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Evaluation of Dry Distillers Grains Plus Solubles Inclusion on Performance and Economics of Finishing Beef Steers[1]

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ABSTRACT

A 167-d feedlot study was conducted to evaluate feeding increasing levels of dry distillers grains plus solubles (DDGS) to finishing cattle and the impact on performance and profitability. Crossbred steer calves (n = 240, BW = 306 ± 24.5 kg) were used in 30 pens with dietary treatments of 0, 10, 20, 30, and 40% DDGS dietary inclusion (DM basis). Quadratic relationships (P < 0.05) were observed for final BW and ADG as dietary DDGS increased, with the greatest ADG observed at 20% inclusion. The DMI was not affected (P > 0.15) by DDGS level, but G:F tended to be quadratic (P = 0.10) as 20% DM inclusion had the greatest value, although steers fed all levels of DDGS had numerically greater G:F compared with steers fed no DDGS. Carcass characteristics, other than hot carcass weight, were not affected by DDGS treatment. Energy value of DDGS at 10 to 40% dietary inclusion resulted in a quadratic trend (P = 0.10) and remained above corn, with the highest values at 10 and 20% inclusion averaging 127% of corn. When DDGS was priced equally to corn, all levels of DDGS from 10 to 40% inclusion resulted in higher profits compared with a dry-rolled corn based diet regardless of corn price. The greatest returns were observed when cattle were fed 20% DDGS. These data indicate that DDGS can be fed up to 40% DM to improve cattle performance and result in economic profits, with optimum levels at 20 to 30% diet DM.

Key words: cattle, dry distillers grains plus solubles, economics, finishing

INTRODUCTION

Ethanol production capacity has changed greatly in recent years with production capacity increasing about 3-fold since 2000, and more increases are projected. As ethanol production increases, wet distillers grains plus solubles (**WDGS**) and dry distillers grains plus solubles (**DDGS**) production will increase as well (Stock et al., 2000). Distillers grains in finishing diets up to 15% of diet DM is primarily used as a protein supplement, and levels greater than 15% are primarily fed as an energy source (Erickson and Klopfenstein, 2002). Vander Pol et al. (2006a) fed WDGS from 0 to 50% of diet DM and observed quadratic increases for ADG, DMI, and G:F, with optimum inclusion at 30 to 40% of diet DM. However, performance results have not been the same for feeding WDGS or DDGS (Ham et al., 1994). Previous research (Ham et al., 1994; Gordon et al., 2002; Benson et al., 2005; Vander Pol et al., 2008) has evaluated few inclusion levels of DDGS in finishing diets. Similar or slightly higher ADG and G:F were observed with DDGS compared with feeding a corn-based diet, but optimum inclusion level of DDGS has not been determined.

The objective of this experiment was to determine the effects of feeding increasing dietary inclusions of

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DDGS from 0 to 50% on finishing cattle performance, carcass characteristics, and economic returns.

MATERIALS AND METHODS

Feedlot Trial

A 167-d finishing study was conducted using 240 crossbred, backgrounded steer calves (306 ± 24.5 kg) in a randomized complete-block design experiment. Steers with ample bunk space were limit-fed a receiving diet containing 30% alfalfa hay, 20% corn silage, 30% DDGS, 14% dry-rolled corn (**DRC**), and 6% liquid supplement (DM basis) once daily for 5 d at 2.0% of BW (6.1 kg). Steers were then weighed on 2 consecutive days (d 0 and 1) and weights were averaged for initial BW and performance calculations. The BW obtained from d 0 was used to block the steers into 4 blocks (one replication for each of 3 blocks and 2 replications for 1 block), stratify steers by BW within block, and assign steers randomly to pens. Pens were then assigned randomly within block to 1 of 5 dietary treatments (5 pens/treatment) with 8 steers/pen. This trial was conducted at the University of Nebraska Haskell Agriculture Laboratory at Concord, Nebraska. All animal care procedures were approved by the University of Nebraska's Institute for Animal Use and Care Committee.

