Corn Gluten Feed for Dairy Cattle

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Wet milling of corn results in coproducts that are excellent feedstuffs for dairy cattle when properly fed. With the recent opening of the wet corn milling plant in southeastern North Dakota, two coproducts, wet and dry corn gluten feed (CGF) are available to area producers. However, it also requires some special considerations, not only in feeding, but also in storage and handling (addressed in a companion circular, AS-1127 Corn Gluten Feed Composition, Storage, Handling, Feeding, and Value).

Optimum Level of Corn Gluten Feed

Defining the optimum level of CGF feed in the diet is often difficult because of the interaction of feed ingredients on diet utilization and the corresponding ability to support a given level of production. Effectiveness of CGF utilization may be different in each feeding situation.

Several feeding characteristics of CGF have become evident through numerous research trials. Some of these include: 1) a lower net energy for lactation (NE_L) availability compared to corn, which tends to vary depending on dietary ingredient combinations, 2) potential feed intake fluctuations when starting cows on diets containing CGF, and 3) a depression in feed efficiency with diets containing high levels of CGF.

The variable energy availability of CGF is an important factor in selecting a dietary level. In general, as the amount of corn silage increases, the energy value of CGF relative to corn also increases suggesting that dry CGF should be fed at lower levels than wet CGF. One of the problems with dry CGF is that it is less digestible (5-10%) than wet CGF. Therefore, cows will generally consume more feed dry matter when fed wet versus dry CGF. However, there is a tendency for intake to fluctuate when starting cows on wet CGF. It is not known whether this is due to the inherent moisture of wet CGF or some other factor. It does suggest, however, that wet CGF should be introduced gradually over a period of two to three weeks to minimize feed intake fluctuations and maintain milk production.

Based on the conditions of an NDSU experiment (feeds used, stage of lactation, etc.), 18.6% of the dry matter, or about 20% of the diet on an as fed basis was determined to be the optimum level of dietary wet corn gluten (Figure 1). Level of inclusion will vary depending on the ingredients fed. Generally, milk production is depressed when either wet or dry corn gluten feed is included at 30% or greater levels in the diet.

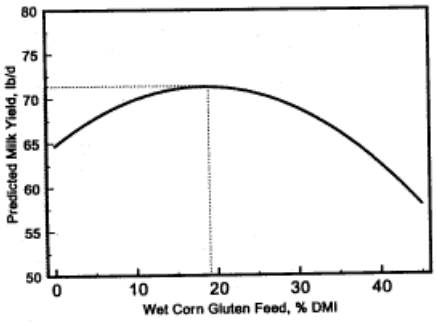

Figure 1.Optimum milk production response from wet corn gluten feed.

CGF to Lactating Cows

Based on NDSU and other research, both wet and dry CGF can be fed up to 30% of the diet dry matter. Corn gluten feed possibly could serve as the sole grain and supplemental protein source for dry cows, heifers older than six months, and late lactation cows. However, for cows in early to mid-lactation, several factors should be considered before incorporating CGF in the diet. These factors include: 1) a lower CGF NE_L concentration, 2) digestibility differences between wet and dry CGF,

and 3) providing for an adequate mineral and vitamin balance.

Typically, early lactation cows are in a negative energy status, demanding both diet palatability and energy density be monitored closely. If cows have difficulty adapting normally to the feed or exhibit low intakes, then the dietary level of CGF should likely be reduced or completely removed from the diet.

University of Wisconsin researchers observed no differences in milk production, milk fat, or protein test when wet CGF made up 36% of the diet. Similarly, Colorado researchers found no differences in animal performance when wet CGF replaced a hominy soybean mixture. In contrast, research at Illinois saw slight reductions in dry matter intake and milk production, especially when wet CGF comprised 40% of diet dry matter. Comparing wet CGF and dry CGF at 26% of diet dry matter as a replacement for corn and soybean meal, Ontario researchers found no significant differences in intake and milk production, but fat test was elevated by including CGF in the diet.

In most situations, dietary calcium and phosphorus levels should be evaluated closely. Corn gluten feed is a poor source of calcium but provides ample phosphorus. The ratio of calcium to phosphorus can be as low as 1:10, where lactating cows require a ratio of 3:1. Therefore, depending on the diet and the amount of CGF fed, supplemental calcium needs may be a real concern. From 4 to 5 ounces per head per day of calcium carbonate (limestone) will meet the dietary calcium needs and provide an adequate calcium-to-phosphorus ratio. This ratio is especially important because it helps regulate proper calcium and phosphorus levels for optimal production and can reduce the chance of cows exhibiting symptoms of metabolic disorders, such as milk fever.

