Table 16. Performance of animals fed diets where 0, 33, 67, 100, or 133% of the NRC predicted degradable intake protein requirement was met with supplemental urea

	.... Diet						F-Test
Item	0	33	67	100	133	SEM	P-value
Individually Fed							
Initial BW, lb	611	611	615	617	614	11	0.99
Final BW, lb	694	697	680	702	702	15	0.85
ADG, lb	1.06	1.03	0.93	1.01	1.04	0.07	0.77
Total DMI, lb	11.3	11.4	11.4	11.5	11.4	0.2	0.95
F:G	11.1	11.8	13.2	11.8	11.7	0.9	0.54
Pen Fed							
Initial wt., lb	452	--	--	449	--	1	0.10
Final wt., lb	579	--	--	585	--	4	0.38
ADG, lb	1.53	--	--	1.63	--	0.05	0.17
Total DMI, lb	11.9	--	--	11.6	--	0.5	0.76
F:G	9.8	--	--	9.1	--	0.5	0.33

[ab]Means within a row with unlike superscripts differ (P<0.05).

Loy et al., (2004) concluded that DCGF decreases feed costs compared to conventional hay feeding when fed over the winter for developing heifers on a commercial Nebraska ranch in the Sandhills. In their study, a treatment system (TRT) was compared to their conventional management using more than 550 heifers in each group across two years. The TRT utilized only grazed winter forage and DCGF supplementation compared to some winter grazing, with hay and protein supplementation. Performance differences are presented in Table 17; however, no differences were observed in developing heifer performance by design. The major implication was reduced costs ($6.71 per heifer) through the winter while maintaining excellent performance and reproduction.

A similar experiment was conducted using DDGS (Stalker et al., 2006a). Because of the higher energy content of DDGS, a smaller amount was needed to meet protein and energy requirements of these bred heifers (1,353 heifers were used). Feeding DDGS and grazing winter range with heifers led to slightly better winter gains and changes in body condition compared to the hay-fed, control heifers. Pregnancy rates were 97% for both treatments. Most important, $10.47 per heifer was saved in feed costs by using DDGS and winter range versus a conventional system of hay, supplement, and range.

Feeding DDGS as a supplement to calves grazing winter range results in similar performance and is less expensive than feeding corn and soybean meal supplement. In a two year study, Stalker et al.(2006b) fed steers grass hay (6.6% CP) and 4.4 lbs/day of a corn-soybean meal based supplement in a dry lot (CON), or fed 6.0 lbs/day of the same corn/soybean meal based supplement 6 days/week (CSM), or the daily equivalent of 4.2 lbs/day of a dried distillers grains based supplement either 6 days/week (DDG6) or 3 days/week (DDG3) to steers grazing native winter range. Treatments were designed to result in similar ADG and the trial lasted 62 days. A partial budget was used to compare costs and calculate cost of gain associated with each treatment. The CON, CSM, and DDG6 steers performed similarly but performance was decreased when dried distillers grains was fed 3 d/week (Table 18). Steers in the DDG3 treatment were offered

Table 17. Weight, body condition score (BCS), and conception rates of heifers in two systems: CON, which were fed hay with supplement, and TRT, which used increasing amounts of corn gluten feed along with grazed winter forage

Item	CON	TRT
Year One		
Pre-calving BW change, lb	100.0	98.3
Pre-calving BCS change	-0.16[a]	-0.08[b]
Post-calving BW change, lb	-100.1	-98.3
Post-calving BCS change	0.16	0.28
Year Two		
Pre-calving BW change, lb	-5.1[a]	12.3[b]
Pre-calving BCS change	-0.75[a]	-0.48[b]
Post-calving BW change, lb	2.82	0.04
Post-calving BCS change	-0.30[a]	-0.57[b]
Pregnancy rate, %[e]	96.1	96.4

[a,b] Unlike superscripts within a row differ, $P < 0.05$.
[c,d] Unlike superscripts within a row differ, $P < 0.10$.
[e] Percentage pregnant with second calf. P-value reflects chi square analysis.

twice the amount offered to DDG6 on alternate supplementation days however DDG3 fed steers only consumed the daily equivalent of 3.9 lb/steer (DM) supplement over the course of the experiment. These results may be related to the fat content of DDGS because the reduction in gain is not completely accounted for by incomplete consumption of the supplement. This conclusion is supported by the results of Loy et al. (2004). These results verify previous research which has shown dried distillers grains has about 125% the energy of corn in forage based diets (Loy et al., 2003) since the DDGS calves were supplemented with 70% as much dry matter as CSM calves to provide equivalent energy intake. Cost of gain was greatest for CON treated steers primarily because of costs associated with feeding hay. Total costs were least but gain was also least for DDG3 steers making their cost of gain greatest among steers grazing range. Feeding dried distillers grains 6 days per week resulted in the lowest cost of gain.

