# Protein Sources and Levels for Dry and High Moisture Corn

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## Story in Brief

Corn grain, in the rolled or high moisture form, was fed with supplemental protein from urea or soybean meal at two levels of protein (10.5 and 11.5 percent of dry matter). One hundred ninety-one 698 lb steers were fed these rations for 133 days. Compared with dry corn, high moisture corn produced superior rates and efficiencies of gain (5.2 and 3.2 percent). This was all attributed to the first two months on feed. Urea supplementation proved quite superior to soybean meal for steers fed dry corn (+11.1 and 5.8 percent) but slightly inferior for those fed high moisture corn (-3.5 and -1.7 percent). The higher level of protein improved performance slightly during the first 66 days of the trial but did not prove beneficial for the total trial.

## Introduction

The effect of level and source of protein with *dry* corn grain upon performance of feedlot steers was examined by Gill *et al.* (1977). Similar work by Martin *et al.* (1978) using *high moisture* corn noted less response to higher protein levels. Since animal types and weights differed in those two trials, a more direct comparison of responses to protein with dry rolled and higher moisture corn was needed. This experiment, conducted at Panhandle State University, was designed to study the effects of corn moisture, level of protein and source of supplemental protein on performance of steers under feedlot conditions.

**Table 1. Ration composition.**

| | Dry corn | | | | High moisture corn | | | |
|---|---|---|---|---|---|---|---|---|
| **Protein level, %** | **10.5** | **10.5** | **11.5** | **11.5** | **10.5** | **10.5** | **11.5** | **11.5** |
| **Protein source** | **SBM** | **Urea** | **SBM** | **Urea** | **SBM** | **Urea** | **SBM** | **Urea** |
| Corn | 83.66 | 83.66 | 81.33 | 83.66 | 83.66 | 83.66 | 81.33 | 83.66 |
| Alfalfa hay | 13.00 | 13.00 | 13.00 | 13.00 | 13.00 | 13.00 | 13.00 | 13.00 |
| Supplement | 3.24 | 3.34 | 5.67 | 3.34 | 3.34 | 3.34 | 5.67 | 3.34 |
| Corn | .84 | 1.32 | .85 | .94 | --- | --- | --- | .80 |
| Soybean meal | .52 | --- | 3.06 | --- | 1.47 | --- | 3.97 | --- |
| Salt | .45 | .47 | .45 | .47 | .47 | .47 | .45 | .47 |
| Alfalfa, Dehy. | .39 | .40 | .40 | .40 | .40 | .40 | .40 | .40 |
| Limestone | .39 | .37 | .40 | .40 | .40 | .40 | .40 | .40 |
| Molasses | .29 | .31 | .31 | .30 | .30 | .30 | .31 | .31 |
| KCL | .09 | .13 | .03 | .13 | .10 | .13 | --- | .13 |
| Dical | .03 | .20 | .17 | .27 | .20 | .27 | .17 | .27 |
| Rumensin[a] | + | + | + | + | + | + | + | + |
| Vitamin A | + | + | + | + | + | + | + | + |
| Urea | --- | .07 | --- | .40 | --- | .17 | --- | .53 |

[a]Fed at 20 g/ton of feed.

## Materials and Methods

One hundred ninety-one steers with an average weight of 698 lbs were allotted to 24 pens. They were fed free choice a ration (Table 1) calculated to provide either 10.5 or 11.5 percent protein on a dry matter basis. The rations contained 13 percent ground alfalfa hay, 81 to 83 percent corn grain and 3.3 to 5.7 percent supplement. Supplemental protein came from soybean meal or urea. The two levels of corn moisture were 15.7 and 26.5 percent. Dry matter of the grain was measured weekly and the ratio of corn to other ingredients adjusted to maintain a constant ration on a dry matter basis.

On day 110 of the trial, chromic oxide was added to all supplements and on day 117 fecal grab samples were obtained from at least three steers per pen for pH, starch, chromium and dry matter determination. Steers were slaughtered after 133 to 134 days on feed and carcass measurements were obtained.

## Results and Discussion

### Corn moisture level

The higher corn moisture (HMC) level produced 7.8 percent greater gain over the first 66 days (Table 2). However, this effect was not retained after this period. Over the 133 days, gain was greater by 5 percent for steers fed the high moisture corn.

Intake of the dry corn ration decreased after the first 66 days by 1.29 lb of dry matter per day or 6.5 percent whereas HMC intake remained constant. For the complete trial, the HMC steers ate .43 lb more dry matter per day. Feed efficiency favored the HMC the first 66 days by 9 percent but tended to favor dry corn the remaining period, so the feed efficiency advantage was diluted to 3.2 percent by the end of the trial.

