Principles for Evaluating Your Feeding Program from an Environmental Perspective

Lee Telega, Senior Extension Associate
Cornell University's PRO-DAIRY Program

Background

Back twenty years ago, when most dairy producers heard the phrase "nutrient management," they would likely think about how they fed their cows. Questions about how often they tested forage, had their rations balanced, checked the accuracy of their feeding scales or cleaned the feed bunks would probably come to mind. Today it means something completely different. It is well understood across all of animal agriculture that the term clearly does not refer to activities done at the front end of the cow.

What happens at the front end of the cow, however, does have an impact on a farm's nutrient management. It has been clearly shown that all livestock operations import considerably more nutrients than they export in the form of animal products. Unless a farm is exporting considerable amounts of manure or manure products, well over half of the nutrients imported for production remains on the farm. Furthermore, of those imported, about two-thirds of the nutrients are imported in the form of purchased feed.

Subsequently, when the US Departments of Agriculture (USDA) and Environmental Protection Agency (EPA) got together several years ago to develop a national strategy for addressing water quality and public health impacts associated with animal agriculture, they came up with performance expectations that all AFO owners and operators develop and implement site-specific comprehensive nutrient management plans (CNMP). A CNMP identifies actions to be taken in six areas of the operation, feed management, manure handling and storage, land application of manure, land management, record keeping, and options for alternative manure utilization when a farm's land base is insufficient to support application of the manure generated.

The Unified National Strategy for Animal Feeding Operations, released March 9, 1999, description of feed management reads as follows:

> *Animal diets and feed may be modified to reduce the amounts of nutrients in manure. Feed management can include the use of low phosphorus corn and enzymes such as phytase, that can be added to non-ruminant animal diets to increase the utilization of phosphorus. Reduced inputs and greater utilization of phosphorus by the animal reduces the amount of phosphorus excreted and produces a manure with a nitrogen-phosphorus ratio closer to that required by crop and forage plants.*

This definition is not exactly what one would find in animal feeding classic, Dr. Frank B. Morrison's Feeds and Feeding. Nor would it be readily forthcoming from any producer or their nutritionist. It clearly focuses on manure, specifically manure phosphorus, with absolutely no mention of animal performance or ration costs.

The Strategy does, however, footnote this paragraph with:

While feed management can be an important tool for achieving the preferred balance of nutrient in manure, USDA and EPA do not intent to propose prescribing feed practices.

Because of the footnote and other clear indications that management of feed nutrients is optional or at most a consideration, CNMPs developed for livestock farms rarely contain specific actions to be taken in the feeding operation.

Where Feeding and CNMPs Meet

Two CNMP objectives that may have direct impact on an operation's feeding program are:

1. Control of soil erosion; and
2. Reducing the total amount of imported nutrients.

A key option for reducing the amount of soil lost from fields in the Northeast is adjusting a farm's crop rotation. This usually increases the number of years fields are in hay crops, while reducing the number of years they are in row crops. For a dairy herd, a farm's new rotation could impact the ratio of corn silage to haycrop that has been traditionally fed to the herd. Furthermore, the new crop rotation may result in wide swings in corn and haycrop acreage from year to year. This can result in some years with lots corn silage and little haycrop forage, and others with lots of haycrop and little corn silage, causing havoc with a farm's feed storage system.

In many states, the land management component of a CNMP is not required to meet USDA defined tolerable levels for soil erosion. In developing their new rules for Concentrated Animal Feeding Operations (CAFOs) permits, EPA concluded the cost-to-benefit ratio could not justify a soil erosion protection requirement. Instead, crop rotations may be adjusted to best fit the feeding needs of the herd at the expense of not achieving full soil conservation. In states like New York, which requires soil loss to meet USDA-defined tolerable levels, animal nutritionists should carefully examine the impact of recommended crop rotations on feed production capabilities.

Reducing the total amount of nutrients imported as feed can be achieved with improved management of a farm's feeding program. Farms with well-managed feeding programs reduce nutrient excretion in manure, increase feed nutrient utilization and improves production. Specifically, there are three areas of feeding management that significantly influences effective feed nutrition use:

1. Quality and utilization of homegrown forages;
2. Accuracy of estimating feed intake; and
3. Standards for determining nutrient requirements.

Assessing the effectiveness of a feeding program is common knowledge of animal nutrition professionals. However, rarely is a nutritionist involved in developing a farm's CNMP. This talk and the environment assessment tools in this paper describe a method that can be utilized by farm-environmental planners with little knowledge of animal nutrition and feeding. The tools were developed to highlight key feeding practices commonly employed in well-managed feeding programs. The use of the tool during a whole-farm environment assessment heightens producer awareness to further engage their nutrition professional in helping to improve the management of feed nutrients.

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AEM Tier 2 Worksheet
Management of Feed Nutrients

Glossary

Digestibility: Percentage of feed or a feed nutrient that is absorbed through the digestive tract. It can be calculated as: [(lbs. nutrient intake - lbs. nutrient in feces) ÷ lbs. nutrient intake] X 100%.

Dry Matter Content: Also expressed as Percent (%) Dry Matter. The portion of a feed remaining after all the water is driven off. It is this portion that contains all the nutrients for which a ration is balanced.

Dry Matter Intake: Amount of feed dry matter content a cow will voluntarily eat in a day. The larger the dry matter intake, the lower the percentage of nutrients required to supply the daily requirements.

Dry Period: Period of time in which a cow is not giving milk. Prior to calving, a mammary gland requires a period of rest in which old lactating tissue is reabsorbed and new milk-secreting tissue replaces it. Without the dry period, the gland will not produce to its potential.

