyzer (Ankom Technology) and dried in a forced-air oven for 48 h at 140°F, air equilibrated for 3 h, and weighed allowing for calculation of intestinal disappearance of RUP.

Data for the performance trial were analyzed using MIXED procedures of SAS (SAS Institute, Inc., Cary, N.C.) as a randomized complete block design with animal serving as experimental unit. *In vitro* and *in situ* data were analyzed as completely randomized designs using the MIXED procedure of SAS. In both cases, residue harvest method was the treatment, and tube (*In vitro*) or steer (*In situ*) was the experimental unit.

Results

Effect of Supplemental RUP

To compare the effects of supplemental RUP to the treatments, the 8-row diets and conventional residue diets were set up as a 2 × 2 factorial. There were no interactions between conventional and 8-row residues, and dietary RUP concentration ($P > 0.12$). The addition of RUP resulted in a significant improvement in ADG ($P = 0.08$; Table 2), and F:G ($P = 0.02$) compared to the same diets without the additional RUP. Metabolizable protein has shown to be a limiting nutrient for growing steers. While the current study did not show an interaction between harvest method and supplemental RUP ($P > 0.12$), it is intriguing that steers fed residue from the conventional harvesting method responded greater to supplemental RUP (8.4% vs. 27.3% improvement in F:G for 8-row and conventional, respectively; data not shown).

Effect of Residue Harvest Method

To evaluate the effects of harvest method, comparisons were made within diets containing added RUP. Steers fed the 2-row residue diet had the greatest ADG, and consequently a greater ending BW compared to the conventionally harvested corn residue ($P < 0.10$; Table 3). There tended to be an improvement in the F:G ratio in the 2-row compared to the conventional corn residue ($P = 0.11$) resulting from the higher quality residue. The 2-row bales have a higher proportion of husk and leaf which are more digestible than stems and cobs. Results from the IVOMD show the 2-row have greater IVOMD compared to the other two residues ($P < 0.01$; Table 4). However, steers consuming the 2-row residue refused 5.0% of their daily feed compared to 1.5% refused by steers consuming conventional corn residue. Visual observations indicated that the refusals were primarily cobs. The 8-row residue diet showed no improvements over the conventional corn residue diet, which is likely due to the 8-row bales containing a similar proportion of stem as the conventional bales. IVOMD results support this conclusion showing no difference ($P > 0.05$) between the 8-row and conventional (IVOMD of 58.00% and 57.82% respectively). *In situ* results showed no difference in RUP content and RUP digestibility among the three residues (Table 5). From the results of this procedure it can be concluded that 40% and 60% should be used for RUP content (% of CP) and RUP digestibility of corn residues respectively.

These results suggest that by changing the harvest method of the residue, the quality can be improved over conventionally harvested residue. As number of rows is reduced in the bales, an increased ADG and improvement in F:G ratio was observed. However, with this reduction in rows, the yield of residue removed from the field is decreased. Based on grain yield, an estimated 4.23 tons/acre of residue is produced in the field. As the quality of the bale increased, the yield decreased down to 0.42 tons DM/acre with the 2-row bales.

Tasha M. King, graduate student

Robert G. Bondurant, research technician

Jana L. Harding, research technician

Jim C. MacDonald, associate professor

Terry J. Klopfenstein, professor, University of Nebraska-Lincoln Department of Ani-

Table 3. Effects of corn residue harvest method on performance of growing steers.

mal Science, Lincoln, Neb.

	2-Row + RUP	8-Row + RUP	Conventional + RUP	SE	Contrasts		
					2-Row vs. 8-Row	Conv. vs. 2-Row	Conv. vs. 8-Row
Initial BW, lb	617	617	618	6.6	0.97	0.90	0.93
Ending BW, lb	760	744	735	10.0	0.26	0.08	0.52
ADG, lb	1.71	1.51	1.39	0.10	0.17	0.03	0.41
DMI, lb/d	13.1	13.1	12.3	0.76	1.00	0.48	0.49
Feed:Gain[a]	7.69	8.33	9.09	—	0.16	0.11	0.83

[a]Statistics calculated on Gain:Feed.

Table 4. Effect of harvest method on IVOMD

	2-Row	8-Row	Conventional	SE	*P*-value
IVOMD[a], %	61.58[e]	58.00[f]	57.82[f]	0.5	< 0.001
IVDMD[b], %	55.77[e]	50.94[f]	49.57[g]	0.3	< 0.001
DOM[c], %	60.28	55.48	54.84	—	—
Residue yield, t/ac (DM)	0.42	2.25	2.22	—	—
TDN[d], t/ac	0.25	1.25	1.22	—	—

[a]In vitro organic matter digestibility
[b]In vitro dry matter digestibility
[c]Amount of digestible organic matter as % of dry matter. Calculated as OM content × IVOMD.
[d]TDN assumed equal to DOM
[e,f,g]Means with differing superscripts are different.

Table 5. Effect of harvest method on RUP of residue.

	2-Row	8-Row	Conventional	SE	*P*-value
CP, %	6.06	7.80	7.78		
RUP (% of CP), %	35.84	40.85	44.57	12.0	0.88
RUP digestibility, %	57.96	51.78	67.36	5.8	0.35