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Growing Calf Intake of Hay or Crop Residue Based Diets

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Summary with Implications

It is important to know or predict feed intake by growing calves on forage-based diets in order to balance these diets for nutrients such as energy and protein. Several growing calf studies with forage-based diets were summarized. These studies evaluated the use of crop residue as a substitute for conventional forages, primarily grass hay. Calves gained about 1.8 lb/day for all forage-based diets. Calves consumed 2.6% of body weight daily when fed hay-based diets, but those fed residue with distillers grains diets consumed only 1.6% of body weight. However, when feeding the residue with distillers grains diets, the cost per lb of gain was less than the grass hay based diets.

Introduction

Most of the feed used in beef production is forage. The amount of forage intake is very important because the energy content is often relatively low. Also, it is essential to know feed intake of the calves in order to balance the diet for energy, protein, etc. There are 2 mechanisms that are proposed to control forage intake, both relating to rumen fill. Fill is the amount of forage the animal can physically contain. The first mechanism proposed is physical rumen fill limits the amount of fiber (neutral detergent fiber, NDF) that cattle can consume from 1.35% to 1.70% of body weight daily. The other mechanism is that the capacity to consume, ruminate and pass forage through the digestive tract is related to fecal dry matter production. Clearly, the more digestible the forage, the less feces produced and the more the animal would consume. The maximum fecal excretion (FE) is proposed to be between 1.07 and 1.16% of body weight daily. Those data relate to conventional forages, primarily grass hays. Because crop residues are readily available, it is important to know how well they compare with conventional forages. The objective was to compare intakes of steers consuming crop residues with distillers grains to those consuming conventional forage-based diets.

Table 1. Ingredient nutrient composition

Ingredients	TDN[1]	DMD[2]	NDF[3]	CP[4]
Grass Hay, %	52	52	71	7.1
Alfalfa Hay, %	55	55	63	16
Sorghum Silage, %	67	67	59	8.6
Corn, %	83	83	0	9.0
Soybean meal, %	80	80	0	50
Crop residue, %	43	43	80	3.5
Distillers grains, %	108	80	35	31
Supp[5], %	80	80	0	0
Sweet Bran, %	89	80	40	23

[1] Total digestible nutrients
[2] Dry matter digestibility
[3] Neutral detergent fiber
[4] Crude protein
[5] Supplement providing minerals and vitamins

Procedure

Numerous experiments have been conducted at ENREC using similar protocols. Studies used steers, and the studies selected were initiated 3 to 5 months following weaning. Calves were limit-fed for 3 to 5 days followed by 2 to 3 day initial and ending body weights. Some of the studies involved calves (8 to 12 hd per treatment) being individually fed using the Calan gate system. Other studies involved pen-fed calves with 8 to 12 hd per pen and 6 to 10 pens per treatment. Seventy-seven treatment means were developed overall, but only a limited number are summarized here. Individually fed, 11 month old implanted steers fed conventional forages, crop residues with distillers grains (DG), or hay with DG within a similar range of daily gains were summarized. Feeds were sampled weekly for dry matter and laboratory analysis. This allowed for the calculation of FE as: Dry Matter Intake—(Dry Matter Intake × Dry Matter Digestibility). Table 1 shows the digestibility and ingredient composition that was calculated from metabolism studies that were done in conjunction with the feeding trials. Cattle were fed ad libitum in all studies.

Diets from these studies were assigned to 1 of 3 categories: Hay (hay based diet with some grain and protein supplement), Residue DG (crop residue based diet with distillers grains supplementation), and Hay DG (hay based diet with distillers grains supplementation). The conventional Hay diets contained alfalfa hay and sorghum silage. A simplified diet of grass hay, corn and soybean meal (SBM) was formulated to provide the energy and protein of the alfalfa hay and silage diet (Table 2).

