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NUTRIENT MANAGEMENT – NO. 5

FEED AND ANIMAL MANAGEMENT FOR DAIRY CATTLE

DESCRIPTION

The attached material was prepared by Dr. Alan Sutton, Professor of Animal Science at Purdue University and Charles H. Lander, NRCS, National Agronomist.

This technical note provides a general discussion on how the feed and animal management for dairy cattle operations can be used to alter the nutrient content in the excreted manure.

USDA United States Department of Agriculture

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Introduction

Dairy operations typically include the milking cow herd with some of the cow population in the nonlactation stage (dry cows). Operations may or may not include growing heifers being raised as replacements for the milking herd. Distinctly different diets are required for each of the three production cycle stages, resulting in great differences in the volume and nutrient compositions of manure. This technical note briefly highlights some factors that affect nutrients in manure from dairy cattle and modifications in the diet that can be used to reduce them.

A critical part of feed management is to accurately formulate diets and manage the feeding so that the nutrients fed consistently match the nutrients needed by each group in the herd. For example, table 1 shows how the concentration of nutrients needed in the diet change with stage of the life cycle and level of milk production. This table is an example to illustrate how the diet formula needs to be specific for each group in the herd. The concentration of nutrients needed in the diet for a particular level of production changes with dry matter intake.

Diet formulation

Diets should be formulated and updated regularly to avoid overfeeding of nutrients or fluctuations in milk production. The most common guideline for diet formulation is the National Research Council's (NRC) publication, Nutrient Requirements of Dairy Cattle, 2001. This publication provides equations to compute nutrient requirements for any size cow and milk production level and any stage of the life cycle. Therefore, actual dry matter intakes and a computer program that includes NRC and/or other research-based equations should be used to formulate diets. Because of the complexity of formulating diets to optimize production while minimizing excretion, producers not trained in nutrition should obtain help from qualified nutritionists when formulating diets. Proper diet formulation requires routine (monthly or quarterly) forage and by-product analysis because these ingredients are highly variable. Tabular values and previous sample analyses are not reliable for determining the nutrient content of these feed ingredients. Conducting a routine moisture analysis is important to adjust and mix feeds to ensure delivery of the formulated diet to the cattle. Cows should be evaluated for their body condition routinely so that the proper energy level of the diet can be determined.

This is the fifth in a series of nutrient management technical notes on feeding management.

Series was prepared by **Dr. Alan Sutton**, professor of Animal Science at Purdue University, West Lafayette, Indiana, and **Charles H. Lander**, national agronomist, NRCS, Washington, DC. This series was developed from material published by the Federation of Animal Science Societies (FASS), Savoy, Illinois.

A 50 percent variation in manure production might result from differences in feed wastage, ration formulation, type of feeding program (e.g., dry lot versus pasture feeding), and/or animal grouping systems.

Since dairy cattle are ruminants, they can utilize forages (generally lower in digestibility) as well as concentrates (generally higher in digestibility) in their diets. Depending upon the stage of production, the roughage-to-concentrate ratio can vary tremendously. As a result, volumes of manure produced are much greater when poorly digestible forages (fiber) are fed as compared to concentrates. In addition, the availability of nutrients in forages can vary considerably with different forage species and stage of maturity. Also, the composition of the manure is significantly different with these different scenarios.

Studies have shown that selecting the right type of protein sources in the diet to meet animal requirements can reduce nitrogen (N) excretion by 15 to 25 percent. Most of the N consumed by cattle is a part of the protein the animal consumes. When cows consume excess protein, an increased amount of N is excreted in the urine as urea. Small amounts of urea can also be diffused into the milk. The concentration of urea in milk is proportional to the amount of N excreted in urine for cows with a given body weight. Cows consuming excess protein typically have higher milk urea nitrogen (MUN) concentration than cows consuming protein at or below their requirements. MUN can be measured for use as an indicator of excess protein in the diet. A general rule is that an average herd MUN should fall between 9 and 14 mg/decaliter of milk. The current recommendation from the NRC (2001) for phosphorus (P) feeding is a range of about 0.32 to 0.42 percent of dietary dry matter content, depending upon level of milk production and stage of lactation. Yet many producers are feeding closer to 0.5 percent for all lactating cows. Farmers often overfeed P with the thought that (1) they will improve reproductive efficiency, and (2) the feed ingredient tables typically underestimate the amount of P in most ingredients.

