Evaluation of Varying Corn Grain (and Byproduct) Inclusion in Beef Cattle Finishing Diets

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Summary

A pooled-analysis of UNL feedlot trials examined the impact of starch (corn grain) on cattle performance. Cattle age (calf-fed or yearling) affected DMI, ADG, and F:G, but not marbling score or fat depth. Intake, ADG, F:G, and fat depth were optimized with 50–70% corn grain in the diet. Marbling was not maximized until the diet contained > 75% corn. Removing either all the corn or all the byproduct from diets did not maximize performance. Including a minimum of 20% byproduct and 20% corn in the diet is biologically advantageous, while the remaining 60% of the diet is flexible based on economics.

Introduction

In recent years, corn grain in finishing diets has been replaced with byproducts, largely due to relatively expensive grain prices. However, this substitution varies greatly with price of distillers relative to grain. Feed byproducts from both the wet and dry corn milling industries contain low concentrations of starch (< 5%). Replacing corn with distillers grains or corn gluten feed improves performance which would suggest that some replacement of starch with non-structural fibrous byproducts benefits cattle and there is no starch "requirement." Likewise, some research has focused on replacement of corn grain with corn silage, or with alkaline-treated forages to replace relatively small proportions of grain. When grain is relatively expensive, beef cattle can be fed alternatives and small replacements of starch can be accomplished. If forages replace grain, then ADG will be reduced, and F:G increased. If distillers grains or corn gluten feed replace grain, ADG and F:G are improved. The development of the cattle feeding industry was largely driven by the availability of cheap corn (relative to other feedstuffs), which is similar to current feeding scenarios. This pooled-analysis was done to identify blends of grain and byproduct that maximize cattle performance.

Procedure

Data were collected from 19 experiments conducted during 2005–2010 at the University of Nebraska-Lincoln. The data included 678 pen means fed 111 different treatment diets with varying inclusion of corn grain. Included in the analysis were 353 pens of cattle fed some level of distillers grains plus solubles (DGS), 184 pens of cattle fed a blend of DGS and wet corn gluten feed (WCGF), and 141 pens of cattle fed no byproduct. For data analysis, pens of cattle were divided into 5 subclasses of corn inclusion in the diet; 0% corn (69 pens of cattle), 1–25.9% corn (28 pens), 26–50.9% corn (238 pens), 51–75.9% corn (250 pens), and ≥ 76% corn (93 pens), on a DM basis. Corn was processed as dry rolled corn, high moisture corn, or a blend of the two. There were 423 pens of yearling cattle and 255 pens of calf-feds. Yearlings were defined as cattle starting on feed in the spring (May) and finished the following fall, typically September. Yearlings had an average initial BW of 726 lb. Calf-feds started on feed in the fall, roughly November, and finished the following spring, approximately May. Average initial BW for calf-feds was 574 lb. Cattle performance was measured using DMI, ADG, F:G, marbling, and 12th rib fat thickness.

Within experiment, cattle were blocked by initial BW, allocated randomly to pens within block, and pens were assigned randomly to dietary treatments. In all but one experiment, cattle within an experiment were fed the same number of days and then marketed at a commercial abattoir. Hot carcass weight was recorded on day of slaughter. Fat thickness was measured after a 24 to 48-hr chill. USDA marbling score was called by a professional USDA grader. Both ADG and F:G were calculated based on hot carcass weights adjusted to a common dressing percentage of 63%. These experiments have been previously published individually as Nebraska Beef Reports (*2006* p. 51; 2007 p.33; 2007 p. 25; 2007 p. 27; 2007 p. 36; 2008 p. 36; 2008 p. 53; 2009 p. 62; 2009 p. 64; 2009 p. 66; 2009 p. 70; 2009 p. 76; 2010 p. 86; 2011 p. 48; 2011 p. 55; 2011 p. 84).

