Myths and merits of grazing corn residue

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Corn residue is an abundant feed resource for Midwestern cattle in the winter and has been utilized by cattle producers for decades. However, there are some questions that consistently crop up every fall when cattlemen are looking to utilize this feed resource.

- What is the ideal stocking rate?
- Do cows need supplemental protein?
- Can corn residue be used to cost-effectively background calves?
- Is the corn residue from GMO corn lower in quality than non-GMO corn?
- Do cattle cause compaction when grazing on cropland?
- Will corn residue grazing impact subsequent crop yields?

This paper will provide answers to these questions based on interpretation of the available research data.

What is the ideal stocking rate and do cows need supplemental protein?

Stocking rate is extremely important because it affects the animal's plane of nutrition. When grazing corn residue, cattle select dropped corn grain along with the husks and leaves. Digestibility (energy; TDN) of the diet is quite high at the initiation of grazing, but declines with time (Figure 1) because cattle select the more digestible parts such as grain and husk early in the grazing period. The corn grain itself has more energy (83% TDN) and protein (9% CP) than any other plant part. Husk is about 60% TDN and leaf is about 50% TDN. Cattle consume cob and upper stalk (which are low energy; 35% TDN) only when availability of husk and leaf is limiting.

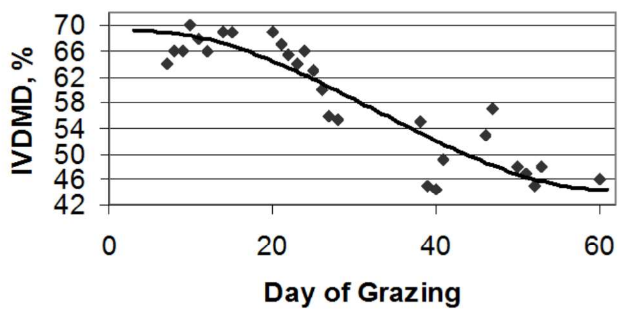

Figure 1. In vitro dry matter digestibility of the diets selected by esophageal fistulated calves grazing corn residue. Consumption of 50% of the available husk and leaf reached around d 50 (Fernandez and Klopfenstein, 1987).

This information has been the basis of stocking rate recommendations (remember other losses will occur such as wind and trampling loss). The general rule of thumb is that corn residue can be stocked at 1 cow (1200 lb) for one month for every 100 bu of corn (Table 1). At this stocking rate, cattle would be consuming half of the leaf and husk available which is only 15% of the total corn residue produced.

Table 1. Suggested stocking rates for grazing cows on corn residue based on corn yield

Corn Yield (bu/ac)	Animal Unit Month[1] (AUM)/ac	# of grazing days at one 1200 lb cow/ac
100	1.1	28
125	1.4	36
150	1.7	43
175	2.0	50
200	2.3	57
225	2.6	64
250	2.8	71

[1] One Animal Unit Month (AUM) is the amount of forage required to sustain a 1,000 pound cow or equivalent for one month

When cattle are stocked at the appropriate rate in one field for the entire winter, they have a high plane of nutrition early when they are eating more corn early in the winter, followed by a higher proportion of husk, and finally primarily leaves late in the winter. The problem with this system is that with spring-calving cows, requirements are increasing late in the winter because the fetus is starting to grow more rapidly. However, in a 5 year study, supplementation of a distillers based cube at 2.2 lb to cows grazing corn residue did not improve pregnancy rates or weaning weights over non-supplemented cows (Table 2) when grazed to the recommended stocking rate. Additionally, supplementation did not appear to have a fetal programing effect on the heifer progeny as replacement heifers born to cows grazing corn residue with and without supplementation had similar gains, age at puberty and pregnancy rates. At the start of the winter, the cows were in good BCS (BCS 5) and non-supplemented cows were able to maintain BCS over the winter when grazing residue alone.

