Phase Feeding Crude Protein to Decrease Ammonia Emissions from Finishing Beef Cattle

Authors: N. Andy Cole and Richard W. Todd, USDA-ARS, Bushland, TX

Emissions Management Practices

Protecting Air Quality

Authors e-mail:

andy.cole@ars.usda.gov

Developed by:

Livestock GRACEnet
leading the development of mitigation practices to reduce emissions from livestock production

For more information visit us at www.ars.usda.gov/livestockGRACEnet

Definition:

Phase feeding is a nutritional management strategy in which the ingredient and chemical composition of the diet is modified over time so that the nutrient composition of the diet more closely meets the nutrient requirements of the animal.

Purpose:

The purpose of phase feeding is to decrease excess nutrients in the diet in order to decrease nutrient excretion and subsequent losses of these nutrients to ground water, surface waters or the atmosphere, to improve nutritional efficiency, and to lower feed costs.

How Does This Practice Work:

As beef cattle grow and mature many of their nutrient requirements, most notably protein, decrease (NRC, 2000). This is also true of lactating cows as they progress through the lactation period. Typically feedlot diets are fed to meet the animal's nutrient requirements early in the feeding period when they tend to be the highest because lean tissue accretion is greatest (Vasconcelos and Galyean, 2007). If the same diet is fed throughout the feeding period, late in the feeding period, when lean tissue accretion slows and adipose tissue accretion increases, the quantity and concentration of protein in the diet may be excessive, leading to increased losses of nitrogen in the urine. The major source of ammonia from feedlot pens is urea from urine. Thus, if the quantity of urea excreted can be decreased, ammonia emissions will also be decreased (Cole et al., 2005; Todd et al., 2006).

Where This Practice Applies and Its Limitations:

Phase feeding can be used in small or large cattle feedlots. However there are a number of limitations. Practically, feedmills at most feedlots are limited in the number of rations they can make and manage each day. Also, managing the delivery of rations to cattle in a timely and consistent manner can be more difficult as the number of rations increases.

Historically, supplemental protein was the most expensive nutrient in a feedlot diet. Today, many feedlot diets containing high protein by-product feeds such as distiller's grains or corn gluten feed which are by-products of ethanol production and the corn starch industry, respectively. These diets may contain concentrations of protein that are in excess of animal requirements. However, there are substantial economic benefits to feeding these co-products and they are a high quality source of fiber and energy. Consequently, the excess protein in many feedlot diets is not a negative economic factor, as it was in the past, thus it does not justify adjusting the ration to limit protein content.

In recent years several new potent growth promoting feed additives, termed beta-agonists, have become available to cattle feeders. Beta-agonists share some pharmacological properties with epinephrine and promote growth by accelerating muscle tissue accretion and decreasing fat deposition. These products are fed the last 20 to 35 days of the 120 or so days beef cattle are typically in the feedlot. Because the diet must be modified to feed a beta-agonist, this is a possible opportunity to also change the protein concentration in the diet if it can be clearly justified for economic or environmental reasons. Because of a lack of controlled studies, at the present time it is not clear if the protein requirements of cattle are increased when they are fed beta-agonists. Thus, it is not clear if phase feeding of protein will work successfully in cattle fed a beta-agonist.

USDA ARS

Effectiveness:

Research studies, in Texas and Nebraska, have noted a 10 to 20% decrease in nitrogen intake, nitrogen excretion, and volatile nitrogen losses from feedlots when cattle were phase fed protein in their diet. Typically, in these studies, initial diets contained 13 to 13.5% crude protein and cattle were fed for 120 to 180 days. Diets fed during the last 28 to 56 days contained 9 to 11% crude protein. When diets were based on dry rolled corn, there was no adverse effect on animal performance, but N excretion was decreased 12 to 21% and N volatilization losses were decreased 15 to 33% (4.5 to 14.7 lb/head: Erickson and Klopfenstein, 2010). When diets were based on steam-flaked corn, effects on animal performance were less consistent (Vasconcelos et al , 2006; Cole et al., 2006), but phase feeding decreased estimated N excretion by 3.5 to 8 lb/steer and nitrogen volatilization losses by 6.5 to 11 lb/steer (Cole et al., 2006).

Cost of Establishing and Putting Practice in Place:

The direct costs of phase feeding are highly dependent upon the costs of feed ingredients, growth rate of the cattle, initial and final weights and genetic ability to efficiently utilize nutrients in the diet. Indirect costs such as changes in feed mill or feed truck management will vary with fuel and labor costs.

References:

Cole, N. A., R. N. Clark, R. W. Todd, C. R. Richardson, A. Gueye, L. W. Greene, and K. McBride. 2005. Influence of dietary crude protein concentration and source on potential ammonia emissions from beef cattle manure. J. Anim. Sci. 83:722-731.

Cole, N. A., P. J. Defoor, M. L. Galyean, G. C. Duff, and J. F Gleghorn. 2006. Effects of phase-feeding of crude protein on performance, carcass characteristics, serum urea nitrogen concentrations, and manure nitrogen of finishing beef steers. J. Anim. Sci. 84:3421-3432.

Erickson, G., and T. Klopfenstein. 2010. Nutritional and management methods to decrease nitrogen losses from beef feedlots. J. Anim. Sci. 88(E Suppl.):E172-E180.

NRC. 2000. Nutrient Requirements of Beef Cattle Update 2000. 7th ed. Natl. Acad. Press, Washington, DC.

Todd, R. W., N. A. Cole, and R. N.Clark. 2006. Reducing crude protein in beef cattle diet reduces ammonia emissions from artificial feedyard surfaces. J. Environ. Qual.35:404-411.

Vasconcelos, J. T., and M. L. Galyean. 2007. Nutritional recommendations of feedlot consulting nutritionists: The 2007 Texas Tech University survey. J. Anim. Sci. 85:2772-2781.

Vasconcelos, J. T., L. W. Greene, N. A. Cole, M. S. Brown, F. T. McCollum, and L. Tedeschi. 2006. Effects of phase feeding of protein on performance, blood urea nitrogen concentration, manure N:P ratio, and carcass characteristics of feedlot cattle. J. Anim. Sci. 84: 3032-3038.

For Further Information:

Contact Andy Cole, Research Animal Scientist and Research Leader at andy.cole@ars.usda.gov.

This practice falls under the NRCS Conservation Practice Standard 592 (Feed Management)