(Continued on Page 2)

Background

Effective management of nutrients is a primary goal of Comprehensive Nutrient Management Plans (CNMPs). These plans aim to reduce a livestock farm's risk of discharging nutrients to surface and ground waters. Although feeding management adjustments are not always components of CNMPs, changes in the feeding program can have significant influence on farm nutrient management. Generally, more than two-thirds of the nutrients annually delivered to livestock farms are in the form of imported or purchased feeds. Farms that intensively manage their feeding program reduce nutrient excretion in the manure, increase feed nutrient utilization and subsequently improve production and the farm's mass nutrient balances.

From an environmental perspective, three areas of feed management significantly influence effective feed nutrient use:

1. Digestible nutrient content of homegrown forages produced and fed,
2. Accuracy of estimating feed nutrient intakes, and
3. Employment of scientific standards to determine nutrient requirements and ration levels.

(Continued on Page 2)

Agricultural Water Quality Principle:

Apply sound animal feeding and husbandry practices to achieve targeted levels of production and minimal excretion of nutrients in manure.

Glossary Continued…

Forages: Feed containing the vegetative parts of a plant. Haycrop forages (i.e. alfalfa hay or silage) do not contain any grains, while grain crop forages (i.e. corn silage) contain both vegetative and grain portions of the plant. Cattle feeds are generally classified into forages or concentrates (grains).

Forage Quality: A qualitative measure of the nutritive value and digestibility of a forage. It is best quantified by measuring the structural fibers of the feed.

NDF (Neutral detergent fiber): In the laboratory, the residual after digesting a sample of feed in a neutral detergent solution. It contains the structural fiber component (cellulose, hemicellulose and lignin) of plant cell walls. It is closely related to the amount of a forage a cow will voluntarily eat.

NRC-National Research Council: Scientific body that sets nutritional standards for feeding animals in the U.S.

Rumen Degradable Protein: Fraction of protein sources that supply peptides, amino acids and ammonia for rumen microbial growth.

Rumen Undegradable Protein: Fraction of protein sources that essentially escape digestion in the rumen and deliver intact protein to the lower digestive tract.

"Wet" Feeds: Forages, grains, or by-product feeds (generally with less than 87% dry matter) such that moisture content can vary significantly over time or between batches (i.e. ensiled forages, high moisture corn, wet brewer's grains).

Wet Chemistry: Complete chemical analysis of feeds to quantify nutrients or minerals in feeds. Two methods of feed analysis are available from most labs: wet chemistry and near-infrared refractance (NIR). Wet chemistry is more accurate for mineral analysis of feeds.

Background Continued…

Digestibility of nutrients in a forage, commonly referred to as forage quality, determines the amount of that forage cattle will consume. The greater the quality of homegrown forages produced and fed, the less purchased feeds must be imported to achieve production. Maximizing the feeding of homegrown forages more effectively recycles nutrients from the crop, to the cow, to the manure, to the soils and back to the crop.

Inaccurate estimates of feed consumption can lead to large imbalances in nutrient intake, ineffective rumen digestion and reduced lower tract absorption. Packaging the nutrients required for animal maintenance, growth, production and reproduction within the meal size the animals are actually eating is a critical component of ration balancing. Rations regularly balanced to supply required nutrients will result in high production and a smaller proportion of feed nutrients excreted in the manure.

General animal husbandry is also critical to insure effective feed nutrient utilization. A feeding program will best perform when animals are kept healthy, comfortable, and housed in a stress-free environment. Furthermore, clean, fresh feed and water must be readily available to achieve maximum feed intake and the projected level of milk or meat production.

AEM Tier 2 Worksheet: **Management of Feed Nutrients**		**Potential Concern**		
Factors Needing Assessment:	Lower 1	2	3	Higher 4
What is the quality of homegrown hay crop forages?	More than two-thirds of the hay crop produced has NDF levels: <=60% (grass) <=45% (legumes)	More than half of the hay crop produced has NDF levels: <=60% (grass) <=45% (legumes)		More than half of the hay crop produced has NDF levels: >60% (grass) >45% (legumes)
How much homegrown forages are being fed? (Lactating dairy herds only. See page 6 for sample calculations.)	Homegrown forage dry matter fed is greater than 2.2% of the average herd body weight.	Homegrown forage dry matter fed is between 2.0 and 2.2% of the average herd body weight.	Homegrown forage dry matter fed is between 1.8 and 2.0% of the average herd body weight.	Homegrown forage dry matter fed is less than 1.8% of the average herd body weight.
How is dry matter intake for various groups of cattle determined?	Reliably measured by weighing amounts fed and feed refused **AND** cattle are consuming appropriate amounts.	Reliably estimated by weighing amounts fed and estimating feed refused **AND** cattle are consuming appropriate levels.	Reliably estimated by weighing amounts fed and estimating feed refused **AND** cattle are **not** consuming appropriate amounts.	Book values for dry matter intake are used to balance rations and amounts fed or refused are not weighed.
How often is dry matter intake measured or estimated?	Weekly.	Every 2 weeks.	Monthly.	Infrequently.
How often are feeds analyzed for nutrient and dry matter	Feeds are analyzed for nutrient content at least monthly **AND** dry matter content of “wet” feeds is	Feeds are analyzed for nutrient content at least monthly **AND** dry matter content of “wet” feeds is	Feeds are analyzed for nutrient content only when a new feed or forage crop is fed **OR** on-farm forage	Feeds are not regularly analyzed.

content?	determined weekly on the farm.	determined less than weekly on the farm.	dry matter determination of "wet" feeds is not practiced.	