Mineral P supplements, such as dicalcium phosphate or monocalcium phosphate, are added to dairy cow diets at levels exceeding recommendations to provide a safety margin, especially if reproductive problems

Table 1 Selected nutrient requirements of dairy cattle (as determined by sample diets) [1]

Holstein, 1,500 lb cow, avg. body condition, 65 months of age	Stage of production						Dry, preg. 270 days in gestation	660 lb heifer @ 1.91 lb gain/day
	early lactation		90 days in milk					
Milk yield, lb/d =	55	77	55	77	99	120	BW=1,656 lb	
Dry matter intake, lb/d	29.7	34.3	44.7	51.9	59.2	66	30.1	15.6
Net energy, Mcal/lb	0.94	1.01	0.62	0.67	0.70	0.73	0.48	1.03
Diet, % RDP	10.5	10.5	9.5	9.7	9.8	9.8	8.7	9.4
Diet, % RUP	7	9	4.6	5.5	6.2	6.9	2.1	2.9
Crude protein, % [2]	17.5	19.5	14.1	15.2	16.0	16.7	10.8	12.3
NDF, min %	25–33	25–33	25–33	25–33	25–33	25–33	33	30–33
NFC, max %	36–44	36–44	36–44	36–44	36–44	36–44	42	34–38
Calcium, %	0.74	0.79	0.62	0.61	0.67	0.60	0.45	0.41
Phosphorus, %	0.38	0.42	0.32	0.35	0.36	0.38	0.23	0.23
Potassium, % [3]	1.19	1.24	1.00	1.04	1.06	1.07	0.52	0.48
Sodium, %	0.34	0.34	0.22	0.23	0.22	0.22	0.10	0.08
Copper, mg/kg [4]	16	16	11	11	11	11	13	10
Zinc, mg/kg	65	73	43	48	55	65	22	27

1 Adapted from tables 14–7, 14–8, 14–9, and 14–16, Nutrition Requirements of Dairy Cattle, 7th revised edition, 2001, National Research Council (NRC), National Academy of Sciences, National Academy Press, 2101 Constitution Ave., Washington, DC 20418 (J.H. Clark, chair, Subcommittee on Dairy Nutrition).
2 Equivalent to the sum of rumen degradable protein (RDP) and rumen undegradable protein (RUP) only when they are perfectly balanced.
3 Heat stress may increase the need for potassium.
4 High dietary molybdenum, sulfur, and iron can interfere with copper absorption, increasing the requirement.

are suspected. As a result, diets typically contain 25 to 35 percent more P than is recommended by the NRC. By reducing or removing all supplemental P in the dairy diet, P excretion in manure can be reduced by as much as 30 percent.

Overfeeding P for reproductive performance has no scientific basis. Research shows that using accurate requirements for P along with actual feed analysis to formulate diets optimizes animal performance and minimizes P concentration in manure. Forages in particular are highly variable in P content and should be determined for each farm, using wet-chemistry procedures.

By-products (e.g., products of the brewing and distilling industries) are often utilized in cattle diets. Balancing the proper nutrient levels in cattle diets can be challenging when by-products are used. A consideration in the use of by-products is that the concentration and availability of nutrients, especially N and P, from each feed ingredient source can vary greatly, causing significant variation in nutrient contents that can create excesses in the diet.

The dietary salt intake level should be reduced in cattle feeds in semiarid and arid climates where salinity problems can exist and sodium accumulation can adversely affect crop production. In addition, beware of potassium accumulation in forages receiving high levels of manure application. This can potentially cause grass tetany problems in cattle consuming such forages.

Production management

Several new technologies have the potential to reduce manure nutrients per 100 pounds of milk produced. Average responses from some research studies are used in this technical note. Actual responses vary from farm to farm and from group to group within a farm.

One such technology is the manipulation of photoperiod by providing artificial lighting. It has been shown that increasing day length can increase milk production in dairy cattle by up to 8 percent. Nutrient intake required by such light-stimulated herds increased by only 4.1 percent, and N and P excretion increased by only 2.8 percent as compared with similar herds under natural day length.

Penning and grouping dairy cattle of similar milk production levels or stage of lactation and formulating diets to meet more nearly the nutritional needs of cattle reduce feed nutrient wastage. Uniform groups (by weight and stage of production) allow the producer to use diets that more closely match the actual needs of all animals in the group since there is less variation among animals, and overfeeding of nutrients can be minimized.

Dividing the milk production cycle into several periods with less variation in milk production within the group allows producers to provide diets that more closely meet the cattle's nutrient requirements. Use of phase feeding has been estimated to reduce N and P excretion by at least 5 to 10 percent.

