IMPACT POINTS FOR IMPROVING DAIRY FORAGE MANAGEMENT

Bill Mahanna, Ph.D., PAS, Dipl. ACAN
Global Nutritional Sciences
Pioneer Hi-Bred International, Inc.
800-247-6803 ext 6673
Bill.Mahanna@Pioneer.com

Introduction

The desire to incorporate high levels of forages in dairy rations will likely continue because they offer the potential for delivering high nutrient densities while optimizing rumen health. The challenges facing forage producers include: 1) identifying superior genetics, 2) choosing crops that fit both labor availability and nutrient plans of the dairy, 3) harvest and storage in a timely manner to achieve high quality, 2) conservation of dry matter, 3) maintenance of intake potential with fermented feeds and 4) ration formulation in a manner that balances demands for nutrient requirements and rumen function.

Although forages are a staple in dairy rations, they are often viewed as "mystery" feeds when palatability, poor intake or associated production problems arise. Nutritionists and veterinarians are often concerned over the nutritional consistency and palatability of commodity feeds in the ration and yet, many dairies experience similar problems with their own homegrown forages. Unlike a trailer load of commodity feed, it is not as feasible to "reject" a bunker or tower silo filled with silage. Rather, we are generally forced to live with the forages that Mother Nature and our management happens to deal us.

It is no secret that the production of quality forage/silage is dependent upon the management decisions and practices implemented before, during and after the harvest/ensiling period. Forage management factors that are (somewhat) under the control of the producer are: 1) forage genetics, 2) maturity and moisture at harvest, 3) harvesting and ensiling methods, 4) type of storage structure, 5) use of silage additives, 6) storage structure feedout methods, 7) feed bunk management and, 8) accurate nutrient evaluation.

This goal of this paper is to highlight several areas where communication among the stakeholders (growers, nutritionist, feeder, owners) and standard operating protocols (SOP) might be implemented to help ensure a higher quality and more consistent forage supply.

Timeliness of Forage Harvest

Weather, cutting schedules and post-harvest handling are more critical to alfalfa or corn silage quality than is variety/hybrid selection. Not that one should start out with sub-standard genetics, but rather that management areas over which we have control (primarily harvest timing and storage) are critical given that we have to live with these decisions for the entire feeding period.

The increased reliance on custom harvesters is growing throughout North America. These professionals have the equipment and skill to harvest and store high quality feeds. The one issue silage producers need to address is the timely availability of custom harvesters especially if growing conditions greatly condense the harvest window.

Alfalfa producers need to establish harvest goals for the desired alfalfa RFV (typically 160-200 depending upon availability/cost of other ration ingredients) and then adjust them for field conditions, field losses

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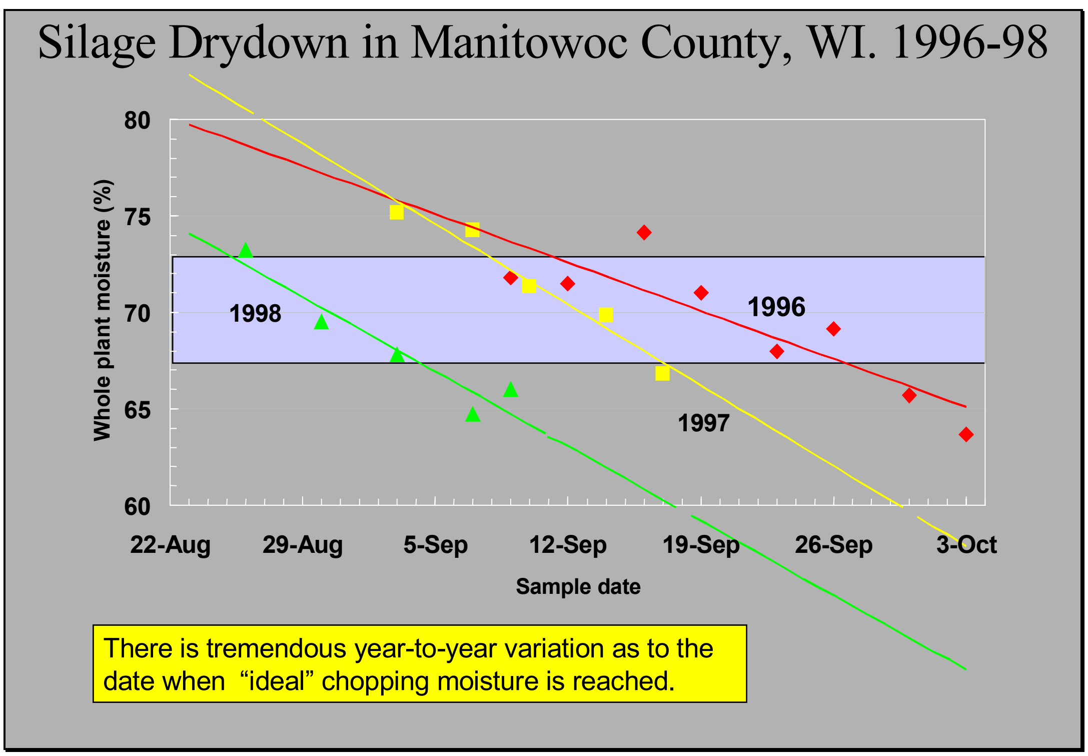
(primarily leaves) and length of time to complete harvest. It is not uncommon to loose 20 RFV points during the entire cutting and curing process.

