Evaluate the Effect of Corn Processing, Drying Distillers Grains, Oil Removal from Distillers Grains, and Distillers Inclusion on Cattle Performance

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Summary with Implications

An analysis of over 9,300 head of cattle and 980 pen means was conducted to evaluate the effect of corn processing, drying distillers grains, oil removal from distillers, and distillers inclusion on cattle performance. This analysis looked at both steam-flaked corn and high-moisture corn or dry-rolled corn or a blend of the latter two grains and their effects on performance with and without distillers grains. Additionally, wet, modified, and dried distillers grains were analyzed as both full fat or de-oiled products at various dietary concentrations with each corn type as the primary cereal grain to determine performance responses. There was an overall improvement in performance when steam-flaked corn was utilized regardless of distillers type or level of inclusion. Feeding full fat byproducts resulted in improved feed conversion compared to de-oiled products, but de-oiled products outperformed control diets with no distillers grains. Economic benefits of feeding distillers grains showed that regardless of corn price and the distillers to corn price ratio, feeding between 5–40% distillers was the optimal cost-minimizing solution, regardless of the type of distillers grains.

Introduction

Cattle performance is closely linked to the diet that is offered during the finishing phase and is one of the main drivers of profitability. Cattle performance equations were formulated from an analysis that showed differing response curves related to intake and performance when feeding increasing inclusions of byproducts. These response curves were used to calculate profitability in a tool known as Cattle CODE (*2008 Nebraska Beef Cattle Report*, pp 37–39). This tool accounted for transportation of byproducts, cost of byproducts relative to corn, and performance benefits of each scenario to determine the most economical feeding scenario. This analysis showed the economic benefits of feeding byproducts like dry, modified, and wet distillers grains plus solubles when priced competitively to corn, which was a result of improved feed conversions relative to a control diet with no byproduct. This tool was updated to include more byproduct options in 2011 (*2011 Nebraska Beef Cattle Report*, pp 37–39).

The distillers market has changed considerably over time as it transitioned from low supply and protein valuation to large supply and use as both energy and protein source for cattle and now appears to be changing further with process changes. Most noticeably, distillers grains can now be sold as either full fat (10–12% fat) or de-oiled (6–9% fat). Before 2012, nearly all distillers products were sold as full fat and since then, ethanol plants have marketed de-oiled distillers and corn oil separately. This change has created industry conversation about differences in cattle performance between these two products and if these differences vary by the type of distillers (e.g. wet, modified, dried). The industry also has observed a price increase of distillers grains as more livestock and poultry producers have found uses with a relatively stable yearly ethanol production. This increased price has been coupled with strong seasonal patterns as the supply of distillers is the largest in the summer coupled with low demand from cattle feeders due to fewer cattle on feed. Seasonal dynamics in the fall are reversed, which results in increased demand from cattle feeders coupled with a lower supply of distillers from ethanol plants.

Another change that has occurred in the last 10 years in Nebraska is an increase in feedyards that steam-flake corn. Traditionally most feedyards in the Midwest fed dry-rolled corn (DRC), high-moisture corn (HMC), or a blend of the two grains. However, some yards are now utilizing steam-flaked corn (SFC) as their primary source of grain. This transition in corn processing has occurred likely due to increased performance benefits coupled with the volatile distillers' prices. Therefore, the objective of this analysis was to summarize all available trial data, calculate new cattle performance response functions, and then use these to calculate economic tradeoffs based on the different distillers products at different levels of inclusion when fed in either a SFC or HMC:DRC based finishing diets.

Procedure

This dataset included over 9,300 head of cattle and a total of 42 studies that were conducted at the University of Nebraska-Lincoln. Pen studies that were analyzed had 5–20 animals per pen. All trials were conducted between 1992 and 2020 and encompassed over 980 pen means. Cattle were sorted into calf-feds (< 775 lb initial weight) or yearlings (> 775 lb initial weight) to help differentiate performance differences between these two types of cattle.

