High Forage Rations for Dairy Cattle – How Far Can We Go?

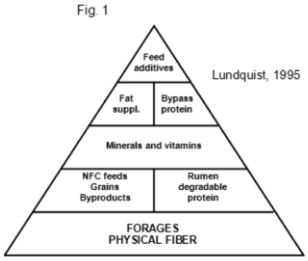
Dr. Larry Chase
Dept. of Animal Science
Cornell University
lec7@cornell.edu

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 are the foundation upon which nutritionally sound, economical and rumen healthy rations are built. The quality and quantity of forages fed to the dairy herd is directly related to milk production, purchased feed costs, whole farm nutrient balance and profitability. The Northeast and Midwest have the resources to produce high yields of high quality forages. On most dairy farms, these home produced forages are the most economical sources of energy and protein fed to the 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 forages and dairy cows.

Figures 1 and 2 provide an overview of the various components that comprise dairy rations. Note the importance of forages as the base building block of dairy rations. Figure 2 is an update of Figure 1 and is based on recent forage quality research results and improved knowledge of how to better utilize forages in dairy rations. Figure 2 also represents a trend we have seen in the last 5-10 years with dairy producers feeding higher forage rations. A primary reason for this is that dairy producers are doing a better job of harvesting and storing larger quantities of consistent higher quality forages. The availability and use of NDF (neutral detergent fiber) digestibility has provided additional information to assist feed professionals in better utilizing higher levels of forages in rations. There have also been improvements in the NDF digestibility of corn hybrids and forage varieties available to producers.

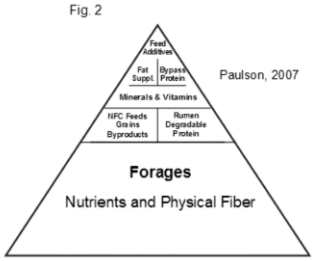
Figures 1 and 2. The Feed Pyramid for Dairy Cows

Fig. 1



Lundquist, 1995

Fig. 2



Paulson, 2007

The quantity of forages actually fed on dairy farms is a combination of forage quality (NDF) and the quantity of forage available. The quantity of forage to be included in the ration can be "estimated" from the NDF content of the forage. Mertens (1988, 1997, and 2010) outlined this concept and suggested that total NDF intake would be 1.1-1.2% of the cow's body weight (BW). He also suggested that the NDF from forages be a minimum of 75% of the total NDF intake. This would be a minimum forage NDF intake of 0.9% of BW if total NDF intake is 1.2% of BW.

The use of forage NDF is a simple way to set the minimum forage level in dairy rations. The following example may help in better understanding this approach:

- Dairy cow body weight = 1450 lbs
- Minimum forage-NDF intake = 1450 * 0.009 = 13.05 lbs of forage NDF
- Forage NDF = 50%
- Pounds of forage DM to feed = 13.05/0.5 = 26.1 lbs.

Can we feed dairy cattle rations that are 100% forage with no supplemental grain? Yes, but milk production may be less than desired. There are dairy herds using managed intensive rotational grazing that feed little or no grain. This topic is currently a source of much discussion and debate within the grazing community. A trial conducted at Penn State University examined the DMI and milk production of Holstein cows fed only pasture (Bargo et. al., 2002). Cows were grazed on a grass pasture averaging about 55% NDF and 20% CP. Daily pasture DMI was between 38.5 to 45.1 lbs/day. Forage NDF intakes were 21.8 to 25 lbs/day. Forage-NDF intakes were 1.6 to 1.8% of BW. Daily milk production was 42 to 49 lbs/.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 have the ability to consume large quantities of NDF from forage when high quality and highly digestible forages are fed.

There have been a number of other research trials with cows on pasture reporting forage NDF intakes >1.3% of BW. Even though these values are higher

than suggested by Mertens (1988,1997), they probably represent the upper end of the range of forage NDF intakes due to the high quality of the pasture forages used in these trials. We have done a number of feeding trials with high quality silages and have measured forage NDF intakes up to 1.4% of BW.