Several practical methods, other than the calendar, exist to guide producers how to harvest for desired quality. These methods include: 1) visually identifying plant growth stages and monitoring re-growth, 2) harvesting on an optimal growing degree days (typically 700 GDD) from the time alfalfa breaks dormancy (this method only valid for first cutting), 3) monitoring the laboratory analysis of fresh plants harvested two to three times weekly beginning at about 35cm in height (scissors method) and 4) utilizing field measurements in Predictive Equations for Alfalfa Quality (PEAQ) developed at the University of Wisconsin. PEAQ predicts NDF and ADF from regression equations based on the height and maturity index of the most mature alfalfa stem. Extension personnel can provide more information and local research that validates if these methods are applicable to different alfalfa growing regions in North America.

Observing the advancement of the kernel milk line can serve as a *trigger* for predicting corn silage harvest. Kernel milk line is more reliable indicator of whole plant moistures as one goes further West of the Mississippi River where weather patterns are more consistent and irrigation is more prevalent. In the Midwest and East, weather patterns and growing conditions are dictating that silage growers also chop and test the moisture of the whole-plant sample to assure proper moisture for ensiling demands. For example, the University of Wisconsin [7] tracks and posts silage moisture during the harvest season on its website. Between 1996 and 1998 there was nearly a three-week difference in the dates at which silage harvest should have started.



Identity Preservation (IP) of Forages

One method to better allocate forages of varying quality is to IP them depending nutritional value. This is relatively easy for hay. However, producers may also want to consider methods to accomplish this with silages.

The advantage to having one large bunker of any crop (assuming one can reach the top and feed off enough per day to stay ahead of heating/spoilage) is that a smaller proportion of the crop will be found in the top three feet where losses are the greatest. However, the disadvantage is that it is difficult to source forages of different quality and use appropriately to certain classes of livestock. Another advantage with IP forages is that a smaller bunker or several bags can be identified as containing the same hybrid or variety. This helps considerably when striving for consistency in the dairy ration. Other advantages that might justify the management challenges include: 1) isolating specially managed crops (e.g. high-chop corn silage), 2) planting a different hybrid more desirable for high string cows (e.g. high starch, good tonnage) versus tail-enders (more moderately priced hybrid with lower starch but relatively high yields) or 3) forage additives used more cost effectively (e.g. those that alter digestion kinetics allocated to the high string and more defensive products allocated to tail-enders or heifers).

Monitoring Kernel Damage in Processing Corn Silage

Several reviews of published processed corn silage studies show that processing improves starch digestibility, improves cob intake and possibly increases packing density in the silo. [1] Milk production was increased slightly with processing, with the average increase from 15 trials equaling 1 lb of milk per cow daily.

The milk production increase (or reduced feed cost from supplementing less concentrate) would probably be greater in actual on-farm situations because in most research trials, the cows fed processed corn silage received the same amount of concentrate as those fed unprocessed silage. Consulting nutritionist recognize that the improved starch availability in processed corn silage dictates that some grain be removed from the ration. I suspect that in many of the research trials, cows fed processed silage supplemented with equal concentrate as the unprocessed treatment group, experienced ruminal starch overload contributing to sub-clinical acidosis leading to lowered components or compromised milk production.

