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The Effect of Harvest Method and Ammoniation of Corn Residue on Growing Calf Performance

Ashley C. Conway
University of Nebraska - Lincoln

Robert G. Bondurant
University of Nebraska-Lincoln, robby.bondurant@unl.edu

F. Henry Hilscher Hilscher
University of Nebraska-Lincoln, henry.hilscher@unl.edu

James C. MacDonald
University of Nebraska-Lincoln, jmacdonald2@unl.edu

Terry J. Klopfenstein
University of Nebraska - Lincoln, tklopfenstein1@unl.edu

See next page for additional authors

Authors
Ashley C. Conway, Robert G. Bondurant, F. Henry Hilscher Hilscher, James C. MacDonald, Terry J. Klopfenstein, and Mary Drewnoski

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Summary with Implications

A growing trial was conducted to determine the effect of feeding baled corn residue harvested using three different methods, with and without ammoniation of the residue. Residue harvested with the New Holland Cornrower™ with two rows of chopped stem added to the windrow resulted in a 9% increase in ADG compared to conventional rake and bale harvest or turning off the combine spreader and baling tailing. Ammoniation of residue increased ADG 67% (increase of 1.1 lb/d) over non-ammoniated residue. Feed efficiency was not affected by harvest method, but ammoniation decreased F:G by 13% compared to cattle fed non-ammoniated residue. Although alternative harvest technologies can improve ADG, ammoniation of corn residue has a considerably greater impact on cattle performance.

Introduction

Baled corn residue is an abundant and economical feed resource but is low in quality (energy and protein), however harvesting technologies can influence the feeding value of baled residue (2017 Nebraska Beef Cattle Report, pp. 53–54). The New Holland Cornrower™ produces baled residue that is more digestible by decreasing the proportion of less-digestible stem to more-digestible leaf and husk (2015 Nebraska Beef Cattle Report, pp 62–63, 2016 Nebraska Beef Cattle Report, pp. 74–75, 2017 Nebraska Beef Cattle Report, pp. 53–54). Corn residue harvested with two rows of stem and eight rows of tailings (2-Row) resulted in a 15% increase in DM digestibility and a 46% increase in NDF digestibility compared to conventionally harvested corn residue (2017 Nebraska Beef Cattle Report, pp. 62–63). In that same study, ammoniation of residue regardless of harvest method increased NDF digestibility 21–37%. Ammoniation is a temperature-dependent chemical reaction where the rate of reaction increases with temperature, and it is unclear if residue can be successfully treated immediately after harvest in the late fall when ambient temperatures are low. It is also unknown how much the improvements in digestibility previously observed would affect the performance of growing cattle. Therefore, the objective of this study was to assess growing cattle intake, gain, and feed conversion when fed diets consisting of corn residue harvested with three different methods that was either non-ammoniated or ammoniated in the late fall.

Table 1. Composition of six treatment diets for growing cattle (% DM)

	CONV[1]	2ROW[1]	EZB[1]
Conventional corn residue	65.0		
2-Row corn residue		65.0	
EZ Bale residue			65.0
Wet distillers grains	30.0	30.0	30.0
Supplement [2]	5.0	5.0	5.0

[1] Ammoniated diets were formulated using portions of the same residue ammoniated at 3.7% DM
[2] Supplement consisted of 3.5% SoyPass, 1.0% limestone, 0.13% tallow, 0.3% salt, 0.05% trace mineral, 0.02% vitamin pre-mix, and 0.014% Rumensin (as a percent of total diet)

Procedure

The study utilized 120 crossbred steers (704 ± 48 lbs.) blocked by BW in a randomized complete block design with a 3 x 2 factorial treatment structure, with harvest method and ammoniation being the treatment variables. The harvest method factor included conventionally harvested rake-and-bale (CONV), corn residue harvested with the New Holland Cornrower™ with two rows chopping stem into the windrow (2ROW), and residue harvested using the EZBale system (EZB) where the combine spreader is disengaged, dropping the tailings in a windrow. The chemical treatment factor entailed feeding residue from each harvest method either untreated or with ammoniation (CONVAM, 2RAM, EZBAM). Diets consisted of 65% corn residue (type varied by treatment), 30% wet distillers grain, and 5% formulated supplement which contained trace minerals, limestone, Rumensin and Soypass (Table 1). Overall, this resulted in six different treatment diets being fed, with 20 steers per treatment. The 84-day trial was conducted at ENREC, in Mead, NE, at the individual feeding barn equipped with a Calan Gate® system. Feed was delivered between 7:00 am and 9:00 am, and was offered at approximately 110% of *ad libitum* intake. Orts were collected daily, composited on a weekly basis and sub-sampled, dried in a 140˚F forced-air oven to determine dry matter, and retained for analysis. Diet ingredients and whole diet samples were also collected weekly throughout the study to assess nutrient content.