Dietary treatments (Table 1) consisted of control (**CON**) with 0% DDGS, or 10 , 20, 30, 40, or 50% DDGS on a DM basis. All DDGS was obtained as needed (approximately once per month) from POET Nutrition (Sioux Falls, SD) and sampled individually for sulfur content. Inclusion of DDGS in the diets replaced DRC and supplemental protein. The CON and 10% DDGS diets included 2 and 1% dry supplement, respectively, which provided supplemental urea to meet a minimum dietary CP of 13%. All diets contained 10% corn silage (approximately 50% roughage) and 2.5% ground alfalfa hay to provide about 7.5% roughage. Diets also contained 6% liquid supplement that included Ca, monensin (320 mg/steer daily; Elanco Animal Health, Greenfield, IN), thiamine (150 mg/steer daily), and tylosin (90 mg/steer daily, Elanco Animal Health). All diets met or exceeded metabolizable protein requirements (NRC, 1996).

Steers were adapted to finishing diets over a 22-d period as 3 diet steps were fed for 7, 7, and 8 d, for which DRC increased in diets and alfalfa hay levels decreased at levels of 30, 20, and 10%, respectively. Inclusion level of DDGS remained the same throughout the adaptation period to the final finishing diets. Steers were fed ad libitum at 0800 h and offered ad libitum access to water.

Steers were implanted initially on d 0 with Ralgro (Schering-Plough Animal Health, Kenilworth, NJ) and re-implanted on d 56 with Revalor-S (Intervet, Millsboro, DE). Feed ingredient samples were collected once every 2 wk, analyzed for DM at 60°C for 48 h, and composited by sample type over the feeding period for nutrient analysis. Analyzed nutrients included CP (AOAC, 990.03), fat (AOAC, 920.39), phosphorus (AOAC, 968.08 and 965.17), and

Table 1. Composition of final finishing diets and nutrient analysis for dietary treatments[1]

	% DDGS[2]				
Item	**0**	**10**	**20**	**30**	**40**
Ingredient					
Dry-rolled corn	79.5	70.5	61.5	51.5	41.5
DDGS	0.0	10.0	20.0	30.0	40.0
Corn silage	10.0	10.0	10.0	10.0	10.0
Alfalfa hay	2.5	2.5	2.5	2.5	2.5
Liquid supplement	6.0	6.0	6.0	6.0	6.0
Limestone	1.55	1.55	1.55	1.55	1.55
Salt	0.3	0.3	0.3	0.3	0.3
Trace mineral[3]	0.05	0.05	0.05	0.05	0.05
Vitamins A, D, and E	0.02	0.02	0.02	0.02	0.02
Monensin-80 premix[4]	0.02	0.02	0.02	0.02	0.02
Thiamine premix[5]	0.01	0.01	0.01	0.01	0.01
Tylosin-40 premix[6]	0.01	0.01	0.01	0.01	0.01
Dry supplement	2.0	1.0	0.0	0.0	0.0
Fine ground corn	0.85	0.43	—	—	—
Urea	1.15	0.57	—	—	—
Dietary nutrient analysis[7]					
CP, %	13.2	13.8	14.4	16.5	18.6
Ca, %	0.78	0.78	0.79	0.79	0.80
P, %	0.28	0.34	0.39	0.44	0.49
K, %	0.59	0.68	0.78	0.87	0.96
S, %	0.15	0.24	0.33	0.41	0.50
Ether extract, %	3.53	4.35	5.17	5.95	6.73

[1]Values presented on %DM basis.

[2]DDGS = dry distillers grains plus solubles.

[3]Supplemental trace minerals providing 50 mg/kg Mg, 30 mg/kg Zn, 22.5 mg/kg Fe, 10 mg/kg Mn, 2.5 mg/kg Cu, 1.5 mg/kg I, and 0.3 mg/kg Co of the diet.

[4]Premix provided a target of 320 mg/steer daily monensin.

[5]Premix provided a target of 150 mg/steer daily thiamine.

[6]Premix provided a target of 90 mg/steer daily tylosin.

[7]Dietary nutrient analysis utilizing analyzed values for CP, P, S, and ether extract of each ingredient. Calcium and K were calculated from book values.

sulfur (AOAC, 968.08; Tinsdale et al., 1985).