AEM Tier 2 Worksheet: **Management of Feed Nutrients**		**Potential Concern**		
Factors Needing Assessment:	Lower 1	2	3	Higher 4
How often are rations balanced?	Rations are balanced more than six times a year **OR** when changes in feel quality are anticipated.	Rations are balanced when a change in production or feed is noticed.		No systematic or regular ration balancing is practiced.
How is protein balanced in rations?	Protein levels are fed at NRC recommendation **AND** balanced for rumen-degradable and undegradable protein fractions **AND** a program that models rumen carbohydrate and protein interactions is used.	Protein levels fed at NRC recommendation **AND** balanced for rumen degradable and undegradable protein fractions.	Protein levels fed at NRC recommendation.	Protein fed in excess or below recommended levels **OR** protein levels fed are not reliable known.
How are phosphorus (P) and potassium (K) levels in rations determined?	P and K levels are fed at NRC recommendation **AND** low K forages are fed to dry cows.	P and K levels are fed in NRC recommendations.	P and K fed in excess or below recommended levels.	P and K levels fed are not reliably known.

Additional Information

Herd Health and Performance Issues

- Is the herd on a regular health program with a local veterinarian

- Is the incidence of calving difficulties or post-calving disorders (ketosis, milk fever, retained placenta, displaced abomasums or mastitis) less than 5% in the herd?
- Are cattle growing and producing up to industry standards or producer's expectations?

Herd Health and Performance Issues Continued:

- For milking cows, are adequate dry periods allowed? (First calf heifers at least 55 days; older cows at least 45 days
- Does the herd show signs of lameness, abnormal hoof growth, or other foot problems

Cow Comfort and Housing Stress Issues:

- Are stalls of proper design, adequate size and in good repair?
- Are animal beds/packs clean and dry with plenty of bedding?
- Do animals show signs of bruising on hocks, thurls or around shoulders or pinbones?
- Is there adequate watering and feeding space for animals?
- Are barns adequately ventilated with no detectable drafts or stale air?

General Nutrition and Feeding Issues:

- Do high-producing dairy cows have access to feed at least 20 hours a day?
- Are feedbunks cleaned daily to avoid fouling of fresh feed?
- Is fresh clean water readily available to animals?
- Is the herd adequately grouped and fed by production or nutritional needs?
- Is wet chemistry used to determine mineral analysis of feeds?

Notes:

Sample Calculations: Calculating Homegrown Forage Dry Matter Fed as a Percent of Average Herd Bodyweight

Information Needed: Total amount of each forage fed to lactating herd **(lbs For_n)**
Dry matter content of each forage fed **(%DM_n)**
Percentage estimate of annual needs of each forage produced on farm **(%$Homegrown_n$)**
Average herd bodyweight **(Herd Bdwt)**

Equation: Ý[[(lbs For_n) X (%DM_n) X (%$Homegrown_n$)] ÷ [(Herd Size X HerdBdwt)]] X 100%
Where "n" defines each forage fed to the lactating herd.
If average herd bodyweight is unknown, use 1400 for large Holstein, 1300 for small Holstein, 1200 for Guernsey and Brown Swiss, and 1000 for Jersey herds.

Example: A 95-cow Holstein herd is grouped by production and fed forages according to table below. The average herd bodyweight is 1350 lbs.

	Pounds as Fed per Production Group			
Feed	**High Group**	**Low Group**	**% Dry Matter**	**% Homegrown**
Corn Silage	2150	2350	34%	100%
Alfalfa Haylage	1185	975	41%	90%
Mixed Grass Hay	0	450	88%	70%

Pounds Homegrown Forage Dry Matter Fed as a Percent of Average Herd Bodyweight

Corn Silage	[[(2150 + 2350) X 0.34 X 1.00]÷ [(95 X 1350)]]	X 100	=	1.19%
Alfalfa Haylage	[[(1185 + 975) X 0.41 X 0.90] ÷ [(95 X 1350)]]	X 100	=	0.62%
Mixed Grass Hay	[[(0 + 450) X 0.88 X 0.70] ÷ [(95 X 1350)]]	X 100	=	0.21%
	Pounds Homegrown Forage Dry Matter Fed/Cow			2.02%

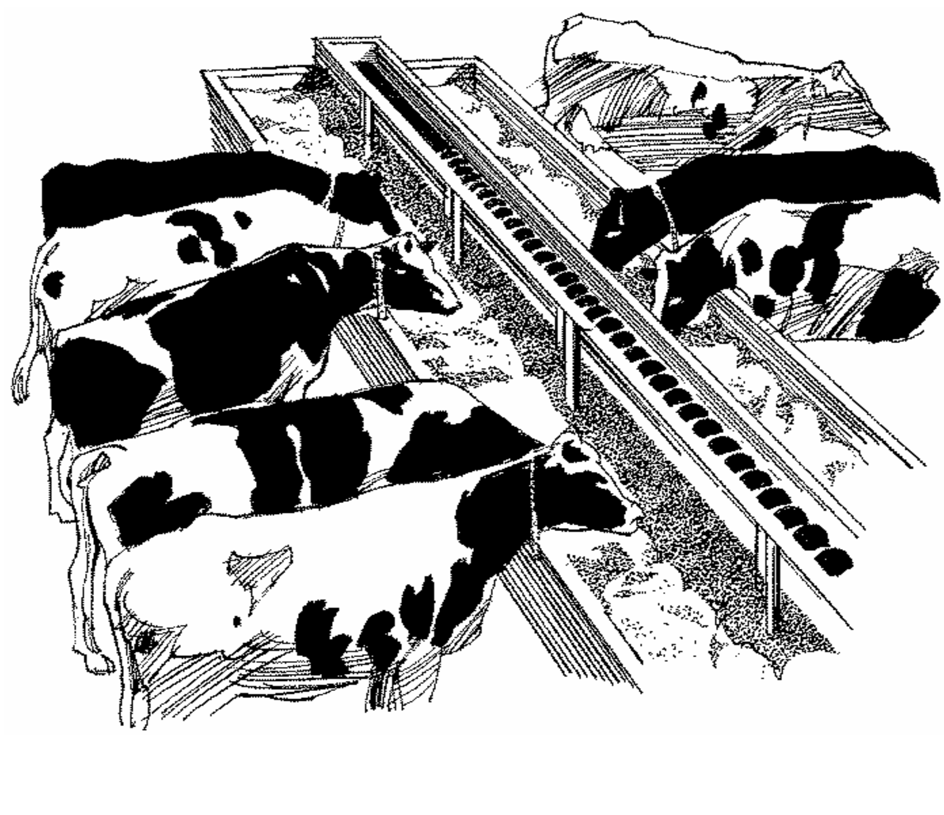
This would be considered #2 level of potential concern for amount of homegrown forage feeding.