**Table 2. Steer performance results.**

| | Corn moisture | | Protein source | | Protein level | |
|---|---|---|---|---|---|---|
| Item | Dry | High Moisture | Soybean meal | Urea | 10.5 | 11.5 |
| Animals, no. | 96 | 95 | 95 | 96 | 95 | 96 |
| Pens, no. | 12 | 12 | 12 | 12 | 12 | 12 |
| Weight, initial | 695 | 701 | 694 | 702 | 700 | 696 |
| Daily gain | | | | | | |
| 0-66 | 3.61[a] | 3.89[b] | 3.72 | 3.78 | 3.68 | 3.82 |
| 66-final | 2.85 | 2.94 | 2.81 | 2.97 | 2.96 | 2.82 |
| 0-final | 3.23[a] | 3.40[b] | 3.26 | 3.37 | 3.31 | 3.32 |
| Daily feed | | | | | | |
| 0-66 | 19.99 | 19.65 | 19.69 | 19.95 | 19.65 | 19.99 |
| 66-130 | 18.70[a] | 19.87[b] | 19.20 | 19.37 | 19.33 | 19.24 |
| 0-final | 19.34[a] | 19.77[b] | 19.45 | 19.66 | 19.50 | 19.61 |
| Feed/gain | | | | | | |
| 0-66 | 5.56[a] | 5.06[b] | 5.32 | 5.29 | 5.37 | 5.25 |
| 66-final | 6.64 | 6.80 | 6.85 | 6.58 | 6.58 | 6.84 |
| 0-final | 6.01[c] | 5.82[d] | 5.98 | 5.85 | 5.89 | 5.93 |
| Fecal starch | 17.9 | 17.7 | 18.3 | 17.4 | 17.9 | 17.7 |
| Est. DMD | 65.6 | 67.2 | 62.9[a] | 69.5[b] | 67.0 | 65.6 |
| Fecal pH | 5.67 | 5.86 | 5.62 | 5.90 | 5.65 | 5.89 |
| $NE_g$ meg/kg | 1.40[a] | 1.44[b] | 1.41 | 1.44 | 1.43 | 1.42 |

[ab]Means in a row within a trial with different superscripts differ statistically ($P<.05$).
[cd]Means in a row within a trial with different superscripts differ statistically ($P<.10$).

Carcass weight (Table 3) was higher for the HMC cattle as were rib eye area and fat thickness at the 12th rib. Marbling also tended to be higher for steers fed HMC. Some of these carcass effects may simply be due to the greater carcass weight.

Dry matter digestibility and calculated metabolizable energy tended to favor the HMC, but some of the increased performance and feed efficiency with the HMC fed cattle can be attributed to higher dry matter intake.

## Protein source

As judged across both ration moisture levels, average daily gain, daily feed intake and feed efficiency were not affected by source of supplemental protein. Unexplainably, dry matter digestibility was 9.5 percent higher with urea than with soybean meal as the supplemental protein source. During the period of sampling, feed efficiency was slightly superior for steers fed urea. Dressing percentage and carcass weight were also higher for the urea treatment. Historically steers fed urea have had reduced feed intake and rate of gain initially with compensation later in the trial. No evidence of such an "adaptation" period was observed in this trial.

An interaction between protein source and corn moisture was evident (Table 4). Throughout the trial, urea addition proved superior to soybean meal supplementation for rate of gain and feed efficiency with dry corn but soybean meal was superior to urea for HMC. If digestion is limited by available ruminal ammonia for digestion and synthesis of microbial protein, the higher nitrogen solubilities of HMC or urea supplementation should prove beneficial, but the combination is not necessary and could reduce intake slightly.

## Protein level

The higher protein level improved gain and feed efficiency slightly the first 66 days of the trial but overall performance was equal. An interaction between protein source and protein level was observed for feed efficiency in the second half of the trial.

When protein was changed from 10.5 to 11.5 percent, feed required per lb of gain increased with added urea (6.26 to 6.91 lb) whereas it decreased with added soybean meal (6.93 to 6.79 lb). This suggests that excess urea may reduce efficiency of feed use of

