FORAGE COMPONENTS FOR THE OPTIMUM RATION

M. B. Hall
Department of Dairy and Poultry Sciences
University of Florida
Gainesville, Florida

Introduction

Dairy cattle, like other ruminants, were designed to use forage. Among feed components, forage has the largest potential to affect animal health and performance as it is relied upon as a source of nutrients, and fiber to maintain rumen function. But, forage can often be a weak link in the ration due to its variability, combined with the sheer quantity required to feed a herd. It is to a farm's advantage to consider the quality and quantity of forage needed to support production in terms of the whole farm: how can forage be managed to make best use of farm resources? Dairy farmers have many management options open to them to improve their odds of getting the appropriate forage quality for their farm.

Quality Forage

A definition of quality forage that considers the whole farm must be defined in terms of animal performance and suitability to the farm. Although quality has been defined in terms of protein or energy content, these factors are not sufficient by themselves. To paint a more complete picture, the following items also need to be considered:

- Palatability -- The "best" feed in the world is worthless if animals won't eat it. Palatability is affected by the type of forage, maturity, processing, spoilage, mold, dustiness, contamination (soil or manure), secondary fermentation, and any of a variety of other factors. Palatability plays a part in feed sorting and selection by animals.

- Supports Performance -- Forage is included in rations for its nutritional and physical contributions. Nutritional characteristics include protein, energy, fiber, and mineral contents, as well as digestibility of those components in the rumen (rumen degradable) and by the cow (rumen bypass). The physical form of the forage contributes to its effective fiber value. Effective fiber reflects the ability of a fiber to encourage rumination and rumen motility. This is related to how finely chopped or ground the forage is, and how digestible it is; generally, the longer the particle size and more slowly digested the fiber, the higher the effective fiber value. Providing adequate fiber of the correct physical form is important to the buffering and mixing of the rumen to help minimize the incidence of ruminal acidosis. To support the desired level of animal performance, the forage must also have the appropriate digestible nutrient content, fed in the correct quantity to complement the other feedstuffs in the ration. Forage of low digestibility requires higher levels of grain feeding to meet animal requirements than does more digestible forage. Low forage digestibility may place an upper limit on animal production.

Presented at the 34th Florida Dairy Production Conference, April 7-8, 1997

- Adequate Quantity -- Enough of the appropriate quality forage should be available to meet the needs of the different classes of animals on the farm over the entire year. Possessing adequate quantities of forage can minimize the number of ration changes and associated fluctuations in production.

- Good Use of Farm Resources -- Particularly when it comes to home grown forages, the type grown and harvesting/storage practices should make good use of the farm's resources. This means that the forages fit the animals' needs, that they are an economical source of feed, and that they allow for efficient on-farm recycling of manure nutrients. The last item has become increasingly important in light of the environmental regulations affecting dairy farms.

Within the whole farm framework of quality forage, the key elements that producers can control are forage type with its appropriate management, and preservation

Forage Type

The type of forage used has a large influence on how it will fit within a dairy ration. Some of the common forages used in Florida include tropical grass (bermudagrass, bahia, stargrass) hay or silage, sorghum silage, ryegrass silage, corn silage, and alfalfa hay. Their nutritional analyses suggest that tropical grasses and ryegrass may serve well as fiber sources, corn and sorghum as energy and fiber sources, and alfalfa as an energy and protein source (Table 1). The long particle size of grass hays and their high neutral detergent fiber (NDF) values would give them the highest effective fiber values to encourage rumination, followed by the silages, depending how finely they were chopped. Alfalfa hay may be used as an effective fiber source, but its effectiveness is a function of NDF content and the point that only the stems will act as effective fiber. The leaves are more similar to concentrates in their digestibility and effective fiber value.

How forages complement other ration components determines how much can be included to support the desired animal performance. When more effective fiber is needed, alfalfa would not necessarily be a first choice. Conversely, a bermudagrass silage with low digestibility cannot make up a large portion of the ration for high producing dairy cows, or their energy and protein needs will not be met.

Table 1. Forage compositions (dry matter basis)[1].