Results

Composition of the diets and cattle performance are shown in Table 2. The alfalfa hay and sorghum silage diet is 95% (DM basis) forage. Steers consumed 2.68% of

Table 2. Diet composition and calf performance

	Diet Type				
	Hay[1]	Hay[2]	Residue DG[3]	Residue DG[4]	Hay DG[5]
Ingredients, % of diet DM					
Grass Hay, %	-	60	-	-	78
Alfalfa Hay, %	57	-	-	-	-
Sorghum Silage, %	38	-	-	-	-
Corn, %	3	29.7	-	3	-
Soybean meal, %	-	8.3	-	-	-
Crop residue, %	-	-	63	55	-
Distillers grains, %	-	-	35	40	20
Supp[6], %	2	2	2	2	2
Cattle performance					
Average BW, lb	745	745	755	737	705
Dry matter intake, % of BW	2.68	2.68	1.64	1.55	2.51
Average daily gain, lb/day	2.0	2.0	1.71	1.87	1.90

[1]Forage Diet based on alfalfa hay and sorghum silage

[2]Grass hay, corn and soybean meal calculated to supply energy and protein equal to alfalfa hay and sorghum silage diet

[3]Corn or wheat residue plus distillers grains, average of 7 treatment means in 4 studies

[4]Corn stalks plus distillers grains treatment from same study as alfalfa and sorghum silage treatment

[5]Grass hay plus distillers grains, 1 treatment

[6]Supplement providing minerals and vitamins

Table 3. Intake regulation

	Diet Type[1]				
	Hay	Hay	Residue DG	Residue DG	Hay DG
DMI[2], % BW	2.68	2.68	1.64	1.55	2.51
NDFI[3], % BW	1.43	1.14	0.79 (0.97)	0.61 (0.90)	1.37 (1.50)
FE[4], % BW	0.95	0.95	0.68	0.62	1.07

[1]See Table 1

[2]Dry matter intake

[3]Neutral detergent fiber intake, dry matter basis, values without parenthesis represent NDFI without NDF from DG included and values in parenthesis represent NDFI with NDF from DG included

[4]Fecal excretion, dry matter basis

body weight as dry matter daily and gained 2 lb/day. The second hay diet was formulated to provide equal energy and protein to the first hay diet using grass hay, corn and soybean meal. Only one trial is available with a 66% hay diet supplemented with corn and protein supplement. However, the trial involved nonimplanted, 8 month old heifers. Their intake was 2.52% of body weight and a 6% increase from implanting would result in intake of 2.67% of body weight, which is consistent with the formulated hay diet.

The first residue DG diet is a summary of 7 treatment means from 4 studies. Distillers grains averaged 35% of the diet and the remainder was corn stalks and 2% supplement. Daily gain was somewhat less (86% of hay diet) than the hay diet, but intake was only 61% that of the hay diet. The second residue DG diet represents steers fed corn stalks and DG in the same study as those in the alfalfa hay and sorghum silage study. In this direct comparison, intake of the residue DG diet was only 58% of the hay diet.

A hay DG diet with 20% DG and 78% grass hay (DM basis) resulted in intakes and gains slightly less than the alfalfa and sorghum silage diet.

The two biological mechanisms that are proposed to limit intake are rumen fill and FE. Table 3 shows the intake of NDF and FE of the 5 diets. Neutral detergent fiber intake was calculated with and without the inclusion of the NDF from DG in all diets containing DG. Both NDF intake and FE were lower for the Residue DG diets, suggesting that fill is not the limiting factor for intake of the residue diets. Because the NDF content of residue is high (80% or greater), it could have been expected that fill would be the limiting factor for intake of the residue diets.

Because fill does not appear to be the answer, perhaps there are 2 other explanations for the lower dry matter intake. One is that the calves find the residues to be unpalatable. The other explanation is more complex. The cattle must reduce forage particle size from 20+ mm to 1 mm in order for the particle to pass from the rumen into and through the rest of the digestive tract. This reduction starts with chewing during consumption and follows with rumination. With conventional forages, reduced FE suggests some other intake control, such as energy value of the feed. However, it is possible that the reduced FE is a sign that particle reduction and passage is slower with residues than conventional forages.

