December 1984

A.E. Ext. 84-31 and
Animal Science Mimeo 81

ECONOMICAL DAIRY CATTLE FEEDING

OR

FEEDING THE BACTERIA IN THE RUMEN

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INTRODUCTION

All dairy farmers are continuing to make adjustments to maintain that delicate balance between cash inflow and cash outflow. With the current unfavorable economic climate, several points must be kept in mind. Although this dramatic shift in the profitability of milk production is unprecedented in recent years, other businesses in and out of agriculture have experienced tight economic times and most have survived. Cash crop farmers are a recent example. In 1981 and 1982 they experienced price declines several times as large as the recent milk price declines while input prices continued to increase. The second point is that nearly all dairy producers have numerous options they can exercise to maintain cash flow. These options are outlined in the first part of this section.

In the second part of the section, we will compare alternative ways to maintain profits. Also, in this section we will begin to highlight the importance of feeding to dairy farm profitability.

Maintaining Cash Flow

The following is a listing of six ways to consider in deciding what must be done to insure that cash inflow is sufficient to meet cash outflow. The alternatives are not limited to the farm business. This is not the time or place for an exhaustive discussion of cash flow. For additional information you should consult your Cooperative Extension agent, credit representative, and/or farm management consultant.

The alternatives are:

1. Increase efficiency and productivity of the farm business. This is the focus of everything after this section.

2. Reducing capital purchases and maintenance expenditures. Doesn't mean reduce to zero, but must be considered carefully.

3. Increased utilization of operator and/or family labor. This includes substituting for purchased labor, maximizing management (carefully analyzing all decisions, heat detection, cleanliness) and off-farm employment. You must not forget the importance of timeliness.

4. Reducing family withdrawals from the business.

5. Restructuring debt. This includes refinancing loans to a longer repayment period, paying interest only, and borrowing money to maintain cash flow. You must work closely with your credit representative.

6. Selling capital assets. This is not the first choice but can be effective if done judiciously and with the concurrence of your credit representative.

Increasing Productivity and the Feeding Program

Economists tell us that when the price declines, production and profits must decline also. This statement is true given the assumptions that production and management were optimized prior to the price change. Given the complexity of the dairy farm and continuing research, the potential for improved management exists on all dairy farms. Further, most dairy farms have not totally maximized the use of available resources (land, buildings, machinery, labor). As a result, production and profits will not necessarily fall as a result of falling milk prices; rather they may remain constant or even increase due to improvements in management.

Dairy farm managers have three general approaches they can use to reduce the impact of the current economic climate on business profitability:

1. Reduce costs through improved cost control while maintaining and even decreasing production.

2. Increase production per cow.

3. Increase the number of cows.

Although the first is the most appealing in light of the milk surplus, the opportunities for improvement are too limited to maintain cash flows on most dairy farms. Even so, cost control should be on the manager's mind when input purchases are made.

On most dairy farms, cash flow and profits will have to be maintained or declines minimized by production increases. For many dairy farmers productivity increases provide a more attractive stimulant to profits while minimizing increases in cow numbers. A prime area for increasing production is through improvements in the feeding program. In this publication, the feeding program is broadly interpretted to include production and allocation of farm-produced feeds, feed purchases, ration balancing, and daily feed allocation. In this and the next section, we consider two examples to motivate the importance of an understanding of the dynamics of the total feeding program and the importance of a detailed understanding of dairy cattle feeding. Particular emphasis is on the importance of dry matter intake.

The first example compares a production increase attained from concentrate and an increase using roughage. The increases are:

1. An increase of four pounds per day or approximately 1,200 pounds per cow per year accomplished primarily by feeding more grain. Assumption is that grain is being fed at less than optimum amounts.

2. An increase of four pounds per cow per day or approximately 1,200 pounds per cow per year accomplished primarily by increasing intake an extra pound and then feeding more forage.

Table 1 compares the two alternatives for a herd with cows currently selling 14,000 pounds of milk per cow per year. The increase using grain is calculated based on the expected increase in intake with a four pound increase in production while the increase using forage is calculated using one extra pound increase in dry matter intake. All concentrate and minerals are purchased while corn silage and hay are included in total ration cost at their opportunity costs.

As can be seen from the table, the increase in production is definitely profitable. The increase in return over feed cost from forage is 41 percent larger and the increase over purchased feed is 76 percent greater than when the production increase is from concentrate.

Table 1. Comparison of Per Cow Grain Fed, Feed Cost and Return with Production Increase Resulting From Forage and From Concentrate

	14,000# Milk Sold[a]	15,200# Milk Sold[a] Increase from Grain	15,200# Milk Sold[a] Increase from Forage[b]
Pounds Grain Fed High Group[c]	15.3	18.1	15.5
Grain Fed, lbs./year	2,100	2,670	2,133
Increase	---	570	33
Purchased Feed Cost[d]			
305 days milking	$267	$332	$276
Increase	---	65	9
Total Feed Cost[e]			
305 days milking	$582	$642	$609
Increase	---	60	27
Return Over Feed Cost and Milk Marketing[f]			
305 days milking	$1,063	$1,144	$1,177
Increase	---	81	114
Return Over Purchased Feed and Milk Marketing			
305 days milking	$1,378	$1,454	$1,510
Increase	---	76	132

[a]Fed in high, medium, and low groups. Rations balanced for average production in group using the least cost ration program (Milligan, et al.).