Can you actually feed high forage rations and still produce acceptable levels of milk? To take a look at this question, we obtained feeding program data from 16 dairy herds feeding "high forage" rations in 2004-2005. These herds were defined as feeding > 55% of the total ration dry matter as forage or feeding forage NDF at >0.9% of body weight. **It is important to remember that this ration and forage information is for one point in time in these herds.** The quantity of forages fed in these herds will vary over time due to changes in forage quality or inventory. All of these herds are located in New York or the Northeast. This survey is being expanded and we are currently adding additional herds.

Table 1 contains overall information on these farms in terms of herd size and milk production. This information is for all milking cows in these herds with the exception for herds G, I, M and P. For these herds, the ration information is only for the high group.

Tables 2 and 3 contain forage analysis data for these herds. Note that 3 herds were using BMR corn silage. These herds are using primarily legume or mainly legume forages in their rations. Only 1 herd (J) is using grass silage. This data should not be used to indicate that legume forages *are required* for herds desiring to feed higher forage rations. Both research and producer experience has indicated that high quality grass forages can be used effectively to support high levels of milk production. NDF digestibility data was not available for the herds in this survey. However, it would be logical to speculate that NDFD would be above average.

Table 4 contains information on the nutrient composition of the rations fed in these herds. Key points from this table are:

- Forage NDF intake as a % of BW from 0.85 to 1.16%.
- Calculated ration NE-l values ranged from 0.74 to 0.8 Mcal/lb of ration DM. These values are similar to NE-l values seen in other herds.
- Forage NDF levels (as a % of the total ration DM) ranged from 24 to 28%. These are higher than we typically see in many herds.
- Ration fat levels were similar to many other rations. Only 3 herds had total fat levels > 5%.

What are the economics of high forage feeding? We had an opportunity to closely follow one herd over a 5 month period. During this time, the forages were sampled and analyzed at least monthly and ration adjustments made by the nutritionist based on the forage analysis results. This was a Holstein herd milking about 100 cows. Key points from this example are:

- Milk production was about 71 lbs/day at the start and 74-75 lbs/day at the end of this time period.
- Forage NDF levels decreased during this time period.
  - Corn silage went from 42 to 38% NDF.
  - Haylage went from 50 to 38% NDF during this time period.
- Forage (as a % of the total ration) went from 50 to 65%
- Forage NDF intake (as a % of BW) went from 0.85 to 0.95% of BW. Forage inventory limited the quantity of forage that could be fed in this herd.
- Income over feed cost ($/cow/day) went from $4.27 to $5.58. This is $130/day for this 100 cow herd. These prices are based on milk at about $12/cwt.
- This herd has varied the % of forage in the ration from 50 to 65% over the last few years. The forage feeding level varies due to changes in forage NDF or the inventories of forage available.

There was a recent article in Hoard's Dairyman about a herd in Northern New York that feeds 73-75% of the total ration as forage using highly digestible forages (Benware and de Ondarza, 2009). This is Herd E in Table 4. This herd has 140 cows with a herd average of 25,756 pounds of milk sold/cow. The dairy producer attributes the availability of highly digestible forage NDF as the key to making high forage feeding work. His forages include grasses, mixed mainly legume silage and high chopped corn silage. Currently, the ration is 29% haylage, 43% corn silage and 28% grain. Total ration NDF is 34-35% and forage NDF is 30-33% of total ration. The NFC level is 36-37% and starch is 22-24%. NE-l of the total ration is 0.76 Mcal/lb of DM. This herd has fed higher forage levels for about 10 years. The 30 hour NDFD values were 56-59% for the grass forages and 55% for the corn silage.

We also recently surveyed a number of herds feeding lower crude protein rations (Chase et. al., 2009). Ration forage levels were 48 to 60% in these herds. Forage NDF intakes were 0.86 to 1%. These herds provide another example of using high forage rations to support high levels of milk production.

For the herds in Table 4, we asked the dairy producers to list the benefits they saw as a result of feeding higher levels of forages. The benefits listed included:

- Improved milk component levels
- Lower incidence of acidosis and metabolic disorders
- Less foot health problems
- Lower culling rates. Most culling is now voluntary.
- Ability to keep cows in the herd for additional lactations
- Feeding less purchased grain
- Improved income over purchased feed costs
- Lower veterinary costs per cow. The primary veterinary costs are pregnancy checks and routine herd checks.

