Supplementation of High Corn Silage Diets for Dairy Cows

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INTRODUCTION

There are times when corn silage is the highest yielding and highest quality forage by far that can be produced in a country or region of a country and the cost of importing hay is usually too expensive to be feasible in large quantities. This situation usually necessitates the feeding of high corn silage diets. The purpose of this paper is to review supplementation strategies for high corn silage diets.

FIBROUS CARBOHYDRATE

Fiber is required in dairy cattle diets to maintain normal chewing activity, rumen function, and milk fat test. Diets are formulated to meet or exceed minimum allowances for chemical fiber. The physical form of fiber influences its effectiveness and should also be considered in diet formulation.

Chemical Fiber

Feed analysis and diet formulation for fiber involve neutral detergent fiber (NDF; hemicellulose, cellulose, and lignin) and acid detergent fiber (ADF; cellulose and lignin). These measures of fiber vary widely in corn silage making routine and accurate analysis critical for formulation of high corn silage diets. Recommended minimum allowances for NDF and ADF are 27%-30% and 18%-21% (DM basis), respectively.

Effective Fiber

The minimum recommended dietary NDF from forage allowance for high corn silage diets is about 20% (DM basis). We observed increased DM intake and milk yield in response to feeding high corn silage diets containing 19%-21% NDF from forage compared to 24% NDF from forage. Both milk fat test and rumen pH were reduced only slightly at the low NDF from forage concentrations.

An exception to the 20% minimum NDF from forage guideline is with diets containing brown midrib corn silage where because of its increased NDF digestibility a minimum dietary NDF from forage allowance of 23%-24% may be more appropriate. The use of whole cottonseed may allow minimum dietary NDF from forage to be reduced 2 to 3 percentage units, but milk fat test and hoof health should be monitored closely.

Total mixed rations (TMR) should contain a minimum of 8% of particles on the top screen of the Penn State-Nasco shaker box. This is especially important for early lactation cows, and may necessitate feeding 25%-30% of the forage DM as long or coarsely processed hay. Whole cottonseed shows up on the middle screen and may allow the minimum recommended percentage on the top screen to be 2% units lower.

NON-FIBER CARBOHYDRATE (NFC)

Percent NFC usually is calculated by subtracting %NDF+%CP+%Fat+%Ash from 100%. NFC contains starch primarily, but also sugars, pectin, and organic acids. The concentrations of starch and organic acids in corn silage are highly variable normally ranging from 20%-30% and 5%-10% (DM basis), respectively. Sugar concentrations usually are low (2%-3% of DM) in well-fermented corn silage. There is negligible pectin in corn silage. A starch assay is recommended for corn silage to define the make up of the NFC fraction.

Recommended dietary allowances for NFC and starch are 35%-40% and 25%-30% (DM basis), respectively. Ruminal starch degradability should be evaluated and in cases where it is low (i.e. coarse-processed dry corn or unprocessed dry corn silage) diet formulation should be to the high end of these ranges. On the other hand, in cases where ruminal starch degradability is high (i.e. immature, wet corn silage or fine-processed high-moisture corn) diet formulation should be to the low end of these ranges.

Feeding corn silage with a high grain (starch) content in high corn silage diets usually necessitates the use of high-fiber byproducts in the concentrate so that the upper limits on dietary NFC and starch are not exceeded. Soy hulls, beet pulp, and citrus pulp are good corn substitutes in high corn silage diets to limit dietary starch concentration. When high-fiber byproducts replace forage and low NDF from forage diets are fed, dietary NFC should not exceed 35% (DM basis).

FAT

Rations for high producing cows usually are formulated to 5%-7% total fat (DM basis). The basal ration without supplemental fat usually contains 3% fat (DM basis). Supplemental fat usually is provided from a combination of oilseeds, animal fat, and(or) rumen-inert fat. With high corn silage diets, high dietary fat concentrations especially from supplementation of non rumen-inert sources may cause milk fat test depression through effects on trans fatty acids. Milk fat test should be monitored closely with changes made in dietary fat concentrations and (or) supplemental fat sources when necessary.

PROTEIN

Diets for dairy cattle are formulated for crude protein (CP), degraded intake protein (DIP), and undegraded intake protein (UIP). Sufficient dietary DIP is needed to support the nitrogen requirements of ruminal microbes for high ruminal digestion of

carbohydrates to volatile fatty acids (VFA) and for high ruminal microbial protein production. Sufficient dietary UIP is needed to supplement ruminal microbial protein output for meeting the amino acid requirements of high producing cows. Dietary CP guidelines for early to mid lactation dairy cows are 16.5%-18.0% (DM basis).