Another new technology that may impact nutrient utilization and excretion is the administration of bovine growth hormone (BGH), or somatotropin. This peptide hormone can increase milk production by as much as 30 percent in certain cows within the herd, although the entire herd's production would increase by only 14 percent. The nutrient requirements of a herd treated with BGH may increase by about 7 to 8 percent, and manure P may increase by 5 percent. However, the nutrient losses from the farm per unit of milk produced would, therefore, decrease by 8 to 10 percent per unit of milk produced.

Milking three times instead of twice per day can increase production per cow by an average of 11 percent and reduce stress on a herd. This increase in production results in the consumption of 5 percent more protein, with 3.5 percent more nutrients excreted in manure. The extra milking per day reduces the amount of nutrient excreted in manure by 7 percent per unit of milk.

Feed management

Feed bunk management. Good bunk management is imperative to reduce feed wastage. This involves checking feed intake levels for each group in the herd and adjusting intake to that required for the production level of each group. Consideration should also be given to how much feed is being wasted. In some operations leftovers are scraped up from lactating cows and re-fed to nonlactating cattle. In other cases refused feed is scraped from the feeding area and discarded. In this situation waste removed from the lot includes wasted feed and manure nutrients that need to be applied to the land.

Feed storage. Proper feed storage is necessary to preserve the nutrient value of the feed and to reduce direct loss of nutrients to the environment. Nutrients

in water can come from leachate from fermented feeds (such as silage) and from runoff from feeds exposed to rain. Containment of silage leachate and good management of all feed storage areas are advised so that feed-based nutrients are not lost directly to the environment.

Nutritional value of water. The mineral content of the water supply should be considered with regard to the total intake of dietary minerals. Depending on the quality of water supply available, water intake may make a substantial contribution to daily mineral intake, particularly with regard to sulfur and, in some areas of the country, salt. Routine water sampling can help the nutritionist formulate properly for the amount of minerals to add to the diet to meet the animal's actual requirements.

Summary

The NRC publication *Nutrient Requirements for Dairy Cattle*, 2001, is a key reference to evaluate dairy cattle diets on a commercial operation. Also consult qualified nutritionists to accurately evaluate current or planned diet compositions during the development of a conservation plan, particularly during the development of a Comprehensive Nutrient Management Plan (CNMP). Various feed management activities can impact the nutrient content of excreted dairy cattle manure. Table 2 lists the potential of various feed management strategies to decrease the N and/or P content of manure excreted by dairy animals.

The actual impact of a feed management strategy or strategies on a dairy operation can only be determined by analysis of the manure after the strategy has been implemented. During the development of CNMPs, the potential impact of such strategies can be estimated using values in table 2. In using data from this table, planners are encouraged to be conservative in their selection of factors. Also, it is important to remember that the impact of using multiple strategies in a single diet is not likely to be additive for each single strategy used. Rather, it is more likely to be something greater than the value for the strategy with the smallest impact, but less than the sum of the values for all the individual strategies used.

During the development of CNMPs, it is better to underestimate the potential impact of feed management than to overestimate it. Later, the plan can be modified based on data accumulated from the actual production operation.

Glossary

By-products. Feed ingredients from sources that are normally waste products of other industries.

Bovine growth hormone. A natural nonsteroidal protein hormone produced in the pituitary glands of cattle that helps cows produce milk. The growth hormone produced in cattle will only be effective in cattle. This protein has been produced synthetically in bacteria.

Concentrate. Plant materials (feeds) that contain relatively high starch content.

Diet formulation. The process of combining an assortment of feed ingredients into a diet that will meet the nutrient and energy requirements of the animal for the intended purpose for which the animal is produced.

Forage. Plant material that contains a relatively high fiber content.

Phase feeding. Changing the nutrient concentrations in a series of diets formulated to meet an animal's nutrient requirements more precisely at a particular stage of growth or production.

Somatotropin. The hormone that regulates growth, affects metabolism of all classes of nutrients, stimulates milk production, and improves efficiency.

Table 2 Potential for feed management to impact the nutrient content of dairy cattle manure [1]

Strategy	Nitrogen reduction %	Phosphorus reduction %
Minimize dietary nutrient excesses	10–15	10–30
Protein manipulation	15–25	n/a [2]
Increase number of production groups	5–10	5–10

1 Adapted from the Federation of Animal Science Societies (FASS) publication, *Dietary Adjustments to Minimize Nutrient Excretion from Livestock and Poultry*, January 2001.
2 Not applicable.