**Table 3. Carcass characteristics.**

| Item | Corn moisture | | Protein source | | Protein level | |
|---|---|---|---|---|---|---|
| | Dry | High moisture | Soybean meal | Urea | 10.5 | 11.5 |
| Dressing percentage | 61.62 | 61.36 | 61.13[a] | 61.84[b] | 61.49 | 61.49 |
| Carcass weight | 699[a] | 716[b] | 701[a] | 714[b] | 709 | 706 |
| Rib eye area | | | | | | |
| Sq. in | 12.62[a] | 13.27[b] | 12.79 | 13.09 | 12.95 | 12.94 |
| per cwt. | 1.81 | 1.86 | 1.83 | 1.84 | 1.83 | 1.84 |
| KHP | 2.94 | 2.98 | 3.00 | 2.93 | 2.95 | 2.97 |
| Fat thickness | 0.42[a] | 0.50[b] | 0.47 | 0.46 | 0.45 | 0.47 |
| Marbling | 14.1 | 14.4 | 14.4 | 14.1 | 14.2 | 14.3 |
| Grade | 12.7 | 13.0 | 12.9 | 12.8 | 12.7 | 12.9 |
| Cutability, % | 50.38 | 50.22 | 50.20 | 50.40 | 50.36 | 50.24 |
| Abscesses | 0.94 | 1.07 | 1.07 | 0.94 | 0.82[a] | 1.19[b] |
| Yield grade | 3.07 | 3.41 | 3.25 | 3.24 | 3.21 | 3.27 |
| Percent choice | 70.8 | 74.9 | 73.8 | 71.9 | 69.7 | 76.0 |

[ab]Means in a row within a trial with different superscripts differ statistically ($P<.05$).

**Table 4. Interactions of corn moisture level and protein supplement source on steer performance.**

| Item | Dry corn | | HMC | |
|---|---|---|---|---|
| | SBM | Urea | SBM | Urea |
| Daily gain, lb | | | | |
| 0-66 days | 3.52[a] | 3.70[ab] | 3.91[b] | 3.87[b] |
| 66-133 days | 2.60[a] | 3.09[c] | 3.03[bc] | 2.84[b] |
| 0-133 days | 3.06[a] | 3.40[b] | 3.46[b] | 3.34[b] |
| Feed intake, lb | | | | |
| 0-66 days | 19.60[a] | 20.37[b] | 19.79[ab] | 19.53[a] |
| 66-133 days | 18.31[a] | 19.09[ab] | 20.09[b] | 19.65[ab] |
| 0-133 days | 18.95[a] | 19.73[b] | 19.94[b] | 19.60[b] |
| Feed efficiency | | | | |
| 0-66 days | 5.57[b] | 5.54[b] | 5.07[a] | 5.05[a] |
| 66-133 days | 7.06[b] | 6.22[a] | 6.64[ab] | 6.95[b] |
| 0-133 days | 6.19[b] | 5.83[a] | 5.77[a] | 5.87[a] |
| $NE_g$, meg/kg | 1.36[a] | 1.44[b] | 1.45[b] | 1.44[b] |

[abc]Means in a row within a trial with different superscripts differ statistically ($P<.05$).

finishing feedlot steers as earlier results had suggested (Martin *et al.*, 1976) but contrasting with conclusions from Nebraska (Schindler and Farlin, 1979).

Rate of gain and feed efficiency responses to added protein for light steers has been observed consistently in previous trials (Gill *et al.*, 1977; Martin *et al.*, 1978). In those trials, initial weights were considerably less (574 lb; 483 lb) than in this trial (698 lb). In the earlier trials, response to elevated protein levels had disappeared by the time a weight of 750 lb was reached.

Liver abscess score, a combination of incidence and severity, was increased at the higher protein level. This has been noted in some earlier trials as well (Martin *et al.*, 1976; 1977) and could be associated with increased stress of the liver for ammonia detoxication with higher protein intakes.

Results suggest high moisture corn produces faster and more efficient gains than dry corn for steers under 850 lb; urea is more useful with dry than high moisture grain, excess urea should be avoided for heavier weight steers; and a protein level of 10.5 percent is adequate for yearling steers over 750 pounds. Phase feeding programs using a soybean-supplemented high moisture corn, high protein level for steers under 900 lb followed by a urea-supplemented, dry rolled or whole shelled corn, lower protein ration deserves further testing.

## Literature Cited


Gill, D. R., F. N. Owens, J. J. Martin, D.E. Williams and J.H. Thornton. 1977. Okla. Agr. Exper. Sta. Res. Rep. MP-101:42.

Martin, J. J., F. N. Owens and D. R. Gill. 1976. Okla. Agr. Exper. Sta. Res. Rep. MP-96:87.

Martin, J. J., F. N. Owens, D. R. Gill and J. H. Thornton. 1977. Okla. Agr. Exper. Sta. Res. Rep. MP-101:47.

Martin, J. J., F. N. Owens, D. R. Gill, J. H. Thornton and D. E. Williams. 1978. Okla. Agr. Exper. Sta. Res. Rep. MP-103:87.

Schindler, Gregory E. and Stanley D. Farlin. 1979. Nebr. Beef Cattle Rep. p. 8.