HIGH FORAGE RATIONS – WHAT DO WE KNOW?

L. E. Chase[1] and R. J. Grant[2]
[1]Cornell University Department of Animal Science
[2]William H. Miner Agricultural Research Institute

INTRODUCTION

Dairy cattle and other ruminants are biologically designed to convert forages and other fibrous feeds into high quality products such as meat and milk. Forages provide the foundation upon which nutritionally sound, economical and rumen healthy rations are built. The quality and quantity of forages fed to the dairy herd are directly related to milk production, purchased feed costs, whole farm nutrient balance and profitability. The Northeast and Midwest have the land and soil resources to produce high yields of high quality home produced forages. On dairy farms, these home produced forages are usually the most economical sources of energy, protein and fiber fed to the dairy cow. As we look ahead, these 2 regions will maintain or increase their role in the dairy industry by taking advantage of this relationship between land, forages and dairy cows.

The trend in the Northeast dairy industry in the last 10-15 years has been an increase in the proportion of forage in the total ration dry matter. Where it was once rare to see rations >50% forage, it is now fairly common to see rations that contain 55 to 70% forage as percent of the total ration dry matter. This has occurred at the same time that milk production per cow has increased significantly. A primary reason for this increase in feeding higher levels of forage is that dairy producers are doing a better job of harvesting and storing larger quantities of higher quality forages. The increased availability and use of NDF digestibility measures has provided additional information to assist feed professionals in incorporating higher levels of forages in rations. There have been continuing improvements in the NDF digestibility of corn hybrids and forage varieties available to producers. Dairy producers that have adopted higher forage rations report additional benefits including higher milk components, improved income over purchased feed costs, better rumen health, lower purchased feed costs, less foot problems, lower veterinary bills and increased cow longevity.

HOW MUCH FORAGE CAN COWS CONSUME?

The quantity of forage that can be consumed depends on the interaction of factors including forage quality, forage digestion rate, passage rate and animal bodyweight (BW). One method to estimate this is forage NDF intake as a percent of the cows BW. Mertens (1988) proposed that maximum total NDF intake was about 1.2% of BW and that 75% of this should be from forage. This would be a forage-NDF intake of 0.9% of BW. A review of pasture research trials reported that forage NDF intake ranged up to 1.3 to 1.7% of BW (Vazquez and Smith, 2000). Forage NDF intake was up to 1.6% of BW in lactation trials comparing alfalfa and grass silages (Chase, 2012). Forage NDF intakes of 1.4 to 1.8% of BW were reported for dairy cows fed mixed grass pastures

(Bargo et. al., 2002). Thus, it appears that dairy cows do have the ability to consume large quantities of forage NDF.

HOW MUCH FORAGE CAN BE FED?

One option is to feed 100% of the total ration dry matter as forage and provide mineral and vitamin supplementation. This option is currently used in some grazing herds. A trial conducted at Penn State University examined this question (Bargo et. al., 2002). Cows were given access to a grass pasture (55% NDF). Estimated daily pasture DMI was 38 to 45 lb. /day. Forage NDF intakes were 21.8 to 25 lb. /day or 1.6 to 1.8% of bodyweight. Daly milk production ranged from 42 to 49 lb. /day. This was a short term trial so that factors such as body condition changes and reproduction could not be determined. However, it does point out that dairy cows do have the ability to consume large quantities of NDF from forage when high quality and highly digestible forages are fed.

How much forage do commercial dairy herds feed? To approach this question, we have been obtaining ration information from commercial dairy herds. The data in Table 1 contains some example rations from 6 herds that are part of larger database. It is important to remember that this information is only a snapshot from a herd at one point in time. Key points from these herds are:

- Milk production ranges from 76 to 105 lb. of milk per cow per day with rations containing > 60% forage (DM basis).
- These herds use a variety of forages. All of these herds use some corn silage.
- Total ration NDF ranges from 31 to 34% while forage NDF is 23 to 30% of the total ration DM.
- Forage NDF intake ranges from 0.9 to 1.1% of bodyweight.

There are other herds in the database that feed 75-80% forage with herd milk production between 70 to 80 lb. per day. Another herd feeds grass silage as the only forage and averages 75 to 85 lb. of milk per day depending on silage quality.

HOW CAN COWS CONSUME HIGH LEVELS OF FORAGE NDF?