One of the issues with processing is monitoring the degree of kernel damage. This process should begin with the dairyman, nutritionist and custom harvester having a discussion and clearly communicating the desired chop length and level of kernel damage. Some nutritionists are satisfied with kernels that are simply halved while others like to see every kernel completely crushed. Nutritionists also have various subjective methods of monitoring kernel damage ranging from taking not wanting to see more than 3 whole kernels in a “big gulp” cup worth of corn silage to conducting a Penn State Screening and estimating the % whole kernels on the middle screen.

Whatever the method, some visual analysis during the chopping process should be conducted and communicated to those running the choppers. Ferreira and Mertens [3] presented a poster at the 2001 American Dairy Science meetings proposing more objective method of quantify the percent of starch from kernels that were retained on various screens. They concluded that particle size separation using a 4.75-mm sieve with vertical shaking might provide a rapid method for measuring the unprocessed starch in corn silage that impacts its energy value. Combining this method with routine chemical analysis would improve the estimation of corn silage digestibility. Table 1 shows the tremendous variation among 32 random corn silage samples for the amount of starch retained on the 4.75-mm screen. This variation makes it very difficult for nutritionists to arrive at energy estimation for corn silage. Several laboratories are currently investigating the possibility of offering this type of procedure as part of their analytical package.

Table 1. Chemical characteristics of kernel and kernel fragments from 32 corn silages.

	Mean	SD	Min	Max
Kernels and fragments[a], % CSDM	20.49	9.66	4.18	48.35
Grain DM, % CG	56.17	4.99	44.80	62.63
Starch, % CGDM	63.68	4.94	43.79	70.27
$\text{Starch}_{>4.75}$, % CSDM	13.27	6.64	1.83	33.02
$\text{Starch}_{>4.75}$, % CS Starch	52.11	20.79	8.73	100.00

[a] Retained by sieves with apertures of 4.75-mm and larger.

Monitoring Particle Size in Silages and TMR

Particle size goals vary by nutritionist and by area of the country. Western dairies that have access to excellent quality hay are probably less concerned about silage particle length than dairies in the Midwest or East that are deriving more of their effective fiber from predominately silage-based rations.

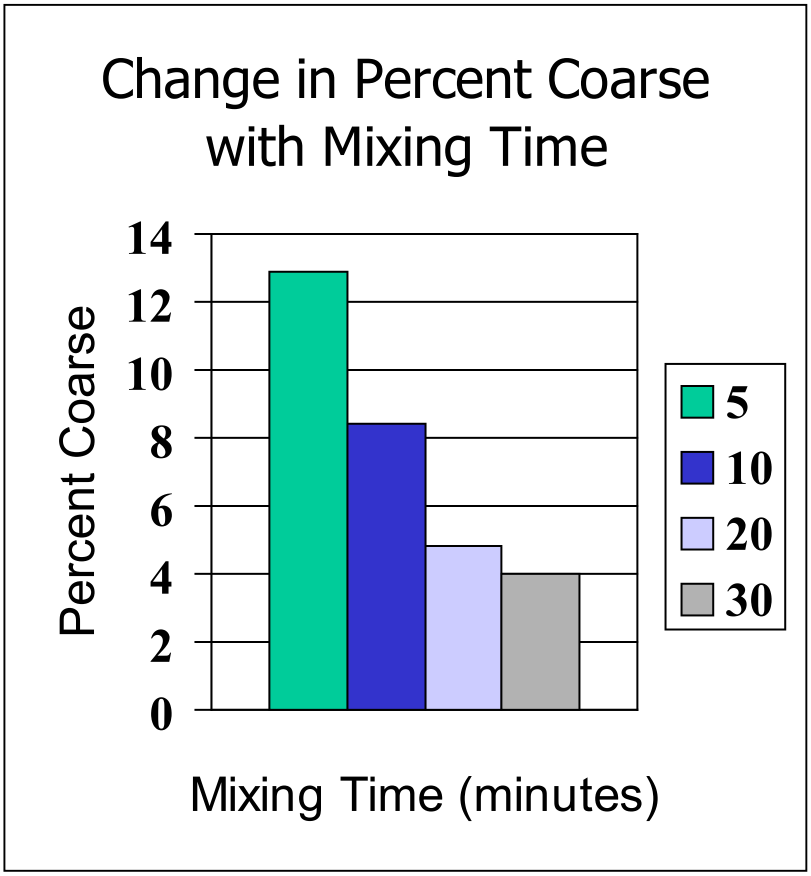
Nutritionists are often asked for their recommendation on chop length of various silages. If one did not have to worry about rumen health, the answer would be easy….as fine as you can get it to: 1) facilitate storage compaction, 2) make it easier to maintain a good face on bunkers at feedout and 3) improve digestibility because of greater surface area for bacterial attachment.