Table 2. Impacts of supplementing 2.2 lb/d of a DDGS based cube to cows grazing corn residue. (Warner et al., 2012)

	SUPP	CON	*P*-value
Dam			
Oct BCS	5.4	5.4	0.89
Feb BCS	5.6	5.4	0.02
Preg rate, %	94	91	0.18
Calf birth wt, lb	86	86	0.27
Calf weaning wt, lb	548	552	0.35
Heifer progeny			
ADG, lb	0.97	1.01	0.20
Age at puberty, d	343	336	0.23
Preg rate,%	75	78	0.64

Stocking density can be used to influence an animal's plane of nutrition. Some producers use a higher stocking density and a shorter amount of time and move cows from field to field over the winter. With this type of grazing, the plane of nutrition cycles with nutrition being greatest at the start of a new field and then declining until they start in a new field again. This allows producers to provide a more nutrient-dense diet in late winter when spring calving cow's requirements are greater. Although there is a nutritional benefit to this strategy, there is also the risk of winter weather such as ice restricting grazing such that the cattle must be removed from residue grazing, resulting in some fields not being grazed.

If mature gestating cows are thin (BCS 4), they will respond to protein supplementation. Typically, we suggest feeding 0.3 lb of protein. This would be 1 lb of dry distillers or 2 lbs of modified distillers. This can allow thin cows to increase BCS before calving and may improve their rebreeding rates.

First calf heifers have the greatest nutrient requirements in the cow herd. First-calf heifers in mid-gestation (6 to 3 months prior to calving) will need protein supplementation at about 0.5 lb of protein/d when grazing corn residue. Supplementing about 1.8 lb/d of dry distillers will correct this deficiency. During late gestation (3 months prior to calving) first calf heifers are both deficient in protein and energy. Feeding 3.3 lb of dry distillers will meet their needs. Corn residue also can be used to cost effectively develop replacement heifers. Supplementation of 2 lb/d of dry distillers to 600 lb heifers will typically result in an ADG of 1 lb/d, and 4 lb/d of dry distillers results in ADG of 1.5 lb/d.

Plane of nutrition can also be increased by using lower stocking rates so that all of the corn and some husk is grazed, but cattle are removed before plane of nutrition declines significantly. This may be beneficial for grazing cattle with higher nutrient requirements such as thin cows, first calf heifers, and growing calves. However, supplementation will still be needed to achieve targeted performance for first calf heifers and growing calves (stockers and replacement heifers) and may be needed to get thin cows on proper condition before calving.

Because total intake, digestibility, and protein content of the diet declines during the grazing period, if greater than recommended stocking rates are utilized both supplemental energy and protein may be needed to maintain BCS of mature cows after they have reached the recommended stocking rate.

Can corn residue be used to cost effectively background calves?

In the Midwest corn residue and distillers grains provide a distinct advantage for growing calves in the winter. Due to the typical rental rates for corn residue and the cost of distillers, these two feed resources together make one of the lowest cost growing rations possible. In ruminant diets, not all protein is created equal and this can particularly become apparent for animals with high protein requirements such as growing calves. Ruminally degradable protein is used by rumen microbes to grow (which then become a source of protein themselves called bacterial crude protein) and degradable protein supplied in excess of the microbes requirements is converted to ammonia in the rumen which cannot be used by the animal as a source of protein. When the animal's protein need is high and the bacterial crude protein does not meet the animal's demand, then a source of undegradable protein is needed. A good example of this concept is the comparison of urea as a source of protein vs distiller grains for growing calves grazing corn residue (Table 3). Urea is 100% ruminally degradable whereas the protein in distillers is only 37% ruminally degradable meaning the 63% of the protein bypasses the rumen and can be absorbed and used as a source of protein for the animal itself. When a similar amount of energy and protein was supplied from corn plus urea vs. distillers grains, the performance of calves receiving distillers was more than double that of the calves receiving the corn plus urea.