What are the risks or potential challenges of feeding higher forage rations in dairy herds? As with any management practice, there are always considerations that need to be evaluated as part of the decision making process. Some of the most common ones that I see for herds considering feeding higher forage rations are:

1. **Mindset** – Both the dairy producer and the nutritionist need to be convinced that this concept is logical and will work in their herd. If they don't buy into this concept, you are setting yourself up for failure.
2. **Consistent Quality Forages** – As forages comprise a higher proportion of the total ration, there is less room for variability. Less grain is being purchased to supply energy and protein to balance changes in forage quality. Variations in forage quality and milk production will be more magnified since there is less opportunity to adjust for forage quality via the grain mix.
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 15-30% more forage to feed the same number of cows. In some herds, we have to make improvements in the cropping program to be able to produce the total quantity of forage needed by the herd. Forage inventories should be checked frequently during the year to assure that required quantity of forage is in storage.
4. **Forage Allocation and Storage** – Very few herds produce and harvest only "high quality" forages. Ideally, the higher quality forages will be stored separately so that 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 since more frequent forage analysis data will be available.
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 require adjustments in the number of times feeds are mixed and delivered to the cow. More frequent feed pushups may also be required.
8. **TMR mixer management** – The ration mixed will be bulkier and less dense (lbs/cubic feet) as more forage is included in the ration. This may require making more mixers per day or considering the purchase of a larger mixer.

Summary

Feeding higher forage rations is an opportunity that should be considered in many dairy herds. Higher forage rations take advantage of the biology of the cow to convert forage into milk. The key to making this 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 take a number of years due to needed changes in the cropping, forage harvesting and forage storage systems on the farm. The long-term potential benefits include higher levels of milk components, improved cow health and herd profitability. This approach may not work on all farms but the concept should at least be considered and evaluated by the dairy producer and other outside consultants or agriservice providers that work with the farm.

References

Bargo, F., L.D. Muller, J.E. Delahoy and T.W. Cassidy. 2002. Milk response to concentrate supplementation of high producing dairy cows grazing at two pasture allocations. J. Dairy Sci. 85:1777-1792.

Benware, L. and M.B. de Ondarza. 2009. Making milk with forage. Hoard's Dairyman. 154(16):583.

Chase, L.E., R.J. Higgs and M.E. Van Amburgh. 2009. Feeding lower crude protein rations to dairy cows – opportunities and challenges. Proc. Cornell. Nutr. Conf., Syracuse, NY. Pp: 235-239.

Mertens, D.R. 1988. Balancing carbohydrates in dairy rations. Proc. Large Herd Dairy Management Conf., Cornell University. Animal Science Mimeo 109:150-161.

Mertens, D.R. 1997. Creating a system for meeting the fiber requirements of dairy cows. J. Dairy Sci. 80:1463-1481.

Mertens, D.R. 2010. NDF and DMI – has anything changed? Proc. Cornell Nutr. Conf., Syracuse, NY. Pp: 160-174.

Table 1.
Herd Characteristics of Herds Feeding High Forage Rations

Herd	Number of Cows	Rolling Herd Avg., lbs.	Daily Milk/ lbs.	Milk Fat, %	Milk True Protein	Times Milked/ Day
A	120		75-78	3.8	3.3	2
B	320		68	3.5	2.95	3
C	100	22,000	76	3.4	2.9	3
D	220	24,000	75	3.5	3	2
E	145	25,500	80+	3.65	2.92	2
F	100		82	3.7	3.95	2
G	100		94	3.7	3.1	2
H	92	22,000		3.65	3	2
I	550*	29,000	100	3.6	3	3
J	60	25,000	78	3.7	3.1	2
K	60		87	3.5	3.02	2
L	56	22,700	74	3.4	2.9	2
M	200*		95	3.6	3	2
N	100	30,000	100+	4.1	3	3
O	100		70-75	4	3	2
P	400*	27,000	85	3.5	2.9	3