However, being cognizant of rumen function, one should really start with the desired particle length of the TMR (typical goals are from 8 to 15% over 1.5 inches) and then work backwards to the particle size required by any individual feedstuff depending on the inclusion level in the TMR.

One also needs to understand that mechanical handling (processing, bagging) and TMR mixing can all exert a heavy toll on fiber particle size. Bal, et.al.,[(8)] published work in 2000 that looked effective fiber from 3/8" unprocessed silage compared to processed silage at three different chop lengths (3/8, 1/2, 3/4). Cows on the different silage diets (25% of total ration DM as corn silage) had fistulas that had weights suspended into their rumen. A counter-balance was attached to the weight. The length of time needed to pull the weight through the rumen mat determined the thickness of the mat (longer time = thicker mat). The 3/8 and 1/2-inch TLC processed silage had significantly shorter ascension times, meaning that rumen mats were not as well formed. When the TLC on the processed silage was increased to 3/4-inch, the time was increase enough that it is considered to be statistically the same as the un-processed, 3/8-inch TLC silage.

Another issue affecting particle size is over-mixing the TMR. Forage may have been chopped at the desired TLC, but then mixed too long in a TMR mixer. Over-mixing will cause the physical breakdown of fiber particles and greatly reduce the effective fiber available from the ration. Diagnosis of over-mixing can be accomplished through the visual comparison or with the Penn State Separator of the machine mixed TMR and a hand-mixed sample of all the ingredients needed for one cow. If there is a large disparity between the two samples over-mixing is occurring. If over-mixing is a concern then one may wish to consider adding forages at the end of mixing to reduce the time that they are exposed to the forces of mixing. A very responsible person should handle all the TMR mixing (and be rewarded accordingly) to increase the consistency of the final product. This process is ready-made for the development of SOP, which should include a timer in the tractor to monitor mixing time.

Below is a graph showing the effect of TMR over-mixing conducted at the Cornell University Teaching and Research Center by Batchelder and Chase in 1998.[4] In the five week feeding trial, cows fed the TMR mixed for 30 minutes versus the 5 minute had reduced intakes and butterfat was depressed by 8 points (3.5% vs. 2.7%).



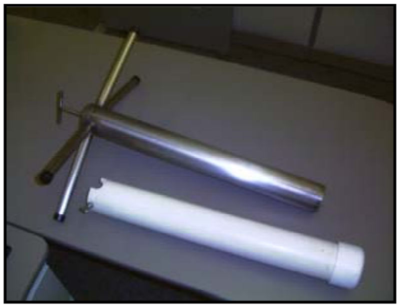
Mixing wagons that don't produce a homogeneous TMR mix can also cause inconsistent intakes in the herd due to delivery along the feed bunk of either too much or too little effective fiber. Diagnosis of this problem may be possible by visual inspection of the feed bunk or by performing Penn State Forage Separator analysis of different spots along the feedbunk. A final diagnostic tool is the use of a non-toxic marker such as gumballs or colored paper that can be added to the TMR during mixing. If poor mixing is occurring there will be a large amount of variability in the amount of the marking material along the feed bunk.

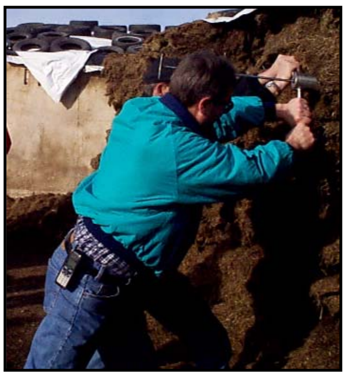
Inadequate effective fiber intake by cows occurs when they are able to sort through the TMR and preferentially select smaller ingredients (grain) over longer forage particles. Sorting can be diagnosed by performing Penn State Forage Separator analysis of the feed bunk immediately after putting out the TMR and then after the herd has been allowed to feed for several hours. If there is a large discrepancy between the two analyses (a higher percentage of large particles in the second sample), sorting is occurring.