CGF to Heifers

Numerous feeding studies suggest that CGF can be an advantageous feed source providing for good performance. This reflects the ability of CGF to meet the energy and nutrient needs of the heifer. In an Illinois study with growing heifers, using wet CGF as the main feedstuff, growth was excellent. However, intake level of wet corn gluten feed should be controlled to avoid excess weight gain. Because of excessive body weight gain and mild diarrhea, the general recommendation is that wet CGF not be fed free choice as the sole feed to replacement heifers. Increasing growth rate to the extent that heifers become fat is undesirable because of negative effects on subsequent milk production and longevity. In addition, mild diarrhea is possible, probably related to the high crude protein and mineral content of this feed. Blending wet CGF with a low-quality roughage prior to feeding (or when ensiling) could result in good utilization of both feedstuffs and produce desirable growth performance.

Level of Escape Protein for Lactating Cows

Supplemental escape protein will increase milk production when fed in addition to meeting ruminal protein needs. The question is whether CGF is able to supply enough escape protein to maintain or increase milk production. The NDSU Dairy Research Center conducted a trial to evaluate supplemental escape protein in CGF-containing diets fed to lactating Holstein cows (average 56 days in milk and tested for 80 days). Escape protein was fed at three levels: 5.4%, 6.3%, 7.2% of the diet crude protein in a CGF/corn silage forage-based diet. Neither actual or adjusted milk yield were greatly influenced by the escape protein level, though milk composition, especially total solids, tended to be higher for the 6.3 and 7.2% escape protein diets.

Feeding Stored (Ensiled) Versus Fresh Wet CGF

The NDSU Dairy Research Center used a silage bag to store wet CGF, then monitored long-term storage and analyzed wet CGF for compositional changes. Cows fed stored (bagged) versus fresh wet CGF revealed no difference in lactational parameters and the CGF exhibited excellent storage quality in the silo bag. When this product was fed, there was no difference in milk yield and milk composition between these storage treatments. Cows consumed rations similarly and had similar feed efficiencies, blood profiles, and ruminal characteristics. However, cows fed fresh wet CGF did tend to have somewhat greater feed intakes.

Implications of CGF Research to Dairy Producers

Wet corn gluten feed is a moderate protein (22% crude protein) and high energy (80% TDN) feed source which can be a cost effective substitute for conventional feed sources. However, as with most coproduct feed sources, CGF appears to be best used when it replaces only part of the conventional feed source.

There are differences in feeding characteristics between the wet and dry CGF products. It is generally recommended that dry CGF be fed at lower levels than wet CGF, because it is less digestible and often restricts intake. In contrast, wet CGF should be gradually introduced over a period of a couple of weeks to reduce daily intake fluctuations. Because of this apparent problem with feeding wet CGF, it may not be advisable to start fresh cows on wet CGF until they are well established with feed intake. This problem may be overcome with experience

Helpful Hints to Feeding Wet CGF

Here are some points learned from experience and research:

- When you switch to wet CGF, do it gradually. Cows may back off feed for a day or two, but intake should recover in four to five days. Total mixed rations minimize but don't prevent this feeding challenge. Remember, dry matter intake is critical to maximum milk production.
- CGF may not totally meet the protein needs of high producing, early lactation cows. Examine diets for crude protein and bypass protein when feeding large amounts of CGF. Dairy managers are encouraged to always conduct a complete analysis of all feeds used in the diet when substituting alternative and non-traditional feeds.
- Wet CGF (43% dry matter) can be effectively stored in a silage bag. It packs tightly and doesn't ferment or spoil when kept in an air-tight environment.
- Cows will eat more dry matter when fed moderate amounts of wet CGF because it appears to have a high rate of passage, facilitating greater intake.
- Replacing some corn with fibrous wet CGF may greatly reduce or even eliminate problems that are associated with high starch diets and acidosis due to its high production of fiber.
- Fiber digestion is sustained when significant amounts of corn gluten feed are fed, explaining why milk fat often improves.
- Have all rations reformulated for the effective use of all nutrients available in corn gluten feed. Guidelines include:

  Fiber: 26-32% neutral detergent fiber (NDF) and 3/8 inch Theoretical Length of Chop (TLC) and 20-24% Acid Detergent Fiber (ADF)
  Starch: 40-45% Non-Fiberous Carbohydrates (NFC) as a maximum
  Forage to concentrate ratio: 60:40 to 40:60
  Protein: balance for stage of production
  Amino acids: lysine amino acid may be limiting in diets high in corn and soybean)
  Escape protein: 33-40% of the dietary crude protein
  Total mixed ration dry matter: 55-65% DM
  Vitamins: thiamine may become limiting at high levels of CGF
  Minerals: calcium-phosphorus ratio must be monitored, especially if fed to dry cows

- Light-colored dry CGF is more desirable than the dark-colored product, which may have been subject to heat damage during drying. As more steep water is added, the wet CGF will become darker in color. The amount of added steep will vary with processing plant needs, so nutrient value will fluctuate.
- Conduct a feed analysis as ingredients change or different forages are added to the diet.