DIP

Degraded intake protein should comprise 60%-65% of dietary CP. Cornell workers recommend that half of the DIP should be soluble making their suggested soluble intake protein (SIP) about one-third of dietary CP. With high corn silage diets, these guidelines may necessitate the use of urea (50-100 grams) or raw soybeans (1.0-1.5 kg).

UIP and Amino Acids

Dietary UIP should be formulated for 35%-40% of CP or about 6.5% of DM. Close attention should be paid to the amino acid profile of UIP supplements. Corn by-products, corn gluten meal, distillers dried grains, and brewers grains, should not be emphasized in the formulation of protein supplements for high corn silage diets because of their low lysine content. Heat-processed soybeans, heat-processed soybean meal, fish meal, blood meal, and meat meal are better UIP sources in protein supplements for high corn silage diets. Among these UIP sources, quality control and cost are important considerations.

Macro-Minerals

Corn silage, relative to alfalfa, is inherently low in its concentrations of calcium, magnesium, potassium, and sulfur. The recommended dietary calcium allowance is .80%-1.0% (DM basis) with calcium carbonate as the primary calcium supplement. The recommended dietary magnesium allowance is .30%-.35% (DM basis) with magnesium oxide as the primary magnesium supplement. Dynamate® (11% Mg - 18% K - 22% S) is a source of magnesium, potassium, and sulfur making it a popular ingredient in high corn silage diets. Other commonly used sources of potassium and sulfur are potassium chloride (Dyna-K®) and potassium carbonate (K-Minus®) and calcium sulfate (gypsum), respectively. Recommended dietary allowances for potassium and sulfur are 1.0%-1.2% and .20%-.25% (DM basis), respectively. In heat stress situations, the recommended dietary allowance for potassium increases to 1.2%-1.5% (DM basis). Salt should be supplemented at the rate of .50% of lactation TMR DM. Use of sodium bicarbonate as a buffer may necessitate the use of potassium chloride rather than sodium chloride to balance dietary sodium, potassium, and chloride concentrations. The recommended dietary allowance for phosphorus is .40% (DM basis).

Buffers

With high corn silage diets, sodium bicarbonate (BICARB) is recommended at the rate of 1% of lactation TMR DM to buffer acidity in the corn silage and acid production in the

rumen. A mixture of BICARB and magnesium oxide (3:1 ratio of BICARB:MAGOX) elicits a better response than either fed alone. Potassium carbonate can substitute for sodium bicarbonate as a ruminal buffer in the lactation TMR, and also supplements needed potassium in high corn silage diets. Calcium carbonate works as a post-ruminal buffer to improve starch digestion and supplements needed calcium in high corn silage diets. Free-choice BICARB may benefit early lactation or high producing cows and cows under heat stress, but may need to be mixed with salt (3:1 ratio of BICARB to NaCl) to limit its intake and should not replace what is provided in the TMR. Sodium or potassium buffers should not be fed to dry cows, because of effects of elevated dietary-cation difference (DCAD) on hypocalcemia.

Feed Additives

Yeast products have been shown to increase DM intake and lactation performance when fed in high corn silage diets, particularly when supplemented during the transition period through the first trimester of lactation.

There are a number of commercially-available propionic-acid based products that reduce the growth of yeast and molds when added to the TMR and thereby may improve bunk stability. These products often contain some acetic acid or benzoic acid to make them more effective against yeast. Since these are buffered-acid products, corrosion of TMR mixer is not a concern. These products are usually added at the rate of 1 to 2 kg per ton of as-fed TMR. They usually cost about $2.00 per kg, making their use in the TMR cost prohibitive unless problems with bunk stability are encountered. Bunk stability can be an issue with high corn silage diets, especially during hot, humid feeding conditions.

There are a number of fine-ground bentonite products that are marketed as mycotoxin binding agents. It appears that they are most effective against aflatoxin—their effectiveness against Fusarium mycotoxins (DON, T2-toxin, Zaeralenone) is not well established. These bentonite products are normally fed at the rate of 150 grams per cow per day with mycotoxin suspicious or contaminated feeds.

Bunk Management

With high corn silage diets, sorting in the feed bunk should be monitored closely. This can be evaluated by using the Penn State-Nasco shaker box on TMR samples collected just after mixing/feeding, 12 hours post feeding, and when the refusal is pushed away the next day. The degree of variation in percentages of as fed mix on the three screens with time post mixing/feeding provides an indication of the degree of sorting. In situations of excessive sorting in the feed bunk, the following practices should be considered: feeding smaller amounts of TMR more frequently, pushing TMR up more frequently, finer or more uniform processing of coarse particles, addition of water to dry TMR, and(or) addition of a liquid-molasses product to TMR to tie up the fines. It is recommended that corn silage be limited to less than 50% of forage DM in

the TMR for transition cows. In situations where corn silage is fed separately from other forages, limit its overall feeding rate and manage the feed bunk to prevent slug feeding.