Corn residue was harvested at the ENREC on two adjacent fields in November 2016 using conventional harvest with rake- and-bale (Vermeer VR1428 High Capacity rake), New Holland Cornrower™ with only two rows of stem being added to the windrow, and the EZ Bale system where the combine spreader is disengaged and the tailings are baled. After baling, 65 bales (19 2ROW, 25 CONV, 21 EZB) were separated and stacked on a concrete pad lined with black plastic. Bales were stacked randomly

Table 2. Summary of cattle performance when fed corn residue harvested conventionally (CONV), EZ baled (EZB), or with two rows selecting for husk and leaf components (2ROW) as affected by harvest method.

	CONV	2ROW	EZB	SEM	*P-values*[1]
Initial BW, lb	701	703	703	3.42	0.39
Ending BW, lb	879[b]	901[a]	887[b]	11.5	0.01
DMI, lb/d	12.6[b]	13.6[a]	12.9[b]	0.23	0.02
ADG, lb/d	2.11[b]	2.34[a]	2.19[b]	0.049	0.01
F:G	6.25	5.93	6.08	-	0.35
Total Diet DMI, % of BW	1.59[b]	1.68[a]	1.62[a]	0.027	0.05

[1] Means with differing superscripts within row are significantly different (*P* < 0.05)

Table 3. Summary of cattle performance when fed corn residue harvested conventionally (CONV), EZ baled (EZB), or with two rows selecting for husk and leaf components (2ROW) as affected by ammoniation

	Untreated	Ammoniated[1]	SEM	*P-values*
Initial BW, lbs	703	702	3.42	0.66
Ending BW, lbs	842	935	11.5	<0.01
DMI, lb/d	10.5	15.5	0.19	<0.01
ADG, lbs/d	1.66	2.77	0.05	<0.01
F:G	6.52	5.66	-	<0.01
Total diet intake, % of BW	1.36	1.90	0.022	<0.01

[1] Corn residue ammoniated at 3.7% DM

Table 4. Average proportions of corn plant parts found in corn residue bales of conventionally baled residue, 2-Row harvested residue, and EZ baled residue.

	CONV	2ROW	EZB	SEM	*P-value*
Husk, %	12.3	14.7	16.3	2.47	0.576
Leaf, %	37.5	25.0	32.6	2.25	0.065
Stem, %	31.6[a]	13.0[c]	24.5[b]	1.13	0.003
Cob, %	6.9[b]	27.2[a]	14.5[b]	2.35	0.020
Chaff[1], %	1.80	1.02	1.42	0.684	0.747

[1] Proportion of sample that was passed through a 0.04 in screen separator, primarily consisting of soil and inseparable plant material

[2] Bale sample was experimental unit (n = 2 per harvest method), means with differing superscripts within row are significantly different (*P* < 0.05)

in a 4 x 3 bale arrangement, covered with black plastic and sealed, and ammoniated with anhydrous ammonia at 3.7% of DM from 12-Nov-2016 to 11-Jan-2017 (60 days). Data-logging temperature probes were placed next to the stack to record ambient temperature during the ammoniation period. At feeding, bales were ground through a 3" screen. Steers were limit-fed at 2% of BW a diet of alfalfa hay and wet corn gluten feed (Sweetbran®, Cargill, Inc.) prior to the start of the trial, and three-day empty body weights were collected on day,-1, 0 and 1. Steers were implanted with Ralgro® (Merck Animal Health, Inc.) on day 0. At the end of the feeding period, they were limit fed with the same alfalfa/Sweetbran® diet for 5 days before collecting three-day weights to determine ending BW.