A two-year study (Martin et al., 2007) evaluated DDGS compared to a control supplement that provided similar CP, energy, lipid, and fatty acids. The protein degradability of the supplements differed such that UIP exceeded requirements for heifers consuming the DDGS supplement. The heifers were program fed to gain 1.5 lb/day and reach 60% of mature weight at the time of breeding. Heifer

Table 18. Weight, average daily gain and cost of feeding steers a corn/soybean based supplement in a dry lot (CON) or while grazing native winter range (CSM) and feeding dried distillers grains while grazing range either 6 (DDG6) or 3 (DDG3) days per week

	Treatment					
Item	CON	CSM	DDG6	DDG3	SE[a]	P-value
Initial BW, lbs	468	468	470	470	1	0.98
Final BW, lbs	585[b]	594[b]	581[b]	560[c]	1	0.004
ADG, lbs/day	2.0[b]	2.0[b]	1.8[b]	1.4[c]	0.1	0.004
Supplement cost, $/hd	19.71	24.10	15.57	14.78		
Hay cost, $/hd	20.27	-	-	-		
Range cost, $/hd	-	8.60	11.11	11.38		
Total cost, $/hd	39.98	32.70	26.68	26.16		
Cost of gain, $/cwt	32.90	25.98	23.78	29.30		

[a]Standard error of the mean, n = 16.

pubertal development and overall pregnancy rate were not affected by supplement type and averaged 89% for each treatment. However, Artifical Insemination (AI) conception rate and AI pregnancy rate were improved by feeding DDGS in the heifer development diet. The proportion of heifers detected in estrus that conceived to AI service was higher for the DDGS treatment than for the control treatment. These data indicate that utilizing DDGS as a protein and energy source in heifer developing diets to promote moderate gains gives highly acceptable pregnancy rates and may enhance AI conception and pregnancy rates.

Cornstalk grazing

The last area where co-products may fit in forage situations is with grazing corn residues. Incremental levels of WCGF were fed to calves grazing corn residues. Based on statistical and economical analysis of the data collected, feeding wet corn gluten feed (5.0-6.5 lb/head/day; DM basis) will increase stocking rate on corn residue and may reduce winter cattle costs. Given that 3.5 lb DM/day WCGF will meet the protein and phosphorus needs of calves, and feeding above 6.0 lb/day will not increase gains, wet corn gluten feed should be fed at 3.5-6.0 lb DM/day, producing gains from 1.28-1.88 lb/day (Jordon et al., 2001). In a similarly designed study using DDGS, Gustad et al. (2006) fed 1.5, 2.5, 3.5, 4.5, 5.5, and 6.5 lb/steer/day to calves grazing corn residue. Gains increased quadratically with ADG ranging from 0.90 to 1.81 lb.

WDGS STORAGE

One problem that can be encountered is storage of wet feeds. WDGS has been successfully bagged if no pressure is applied to the bagger. Bags tend to settle because of the weight of the WDGS, resulting in low height and expanded width. Modified wet distillers grains (45% DM) and WCGF bag well, even with pressure.

Adams et al. (2007) conducted two experiments to determine methods to store WDGS (34% DM), because WDGS will not store in silo bags under pressure or pack into a bunker. The first study evaluated three forage sources, as well as DDGS or WCGF mixed with WDGS. The products were mixed in feed trucks and placed into 9-ft. diameter silo bags. The bagger was set at a constant pressure of 300 psi. The height of the silo bag was a determining factor of storability. Inclusion levels of the feedstuffs were adjusted to improve the bag shape. The recommended levels of feedstuffs for bagging with WDGS (DM basis) are 15% grass hay, 22.5% alfalfa hay, 12.5% wheat straw, 50% DDGS, or 60% WCGF. The corresponding as-is percentages for the feedstuffs are 6.3, 10.5, 5.1, 27.5, and 53.7% of the mix, respectively. The second experiment was conducted by mixing grass hay with WDGS and storing in a concrete bunker. Both 30 and 40% mixtures of grass hay with WDGS (DM basis) packed into the bunker. These values correspond to 14.0 and 20.1% of the as-is grass hay mix. In both experiments, the product was stored more than 45 days and the apparent quality did not change. Wet DGS can be stored in a silo bag or bunker silo when mixed with drier or bulkier feedstuffs. More information is available at http://beef.unl.edu.