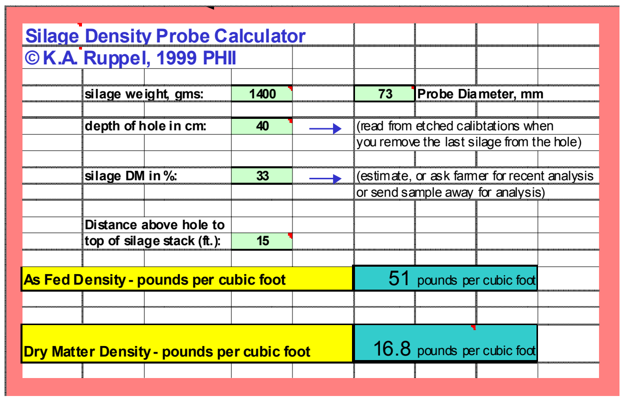
Reasons for sorting include: 1) large amounts of both very large (or long) ingredients and fine-sized ingredients, but not much medium-sized ingredients in the ration. To avoid this problem, it may be necessary to chop the long-stemmed forage to reduce its length and increase its mixing ability. 2) low moisture TMR mixes. It may be necessary to add water to the ration. 3) cows that are low on the pecking order tend to consume more hay and less of the silage/concentrate mix. To avoid this problem the effect of dominant cows must be controlled. This may be accomplished by providing adequate bunk space for consumption and/or having separate strings for smaller first-calf heifers.

Monitoring Bunker Silo Compaction and Feedout

Proper silage compaction is critical to facilitating a proper fermentation. Pioneer has developed an on-farm tool and software to help monitor silage density. Field studies in Wisconsin[9] have provided data allowing producers to set compaction benchmarks for improvement.







Compaction Benchmarking Goals…

Table 1. Summary of samples collected from 168 bunker silos

	Haycrop silage (87 silos)		Corn silage (81 silos)	
Characteristic	**Avg.**	**Range**	**Avg.**	**Range**
Dry Matter, %	42	24-67	34	25-46
Wet density, lbs/ft^3	37	13-61	43	23-60
Dry density, lbs/ft^3	14.8	6.6-27.1	14.5	7.8-23.6
Avg. particle size, in.	0.46	0.27-1.23	0.43	0.28-0.68

Source: Holmes, B.J., and R.E. Muck. Pack Silage to Achieve High Density, Quality Feed. Hoard's Dairyman, May 25, 2000

Proper silage compaction and covering are critical not only for fermentation but also to reduce spoilage and costly dry matter shrink. Feeding spoiled feed can also adversely affect cattle performance. A recent study at Kansas State University by Whitlock et.al.,[2] showed that dry matter intake and corn silage dry matter digestibility and steer dry matter intakes were statistically reduced when 25% spoiled silage (top 36-inches of a 3-foot deep pilot scale bunker) was mixed in with 75% normal silage (good silage stored in an AgBag).

Further attention must be made to bunker face management. Having an uneven face with feed heating in piles that have fallen down and not cleaned up costs in terms of palatability (heating) and sugar loss. When the bunker face is not managed correctly, sugar is the first nutrient that will be utilized by the heating and spoilage bacteria and fungi. Research from Idaho on the effect of afternoon cutting on alfalfa sugar content and the accompanying increases in dry matter intake and production in cows fed this hay supports the importance of sugar. Ruppel [4] recently estimated the sugar loss impact of heating from an improperly managed bunker face.

Percent Sugar Lost on Face of Bunker Silos

Pounds of 'sugar' lost per ton of silage:		**1.5**	**3.0**	**4.5**	**6.0**
		Heating on Bunker Face, ° F.			
Silage % - 'sugar'	**Lbs. 'sugar' per ton**	**+ 5°**	**+10°**	**+15°**	**+20°**
0.5%	**3.2**	47%	94%	141%	188%
1.0%	**6.4**	23%	47%	70%	94%
1.5%	**9.6**	16%	31%	47%	63%
2.0%	**12.8**	12%	23%	35%	47%
3.0%	**19.2**	8%	16%	23%	31%