Both research and on-farm data do indicate that dairy cows can consume higher quantities of NDF and forage than some of the previous guidelines. One piece of this puzzle is the use of higher digestibility forages. Oba and Allen (1999) reported that a 1 unit increase in NDF digestibility was associated with an increase in DMI of 0.37 lb. and an increase in fat corrected milk of 0.55 lb. These higher digestibility forages would have a lower indigestible NDF (iNDF) value. A second component of the explanation could be that these herds may be feeding lower NDF forages. Research in Sweden examined the effect of grass maturity and NDF on intake (Rinne et. al., 2002). In situ work indicated significant decreases in rate of digestion and potential NDF digestion as forage maturity increased. The authors concluded that early cut grass silages had a lower rumen fill and increased intake when compared with more mature forages. These 2 factors would account for some of the differences in NDF intake observed but may not be the total explanation.

Table 1. High Forage Rations

Item	Herd A	Herd B	Herd C	Herd D	Herd E	Herd F
Milk, lb./day	91	88	105	90	76	100
Milk fat, %	3.8	4.3	3.8	4.0	3.8	3.6
Milk true protein, %	3.10	3.10	3.10	3.25	3.15	2.90
Forage, % of ration DM	65	64	62	70	75	62
Corn silage, % of forage DM	66	36		60	61	56
BMR corn silage, % of forage DM			56			
Alfalfa silage, % of forage DM	34		29			40
Mixed legume-grass forage, % of forage DM		64	15	40		
Grass silage, % of forage DM					39	4
Total ration NDF, % of DM	32.7	33.3	32.7	30.8	34.4	32
Forage NDF, % of ration DM	23.0	29.3	26.0	27.6	30.0	25.8
Forage NDF, % of BW	1.0	1.1	1.0	0.9	1.0	1.0
Ration CP, % of DM	15.5	15.7	18.3	17.3	16.3	17.2
Ration starch, % of DM	27	24	26	24	24	24

In 1979, a proposal was made that NDF degradation in the rumen was a 2 pool system rather than a single NDF pool (Mertens and Ely, 1979). They termed these as a fast-digesting fraction and a slow-digesting fraction. An expansion of this 2 pool concept was recently described (Raffrenato and Van Amburgh, 2010). The thought is that higher digestibility forages may have a greater portion of the total NDF in the fast-digesting fraction. As an example, they compared conventional and BMR corn silages. The BMR corn silage had 73.7% of the total NDF in the fast pool compared with 60.7% in the conventional corn silage. The portion in the slow NDF pool was 18.7% for conventional corn silage versus 13.1% for the BMR. The iNDF was 20.6% of total NDF in the conventional corn silage compare with 13.1% for the BMR sample. This same pattern may exist in legume and grass forages but laboratory methods are not routinely available to determine this in a larger number of samples.

A trial was conducted to evaluate the relationships between ration forage levels and forage digestibility on DMI, milk production, ruminal digesta, pool sizes, and fiber turnover (Grant and Cotanch, 2012). Rations with conventional corn silage contained 39 or 55% corn silage and had 52.6 or 68.3% total forage. The rations with BMR corn silage had 36 or 50 % corn silage and 49.4 or 63.5% forage. All rations contained 13.3% haycrop silage. Key results from this trial are:

- DMI and solids corrected milk was lower on the high corn silage conventional ration but similar for the other 3 rations. Milk production ranged between 92 and 105 lb. per day per cow.
- Solids corrected milk production was unaffected by source of corn silage at the lower forage content, but it was significantly increased by BMR corn silage when fed in a higher forage diet. Efficiency of milk production was unaffected by source of corn silage at either level of dietary forage but was lower or the high forage diets.
- Total NDF intake was significantly higher for cows on the high BMR ration at 1.53% of BW. NDF intakes on the other rations were about 1.4% of BW.
- The more highly digestible BMR NDF allowed for greater intake related to greater ruminal turnover. The intake of NDF, as a percentage of body weight, was high for all diets but was increased specifically for cows fed the BMR corn silage in a high forage diet.
- Cows fed rations with BMR corn silage had lower rumen digesta volume and mass.
- The NDF pool size was reduced for cows fed the low level of BMR corn silage.
- -NDF pool size was similar for the other rations.
- Chewing time and rumen pH were enhanced by the higher amount of dietary forage and reduced by the BMR versus the conventional corn silage.
- Microbial protein production was increased by BMR versus conventional corn silage which presumably reflected the greater fermentability of this forage.
- When conventional corn silage was fed, the ruminal turnover rate was slower and turnover time was longer.
- Cows fed the BMR corn silage had a faster rumen turnover rate and turnover time was shorter.
- Rumen digesta mass was less for cows fed the BMR diet indicating that cows were able to obtain the required nutrient supply from this smaller, but ore quickly turning over, rumen NDF pool.

This trial provides some insight into the relationships of forage NDF, NDF digestibility, DMI and rumen function in high producing dairy cows. Similar data are needed on a wider range of forage types and feeding levels with high producing cows to provide a better understanding of this complex system.