Note: Since a herd ration generally changes many times over the year, it is best to calculate this parameter periodically.

Management of Feed Nutrients

(Dairy Farms)

Contents



Environmental Concern

- Unless a farm is exporting a significant amount of manure, dairy and other livestock farms import more nutrients than they export in the form of milk, meat and other products. This can be determined through a Whole Farm Nutrient Balance. (http://nmsp.css.cornell.edu/projects/massbalance.asp)

- Over two-thirds of the nutrients coming onto a dairy farm is in the form of purchased feed, usually as grains, oilseed meals, by-product feeds and minerals to supplement homegrown forages.

- A ration is a combination of feed ingredients formulated to meet specific performance criteria for an animal or group of animals. Nutritionists work to satisfy requirements for maintenance, growth, lactation, and/or reproduction (depending on the animal type and stage) with a mix of carbohydrates, proteins, minerals, etc. in a blend animals will consume. Rations supplying nutrients in amounts greater than what the animal requires results in excess nutrient excretion in manure.

- Feeding precisely to meet the nutritional needs of the herd will reduce the amount of nutrients in the manure stream. This requires careful characterization of the animal, its stage of growth, and needs as well as the nutrient content of the various forages and concentrates available for feeding.

- A well-managed feeding program will increase the efficiency with which feed nutrients are converted to milk, meat, and other animal products.

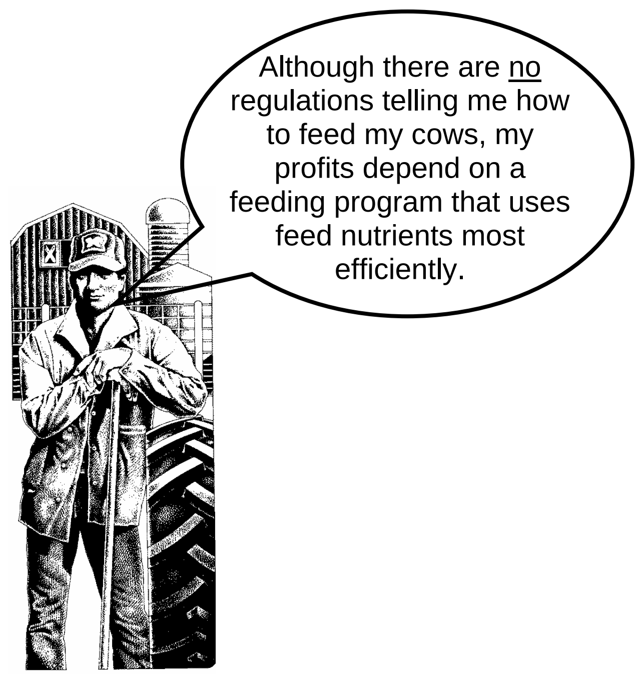
- Feed management is one of the six components of a Comprehensive Nutrient Management Plan. However, in the NRCS Nutrient Management Standard (590) feed management is listed as a consideration and not a required part of a CNMP.

Potential Economic Benefits

- Net farm income, a common measure of profitability, is inversely related to the cost of production. The more it costs to produce milk, the lower the farm's profit.

- Feeding the herd is the single largest cost of producing milk, generally representing 40-60% of operating costs on most dairy farms in New York.

- Dairy farms in New York generally produce all or most of their own forage (pasture, greenchop, dry hay, and haycrop, corn or other grain-silages) and purchase all or most of their grain and other concentrate supplements.



- Intensively managing the delivery of rations so that animals actually consume the nutrients they need improves the conversion efficiency of feed to milk.

- Nutrients in high-quality, homegrown forages are the least expensive source of nutrition for producing milk in New York.
  - Producing and feeding high-quality forage is a key goal for dairy farm profitability.
  - The higher the quality of homegrown forage, the more cows will eat, requiring less purchased grain and other concentrates to meet nutritional needs. This reduces nutrient imports and increases on-farm nutrient recycling by growing homegrown forages using the farm's manure.

- Everyone knows cattle and other ruminants have four stomachs. The first stomach which feed enters is the rumen, a large compartment in which anaerobic microbes start fermenting and digesting the feed. Rations balanced to maximize microbial protein production in the rumen have been shown to improve feed-to-milk conversion on many dairy farms in New York.