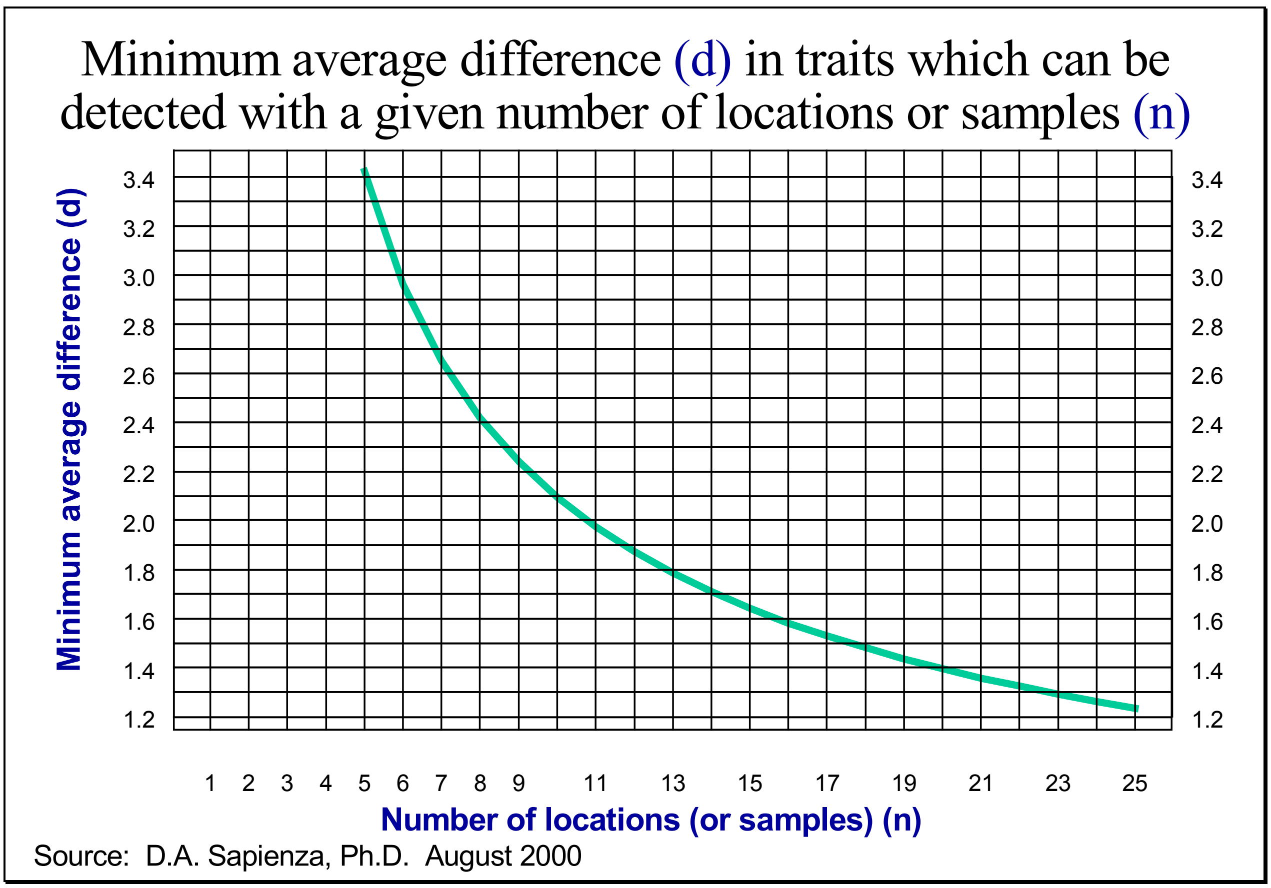
Benchmarking Forage Nutritional Quality

Production problems are a very real possibility every time a new lot of hay is fed or a new bunker containing a different hybrid is opened. Laboratory analytical capabilities are now starting to keep pace with the need for additional nutrient profiles and digestion rates to optimize the feeding of high producing cattle. The availability of routine analysis for traits such as 30-hour in vitro true digestibility (IVTD), 30-hour dNDF, water soluble carbohydrates, starch, lignin and silage volatile fatty acids allows nutritionists better insight into making relative comparisons between forage sources.

Obtaining traditional analysis along with some idea of digestion kinetics allows nutritionists to better predict what changes might be required in the ration. Examples might be a reduction in concentrate to compensate for high starch, well processed corn silage or conversely more concentrate to adjust for low sugar, high lignin:NDF ratio (e.g. >20%) alfalfa (whose feeding value may appear relatively normal using traditional RFV values). Freezing historic samples and analyzing them in the same run as the new forage is especially useful when using in vitro, rumen fluid methods to benchmark digestion extent.