METHANE EMISSIONS

One potential concern with using high forage diets is an increase in methane emissions. A challenge in sorting out the effect of forage intake on enteric methane emissions is the interactions between forage quality, NDF digestibility and dry matter intake. A recent review paper indicated that improving forage quality had a low to medium effectiveness rating on mitigating methane emissions (Gerber et. al., 2013). However, these same authors conclude that the overall effectiveness of this change was variable when interactions such a dry matter intake and other ration nutrients were considered. A trial was conducted using a high quality perennial ryegrass pasture (42% NDF) at 2 levels of daily pasture allowance (O'Neill et. al., 2012). No grain was supplemented to cows on these 2 levels of pasture availability. A third treatment added 8.6 lb. of a concentrate supplement. There was a significant increase in daily methane emissions as DMI increased. However, there were no significant differences in daily methane emissions when expressed per unit of DMI or milk yield. Workers in Sweden fed rations containing 50, 70 or 90% forage using timothy/fescue silage that was 40% NDF (Patel et. al., 2011). The cows in this trial were producing about 40-45 lb. of milk per day. There were no significant differences in methane emissions between these 3 rations on either a grams/day, grams/unit of DMI or grams/kg. of milk. The effect of forage to concentrate ratio on milk production and methane emissions has been reported (Aguerre et. al., 2011). The diets fed contained equal portions of alfalfa silage and corn silage on a dry matter basis. Diets fed contained 47, 54, 61 or 68% forage. Dry matter intake was not different between the 4 diets but there was a tendency for milk yield to decrease on the higher forage diets. Milk production was 80 to 85 lbs/day. There was no significant difference in energy corrected milk in this trial. There was significantly higher daily methane emissions on the diet with 68% forage compared with the diet containing 47% forage. Cows fed the diet with 68% forage had daily methane emissions 17% higher than those receiving the diet with 47% forage. It is important to remember that forage quality was the same for all 4 diets. The results of these trials provide some insight into the relationships of forage quality, forage intake and methane emissions. Additional work is needed to better define the interactions of DMI, forage quality and forage intake on methane emissions. Whole farm nutrient balance and profitability will be key considerations that need to be addressed in evaluating the relationships of forages and methane emissions.

CONSIDERATIONS FOR FEEDING HIGHER FORAGE RATIONS

As with any management practice, there are always considerations that need to be evaluated as part of the decision making process. The following points should be considered for herds that are intending to feed higher amounts of forage:

1. Mindset – Both the dairy producer and the herd nutritionist need to agree that this concept is logical and can work in the herd, if they don't buy into this concept; the risk of failure is high.
2. Consistent quality forages – As forages comprise a higher proportion of the total ration, there is less room for variability. Variations in forage quality will

have more impact on variations in milk production as the level of forage in the diet increases.

3. Forage inventory – Don't implement higher forage rations without calculating forage inventory and availability. Cows will be consuming more pounds of forage per day. It may require 15 to 30% more forage to feed the same number of cows. In some herds, this may require changes in the cropping program to be able to produce the total quantity of forage needed by the herd. Forage inventories need to be checked frequently to assure that the required quantity of forage is available.
4. Forage allocation and storage – It is difficult to produce only high quality forages for the dairy herd. Ideally, the higher quality forages will be stored separately so they can be allocated at feeding to the appropriate animal groups.
5. Forage analyses – More frequent forage analysis is needed to keep the feeding program on target. NDF digestibility should be included as part of the forage analysis package.
6. Ration formulation and adjustments – Rations will need to be monitored more closely to determine if adjustments are needed based on forage test results. A key item to monitor on the farm is forage DM since this can vary considerably between days.
7. Feeding management – The goal is to have a consistent supply of fresh, palatable and high quality ration available to the cow throughout the day. With silage based high forage rations, feed shelf life may be a problem in warm, humid conditions. This may indicate a need to increase the number of times that feeds are mixed and delivered to the herd. More frequent feed pushups may also be needed. The use of a TMR preservative could also be considered.
8. TMR mixer management – The ration mixed will be bulkier and less dense (lbs. /cubic foot) as more forage is included in the ration. This may require making more mixes per day or considering the purchase of a larger mixer.

SUMMARY

Feeding higher forage rations is an opportunity that should be evaluated in dairy herds. Higher forage rations take advantage of the biology of the cow to convert forage into milk. The key to making the system work is having adequate quantities of consistent, high quality forage available on the farm. In some herds, the move to feeding higher forage rations will require a number of years due to needed changes in the cropping, forage harvesting, forage storage and feeding management systems on the farm. The long-term potential benefits include higher milk component levels, improved cow health and herd profitability. This approach may not fit all farms. However, the concept should at least be considered by the dairy producer and the agriservice providers that work with the farm.

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