High total dietary S levels of 0.6% with the 50% DDGS treatment contributed to some polioencephalomalacia (**PEM**). By d 22 of the trial, there were 6 steers that exhibited symptoms and were treated for PEM and removed from their pens, with 5 of the steers from the 50% DDGS treatment, and 1 from the 40% DDGS treatment. Therefore, all steers on the 50% DDGS treatment were removed from the study.

Steers were slaughtered on d 168 at a commercial abattoir (Greater Omaha Pack, Omaha, NE) where hot carcass weight (**HCW**) and liver scores were recorded on day of slaughter. Fat thickness and LM area were measured, and % KPH and USDA marbling scores were recorded after a 48-h chill. Hot carcass weight, fat thickness, LM area, and KPH were used to calculate USDA YG as follows: 2.50 + 6.35 × fat thickness (cm) + 0.0017 × HCW (kg) – 2.06 × LM area (cm^2) + 0.2 × KPH (%; Boggs and Merkel, 1993). Final BW, ADG, and G:F were calculated based on HCW and were adjusted to a common dressing percentage of 63% to minimize error associated with gut fill and to obtain an accurate estimate of final BW. Dressing percentage tended to be quadratic ($P = 0.08$) with greater HCW (i.e., greater dressing percentage) for steers fed DDGS compared with corn. Therefore, final live BW are provided as well.

Calculated net energy for gain was estimated using a model developed by Owens et al. (2002). This model uses iterative equations accounting for pen-level ADG, DMI, G:F, and percent DDGS to calculate the energetic responses due to DDGS inclusion. Energy values for DDGS were calculated using the CON diet as the basis at 100%.

Some pens of cattle were observed to be moving feed around or tossing feed out of their bunks late in the finishing period. A 4-point (0 to 3) visual scoring system was used on 5 random days within the last month of the trial to determine any relationships between behavior at the feed bunk and level of DDGS fed. Scores used were 0 for no feed movement, 1 for little feed moved around inside the bunk, 2 for feed moved within the bunk and little feed pushed over the bunk walls, and 3 for a significant amount of feed moved within the bunk and some feed tossed over the bunk walls onto the feed alley.

Performance and carcass data were analyzed as a randomized complete-block design using the mixed procedures of SAS (Version 8.02, SAS Inc., Cary, NC) with pen as the experimental unit and block as a fixed effect. Orthogonal contrasts were used to test significance ($P < 0.05$) for the highest order polynomial. Feeding behavior data were analyzed with the chi-square procedures of SAS.

Economic Analysis

Performance Inputs. Response equations for DMI and G:F from this experiment were used to predict biological performance for feeding increasing dietary amounts of DDGS from 0 to 40% (DM basis). Steers fed the corn-based diet were used as a baseline to predict feedlot cattle performance when feeding DDGS, which included 9.25 kg DMI and 0.162 G:F for cattle fed corn. Initial (307 kg) and final (558 kg) BW for cattle fed the corn-based diet were also used, which remained constant across all levels of DDGS. Biological DMI and G:F were estimated from prediction equations assuming a quadratic relationship with the equations generated from Microsoft Excel (Microsoft, Redmond, WA) for feeding 10, 20, 30, and 40% DDGS (DM basis). Gain and days on feed were calculated assuming equal final BW to that of steers fed the corn-based diet. Total yardage costs ($0.35/head daily) were divided into 2 parts: nonfeeding costs at two-thirds and feeding costs at one-third of total yardage costs. Processing and medical expenses, death loss, and cattle loan interest remained constant for any DDGS scenario analyzed at $20.00/head, 1.5%, and 8.1%, respectively, as minimal health challenges were observed for steers fed 0 to 40% DDGS. This approach is a modified version of the economic analysis that Vander Pol et al. (2006b) conducted for feeding WDGS.