Summary of Pollution Prevention Practices

PRODUCE AND FEED HIGH-QUALITY HOMEGROWN FORAGES

The intensive management of pasture and the timely harvest, proper handling and proper storage of hay, green-chop and silage ensure the availability of high-quality forage for the dairy herd. Of the common forages fed in New York, timeliness in harvest of grasses and legumes is more crucial than for corn silage. Measures of nutritional quality change more rapidly for grasses and legumes than for corn as the crop matures. Furthermore, with grasses and legumes harvested several times throughout the growing season, missed opportunities for timeliness, particularly in the spring, can have an accumulating, negative impact on forage quality and quantity of the whole year.

Dairy farms that utilize managed pasture also need to be timely with their grazing management. Maintaining pastures in a state of early vegetative growth (approximately 8–10 inches tall) offers grazing cattle a high quality forage. Otherwise, as pastures mature, the quality of forage declines, animals eat less, and fewer nutrients are derived from pasture. To maintain performance, increased supplementation with grain would be required. Mechanical clipping of older growth pastures stimulates regrowth which, when grazed early, is of higher quality.

For more forage and pasture management information, see the Forages.org site from Cornell University (www.forages.org).

TEST FEEDS FOR NUTRIENT CONTENT

Laboratory analyses of feed ingredients are needed to accurately balance rations. There is variation in nutrient content of all feedstuffs. Forages have significantly more variation than grain commodities such as ground corn or soybean meal. 'Book values' of nutrient content should never be used for forages. Laboratory analysis of grain commodities may be needed to troubleshoot ration performance problems or when a load appears abnormal.

TAKE MEASURES TO ENSURE FEED NUTRIENT INTAKE IS ACCURATE

Nutrient requirements are expressed in total quantity (pounds or calories) per day to meet the maintenance, growth, production and reproductive needs of an animal or group of animals. Subsequently, knowing how much animals actually eat is the first step in balancing and delivering a ration that meets their nutritional requirements. All needed nutrients except water are included in the dry matter content of feeds. Not only knowing how much of the ration animals eat, but also the dry matter content of all its ingredients is needed to ensure adequate nutrients are delivered by the ration. Dry matter content of ‘wet’ feeds (silages and high moisture grains) can vary significantly over time, between storage units, within a single storage unit and between cuttings.

BALANCE RATIONS TO MEET ANIMAL REQUIREMENTS RECOMMENDED BY THE NATIONAL RESEARCH COUNCIL (NRC)

The National Research Council (NRC) Nutrient Requirements for Dairy Cattle, 2001 (http://www.nap.edu/catalog/9825.html) is the current standard for developing dairy rations. Most dairy producers and animal nutritionists use this standard in developing ration recommendations for herds. Nutrient requirements are based on age and size of animal, level of milk production, butterfat content of milk and stage of pregnancy. Many farmers divide their herd into groups of similar production, stage of lactation, size, reproductive status and/or age so as to better meet the nutritional requirements and make more efficient use of nutrients than a “one-size-fits-all” approach to feeding.

From an environmental perspective, the two nutrients of concern are nitrogen and phosphorus. The initial source of nitrogen in manure comes from the protein fraction of the ration. Amino acids, the building blocks of proteins consist of an amine (NH_3) group attached to a carbon skeleton. To a lesser extent, non-protein nitrogen sources such as urea may also be included in rations. Because of active microbial growth and reproduction in the rumen fueled by the ration, ruminants have the ability to capture amine groups from such sources to build microbial protein. Rumen microbes are regularly flushed into the lower stomachs and digestive tract where their proteins are then digested and become available to the cow.

Rations that promote the synthesis of large quantities of microbial protein have been shown to be most effective in converting feed nitrogen to milk and growth. Poorly balanced rations, low quality forage, health problems and other stresses can limit microbial action in the rumen, resulting in a higher proportion of feed nutrients escaping digestion and being excreted in the manure.

Phosphorus in rations comes from two sources, organic phosphorus inherent in the ration's feeds and supplemental inorganic phosphorus added to the ration to make up for deficiencies or to balance ratios with other minerals. For many decades, it was believed that increasing ration phosphorus would improve reproductive performance of herds having breeding problems. That thinking has changed and with the increased sensitivity of the environmental consequences of phosphorus, more judicious supplementation is being practiced by producers and nutritionists.

PRACTICE SOUND HUSBANDRY TO KEEP ANIMALS HEALTHY, VIGOROUS, COMFORTABLE, AND STRESS-FREE

High levels of milk production in cows and targeted rates of gain in youngstock require comfortable housing environments and care regimes that promote animal health, as well as expected levels of performance. A local veterinarian should be actively involved in developing and monitoring vaccinations, animal care and other health-related operations on the farm. New York State Department of Agriculture & Markets operates the Cattle Health Assurance Program. NYSCHAP is an integrated disease prevention program that utilizes a team of advisors to develop a farm-specific herd health plan. More information is available at http://nyschap.vet.cornell.edu/.

Records of disease incidences and other problems on individual animals should be maintained and regularly evaluated. In the housing area, lameness, bruising and other signs of discomfort may suggest improper stall design. Stuffy, stale air with hints of ammonia indicates inadequate ventilation. High producing cows should not be away from feed or water more than one hour at any one time. Regular cleaning of feed bunks and water troughs helps stimulate high intakes needed for high production and efficient feed nutrient utilization.

PHYTASE IS NOT NEEDED IN DAIRY CATTLE RATIONS

Making phosphorus in a ration more readily available to be absorbed by the animal is one way of reducing the amount of phosphorus excreted in manure. Two-thirds or more of the phosphorus in grains, oilseed meals and grain by-product feeds is in the form of phytate. Phytate phosphorus is bound to fiber components of the grain. Stems and leaves contain very little phytate.