Table 3. Effect of supplement and source of protein on calf performance when grazing corn residue

Supplement information	No Suppl.	Corn	Corn+ Urea (5%)	DDGS
DM, lb	-	3.75	4.0	3.0
TDN, %	-	83%	78%	104%
TDN, lbs	-	3.11	3.12	3.12
CP, lbs	-	0.37	0.92	0.90
Calf Performance[1]				
Initial BW	516	516	516	516
Ending BW	504[a]	539[b]	559[c]	629[d]
ADG	-0.18[a]	0.31[b]	0.53[c]	1.32[d]

[1]Means within row lacking common letters differ ($P < 0.05$)
Tibbitts et al, 2016

Distillers grains have consistently been the lowest cost source of bypass protein in the Midwest. In addition, distillers grains are very high in energy (greater than corn). Thus, distillers grains make an ideal low cost supplement for calves grazing corn residue. Table 4 provides the amount of distillers grains that would need to be fed to achieve various rates of gain based on data gathered from multiple trials where distillers grains have been fed to calves grazing corn residue. In forage based systems, we observe similar performance with dry, modified and wet distillers as long as the same amount of dry matter is fed. It is important to note that the estimates in Table 4 are based off of calves being fed in a bunk. Feeding on the ground will increase waste and thus increase the amount needed to be provided. In trials, evaluating the waste with ground feeding, waste of 5% was measured for modified distillers, 20% for wet distillers and as much as 40% for dry distillers when compared to bunk feeding.

Table 4. Amount of distillers supplementation needed for a 600 lb steer to achieve targeted rate of gain

ADG lbs/d	Lbs of DM	Lbs DDGS	Lbs MDGS	% BW
1.08	1.8	2.0	3.6	0.3
1.23	2.4	2.7	4.8	0.4
1.37	3.0	3.3	6.0	0.5
1.49	3.6	4.0	7.2	0.6
1.61	4.2	4.7	8.4	0.7
1.71	4.8	5.3	9.6	0.8
1.88	6.0	6.7	12.0	1.0
1.95	6.6	7.3	13.2	1.1

Assumes 90% DM for DDGS and 50% for MDGS
Based on Welchons andMacDonald, 2017

Is the corn residue from GMO corn lower in quality than non-GMO corn?

The digestibility of the forage selected by cattle has not been found to differ between transgenic and the non-transgenic parent. Additionally, in five different trial with various genetic modifications to the corn plant, the gain of calves (supplemented with distillers grains or corn gluten feed) grazing transgenic vs the parental hybrid was not different (Table 5). In fact the numerical differences in gain appeared to correlate with the amount of dropped corn in the field rather than with genetic modification. Ear drop may explain why some producers have felt that Bt corn has a lower feeding value. In cases where there iscorn borer pressure, the amount of dropped corn in non-Bt corn varieties may begreater resulting in greater feeding value for cattle grazing. However, this also means that less corn ended up going to market.

Table 5. Summary of five trials evaluating growing calf gain when grazing genetically modified (Bt or roundup ready) corn residue

		Calf gain, lb/d				Residual corn, bu/ac	
Trial	**Protein**	**TRAN**	**CON**	**Diff**	***P*-value**	**TRAN**	**CON**
Folmer, 2001	Bt (Cry1Ab)	0.54	0.70	-0.17	0.12	1.00	1.50
Wilson, 2003	RR (EPSPS)	1.28	1.05	0.23	0.07	2.30	1.60
Wilson, 2003	RR (EPSPS)	0.86	0.79	0.07	0.23	0.00	0.13
Wilson, 2003	Bt CRW (Cry3Bb1)	0.75	0.87	-0.12	0.31	0.29	0.58
Weber, 2011	Bt (Cry1A.105 + Cry2Ab2)	0.52	0.39	0.13	0.20	2.41	2.48

Do cattle cause compaction when grazing corn residue and will grazing impact subsequent crop yields?

Many crop producers have concerns that cattle trampling will adversely affect soil physical properties and subsequent crop productivity. Soil compaction, measured as an increase in bulk density or penetration resistance, influences the ability of a plant to acquire water, nutrients, and oxygen because of restricted soil water movement, oxygen and nutrient diffusion to roots, consequently reducing crop yield. Grazing in late fall or winter has very rarely resulted in biologically significant compaction on cropland. When compaction was measured, the effects were usually confined to the upper 0-2" of top soil and were thus short-lived due to natural processes of wetting-drying cycles, freezing-thawing cycles, root growth, and the activities of soil organisms. In one study, winter grazing of wheat residue increased bulk density of the top 2" when measured prior to corn planting but by the time the corn was at the six leaf stage, no difference in bulk density was observed.