Management and Economic Considerations

Variation in nutrient content (wet and dry CGF) must be recognized. The nutrient composition of wet CGF compared among research studies suggests that herd managers need to monitor moisture and nutrients frequently.

Economics of corn gluten feed warrants value on price alone as it is not expected to increase milk production. However, it can be an excellent substitute for a portion of the grain or forage in the mix.

Iowa State University developed feed constants for corn coproducts (Table 1). The approach is similar to Morrison feed constants (add together the products: multiply the energy constant times the value of a ton of shelled corn; multiply the protein constant times the value of a ton of 44% soybean meal). If you bring these feeds into the yard for less than the breakeven calculated price, consider their use economically feasible. Be sure to consider handling and storage requirements.

Exercise caution when total coproducts used in the diet exceed 35% of the total dry matter intake so that effective fiber needs are meet.

Table 1.A calculated breakeven price with shelled corn priced at $100 per ton and soybean meal (44%) at $200 per ton.

Product	DM (%)	CP (%)	NE (Mcal/lb)	Protein Constant[1]	Energy Constant[1]	Value ($/ton)[1]
Dry CGF	90	21.5	.82	.316	.592	122
Wet CGF	43	21.5	.86	.146	.309	60

[1] Combine the products: (316 x 200) + (.592 x 100). Substitute farm delivery cost when calculating your breakeven value.

Example rations including corn gluten feed for large breed heifers and lactating cows. (Actual diets will vary.)

	Mid Lactation*	Dry Cow+		Heifers^ (7-12 mo)		
		First 5 Weeks	Last 3 Weeks	20-24 Months	13-19 Months	7-12 Months
Feed (lbs as fed)						
Corn gluten feed: wet (dry)	24(12)	18(9)	24(12)	12(6)	6(3)	10(5)	8(4)	4(2)
Alfalfa hay bud stage	23	--	14	--	8	--	--	8.3
Grass hay mid bloom	--	--	--	17	--	--	--	--
Alfalfa hay mid bloom	--	--	--	--	--	12	7.5	--
Corn silage (46% DM)	--	51	30	--	11	23	--	--
Barley	8	4	5.0	--	--	--	3	1.5
Soybean meal	3	11	4.0	--	1.4	--	--	--
Mineral (23% Ca, 18% P)	--	.25	--	--	--	.08	.08	.02
Limestone or CaCo3	.6	.6	.6	.2	--	--	--	--
Vitamins and TM salt	.25	.35	.3	.2	.1	.15	.05	.05
Potassium chloride	--	.2	--	--	--	--	--	--
Sodium bicarbonate	--	.3	.25	--	--	--	--	--
Composition of diet (DM basis)								
Dry matter intake, lb/d	53	53	53	26	22	25	18	13
Crude protein (%)	19.7	17.9	17.4	15.2	17.5	14.8	16.9	19.3
Degradable protein (% CP)	71	71	71	73	70	73	72	72
NE Lactation (Mcal/lb)	.76	.78	.78	.68	.74	--	--	--
NE Maintenance (Mcal/lb DM)	--	--	--	.71	.76	.69	.78	.72
NE Growth (Mcal/lb DM)	--	--	--	.44	.48	.42	.49	.45
TDN (% DM)	47.7	75.1	57.4	65.8	48.7	66.7	71.9	31.3
ADF (%)	19.0	20.0	21.6	28.5	23.9	30.1	20.3	24.5
NDF (%)	33.9	37.6	39.3	56.2	40.0	48.7	35.9	38.8
Calcium (%)	.99	.71	.83	.56	.61	.82	.65	.88
Phosphorus (%)	.66	.48	.51	.45	.56	.42	.47	.71
Calcium: Phosphorus	1.50	1.50	1.53	1.28	1.10	1.95	1.39	1.24
Grain (% in diet DM)	41	54	48	27	37	20	37	23
Forage (% in diet DM)	59	46	52	73	63	80	63	77

* Assumed 120 DIM, second lactation, 90 lb milk/day, 3.5% milkfat + 3.3 % milk protein, 1,350 lb cow.

+ Assumed first dry period, 50 + 15 days until freshening, respectively, 1,350 lb cow, body condition score of 3.4.

^ Assumed (age in months - body weight in lbs - average gain in lbs) 21, 1150, 1.6; 15, 850, 1.6; 9, 550, 1.6. Use these examples with care.

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