In the digestive tract of nonruminants such as poultry and swine, phytate phosphorus is unavailable for absorption. Phytase is an enzyme that releases this fiber-bound phosphorus, making it more available to be absorbed by such monogastrics. It is added to poultry and swine rations to reduce the need for supplemental inorganic phosphorus.

Microbes in the rumen of cattle, however, naturally produce phytase, making phytate phosphorus readily available for absorption. Adding phytase to ruminant rations is not needed or recommended.

Summary of Regulations

There are no regulations requiring specific feed nutrient management practices. With the cost of feeding animals being such a critical factor in dairy farm profitability, there is strong economic incentive to utilize feed nutrients most efficiently.

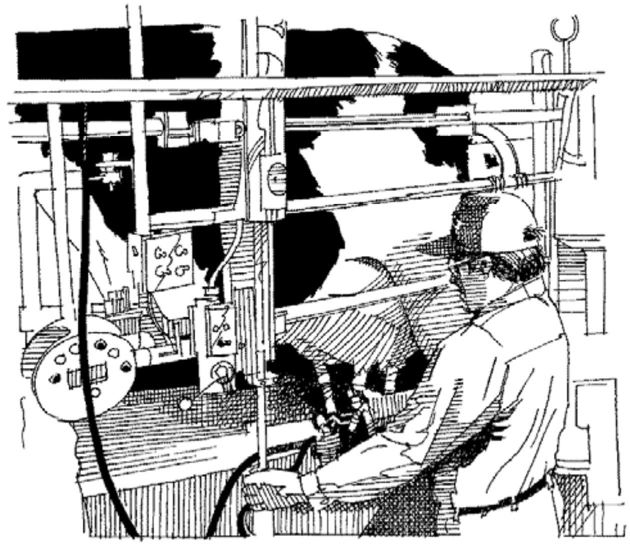
USDA Natural Resources Conservation Service lists feed management as one of the six components of a Comprehensive Nutrient Management Plan. The NRCS Nutrient Management Standard (590) discusses modifications of animal diets to change the nutrient content of manure as a consideration. The NRCS Feed Management Standard (592) outlines sound practices for the feeding of livestock and poultry. Other NRCS Standards relevant to feed management are Prescribed Grazing (528) and Forage Harvest Management (511). To view these and other NRCS Standards, visit the NRCS electronic Field Office Technical Guide – eFOTG (http://www.nrcs.usda.gov/technical/efotg).

Background Information for Worksheet Questions

What is the quality of homegrown haycrop forages?

As a physiological function, the production of large quantities of milk is a metabolic challenge, requiring consumption of a balanced, nutrient-dense ration. The amount of forage that fits into such rations is directly related to the quality of forage available. With NY dairy farms generally producing most or all of the forage needed for their herd, an overall assessment of a farm's ability to produce quality forage is important. This question attempts to make such an assessment.

Forage is produced from two types of crops: hay crops and grain crops. Grain crop forage is usually fed as silage by chopping the whole plant and storing it in oxygen-limiting conditions at the proper moisture level. This allows anaerobic microbes to ferment some of the plant carbohydrates to organic acids, primarily acetic, lactic and proprionic acid. This lowers the pH and stabilizes the forage for long-term storage.



Corn is the most common grain crop grown for silage, although some cereal grains and sorghum are also fed in New York. New York ranks second, behind Wisconsin, among all states in corn acres harvested for silage.

Grasses (orchardgrass, timothy, reeds canarygrass, etc.) and legumes (alfalfa, clovers, birdsfoot trefoil, etc), referred to as hay crops, are always considered forage, fed either as pasture, greenchop (direct-cut) or either stored as dry hay or ensiled.

The best quality of forage contains the highest concentrations of nutrients. But which nutrient is the best measure of forage quality?

For ruminants, neutral detergent fiber (NDF) has been shown to be the best overall measure of forages quality. NDF is determined in the laboratory by boiling a dry, ground sample of feed for a specified period of time in a standardized detergent solution containing buffers to keep pH neutral. The fraction remaining after this procedure primarily consists of the plant's cell wall components (hemicelluloses, cellulose and lignin), the less digestible portion of the forage. Forage's NDF is thus inversely correlated to intake. The higher the NDF, the less of that forage a cow will voluntarily consume. Subsequently, low NDF forages are better quality.

NDF of grasses and legumes are not equal. Because of differences in the type of carbohydrates that make up the hemicelluloses, cellulose and lignin in grass and legumes, good quality legume forage will have a lower NDF value than good quality grass. In general, good quality forage for grass and legume have an NDF greater than 60% and 45%, respectively.

One key difference between hay crop forage and grain crop forage is their variability in quality throughout the growing season. For one thing, hay crop is harvested two, three, four and sometimes five times in a season. Grain crop is only harvested once. Also, as hay crop plants mature, their NDF changes more rapidly than grain crops, particularly corn and sorghum. Although there are more windows for harvesting high quality forage with a hay crop, the windows are much shorter than for grain crops. For example, here in NY, grasses increase in NDF about 1 percentage point each day between May 15 and June 1. Protein content decreases about ¾ of a percentage point for each day during that time.

Because of this rapid change in grass and legume quality, a quick assessment of the percentage of hay crop falling in the good quality range is a rough estimate of the farm's ability to produce quality forage.

How much homegrown forages are being fed?

This question is closely related to the first question because it, too, is focused on forage quality. It attempts to indirectly assess the level of feed nutrients a farm is importing. The principle is simple: the greater the quality of forage available to feed the herd, the more of it a herd will eat. The more of a herd's total nutrient requirements met with homegrown forage, the fewer nutrients a farm will have to import (purchase) as grains and concentrates.