Corn type was separated into two categories which were: SFC or HMC:DRC. The first category included only cattle that were fed exclusively SFC as the grain in the finishing diet, whereas the HMC:DRC included cattle fed either HMC, DRC, or any blend of the HMC and DRC as the concentrate in the finishing diet. Over 85% of the pens were fed a HMC:DRC based finishing diet (Table 1). Distillers types including dry (DDGS), modified (MDGS), and wet (WDGS) distillers grains plus solubles were also evaluated. Each distillers type was further separated into either full fat (FF; 10–12% fat) or de-oiled (DO; 6–9% fat) byproducts. A total of 410 pen observations were fed WDGS, which represented the largest proportion of cattle fed a

Table 1. Pen observations by type of distillers grains and corn.

	Corn Type by Cattle Weight Class				Totals		
	< 775 lb		> 775 lb		Oil Type		Distillers Grains
	DRC:HMC[1]	SFC[2]	DRC:HMC	SFC	DRC:HMC	SFC	DRC:HMC + SFC
DDGS[3]							
BOTH[4]	34	6	40	0	**74**	**6**	**80**
MDGS[5]							
DO[6]	9	24	16	0	**25**	**24**	**49**
FF[7]	38	0	82	0	**120**	**0**	**120**
					175	**24**	**169**
WDGS[8]							
DO	18	24	43	10	**61**	**34**	**95**
FF	150	23	126	16	**276**	**39**	**315**
					337	**73**	**410**
Control[9]	123	27	155	18			

[1]DRC:HMC—diets with dry-rolled corn, high-moisture corn, or a blend of the two grains as the concentrate

[2]SFC—diets with steam-flaked corn as the concentrate

[3]DDGS—dry-distillers grains plus solubles

[4]BOTH—includes both de-oiled and full-fat studies

[5]MDGS—modified distillers grains plus solubles

[6]DO—de-oiled distillers grains (6–9% fat)

[7]FF—full fat distillers grains (10–12% fat)

[8]WDGS—wet distillers grains plus solubles

[9]Control—diets containing no distillers grains

byproduct in this data set. Each byproduct included observations between 0% and 40% inclusion on a DM basis. Although some studies included inclusions of more than 40%, the number of observations and the industry implications did not warrant accurate modeling above 40% inclusion. These studies did not contain any observations for FF MDGS fed in SFC based finishing diets, as a result, the performance could not be modeled. Additionally, only 6 pen means were available to model DDGS fed in SFC based finishing diets, which should be considered while interpreting the results.

Cattle performance, which included average daily gain (ADG), feed conversion (F:G), and dry matter intake (DMI), response functions were calculated for each distillers using a combination of distillers and corn type attributes. The final model included the fixed effects of corn processing type (TYPE: SFC, HMC/DRC, NONE), linear and quadratic effects of byproduct level (LEVEL), linear cattle placement weight (IW), fixed effects of byproduct oil (OIL: DO, FF), and random effects for the trial (TRIAL), experimental block (BLOCK) nested within the trial, and residual error. Non-significant interactions and quadratic terms ($P > 0.05$) were dropped to produce the final model for each distillers. Normal distributions were assumed for all traits measured. Significance was determined at $P < 0.05$. All analyses were performed using the lme4 package in R.

A few modifications were made to the cattle performance response functions for DDGS due to a lack of data. Specifically, the FF DDGS fed with SFC was not able to be estimated as there were no pen trials. Thus, DDGS cattle performance response functions by oil type were combined into one equation (e.g. DDGS-BOTH). A total of 6 byproduct options are available with each corn type: FF WDGS, DO WDGS, FF MDGS, DO MDGS, FF DDGS, and DO DDGS.

Using the estimated cattle performance response functions by type of distillers grain and corn used in the cattle finishing diet, an economic analysis was conducted to determine which type and level of inclusion of distillers minimized the total cost to finish a steer ($/head). Results were estimated at various levels of corn prices (e.g. $4.00/bu, $6.00/bu, and $8.00/bu) and distillers to corn price ratios (e.g. 80%, 100%, and 120%). When comparing DDGS, MDGS, or WDGS, products were priced equal on a DM basis to allow for economic comparisons based on performance differences. No additional cost associated with trucking distillers was accounted for in this model.

A base diet was modeled which included corn, distillers grains (if any), grass hay, and a supplement. Corn was calculated assuming a 56-pound bushel at 85% DM. Additionally, corn processing cost was added when SFC was utilized to reflect $9.00/DM ton for the cost of flaking the corn. Each diet scenario consisted of a base diet with 7% DM grass hay and 5% DM supplement inclusion. The price of grass hay was $100.00/DM ton and the price of the supplement was set at $300.00/DM ton.