Feed Ingredient Prices and Transportation Costs. Dry distillers grains plus solubles were evaluated at 80 or 100% the price of corn (DM basis) at the ethanol plant with 1 of 3 different corn prices, resulting in 6 scenarios. Price of DDGS relative to corn is elusive, but USDA Agricultural Marketing Service price reports suggest a range between 80 and 100% (or more) the price of corn on a DM basis. Therefore, both pricing scenarios were evaluated for DDGS price relative to corn (DM basis). Alfalfa hay, dry supplement, and urea costs were $0.033, $0.045, and $0.073/kg of DM, respectively. Alfalfa hay (88% DM) and dry supplement (95% DM) remained constant in all diets at 7 and 6% of diet DM, respectively. Urea (100% DM) inclusion (part of the dry supplement inclusion) and pricing was only used if diets needed supplemental protein to meet a minimum 13% CP diet (i.e., for CON and 10% DDGS). Inclusions of DDGS used were 0, 10, 20, 30, and 40% DM, and the remainder of the diets (minus alfalfa hay, supplement, and urea) consisted of DRC. Three scenarios were compared using dry-rolled corn prices of $0.144, $0.197, and $0.250/kg of DM ($3.14, $4.30, and $5.47/bushel at 86% DM).

Transportation costs were assumed to be $3.00/loaded 1.61 km (mile) based on a 22,700 kg (as-is) load. Because costs for transporting a dry product from an ethanol plant have small effects on total costs, these analyses were conducted with the 96.6-km trucking distance held constant.

Cattle prices leaving the feedlot were based on an assumed $90/45.4 kg BW. Prices for cattle entering the feedlot vary inversely with corn prices to maintain relatively constant feeding margins. Therefore, feeder

Table 2. Cattle performance and carcass characteristics for finishing steers when fed increasing levels of DDGS[1]

	% DDGS						*P*-value	
Parameter	0	10	20	30	40	SEM	Lin[2]	Quad[3]
Performance								
Initial BW, kg	307	305	307	306	305	1.4	0.34	0.86
Final BW,[4] kg	553	562	575	566	559	7.4	0.46	0.07
Final BW,[5] kg	558	574	588	577	570	8.9	0.32	0.04
DMI, kg/d	9.25	9.47	9.52	9.71	9.47	0.17	0.23	0.30
ADG, kg	1.50	1.61	1.68	1.62	1.59	0.05	0.26	0.05
G:F[6]	0.162	0.171	0.177	0.168	0.168	0.01	0.61	0.14
DDGS NE_g, %	—	127	128	106	105	11.8	0.73	0.10
Carcass characteristics								
HCW,[7] kg	351	362	370	364	359	5.6	0.32	0.04
Marbling score[8]	533	537	559	527	525	12.7	0.50	0.18
12th rib fat, cm	1.42	1.37	1.50	1.40	1.47	0.08	0.48	0.99
LM area, cm^2	80.0	80.6	82.6	81.3	81.3	1.29	0.42	0.37
YG[9]	3.36	3.36	3.49	3.38	3.42	0.09	0.62	0.63

[1]DDGS = dry distillers grains plus solubles.

[2]Contrast for the linear effect of treatment *P*-value.

[3]Contrast for the quadratic effect of treatment *P*-value.

[4]Final live BW shrunk 4% before slaughter

[5]Calculated from hot carcass weight, adjusted to a 63% common dress.

[6]Calculated as total gain over total dry matter intake.

[7]HCW = hot carcass weight.

[8]USDA marbling score 450 = $Slight^{50}$, 500 = $Small^{0}$, 550 = $Small^{50}$.

[9]USDA YG calculated as = 2.50 + 6.35 × fat thickness (cm) + 0.0017×HCW (kg) – 2.06×LM area (cm^2) + 0.2×KPH (%; Boggs and Merkel, 1993).

cattle prices were adjusted to reflect a $0 profit in the corn-based diet.

Total feeding costs were calculated by combining feeding yardage costs, total feed consumed, diet costs, and transportation costs of hauling DDGS to the feedlot. The economic outcome was marginal returns per steer from feeding DDGS compared with feeding the DRC-based diet.