Performance data for each pen of cattle were available, thus, pen means were used in the pooled-analysis. Experiment was included in the model as a random effect and type of byproduct in the diet was included as a covariate. Corn inclusion in the diet was treated as a fixed effect. Interactions between study and corn inclusion or byproduct type were not significant ($P > 0.10$). Quadratic responses were plotted and the first derivative calculated to determine the maximum or minimum point. Age of cattle was tested to determine if calf-feds and yearlings had different responses. Factors that may have affected the results, but were not included in the statistical model; include type and amount of forage in the diet, processing of corn, implant program, and year effects.

Results

Age of cattle affected DMI, ADG, and F:G ($P < 0.01$). Marbling score and fat depth were not affected by age of cattle ($P \geq 0.18$), thus those data were combined across all pens. All cattle were fed with the goal of reaching 0.5 in of backfat. For calf-feds, DMI quadratically increased as inclusion of corn in the diet increased ($P < 0.01$; Table 1). Maximum DMI was 22.3 lb/d, corresponding with a 70% corn diet. Yearling DMI was not affected by corn inclusion ($P = 0.95$) and averaged 25.1 lb/d. Both calf-feds and yearlings had a quadratic increase in ADG as amount of corn in the diet increased ($P < 0.01$). For calf-feds, maximum ADG was 3.95 lb at 49% corn in the diet while yearlings had a maximum ADG of 3.85 lb with 44% corn in the diet.

Feed conversion was minimized with 47% corn in the diet with a conversion of 5.39 for calf-feds; F:G was optimized at 6.30 with 64% corn in the diet for yearlings. Marbling was maximized with 83% corn and a marbling score of 533 for all cattle combined. Fat thickness for all cattle was maximized at 49% corn in the diet at 0.52 in. Marbling and fat thickness change across days on feed, energy content of the diet can affect how many days on feed are required to reach a 0.5 in fat thickness endpoint.

Optimal ADG and F:G occurred when grain was included at 26 to 50% of diet DM in finishing diets, and likely reflects improved performance when some grain is replaced with distillers grains (most common substitute for corn in these studies). Complete removal of corn grain decreased ADG and increased F:G suggesting that some corn (> 25%) is beneficial. Carcass characteristics generally reflected changes in gain as cattle within experiments with different treatments were fed similar days in all but one experiment. It is unclear whether complete removal of corn hindered ADG and F:G due to less starch, or if certain nutrients in the diet became a challenge, such as sulfur or fat. The diets with the majority of the corn replaced were based on common byproducts such as distillers grains replacing corn, which dramatically increase dietary sulfur and fat. Depending on the definition of requirement, some starch may be required; however, this likely reflects no appropriate substitute (byproducts or forages) available for complete replacement of starch.

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Table 1. Finishing steer performance when fed different dietary inclusions of corn grain

	Corn grain inclusion, % of dietary DM					Peak[a]	SEM	Linear	Quad
	0	1–25.9	26–50.9	51–75.9	≥ 76				
Calf-feds									
No. of pens	26	17	57	105	50				
DMI, lb/d	18.7	20.5	21.5	22.4	22.2	70	0.75	< 0.01	< 0.01
ADG, lb	2.59	3.61	3.88	3.92	3.55	49	0.15	0.01	< 0.01
F:G[b]	7.20	5.67	5.52	5.67	6.33	47	—	0.34	< 0.01
Yearlings									
No. of pens	43	11	181	145	43				
DMI, lb/d	25.2	24.7	25.1	25.2	25.2	—	0.78	0.70	0.90
ADG, lb	3.50	3.61	3.91	3.99	3.79	44	0.16	0.07	< 0.01
F:G[b]	7.10	6.85	6.49	6.47	6.77	64	—	0.31	< 0.01
All cattle									
Marbling score[c]	462	488	511	529	532	83	10.3	< 0.01	< 0.01
12th rib fat, in	0.41	0.50	0.52	0.53	0.50	49	0.03	< 0.01	0.01

[a]Peak is the amount of corn in the diet, % of DM, at which DMI, ADG, marbling, and 12th rib fat were maximized and F:G was minimized.
[b]Analyzed as G:F, the reciprocal of F:G.
[c]Marbling score: 300 = slight, 400 = small, 500 = modest.