Grazing of corn residue generally has no negative impact on subsequent crop yields. Grazing in the fall/winter or in the spring in a long term study (16 years) in eastern NE with fields managed in a corn-soybean rotation without tillage (no-till) did not result in detrimental effects on soil properties nor crop yields. In fact, grazing of corn residue improved soybean yields by 1.5 bu/ac for spring grazing and 3.4 bu/ac with fall grazing. In a western NE field managed in a continuous corn rotation, grazing of corn residue for a 5 year period did not affect corn yields (148 vs 154 bu/ac, for not grazed and grazed, respectively). Shorter term studies have shown similar results. A two year study with four locations in eastern NE reported that grazing had no impact on subsequent crop yields. Three locations were managed under a continuous corn rotation with subsequent corn yields of 239 bu/ac for grazed and 223 bu/ac for ungrazed (which did not statistically differ). One location was in a corn-soybean rotation with soybean yields not differing between grazed (59 bu/ac) and ungrazed (62 bu/ac).

It should be noted that an increase in surface roughness due to grazing has been observed, especially under wet soil conditions, in soils with low soil organic matter content, or intensive tillage (as these soils have less soil structure) which can sometimes impede seed placement. A study in SE Iowa evaluated the effects of grazing corn residue on fields managed under spring till or no-till in a corn-soybean rotation over a three-year period. Cows were moved to a new section of the field each month during the winter. Therefore, the impact of grazing was measured in 15 areas for each tillage treatment. There was only one instance when grazing had an effect on soybean yield. In this instance, they reported a reduction in soybean yields from 45 bu/ac to 41 bu/ac when corn stover was grazed in the no-till system. Bulk density was not affected. However, surface roughness was increased in this instance, suggesting seed placement may have been the cause of yield loss.

Grazing may provide some benefits when implemented consistently over a long period of time. After 16 years of grazing corn residue in the fall (FG) or spring (SG), an increase in the soil microbial community (Table 6) was observed (when compared to areas that were not grazed; NG). The effects on the soil microbial community may explain the improvement in soybean yields which was observed in the grazed treatments because an increase in soil microbes, actinomycete bacteria, and saprophytic fungi may increase the rate of nutrient cycling.

Table 6. Impact of 16 years of grazing in the fall (FG) or spring (SG) corn residue on soil microbial community as compared to no grazing (NG)

	Treatment				P-value
nmol/g of soil	NG	FG	SG	SEM	NG vs G
Total microbes	62.7	74.8	76.2	4.5	0.06
Bacteria	32.3	38.6	39.1	2.1	0.04
Actinomycete-bacteria	3.3	4.3	4.2	0.21	0.01
Micro-Eukaryote	2.0	2.3	2.1	0.16	0.30
Arbuscular mycorrhiza (AMF)	5.0	5.3	5.6	0.70	0.64
Saprophytic Fungi	3.1	4.0	4.2	0.28	0.03

Another concern is that grazing may reduce soil OM (due to residue removal) or result in the export of nutrients such as N, P and K. After 16 years of grazing, no differences in soil organic matter, N, P or K were measured. It is important to remember that most of the nutrients (such as N, P, K, Ca, etc.) consumed are excreted back on to the land. Additionally, grazing only removes a small percentage of residue (target 15%) and thus cover is maintained and erosion risk is not substantially increased. However, it should be noted that there are some corn fields which, due to topography (steep slopes) and/or low corn grain yield (especially in rotation with other low residue crops like soybeans) which should not be grazed by cattle because there is not enough residue present to provide adequate cover (even before grazing). Alternatively, grazing can be used as a residue management strategy for high yielding or continuous corn rotations where excess residue is a problem. The combination of the residue consumption and the increase in microbial activity may be beneficial in these fields.

Note: P-value (probability value) refers to the likelihood that the observed differences among means (treatment averages) are due to chance (thus the smaller the P-value the more likely there is a difference). Example: P = 0.05 suggests that there is a 5% chance that the differences observed between means are due to random chance.

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