[b]Increased nutrients come from forage rather than grain by increasing dry matter intake one extra pound per day.

[c]Corn grain and soybean meal as required.

[d]Corn grain at $4.20 per bushel and soybean meal at $360 per ton. Both purchased.

[e]Opportunity cost of corn silage at $22 per ton and mixed mainly legume hay at $60 per ton fed in equal quantities of dry matter plus minerals as required.

[f]Milk price net of marketing of $11.75 per hundredweight.

OPTIMIZING DRY MATTER INTAKE

Dr. Peter Van Soest, world famous Cornell nutritionist, repeatedly tells the students in his course titled Forages, Fiber and the Rumen, that intake is the most important priority in feeding. Intake is crucial because it can be significantly altered, thus changing productivity of the animal and/or nutrient density of the ration.

Economic Importance

If we consider a ration fed to an individual cow or group of cows, an increase in dry matter intake will usually result in some combination of the following two benefits:

1. The cows will produce more milk since nutrient intake has been increased. Since the increase comes from roughage as well as concentrate, the increased costs will be substantially less than the value of the increased milk and profitability will increase.

2. For cows that genetic, stage of lactation, or environmental factors inhibit increased production commenserate with increased intake, the nutrient density can be decreased while meeting nutrient requirements. The economic advantage of reduced nutrient density is that lower cost forage can be substituted for higher cost concentrates.

The economic benefit of increased dry matter intake of two pounds per cow per day is quantified by comparing three production levels and ration combinations for a current herd production level of 16,000 pounds of milk per cow per year. The three situations are:

1. Base: 16,000 pounds with balanced rations for three production groups with typical dry matter intake.

2. Same Production: Same production levels with balanced rations based on increased intake and with resulting reduction in nutrient density.

3. Increased Production: Increased production level determined by nutrients available with increased intake of ration in the base situation.

Tables 2 and 3 contain the quantification of the above situations for 16,000 pound production level with Table 2 containing the results for the production year and Table 3 detailing average daily results for the high group. As can be seen, significant increased returns are obtained by the reduced nutrient density situation. The increase in return over feed is more than doubled when production responds to the increased intake. The greatest impact of the reduced nutrient density on profitability is observed in the high group with the greatest response to increase in production coming in the low group. The increased return in this example from the two pound intake increase would completely compensate for an 80 cent price decline when production responds.

Table 2. Ration Composition and Economic Consequences of Increased Dry Matter Intake with 16,000 Pounds Production -- Per Cow Per Production Year Results

	Base	Decreased Nutrient Density	Increased Production
Milk Production, Pounds	16,000	16,000	17,360
Dry Matter Intake, Tons[a]	6.46	6.77	6.77
Ration Cost[a]			
Total	$691.13	$640.19	$724.68
Change	---	$-50.94	$+33.55
Purchased Feed Cost[a b]	$389.18	$282.43	$405.61
Return Over Feed Cost[a c]			
Total	$1,188.87	$1,239.81	$1,315.12
Increase	---	$50.94	$126.25
Per Hundredweight	$7.43	$7.75	$7.58

[a] Total of 305 production days.

[b] Concentrates are purchased, forages are farm produced.

[c] Milk price net of marketing of $11.75 per hundredweight.

Table 3. Ration Composition and Economic Consequences of Increased Dry Matter Intake with 16,000 Pounds Production -- Daily High Group Results

	Base	Decreased Nutrient Density	Increased Production
Milk Production, Daily Average	69	69	73.76[a]
Ration Balanced for	75.9	75.9	81.1
Dry Matter Intake	44.8	46.8	46.8
Percent Forage	52.1	64.8	52.1
Total Ration Cost			
Per Day	$3.26	$3.00	$3.40
Per Hundredweight	$4.72	$4.35	$4.61
Purchased Feed Cost[b]	$2.46	$1.96	$2.57
Return Over Feed Cost			
Per Day	$4.85	$5.11	$5.27
Per Hundredweight	$7.03	$7.41	$7.14

[a]Additional energy in the two pounds of dry matter (1.50 Mcals) divided by energy requirement per pound of 3.5 percent fat milk (0.314) equals 4.76 pounds additional milk.

[b]Concentrates are purchased, forages are farm produced.

Management Practices to Optimize Dry Matter Intake

The following management strategies have been shown to increase dry matter intake at least in higher producing cows:

1. Removal of stress on cows produced by environmental conditions or poor herd health.

2. Access to fresh feed at all times.

3. Improvement in quality of forage.

4. Allocation of forages to minimize feed changes and maximize utilization of highest quality feeds.

5. Manage the sequence in which feeds are fed.

6. Balance rations for protein solubility and degradability.

7. Maintain rumen function by including adequate fiber.

The implementation of these practices, especially 3-7, is the focus of the remainder of this reference manual. We next turn to understanding how the rumen functions.