Storage allows cattle feeders with smaller numbers of animals to use wet co-products and not have the products deteriorate with extended time between deliveries of fresh material from the plant. Wet co-products are often more available and less expensive in the summer. Storage allows for purchase of wet co-products in the summer and subsequent feeding in the winter.

The resulting stored (ensiled) mix of wheat straw and WDGS has been fed to stocker calves. The palatability of the straw (cornstalks as well) seems to have been enhanced by storage. The feeding value is at least equal to what would be expected from the mathematical blend of WDGS and wheat straw. Further, the resulting mix after storage can be fed on the ground in range and pasture situations where cubes (cake) are normally fed on the ground.

NEW ETHANOL INDUSTRY CO-PRODUCTS

The evolving ethanol industry is continually striving to maximize ethanol production efficiency. Changes associated with this progress will provide innovative new co-products feeds for producers to utilize that may be quite different nutritionally when fed to cattle. One example of a new co-product feed is Dakota Bran Cake. Dakota Bran Cake is a distillers co-product feed produced as primarily corn bran plus distillers solubles produced from a prefractionation dry milling process. On a DM basis, bran cake contains less protein than WDGS and WCGF, similar NDF to both feeds and similar to slightly less fat content as WDGS. Bremer et al. (2005) evaluated Dakota Bran Cake in a finishing diet by comparing inclusion levels of 0, 15, 30, and 45% of diet DM. Results indicated improved final weight, ADG, DMI and F:G compared to feeding a blend of HMC and DRC, suggesting this specific feed has 100-108% of the feeding value of corn. Buckner et al. (2007c) compared dried Dakota Bran Cake to DDGS supplementation in growing calf diets. They fed each of the two products at 15 or 30% of the diet replacing a 70:30 blend of brome grass hay and alfalfa haylage (DM basis). Animal performance improved as the inclusion of the co-products increased. DDGS had improved performance compared to the dried Dakota Bran Cake at both inclusion levels. Dried Dakota Bran Cake had 84% the feeding value of DDGS with growing steers. Previous research has shown that DDGS has about 127% the feeding value of corn in forage based diets. Therefore, dried Dakota Bran Cake appears to have an energy value equal to 103% of corn. Dakota Bran Cake is only one example of how new ethanol industry co-products will feed relative to traditional finishing rations. Each new co-products feed needs to be analyzed individually for correct feeding value. Changes to plant production goals and production efficiency have a significant impact on the feeding value of co-products produced.

CONCLUSIONS

Distillers grains, CGF, or a combination of both co-products, offer many feeding options to producers when included in feedlot diets. These co-product feeds may effectively improve cattle performance and operation profitability. WDGS and WCGF have feeding values greater than DRC in beef finishing diets. Drying appears to reduce the feeding value of co-products. The ability to keep cattle on feed and acidosis control are likely responsible for the higher apparent feeding values and may be the primary advantages of using WDGS and WCGF in feedlot diets. Understanding and managing variations in fat and sulfur levels in DGS products may help optimize DGS inclusion in feedlot diets. It appears that WDGS feeds better with HMC and DRC than with steam flaked corn. With feedlot cattle, more intense corn processing may be optimal for diets containing WCGF. It appears that WCGF is a complementary feedstuff for diets containing WDGS, SFC, HMC, and DRC. The quality and quantity of roughages may be minimized in finishing diets containing co-products. In the future, with increased supply of co-products, feeding combinations of WDGS and WCGF may be advantageous. The high UIP value of the DGS and WCGF make them excellent protein sources for young, rapidly growing cattle and lactating cows. Alternate day (or three days/week) feeding appears to be feasible and DGS may have an advantage to grains, non-protein nitrogen sources, and more degradable protein sources in alternative day feeding systems. Innovative ways of storing wet products offer opportunities for smaller producers to capture the value of co-products feeds. It also appears that new co-products will be available in the future as the processes of making ethanol and other products from corn evolve. These "new" feeds should be evaluated with performance data to determine their respective feeding values.

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