The calculation is illustrated on the back of the AEM Tier II Management of Feed Nutrients Worksheet. The principle is to calculate the amount (in pounds) of homegrown forage dry matter per cow being fed to the lactating herd. The calculation is then equalized for animal size by dividing through by average body weight of cows in each group. The result is in terms of homegrown forage dry matter fed as a percent of body weight.

For a herd of large Holsteins, feeding more than 30 lbs of forage dry matter per lactating cow puts that herd in the lower (number 1) level of potential concern. Feeding less than 24 lbs is in

the higher (number 4) level of concern. For the smaller animals of a Jersey herd, the lower level (number 1) would be greater than 22 lbs. and the higher lever (number 4) less than 18 lbs.

Since rations change over time, this assessment is most useful when averaged over several calculations throughout the year.

How is dry matter intake for various groups of cattle estimated?

Except for water, nutrients are contained in the dry matter portion of a feed. This is why animal nutritionists use the term ‘dry matter intake’ when talking about the amount of feed a cow or group of cows will consume. Knowing how much dry matter cows are eating is the first step in formulating a ration that meets nutrient requirements. One has to know the size of the package into which the needed nutrients must fit. Regularly determining how much a group of cows is consuming and then adjusting the ration to reflect this consumption is a common practice of well-managed feeding programs.

The most reliable way to estimate dry matter intake is to accurately weigh the feed delivered to a feed bunk and the feed uneaten after a day’s time. By determining the dry matter content of a sample of each, simple math will calculate dry matter intake for the group and average dry matter intake per cow in the group.

On many dairy farms, feed wagons are equipped with electronic scales so the amount delivered to feed bunks is easily obtained. Feed refusals, on the other hand, are often only estimated, and in some cases are neither measured nor estimated. Such estimates can be fairly reliable particularly if feed bunks are cleaned out regularly and often. The least reliable way to estimate dry matter intake is to use a book value and never actually make measurements or estimates of what is consumed from the feed bunk.

How often is dry matter intake measured or estimated?

The more often and regularly this measurement or estimate is made, the better.

How often are feeds analyzed for nutrient and dry matter content?

It is not uncommon for dairy farms to sample and analyze feed ingredients and forages regularly or even monthly. However, the most common practice is to get laboratory analysis done when change is anticipated or noticed. Examples of such changes include when a new feed is incorporated into the ration, when a change is noticed in the forage being fed, when a new source of forage is being fed or when there is an unexpected change in milk production. Using book values, particularly for forages, offers the least reliable information about the nutrient content of what is actually being fed on the farm.

The ability to determine dry matters on the farm is a critical capacity for closely managing a feeding program. The dry matter content of wet feeds (silages, haylages and wet by-product feeds such as brewer’s grains) can be significantly different between loads, cuttings, storage structures or even within a storage structure. Particularly with wet forages coming out of a silo, the change can be gradual and visibly unnoticeable.

For example, in a ration calling for 35 lbs as fed of a haylage containing 18% crude protein, a change in the dry matter content of the haylage from 45% to 35% (it becomes wetter) delivers 3.5 lbs less dry matter and 0.6 lbs less crude protein. Unless this is detected early and the as-fed amount of haylage adjusted, the ration delivered drifts away from effectively meeting cows’ nutrient requirements. This can have major, long-term impacts on their production and health.

How often are rations balanced?

Most dairy farms in New York work closely with an independent animal nutritionist or one affiliated with the company from which they purchase feed. Also, nowadays, many owners or herdspersons, particularly on larger operations, have ration balancing expertise and use the sophisticated software themselves.

The most common practice is to balance new rations when there is a change in the forage being fed to the herd. Usually samples are drawn, sent off for analysis with copies going to the farm's nutritionist. A few days later, the new ration formulations are delivered to the farm to be implemented. A better practice is to know ahead of time when new forages will be fed, have pre-storage analysis of the forage, and have rations ready to implement when the new forages start being fed. In either case, reformulating rations regularly, at least every two months, is a practice to ensure accurate feeding of nutrients to the herd.

How is protein balanced in rations?

The understanding of protein nutrition in dairy cattle and other ruminants has vastly improved over the past several decades. Feeding principles have evolved from general recommendations (e.g., feed 1 lb. of 16% crude protein concentrate for every 3 lbs. of milk) to rations with sophisticated combinations of protein and non-protein nitrogen sources formulated to compliment the specific forages being fed.

Protein in feed is referred to as crude protein. By definition crude protein for common feeds is the nitrogen content times 6.25. This definition is based on the observation that the average nitrogen content of feedstuffs is 16g per 100g of protein.

This calculated crude protein contains both proteins (made up of amino acids) and non-protein nitrogen compounds containing amine (NH_3) groups that are not amino acids. Urea is a common non-protein nitrogen source.

Feeds vary widely in their relative proportions of protein and non-protein nitrogen in their crude protein fraction. Crude protein of different feeds also vary in the rate and extent of degradation in the rumen, their amino acid composition and their digestibility of proteins that escapes rumen degradation. Non-protein nitrogen compounds and proteins that are degraded in the rumen become available to the rumen microbes to synthesize their own proteins.

In cattle, digestion and absorption of compounds that meet the animal's nutritional protein needs takes place in the digestive tract 'downstream' of the rumen. Subsequently, there are two post-rumen protein sources; the proteins that make up the actual rumen microbes (microbial protein) and feed proteins not degraded in the rumen (escape or undegraded intake protein, sometimes referred to as bypass protein). The goal of ruminant protein nutrition is to provide adequate amounts of these protein sources to obtain the desired animal productivity with a minimum amount of ration crude protein.