RESULTS AND DISCUSSION

Feedlot Trial

A quadratic relationship was observed for final BW ($P = 0.04$) and ADG ($P = 0.05$) as DDGS increased and replaced DRC (Table 2). The equation for ADG (determined by final BW) was $y = -0.0003x^2 + 0.01411x + 1.50$, where y = ADG and x = inclusion percentage of DDGS. Therefore, ADG was maximized at 23.5% inclusion of DDGS (DM basis) using the prediction equation. Steers fed 20% DDGS had the heaviest final BW and highest ADG among all of the treatments in this experiment. Feeding any level of DDGS in this study resulted in numerically heavier final BW and higher ADG compared with the CON diet. These results indicate that higher inclusions of DDGS may not be optimum for cattle performance, but ADG remained greater than for steers fed a DRC diet. Increasing DDGS inclusion from 0 to 20% of diet DM increased ADG from 1.50 to 1.68 kg. Intermediate ADG of 1.62 and 1.59 kg was observed for cattle fed 30 and 40% DDGS, respectively. These data agree with Gordon et al. (2002) who fed 15% DDGS in steam-flaked corn diets and observed increased final BW and ADG. This same study resulted in similar final BW and ADG for feeding 30% DDGS and the control, steam-flaked corn diet. Ham et al. (1994) compared DDGS at 40% of diet DM to a DRC-based diet and observed that ADG increased from 1.46 to 1.68 kg. Benson et al. (2005) fed 0, 15, 25, and 35% DDGS in cracked-corn based diets and reported a significant quadratic response for ADG as inclusion of DDGS increased. They found that feeding 25% DDGS tended to increase ADG compared with feeding 0% DDGS. Feeding 35% DDGS numerically decreased ADG compared with feeding 25% DDGS, but ADG remained higher relative to feeding 0% DDGS in a DRC diet.

No significant relationship (linear $P = 0.23$, quadratic $P = 0.30$) was observed for DMI as increasing levels of DDGS were fed. However, steers fed the control, corn-based diet had numerically the lowest DMI. This agreed with Mateo et al. (2004) as they observed the lowest numerical DMI for cattle fed 0% DDGS at 9.09 kg compared with 10.5 and 10.6 kg for cattle fed 20 and 40% DDGS, respectively. Benson et al. (2005) also observed that DMI was greater ($P < 0.05$) for cattle fed 15, 25, and 35% DDGS compared with the corn diet containing no DDGS. Stock et al. (1990) suggested that cattle fed high starch diets tend to experience more subacute acidosis challenges and they offset these situations by eating smaller meals more frequently. When by-products are included in finishing diets, starch levels are decreased. Therefore, it is possible that DMI may increase when including DDGS in diets due to less dietary starch and potentially less subacute acidosis.

Because DMI was not affected and ADG resulted in a significant quadratic relationship as DDGS inclusion increased, G:F approached a significant quadratic trend ($P = 0.14$) for increasing levels of DDGS. The equation for G:F was $y = -0.00002x^2 + 0.000987x + 0.162$, where y = G:F and x = inclusion percentage of DDGS. Optimum G:F was observed when steers were fed 20% DDGS (0.177) in the experiment; however, solving for maximum G:F using the prediction equation suggests that G:F is maximized at 24.7% inclusion (DM basis). Efficiency was the lowest for CON fed steers (0.162) and intermediate (0.168) for steers fed 30 and 40% DDGS. These feed efficiency results agree with other research conducted with DDGS. Vander Pol et al. (2005) observed numerically improved G:F as dietary DDGS increased from 10 to 20% of DM, and Ham et al. (1994) also reported increased G:F when steers were fed 40% DDGS compared with a corn-based diet. Numeric G:F increases were reported by Gordon et al. (2002) when they fed increasing levels of DDGS at 15, 25, and 35% of DM compared with a corn-based diet.