The total cost to finish one steer entering the feedlot at 775 lbs and being shipped at 1350 lbs was calculated for each ration combination. Equations were used to predict ADG of each diet, which determined days on feed (DOF). Using DOF, the total tonnage of feed required was calculated based on DOF x DMI = total feed. Additionally, yardage costs were calculated based on $0.60/hd/d. The total cost associated with finishing one steer reflected both feed

Table 2. Pen performance summary by type of distillers grains and corn.

						Trial Cattle Performance (i.e. Distillers in Diet)				Control Cattle Performance (i.e. No Distillers in Diet)			
By Product	Corn Type	Trials (N)	DGS Pens (N)	Control Pens (N)	Avg. % Distillers	In weight	ADG[1]	F:G[2]	DMI[3]	In weight	ADG	F:G	DMI
DDGS[4]- DO[5]													
	DRC:HMC[6]	2	12	12	35	628	3.74	5.79	21.50	628	3.46	6.04	20.80
	SFC[7]	1	6	6	30	635	3.44	5.82	20.00	635	3.24	5.68	18.40
DDGS- FF[8]													
	DRC:HMC	7	62	41	33	837	4.01	6.84	27.40	821	3.63	7.02	25.50
	SFC	-	-	-	-	-	-	-	-	-	-	-	-
MDGS[9]-DO													
	DRC:HMC	3	25	19	27	804	3.61	6.43	23.10	807	3.32	6.74	22.30
	SFC	1	24	8	20	636	4.06	5.52	22.30	637	3.75	5.86	21.90
MDGS-FF													
	DRC:HMC	8	120	63	28	836	3.94	6.39	25.10	841	3.63	6.74	24.40
	SFC	-	-	-	-	-	-	-	-	-	-	-	-
WDGS[10]-DO													
	DRC:HMC	6	61	42	29	805	3.97	6.41	25.40	816	3.74	6.85	25.50
	SFC	2	34	13	22	705	4.01	5.85	23.40	727	3.72	6.39	23.70
WDGS-FF													
	DRC:HMC	28	276	169	30	764	3.94	6.12	23.90	764	3.62	6.67	24.00
	SFC	4	39	31	32	763	4.00	5.81	22.80	781	3.84	6.18	23.10

[1]ADG—average daily gain
[2]F:G—feed:gain
[3]DMI—dry matter intake
[4]DDGS—dry distillers grains plus solubles
[5]DO—de-oiled distillers grains (6–9% fat)
[6]DRC:HMC—diets with dry-rolled corn, high-moisture corn, or a blend of the two grains as the concentrate
[7]SFC—diets with steam-flaked corn as the concentrate
[8]FF—full fat distillers grains (10–12% fat)
[9]MDGS—modified distillers grains plus solubles
[10]WDGS—wet distillers grains plus solubles

and yardage costs, which were used to determine the optimum inclusion of distillers.

Results

The results of this analysis showed the performance benefits of feeding SFC relative to HMC:DRC based finishing diets. Cattle fed SFC had lower DMI and similar ADG compared to cattle fed HMC:DRC, which resulted in a 0.6–0.7 lb improvement in feed conversion. This trend was evident in both control-fed cattle and cattle where distillers were included in the diet. Overall, these data suggest that feeding SFC would reduce the total tonnage of feed needed to achieve similar gains when fed equal days on feed.

Feeding distillers grains resulted in increased DMI and increased ADG on average, regardless of corn type. (Table 2). This intake and gain response resulted in a 0.3 unit improvement in feed conversion and suggests that including distillers grains improves the efficiency of cattle compared to cattle fed without distillers. This response was largely influenced by the feed conversion improvement when WDGS was included in the diet. Cattle fed DO WDGS and FF WDGS both had similar DMI as the control fed cattle but had 0.20 lbs/d improvements in ADG. The oil content of the distillers products showed cattle fed FF products had similar DMI but improved ADG and 0.13 lb improvement in feed conversion compared to cattle fed DO products. In HMC:DRC based diets, FF WDGS improved feed conversion by an average of 4.74% compared to DO WDGS. However, when comparing FF MDGS to DO MDGS when fed in HMC:DRC based diets, less than a 1% difference in feed conversion was observed. When comparing MDGS to WDGS, regardless of oil level, feeding WDGS improved feed conversion by 2.31% suggesting wetter products will improve performance. Although the data suggests that feeding DDGS will improve feed conversion compared to either MDGS or WDGS, this is likely a reflection of the type of cattle being fed in the few studies that contain DDGS. Studies that evaluated DDGS performance were conducted on primarily calf-fed animals, which tend to have lower DMI and ADG, but improved F:G compared to yearling cattle. This increased proportion of calf-fed observa-

Table 3. Optimum inclusion of distillers based on performance and pricing relative to each corn type.