One of the most basic nutritional determinants that we require is forage dry matter (DM). Producers are often unsure how many samples to take for determining moisture content. This generic chart below estimates the number of samples that should be taken to be 95% confident that a given difference exists for any particular nutritional trait (e.g. moisture, ADF etc). The way to use the chart is to establish the acceptable measurable difference on the Y-axis (vertical) and then go across the chart until you intercept the curve. Dropping down to the value on the X-axis (horizontal) indicates the approximate number of samples that should be taken.

One must define the population of interest (e.g. an individual silage truck, the total number of silage trucks coming across the scales per hour or per day, an individual growers field or an entire silage pit) and the acceptable level of confidence you require for the trait in question (e.g. silage moisture). For example, if you want to be 95% confident in a 2% unit moisture difference (e.g. 70 + / - 1% unit) to base silage grower compensations, then you would need 11 samples. If you want this level of confidence in a truckload, then you need to sample the truck 11 times. If you want to be 95% confident in a (reasonably uniform) field (same hybrid, uniform soil types etc.) in which the chopper capacity is delivering 11 truckloads per hour to the silage pit, then you would collect 1 sample from every truck (or if 22 trucks/hour, then sample every other truck). We have made some assumptions in developing this curve and the recommendations concerning the representative nature of the sample and the coefficient of variation (CV) of the analytical method. Poor sampling in the field or poor analytical practices in the lab will increase the CV and thereby the number of samples.



A recent analytical tool available to silage feeders is volatile fatty acid analysis. When used across enough representative samples, this tool has tremendous utility for companies researching and developing forage additives. As far as field application, some respected nutritionists are using the analysis and adopting protocols for adding buffer to silages that exceed threshold levels of acetic acid (e.g. 3%). Other consultants are advising clients reduce what they pay for silages that do not have a certain recommended VFA profile (e.g. 3:1 lactic:acetic acid ratio).

However, the author still questions the practical field utility for consulting nutritionists. It has never been clearly established that slightly altered VFA profiles are the cause of reduced intakes or performance. Furthermore, the VFA profile is confounded with other nutrient dynamics such as proteolysis and the production of amines and amides. Personal experience in troubleshooting rations indicates that more often than not, production problems are the result of the inability to correctly assess the digestion kinetics effect of high starch, well processed corn silage in the ration, rather than the causative problem being slightly altered VFA profiles.

One application that does have great field utility is the ability to quantify the amount of butyric acid in clostridial silages. VFA analysis would help nutritionists determine how much clostridial silage could be incorporated in the ration given the literature reports [6] [5] that cows consuming in excess of 50 grams/day of this acid may be more prone to ketosis and off-feed problems.

Butyric Acid Dose Calculator

Butyric acid concentrations and pounds of silage DM intake to reach butyric acid doses of:

- **50 gms** – reduced DM intake and risk of ketosis to early lactation cows
- **150 gms** – high risk of ketosis in early lactation cows
- **250 gms** – high risk of ketosis in all lactating cows

Source: Dairyland Laboratories, Inc. 12/2000 and Gary Oetzel, DVM – Univ of Wisconsin

% DM	Mg/lb	50 gms	150 gms	250 gms
0.25	1.1	44.1	132.2	220.3
0.50	2.3	22.0	66.1	110.1
0.75	3.4	14.7	44.1	73.4
1.00	4.5	11.0	33.0	55.1
1.25	5.7	8.8	26.4	44.1
1.50	6.8	7.3	22.0	36.7
1.75	7.9	6.3	18.9	31.5
2.00	9.1	5.5	16.5	27.5
2.25	10.2	4.9	14.7	24.5
2.50	11.4	4.4	13.2	22.0
2.75	12.5	4.0	12.0	20.0
3.00	13.6	3.7	11.0	18.4
3.25	14.8	3.4	10.2	16.9
3.50	15.9	3.1	9.4	15.7
3.75	17.0	2.9	8.8	14.7
4.00	18.2	2.8	8.3	13.8
4.50	20.4	2.4	7.3	12.2
5.00	22.7	2.2	6.6	11.0
5.50	25.0	2.0	6.0	10.0
6.00	27.2	1.8	5.5	9.2
7.00	31.8	1.6	4.7	7.9

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