Forage	CP%	NDF%	NEL, Mcal/lb	TDN%
Grass hay	10.0	73.5	0.50	61.1
Grass silage	10.9	70.1	0.46	58.6
Sorghum silage	9.0	62.2	0.63	64.0
Ryegrass silage	10.9	70.1	0.46	58.6
Corn silage	8.6	48.3	0.71	68.8
Alfalfa hay	18.2	41.6	0.64	63.3

[1] Average values from Northeast Dairy Herd Improvement Association analysis of samples submitted from Florida.

Table 2. Changes in coastal bermudagrass nutrient values and yield by cutting interval (dry matter basis).[1]

Nutrient	3 weeks	4 weeks	6 weeks	8 weeks	12 weeks
Crude Protein %	18.5	16.4	13.3	10.7	9.0
Dry Matter Yield, tons/A	6.6	7.1	8.7	8.6	8.7
In Vitro Dry Matter Digestibility %	65.2	61.9	58.0	54.1	51.0

[1] Burton, 1994. Forage fertilized with 600 lb nitrogen/acre/year.

In spite of the weather, dairy farmers can decide the quality of their forage by the management they devote to it. It is critical that equipment, facilities, and people are ready for harvest when the forage is, in order to take advantage of what the weather will allow. Cutting interval or maturity at harvest greatly affects the nutritional value of forages. With a tropical grass such as bermudagrass, digestibility and crude protein content decline with increasing intervals between cuttings (Table 2). Unlike crude protein and digestibility, NDF content does not change as drastically with increasing maturity. Between 4 and 8 week regrowth cuttings of Tifton 81 bermudagrass, the increase in NDF content of the dry matter (70.2% to 72.9%) with increasing maturity did not reflect the 21% decline in digestibility (54.7% to 43.2% in vitro organic matter digestibility; Bernal, 1993).

When faced with low digestibility forage, attempts are often made to make up for poor quality by increasing grain supplementation. Concentrates cannot make up entirely for indigestible forage that takes up space in the ration. The net result of such attempts is usually either reduced usage of forage, higher feed bills, and more rumen upsets, or decreased milk production at the same forage feeding level. For example, when feeding Tifton 81 bermudagrass silage harvested at 4 week or 8 week intervals, cows fed more mature forage produced 3 pounds less milk at each level of concentrate feeding than when they were fed less mature grass (Figure 1; Bernal, 1993). On average, cows fed the mature bermudagrass required 6.5 lb/day more concentrate to produce the same amount of milk as cows fed 4-week-old bermudagrass (Staples, 1995).

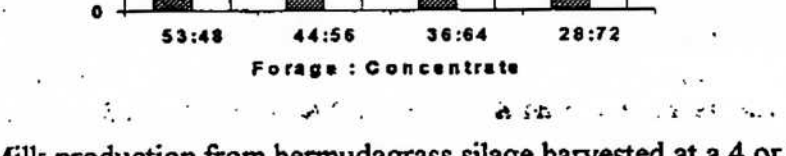

Figure 1. Milk production from bermudagrass silage harvested at a 4 or 8-week cutting interval at different forage to concentrate ratios (Bernal, 1993).

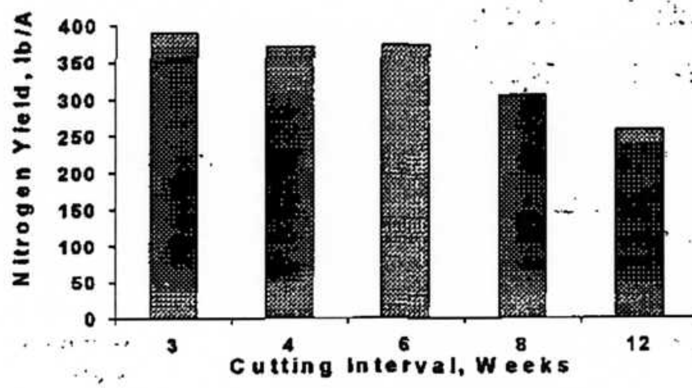

Figure 2. Changes in nitrogen yield of coastal bermudagrass with harvest interval. Forage fertilized with 600 lb N/acre/year. (Burton, 1995).