In the 1980's, research was conducted with stalklage harvested with a John Deere stalker head immediately after high moisture corn harvest. This corn residue had less NDF (70%) compared to baled stalks (80%), more soluble carbohydrates and sufficient moisture to ensile. This corn residue was fed at 84% of the diet dry matter with a soybean meal supplement. Intake was 2.0% of body weight, NDF intake was 1.2% of body weight and fecal excretion was 0.92% of body weight. These values are greater than those of baled stalks with 35% DG and more similar to brome hay values of dry matter intake at 2.1% of body weight, NDF intake of 1.4% of body weight and fecal excretion at 0.95% of body weight. Palatability is probably the primary issue with low intake of baled stalks.

While overall intake was lower for the Residue DG diets, the diets contained 35% DG which have 130+% the energy of corn in forage-based diets. Further, the DG are an excellent supply of protein. Based on the performance data, a simple economic analysis was conducted using corn priced at $3.45/bu and other ingredients at comparable prices (Table 4). The cost per lb

Table 4. Economics

	Diet Type[1]				
	Hay	Hay	Residue DG	Residue DG	Hay DG
Dry matter intake, lb/d	19.9	19.9	12.4	11.4	17.7
Cost[2], $/lb DM	0.0622	0.0753	0.0515	0.0531	0.0623
Daily Feed Cost, $/animal	1.24	1.50	0.71	0.61	1.10
Cost, $/lb BW gain	0.62	0.75	0.42	0.32	0.58

[1]See Table 1

[2]Corn, $3.45/bu = $0.073/lb DM

Alfalfa hay $90/ton + $15/ton grinding = $0.06/lb DM

Sorghum silage = $0.06/lb DM

Grass hay, $85/ton + $15/ton grinding = $0.056/lb DM

Corn Stalks, $45/ton + $15/ton grinding = $0.034/lb DM

Soybean meal, $360/ton = $0.20/lb DM

Distillers grains, $0.073/lb DM (equal to corn)

Supplement, $300/ton = $0.15/lb DM

of dry matter is less for the Residue DG diet because of the lower cost of residues compared to hay. The lower intake and the lower diet cost per lb makes the daily cost of the Residue DG diet much less than both the Hay-based diet and the Hay DG diet. Feed cost of gain is also lower for the residue-based diets.

One of the 7 treatment means for the residue DG diets consisted of Sweet Bran and Soypass instead of DG, which provided similar performance to the distillers grains. The Soypass supplied undegradable protein that is provided by DG. These results suggest that a mixture of DG, as a source of rumen undegradable protein, and gluten feed would provide similar performance as DG alone.

Clearly, harvested cornstalks or wheat straw are not well consumed by steer calves and the same may be true for cows. With harvested corn residue, much of the residue is stalks or cobs which may be the primary unpalatable fractions. Alternatively, when corn stalks are grazed, the primary components consumed are husks and leaves. Because the leaves and husks are preferentially consumed, palatability must be better than for the stalks or cobs. Because we cannot harvest the husks and leaves separate from the stalks and cobs, we do not have direct measurements of intake of the husks and leaves. Based on cow performance while grazing corn residue and knowing the quality of the leaves and husks, we estimate that cow consumption of leaves and husks, even without supplement would be 2% of body weight (*2019 Nebraska Beef Cattle Report*, pp. 50–52).

In a recent study, cows were offered baled cornstalks in round bale feeders. The bales contained over 40% stems and cobs, the remaining nearly 60% was leaves and husks. The wasted and refused feed was measured and totaled to about 40%. Therefore, it appears the cows selected the leaves and husks and refused the stems and cobs. This is consistent with the grazing situation and suggests again that palatability is the issue with intakes of calves fed the ground residue, which minimizes the opportunity to sort stems and cobs.

Clearly the best use of corn residue is with grazing cows or calves because they select the more digestible and palatable parts leaving the less digestible and less palatable parts for soil cover. However, harvested cornstalks and wheat straw can be used economically in growing diets when fed with DG. Residues at 5% of finishing diets are likely very effective because the residues may be quite palatable to the cattle as a "roughage" in that feeding situation.

Conclusion

Intake of diets based on crop residues is about 30% less than intake of hay-based diets for growing steers. However, because the residues are less expensive and give similar performance when fed with DG, they are much more cost effective than hay-based diets.

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