Steers fed 50% DDGS were removed from the study following the grain adaptation phase. Only one steer exhibited signs of PEM and was removed from the study for the 40% DDGS treatment. Average analyzed S content for the DDGS used in this experiment was 1.01% (DM basis) and ranged from 0.87 to 1.20%. Total dietary S increased as dietary inclusion of DDGS increased from 0.15% S in the CON diet to 0.50% S in the 40% DDGS diet. However, other than the one steer on 40% DDGS, no other treatments were impacted and no other steers appeared to be affected due to PEM. One additional steer death did occur on the 30% DDGS treatment due to causes unrelated to the diet. The NRC (1996) suggests the maximum tolerable level of dietary S is 0.4% of diet DM. More recently, maximum tolerable levels of dietary S are suggested to be 0.3% S in grain-based diets, and 0.5% S in forage-based diets (NRC, 2005). It is clear that elevated S consumption by cattle can cause PEM (Gould, 1998); however, maximum tolerable levels from diets or different sources of S within diets is not well established because cattle fed 40% DDGS in the current study were fed diets containing 0.5% S on average.

Calculated energy values relative to the CON diet resulted in a quadratic trend ($P = 0.10$; Table 2) as inclusion of DDGS was increased in diets from 0 to 40% of DM. Feeding 10 or 20% DDGS resulted in similar energy values of 127% of corn and feeding 30 and 40% DDGS resulted in similar energy values of 106% of corn. The reasons for improved energy values when feeding DDGS compared with corn are not completely clear. In a review on the use of wet and dry milling byproducts, Stock et al. (2000) suggested that the improved energy responses from feeding by-products may be due to additional undegradable intake protein, higher fat content, or potential for reducing acidosis. Ham et al. (1994) proposed that replacing concentrate feeds with high fiber ingredients in feedlot diets decreases starch levels and reduces acidosis incidences, which may contribute to an improved energy response when feeding DDGS compared with corn. In a metabolism study, Vander Pol et al. (2008) observed that feeding 40% WDGS (DM basis) decreased average pH values and increased time spent with a pH under 5.6, which is considered subacute acidosis. Therefore, the energy value improvement for distillers grains may not be due to controlling pH and subacute acidosis. However, they observed that feeding 40% WDGS increased propionate production, decreased the ratio of acetate to propionate, increased total tract fat digestion, and increased the amount of unsaturated fatty acids reaching the duodenum compared with a DRC-based diet or corn plus supplemental fat. Therefore, increased propionate production and fat digestion may explain the greater energy values when feeding distillers grains in finishing diets. In addition, distillers grains contains about 3 times the fat of DRC, thus providing more energy. Vander Pol et al. (2008) compared energy sources for cattle fed either WDGS or corn supplemented with added corn oil and observed that cattle fed WDGS consumed more feed, gained more weight, and were more efficient than cattle fed either corn or corn plus oil. They suggested that most of the improved energy response in WDGS was due to the fat content, but the source or availability of fat may be important as well.

A quadratic relationship for HCW was observed ($P = 0.04$) similar to final BW, but no other carcass characteristics were affected by DDGS inclusion level. Steers fed all of these treatments finished with similar degrees of fat thickness at 1.43 cm, USDA marbling score of 536 (low Choice), and USDA calculated YG of 3.40. Benson et al. (2005) reported an increase in fat thickness for feeding steers 35% DDGS compared with the corn-based diet, with no differences in carcass quality. Ham et al. (1994) and Vander Pol et al. (2005) did not observe any carcass characteristic differences other than HCW when feeding 40% or 10 and 20% DDGS, respectively. These studies indicate that feeding varying levels of DDGS in finishing diets results in similar or slightly greater fat thickness with no changes in carcass quality.

Visual bunk scores indicated that cattle fed 10, 20, and 30% DDGS tended to move feed within the bunk (data not shown). Interestingly, cattle fed 40% DDGS did not move their feed around as much as intermediate DDGS levels. It is important to note that proper mixing can be a challenge with use of DDGS at greater inclusions in the diet. Because DDGS is a dry, less bulky feed, care should be used when feeding high levels to ensure sorting does not occur, as cattle may choose to sort out the DDGS to consume it first.

Economic Analysis

Predicted days on feed, transportation costs to the feedlot, and returns for feeding 10, 20, 30, and 40% DDGS (DM basis) are presented in Table 3. Days on feed, calculated from ADG and BW, responded quadratically with a decrease and then increase as DDGS level increased. Days on feed were the greatest for CON fed steers at 166 d and lowest for 20% DDGS at 149 d. This decrease in days on feed calculated to a $3.93 savings for a steer fed 20% DDGS compared with CON over the feeding period due to decreased yardage costs.