Plant maturity can also affect the amount of soil nutrients harvested. As forage grows, increasing amounts of nutrients are accumulated as forage mass increases. After a certain point, that quantity can remain the same or decline, possibly as leaves die and are lost (Figure 2). This occurs with bermudagrass (Burton 1994), as well as bahiagrass, stargrass, and pangola digitgrass (W. Kunkle, personal communication). Harvesting at the correct maturity optimizes the nutrients taken up from the soil, as well as forage digestibility, to the benefit of the animal and the farm.

Forage Preservation

The highest quality a homegrown forage ever achieves is its value at harvest. Preservation methods do not tend to improve upon forage's value, but they can degrade it -- after all of the work and costs of growing and harvesting the forage have already been invested. The goal of any silage or hay system is to maintain the forage quality as close as possible to the original. The effectiveness of forage preservation on a farm determines what is available to be fed: forage, roughage, or spoilage.

General recommendations for hay production include baling at more than 86% dry matter, followed by storage in a dry area protected from weather. The losses, or "shrink", that occur during bale storage fall under the headings of dry matter, handling, and animal refusal. Dry matter losses include those due to plant respiration, mold, and microbial action, leaching of nutrients, and weathering. These occur to some extent even in properly harvested hay stored in a barn. Handling losses are those incurred by the moving and processing of bales. The portion of the hay offered that is not eaten for whatever reason -- spoilage, mold, dustiness, weeds, overmature, etc. -- is counted in with the animal refusals. A study from Louisiana detailed the fates of round bales of ryegrass hay that were stored under different conditions (Table 3). Overall, the bales stored unprotected outside had more shrink, and the remaining nutrients were less digestible than those stored with any sort of protection. When you consider the initial value of the hay ($60/ton) and apply that to the remaining feed that the animals actually ate (35% of original), the cost per ton rises to $171/ton for poorer quality hay.

Table 3. Changes in dry matter losses and digestibility of large round bales by storage method.[1]

Storage Method	Losses, % of Original Weight			Change From Original, %
	Handling	Dry Matter	Animal Refusal	In Vitro Digestible Dry Matter
Ground/No Cover	15.0	27.6	22.0	94.1
Rack w/ Plastic Cover	0.0	12.3	1.5	102.3
Barn	0.0	2.3	1.2	100.1

[1] Nelson et al., 1983. Ryegrass bales stored for 7 months.

Ensiling forage offers the most convenient route to store large quantities of forage and minimize weather related harvest losses. The general recommendations for ensiling forages are:

1. Ensile at 28-35% dry matter for bunk silos, 45% for round bale silage. Silage much drier or wetter than this will increase dry matter losses above the expected 5-15%.
2. Wilt grasses rather than ensiling direct cut material. Animal performance is improved when animals are fed wilted silage (W. Kunkle, personal communication). This may be related to better preservation of the forage.
3. Chop at one-quarter to three-eighths inch theoretical cut. The silage will pack better than at longer cuts.
4. Fill fast and pack quickly! The more quickly the silo is filled and packed to exclude air, the less dry matter loss and better keeping quality of the silage. Well packed silage shows improved aerobic stability (reduced heating in the feedbunk) (Ruppel et al., 1995).
5. Cover! Silage not covered with plastic suffers greatly from deterioration due to weather and spoilage. Plastic covered round bales and plastic silage bags that have been punctured by wildlife or equipment will spoil and mold where air is able to infiltrate. Bunker silos left uncovered show increased deterioration from the weather. Water from rain penetrates even well packed silage, increasing the amount of spoilage. In corn and sorghum silages, uncovered silages had considerably more dry matter loss in the top 20 inches of the silo than did silages covered with 0.4 mm plastic sheeting (Table 4). Immediate rather than delayed sealing of bunk silos resulted in lower dry matter losses (Bolsen et al., 1993).
6. Maintaining a "fresh face" on the silo by feeding out at least 8 inches per day evenly across the face, and leaving the face relatively undisturbed will minimize deterioration. The point of these practices is to minimize air infiltration of the silage, thus preventing mold growth.