For example, rations can be balanced with common feeds for a herd to average 70 lbs of milk production. One ration may contain 17% crude protein (dry matter basis) while another ration only contains 16% crude protein. The lower protein ration would be more closely balanced to stimulate higher levels of microbial protein production in the rumen, more feed protein escaping rumen degradation, or both. For the farm, that's a savings of ½ lb protein per cow per day, or approximately 1 lb of soybean meal per cow per day. In environmental terms, the difference is equivalent to the excretion of an additional 30 lbs of nitrogen per cow per year.

In respect to protein nutrition, each farm is unique because of the quality of the forages and other feeds they have available. But, for rations typically fed on New York dairy farms, the addition of protein sources that increase rumen undegraded protein can result in lower total crude protein rations.

The pinnacle of ration balancing and protein nutrition for ruminants are models that predict the amount of microbial protein produced in the rumen. Commonly referred to as precision feeding, such models consider the rate at which ration carbohydrates ferment and the ration crude protein releases ammonia. These two factors determine how rapidly microbial mass increases and microbial protein synthesis occurs. Rumen microbes produce their own proteins by either absorbing free amino acids from the rumen fluid or capturing free ammonia and linking it to a carbon skeleton to make amino acids. Matching the availability of ammonia and carbon skeletons (primarily products of carbohydrate fermentation) ensures optimal efficiency of microbial synthesis over time. If at any time more ammonia is available than carbon skeletons, ammonia spills over into the bloodstream, is converted to urea in the liver and excreted in the urine. If at any time more carbon skeletons are available than ammonia, microbial protein synthesis slows and optimum productivity is not achieved.

In New York, the common program used in precision feeding is the Cornell Net Carbohydrate Protein System, commonly known as CNCPS (www.cncps.cornell.edu). Mostly used as a ration diagnostic tool, it has helped nutritionists and dairy farmers formulate better rations for more effective utilization of feed nutrients.

How are Phosphorus and Potassium levels in rations determined?

Surveys in the mid 1990's showed dairy herds nationwide were overfeeding phosphorus above NRC recommendations, costing the US dairy industry an estimated $100 million per year. In a New York City Watershed study, it was estimated that 75% of the reduction in phosphorus excretion from dairy herds could be achieved by decreasing phosphorus mineral supplementation to recommended ration levels.

The connection between phosphorus feeding practices and the environment has only recently become a concern to dairy producers and nutritionists. Though phosphorus is a very expensive nutrient on a per pound basis, it is only a very small component of overall ration cost. Also, in the practicing veterinary profession, the notion that increasing ration phosphorus improved reproductive performance in herds was widespread. Subsequently, over supplementation with phosphorus was cheap insurance for herds to avoid reproductive problems without any apparent negative side effects.

Today, there is a better understanding of the environmental consequences of overfeeding phosphorus. There is also definitive research indicating recommended phosphorus levels are sufficient for effective reproduction in dairy herds. Fewer veterinarians today are recommending additional phosphorus supplementation to improve herd reproductive performance. More dairy cattle nutritionists have taken steps to more closely balance phosphorus in herd rations.

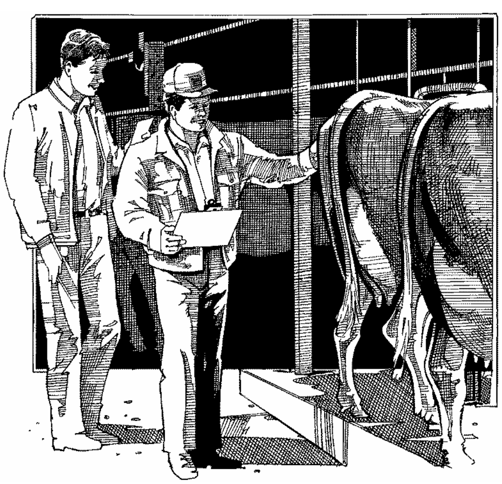
Rations fed to high producing cows will have the highest phosphorus content of all rations fed in a herd. Rations greater than 0.45% phosphorus (dry matter basis) may indicate over supplementation with mineral phosphorus. It is important to point out that many by-product feeds such as wet brewer's grains, corn gluten meal, soy hulls, and wheat mids contain high concentrations of phosphorus. Rations utilizing high levels of these feeds should limit or eliminate phosphorus in their mineral supplements.

Potassium on farms is not recognized as an environmental issue. It is, however, an issue in herd nutrition, specifically for dry cow rations. Consumption of high levels of potassium during the dry period increases problems with post-calving udder edema (swelling) and other complications.

Potassium is a mineral that when abundant in the soil, will be taken up in high levels by crops. Fields with high soil test potassium produce forages with high potassium content. On some farms, specific fields are identified where no manure or potassium fertilizer is added so to produce forages specifically for feeding dry cows.

Additional Information

The effectiveness of a feeding program is



influenced by a host of practices and conditions on the farm. Questions in this section of the assessment cover three general areas:

1. Herd health and performance;
2. Cow comfort and housing stress; and
3. General nutrition and feeding.

Management of feed nutrients plays a key role in the profitability and environmental management of dairy farms. Assistance in understanding the relevance of these additional questions as well as the questions throughout the AEM Tier II Worksheet will likely require communications with the nutritional and animal health specialists. In assessing these areas, it will be helpful to discuss them with the farm's nutritionist, veterinarian and/or the local dairy extension agent in addition to the producer.

Since everyone approaches agricultural environmental management from their own perspective and knowledge-base, involving a team helps in assessing farming practices, identifying issues of concern and developing effective solutions to help producers farm in an environmentally-sound way.

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