		Optimal Inclusion Level Based on Animal Performance:			Optimal Inclusion Level Based on Pricing:								
					Distillers Price is 80% of Corn Price with:			Distillers Price is 100% of Corn Price with:			Distillers Price is 120% of Corn Price with:		
By Product	Corn Type	ADG[1]	F:G[2]	DMI[3]	$4 Corn	$6 Corn	$8 Corn	$4 Corn	$6 Corn	$8 Corn	$4 Corn	$6 Corn	$8 Corn
DDGS[4]-DO[5]													
	DRC:HMC[6]	36	40	37	38	38	38	33	33	33	19	9	9
	SFC[7]	36	40	37	40	40	40	31	31	31	16	12	12
DDGS-FF[8]													
	DRC:HMC	36	40	37	38	38	38	33	33	33	19	9	9
	SFC	36	40	37	40	40	40	31	31	31	16	12	12
MDGS[9]-DO													
	DRC:HMC	28	40	24	39	39	39	36	36	36	12	12	12
	SFC	28	40	24	40	40	40	36	40	40	11	7	1
MDGS-FF													
	DRC:HMC	28	40	24	39	39	39	35	39	39	17	7	7
	SFC	28	40	24	40	40	40	36	40	40	11	7	1
WDGS[10]-DO													
	DRC:HMC	29	40	19	40	40	40	35	35	35	22	22	22
	SFC	29	40	19	40	40	40	36	36	36	27	27	27
WDGS-FF													
	DRC:HMC	29	40	19	40	40	40	34	34	34	24	24	24
	SFC	29	40	19	40	40	40	35	35	35	23	23	23

[1]ADG—average daily gain

[2]F:G—feed:gain

[3]DMI—dry matter intake

[4]DDGS—dry distillers grains plus solubles

[5]DO—de-oiled distillers grains (6–9% fat)

[6]DRC:HMC—diets with dry-rolled corn, high-moisture corn, or a blend of the two grains as the concentrate

[7]SFC—diets with steam-flaked corn as the concentrate

[8]FF—full fat distillers grains (10–12% fat)

[9]MDGS—modified distillers grains plus solubles

[10]WDGS—wet distillers grains plus solubles

tions fed DDGS resulted in improved feed conversion compared to MDGS and WDGS fed cattle.

When distillers are priced at 80% the value of corn, there is a reduction in the total cost as the inclusion of distillers approaches 40%, regardless of distillers type (Table 3). In HMC:DRC diets, as distillers DM decreases from DDGS to WDGS, the cost benefit increases in favor of the wetter products. As the distillers' price increases to 120% the value of corn, the optimum inclusion decreases, but the cost is still reduced by including distillers between 7–24% depending on the diet combination. For example, in HMC:DRC based diets, the optimum inclusion of FF WDGS is still 24% DM even though it is priced 20% higher than corn. This reflects the additional performance that FF WDGS yields when fed in these diets. In SFC based diets, the economic average optimum of FF WDGS and DO WDGS is 25% DM inclusion.

Conclusion

Overall this analysis showed the performance benefits of feeding SFC relative to HMC:DRC, which lowered DMI and feed conversion and made it economically viable even with the additional processing costs. Feeding distillers grains resulted in improved performance and improved feed conversion, which was economically beneficial, especially when distillers were priced at or below corn price. The benefits of feeding WDGS are slightly larger in HMC:DRC based diets, which resulted in higher optimum inclusions even when priced at 120% the value of corn. However, WDGS should still be included in SFC based diets even when priced higher than corn. The fat level did show that FF products have slightly more performance benefits than DO products but feeding DO products still improve performance and economics. Additional research with distillers grains in SFC based diets is needed. The benefits of feeding distillers, especially wetter products, are evident and economically favorable in both corn types up to 120% the value of corn.

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