Table 4. Dry matter losses of uncovered and covered silages in bunker silos (% of DM ensiled).[1]

Silage Depth	% of Ensiled Dry Matter Lost	
	Uncovered	Covered
Corn Silage		
10 inches	80.4	22.5
20 inches	29.4	9.1
Sorghum Silage		
10 inches	77.0	21.3
20 inches	53.2	6.7

[1] Bolsen et al., 1993

Budgeting Forage

Planning for an adequate supply of forage to feed the entire herd is essential to maintaining animal productivity. Additionally, animal performance is maintained best by feeding a consistent ration. This includes minimizing the need to switch among different forage sources. The amount of forage required to support a herd for a year can be calculated as:

(Number of cows) x (forage DM/cow/day) x (365 days) x (shrink factor) + forage for heifers

Estimated forage dry matter required per cow per day will depend upon the type of ration system used. In the total mixed rations (TMR) prevalent in Florida which also include purchased cottonseed hulls and alfalfa, forage budgets for 25% of the dry matter intake, (12 to 14 lb) not including cottonseed hulls and alfalfa are reasonable. "One-shot" rations in which cottonseed hulls provide a significant amount of "built in" roughage, require budgets for 5 pounds or more of tropical grass hay plus any alfalfa or silage fed. The amount of shrink, or feed loss that must be included will depend upon the efficiency of feed handling and preservation. Typical handling losses from mixing and feeding can be estimated to be approximately 5% (1.05 factor). These losses can increase depending upon the feeding system (outside bunk feeding higher than indoor fenceline bunks), feed storage facilities, and operator. The animal refusal included in this value will vary by quality of the feed, efficacy of feed preservation, the extent to which the refusal is consumed by other animals on the farm, and overall feeding management. The amount of forage required for replacement heifers will vary among farms depending upon the number of heifers being raised. When determining the amount of forage needed for replacement animals, subtract the amount of forage that they actually consume that is provided to them from feed refusals from the cows.

It is just as important to budget for the allocation of the different qualities of forage as it is to budget for total forage. Simply put, reserve the highest quality forage purchased or grown for the animals with the highest nutrient requirements, namely the higher producing cows and the young calves. Given that adequate effective fiber is provided, this will allow the formulation of more nutrient dense rations at higher intakes for these animals to obtain the best performance possible.

Summary

In terms of the whole farm, the best quality forage can be defined as that which is palatable, supports animal performance as a source of effective fiber and digestible nutrients, is available in adequate quantity, and which makes good use of farm resources. Forage type, forage management, efficacy of preservation, and allocation of the farm's forage resources all depend upon management decisions. These decisions greatly affect how the quality of forage fits farm and animal needs.

References

Bernal, E.J. 1993. Utilization of Tifton 81 bermudagrass silage by lactating and nonlactating dairy cows as influenced by forage maturity and dietary ratios of forage-to-concentrate. M.S. thesis. University of Florida, Gainesville, FL.

Bolsen, K.K., J.T. Dickerson, B.E. Brent, R.N. Sonon, Jr., B.S. Dalke, C. Lin, and J.E. Boyer, Jr. 1993. Rate and extent of top spoilage in horizontal silos. J. Dairy Sci. 76:2940.

Burton, G.W. 1995. Bermudagrass varieties for top quality and yields. In Dairy Science Handbook, University of Florida, pp. 92-97.

Nelson, B.D., L.R. Verma, and C.R. Montgomery. 1983. Effects of storage method on losses and quality changes in round bales of ryegrass and alfalfa hay. Louisiana Agricultural Experiment Station Bulletin No. 750.

Ruppel, K.A., R.E. Pitt, L. E. Chase, and D.M. Galton. 1995. Bunker silo management and its relationship to forage preservation on dairy farms. J. Dairy Sci 78:141.

Staples, C.R. 1995. Bermudagrass: growing, storing, and feeding for dairy animals. University of Florida Circular 1140.