Table 2.
Corn Silage Nutrient Composition

Herd	DM, %	CP, %	Soluble CP, % of CP	ADF, %	NDF, %	Lignin, % of DM	Starch %
A	28.7	7	61	27.3	44.5	3.3	28.1
B	30.4	8.5	60	25.6	42.3	2.8	29.3
C	31.2	8.3	52	33.3	53	3.8	16
D	29.6	7.8	61	25.2	43.4	3	30
E	45	7.8	56	20.1	35.6	2.5	39.6
F	31	7.8	55	24	40	2.9	31.5
G	29	8.5	60	24	38	2.7	35
G-BMR	26	8.6	60	25	40	2.3	33
H	32	7.7	51		43.7	3.5	35.3
I-BMR	30	8.6	55	26	41.6	2.9	34.6
J	33.7	8.2	60	22.4	43.2		
K	35	8	45	26	41	2.9	35.5
L	31.5	9.1	61	17.6	37	2/5	39.7
M	33	8.2	67	25	40	3.2	35
N	35.4	7.5	61	22.4	38.7	3.2	41.1
O	31.5	9.2	48	22	37.7	3.2	34.7
P-BMR	26.6	9.1	54		40	2.5	29.7

Table 3.
Nutrient Composition of Legume and Grass Forages

Herd	Forage	DM, %	CP, %	Soluble CP, % of CP	ADF, %	NDF, %	Lignin, % of DM	Ash, %
A	Leg. Sil.	38	21.7	63	28.6	34	6.45	11.5
B	Leg. Sil.	44.5	24	65.5	31.2	35.6	6.4	9.1
C	Leg. Sil.	36	19.8	51	33.4	43.5	6.7	9.8
D	Leg. Sil.	43.7	18.9	51	33.4	43.5	6.9	10
E	Leg. Sil.	41.8	22.1	53	33.5	41.2	6.7	11.4
F	Leg. Sil.	40	20.5	60	37	46	7.2	12
G	Leg. Sil.	35	20.5	60	31	40	7.6	11
H	MMG 1	26.8	21.5	62		49.1	9.6	
H	MMG 2	89.3	26			56.4	14.2	
J	Grass sil.	25.6	18	57	32.4	49.2	4.8	10.1
L	MML sil.	33.1	17.9	56	39.1	48.8	7.7	8.9
M	Leg. Sil.	32	22	58	32	42.3	6.8	10
N	MML sil.	28.6	18.5	58	40.3	48.9	8.9	14.1
O	MML Sil.	39.3	24.5	56	28.8	36..7		
P	Leg. Sil.	33	22.4	63		38.2	6.9	10.4
P	Leg.Hay	87	20.7	29		47.5	7.8	8.1

Table 4
Ration Nutrient Composition

Herd	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Formulated milk, lbs.	80	90	75	90	85	90	95	80	100	80	82	75	95	85	85	85
Forage, % of ration DM	58	58	59	59	67	58	63	58	82	62	57	69	63	57	66	65
F-NDF intake, % of BW	0.93	1.06	1.04	0.96	1.16	0.88	0.98	1.04	1	1.02	0.85	1.1	1	1.02	0.94	0.97
NE-l, Mcal/lb	0.77	0.78	0.79	0.76	0.75	0.76	0.78	0.76	0.77	0.78	0.78	0.74	0.75	0.76	0.77	0.8
Crude Protein, % of DM	17.8	18	16.2	18.3	17	18	17.8	17.6	18.2	16.4	18.2	16.8	18.6	16.8	17.7	18.5
Soluble protein, % of CP	39	39	40	37	38	35	38	34	37	37	26	39	39	44	41	36
NDF, % of DM	31.2	32	31.4	35	34.5	32	30.6	34.3	32	37	32	36	33	30.4	30.7	30
F-NDF, % of DM	24.8	24.4	27	26.4	26	25	25.4	28	25.8	28	24.6	28	26	24	24.5	25
NFC, % of DM	41	37	39	35	38	41	42	38	40	40	40.6	38	41	42.8	41.6	41
Starch, % of DM	26					25	24				29		24.8	30.7		26.7
Fat, % of DM	4	5.5	5.5	5	4.5	3.8	3.9	4.5	4.8	4.1	4.1	3/8	4	5.2	4.4	4.7