Costs per steer for transporting DDGS from an ethanol plant to the feedlot at 96.6 km over the feeding period were $1.34, $2.63, $3.98, and $5.51 for 10, 20, 30, and 40% DDGS, respectively. Transportation costs for DDGS increased feeding costs but decreased days on feed, which led to less total intake over the feeding period, resulting in decreased feeding costs. Although corn price changed in these scenarios, feeding costs were consistently the greatest for steers fed CON and the lowest for steers fed 20% DDGS whether DDGS is priced at 80 or 100% of corn price. Regardless of corn prices, cattle fed any level of DDGS from 10 to 40% resulted in greater marginal returns per steer compared with feeding predominately DRC, and profit increased across all levels of DDGS as corn prices increased. Similarly, marginal returns increased as DDGS price decreased relative to corn, as expected. However, this did not change the optimal inclusion of DDGS, but did result in greater returns when DDGS was included at higher inclusions (30 and 40%). The economic optimum level of DDGS was 20% of diet DM, with marginal returns of $23 to $31 per steer or $26 to $40 more per steer compared with steers fed corn-based diets when DDGS was priced at 100 or 80% of corn price, respectively. Return was actually greater relative to corn-based diets as corn became more expensive; however, profits would decrease if initial steer prices were not decreased.

Table 3. Economic analysis for predicting DDGS[1] returns

	% DDGS				
Item	0%	10%	20%	30%	40%
Predicted DMI,[2] kg/d	9.25	9.48	9.60	9.62	9.52
Predicted G:F[2]	0.161	0.169	0.172	0.171	0.164
Calculated ADG,[3] kg/d	1.49	1.60	1.65	1.64	1.56
Calculated DOF,[4] d	166	154	149	150	157
DDGS transportation,[5] $/head	0	1.34	2.63	3.98	5.51
Nonfeeding yardage costs,[6] $/head	39.34	36.56	35.41	35.67	37.39
Feeding yardage costs,[7] $/head	19.67	18.71	18.32	18.44	19.09
Marginal return with DDGS priced at 100% of 3 different corn prices,[8,9] $/head					
$0.144/kg	—	16.68	22.96	19.43	6.67
$0.197/kg	—	19.62	27.01	22.98	8.00
$0.250/kg	—	22.56	31.07	26.53	9.33
Marginal return with DDGS priced at 80% of 3 different corn prices,[8,9] $/head					
$0.144/kg	—	17.80	26.43	25.42	15.25
$0.197/kg	—	22.17	33.08	32.50	20.81
$0.250/kg	—	26.53	39.71	39.52	26.29

[1]DDGS = dry distillers grains plus solubles.

[2]Predicted by DMI and G:F equations derived from experiment results.

[3]Calculated from predicted DMI and G:F values.

[4]DOF = days on feed; calculated with ADG combined with feeder and market cattle weights.

[5]Costs needed to transport DDGS 96.6 km from ethanol plant to feedlot.

[6]Calculated based on two-thirds of $0.35/head daily yardage cost.

[7]Calculated based on one-third of $0.35/head daily yardage cost.

[8]Corn prices expressed as $/kg of DM and equate to $3.14, $4.30, and $5.47 per bushel (86% DM).

[9]Calculated as the difference between profit or loss per animal fed DDGS compared with dry-rolled corn-fed cattle.

IMPLICATIONS

Feeding increasing levels of DDGS in place of corn increased ADG and G:F quadratically. The calculated optimum level of DDGS inclusion for performance is 23 to 24% of diet DM. Economic marginal returns for feeding DDGS from 0 to 40% of diet DM increased quadratically, with the optimum inclusion at 20%. Economic returns remained greater when including 30 and 40% DDGS in feedlot diets compared with a DRC diet, but depends on price relative to corn.

These performance and economic results suggest that the optimum DDGS inclusion level was 20% of diet DM, but greater inclusions may be fed to allow greater use of DDGS from increased ethanol production.

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