Bulk samples from bales of each harvest method were collected at feeding to assess the proportions of each plant part in the bales. Total samples were weighed and residue was hand separated into husk, leaf (with shank), stem and cob. Residual chaff at the bottom of each sample bag was separated through a 0.04" screen. The residue not passing through the screen was considered leaf (due to excessive leaf shatter), and the remaining chaff was weighed. Each plant part was weighed, and sub-samples from each part were collected and dried in a 140°F forced-air oven to determine DM. Proportion of each plant part was calculated with DM adjustments for each part.

Data were analyzed using the MIXED procedure in SAS 9.2 and significance was declared at $\alpha = 0.05$, with tendencies declared at $P < 0.10$. Block, harvest method and ammoniation and interactions were tested as fixed effects and animal was the experimental unit. Response variables included final BW, ADG, F:G, and intake. Plant part data were analyzed with harvest method as the fixed effect and bale as the experimental unit using the MIXED procedure.

Results

There were no significant interactions between harvest method and ammoniation. Harvest method affected ending BW ($P < 0.01$), with cattle fed 2ROW having greater ending BW than CONV and EZB (Table 2). Significant effects were observed for ADG due to harvest method ($P < 0.01$). There was no difference ($P = 0.27$) in ADG between CONV and EZB, but 2ROW cattle gained more than CONV and EZB ($P \leq 0.03$). There was no effect of harvest method on F:G ($P = 0.35$). Intake as a percent of BW was significantly different between harvest methods ($P < 0.01$) with cattle eating 2ROW residue consuming a greater ($P = 0.02$) percent of their BW compared to CONV and tending to consume more than EZB ($P = 0.10$), which did not differ ($P = 0.48$).

Ending BW, ADG, and intake as percent of BW were greater for steers fed ammoniated residues compared to non-ammoniated residues ($P < 0.01$). There was a significant improvement in F:G due to ammoniation ($P < 0.01$), where non-ammoniated residue resulted in a F:G of 6.55 and ammoniation decreased this value to 5.66.

Plant parts differed by harvest method (Table 4). There was a tendency for changes in proportions of leaf in the bales ($P = 0.065$), with no difference between CONV (37.5%) and EZB (32.6%), but 2ROW containing less leaf (25.0%). There was no difference in the proportion of husk due to harvest method ($P = 0.58$), with husk percentage for CONV, 2ROW and EZB averaging 12.3, 14.7 and 16.3% respectively. However, harvest method did change the proportion of both stem and cob in the bales ($P = 0.01$ and 0.02). The CONV bales contained 31.6% stem, EZB contained 24.5% stem, and 2ROW contained 13.0% stem and all values were significantly different from one another. Conversely, 2ROW contained the most cob proportionally at 27.2%, EZB was less at 14.4%, and CONV tended to be less than ($P = 0.06$) EZB at 6.9%. In this study, the more digestible plant parts (leaf and husk) were not significantly affected by harvest method, but the less digestible parts (stem and cob) were affected. While the proportion of stem decreased with alternative harvest technologies compared to conventional rake and bale, the proportion of cob increased in the bale.

Conclusions

As observed in previous studies, corn residue harvested with the New Holland Cornrower™ with two chopped rows of stem results in a more digestible baled product compared to conventionally harvested residue. This enhanced feeding value lead to a 6% increase in intake and a 9% increase in ADG, but no improvement feed efficiency. There was no difference in gains between the EZ bale residue and the conventional residue and husk. The ammoniation of the corn residue increased ADG by 67% and decreased F:G by 13% across all harvest methods. Ammoniation did not interact with the various harvest methods to have an impact on animal performance, and it appears that the average ambient temperature of 36˚F (average low of 27.1˚ and average high of 49.8˚) during the initial 30 days of the ammoniation period did not inhibit the ammoniation reaction. Increasing the length of exposure time to the ammonia appears to compensate for the reduction in ambient temperature, indicating that similar responses can be achieved when ammoniating at lower temperatures. In conclusion, ammoniation of corn residue, regardless of harvest method, is a valuable tool to enhance the performance of growing cattle fed corn residue, and can be successfully done in the late fall after corn harvest.

Ashley C. Conway, graduate student, Lincoln

Robert G. Bondurant, research technician, Lincoln

Henry F. Hilscher, feedlot manager, Mead

James C. MacDonald, associate professor, animal science, Lincoln

Terry J. Klopfenstein, professor, animal science, Lincoln

Mary E. Drewnoski, assistant professor, UNL Department of Animal Science, Lincoln, Neb.