HOW DOES THE RUMEN FUNCTION?

When considering the feeding program, the most important thing we need to ask is what are we feeding? The cow is a ruminant not a pig. The ruminant has a large pregastrice pouch called a rumen. For an average sized Holstein cow the rumen has a volume of 144 lbs. The microbial mass in the rumen is responsible for digestion of 70 to 80% of the dry matter digested in the whole tract.

Given this fact, it is crucial that producers and those serving them command an understanding of the factors influencing digestion in the rumen. This understanding will allow us to make management decisions based on biological fact and economic circumstances.

First, lets understand a few basic concepts. We currently formulate diets based on the guidelines of the National Research Council (NRC). The recommendations for energy are based on the net requirements for energy for growth, milk production, pregnancy and maintenance. Assumptions are made about the efficiency of energy utilization. The largest assumption is the decline in the energy value (average of 4%) of feeds for each increment or level of energy intake above maintenance. This assumption reflects the phenomenon that as intake increases, the rate at which undigested feed passes out of the rumen increases. This is particularly important in the case of undigested fibers which will pass through the whole tract with a minimum of digestion. Protein recommendations are developed along similar lines with assumptions concerning efficiency of utilization. Requirements for minerals, unfortunately, are less well described than the energy and protein requirements. All of the recommendations make implicit assumptions about the impact of the rumen on efficiency of nutrient utilization. These assumptions are a major weakness in our current system.

Have you ever looked at a cow producing 120-140 lbs of milk per day? You should notice several things. She eats a lot and almost continuously, she loses little weight and she has a large barrel and is deep in the heart area. Here we have an animal where there is a minimization of depression of efficiency of digestion with increasing intake. What is unique about this cow? The answer is in the rumen.

We need to understand a few things about the rumen. First, we must remember that the rumen is a very active compartment of the stomach and that it is a mixing vat with an orifice through which particles of undigested feed flows. We call this flow passage. As intake increases passage rate increases and the digestibility of feed can be depressed. Inside the rumen is the microbial mass digesting the feed. The microbial mass is a balance between passage and digestion.

Let's first look at the microbial side a little closer. We then return to passage and the importance of controlling it. The microbial mass in the rumen is a diverse, fascinating and complex system containing many hundreds of different organisms. We can divide these organisms into large classes based on what carbohydrate they prefer to digest (substrate preference). We must remember that these organisms are <u>carbohydrate</u>

digester.

These organisms are interdependent on each other and have distinctly differing characteristics. The fiber bacteria need a neutral pH and time to attach to the fiber and digest it (table 4). They are slow growing (8-10 hours to double). In contrast the starch and sugar bacteria grow very fast (15 minutes to 2 hours to double), can live in a more acid pH and can survive longer periods of no food than the fiber digesters. The secondary bacteria can best be described as necessary bacteria that digest other bacteria products and at the same time provide necessary products to the bacteria from which they derive their energy. This is called crossfeeding. Keeping the correct balance of bacteria is very important.

The protozoa play an important role in the rumen. Under normal conditions they will be 50% of the microbial mass in the rumen. They grow slowly, need places to hide (plenty of fiber in the rumen) to avoid being washed out, like a neutral pH and can eat large quantities of starch. They will also harvest (eat) a large number of bacteria which the cow could potentially use to meet her protein requirement. It is important to realize the protozoa may play an important role in delaying the fermentation of starch and sugars by ingesting and storing as reserves. They also compete with the bacteria that produce large quantities of lactic acid. Because of their slow growth they hide in the fibrous mat and along the rumen wall and only come out to feed when the cow eats. If there is no mat and it is acid (high grain) they die and wash out of the rumen.

Our goal in feeding the dairy cow is to maximize digestion of fiber in the rumen. Further, if we are feeding corn it is important that we maximize its digestion in the rumen under controlled conditions. Many times when cows do produce at low levels we assume they need more grain. Sometimes quite frequently!!) it is just the opposite - they need more forage!!

In order to achieve our goal it is necessary to meet the microbial requirements for growth and further we want to maximize the growth of the fiber digesters and control the growth of bacteria that digest starch and sugars. In other words we must balance the rumen.

In order to do this we must understand a few characteristics about the feeds fed to dairy cows. We will look at them based on how fast the carbohydrate and protein are digested in the rumen. In table 5 there is a general description of the characteristics of selected feedstuffs. Our challenge is to balance these feedstuffs in such a way that we maintain the ecological balance in the rumen between the fiber and non fiber bacteria and at the same time meet the cow's requirements.

How do we feed the cow to maintain optimum microbial growth? The optimum feeding program for bacteria is to feed them continuously. This, of course, is not possible. Labor constraints dictate that the cow be fed a few times per day. We can, however, strive toward continuous feeding by combining the feeds in table 5 in such a manner that there is not too much rapidly degradable starches and sugars in the ration. This will ensure that the rapidly growing bacteria will not overwhelm the microbial balance. For example, the inclusion of wheat or barley as a substitute for corn can increase the opportunity for acidosis and cows going off feed. The starch

Table 4: Characteristics of Classes of Organisms

Class of Organism	Substrate Preference	Major Need	Major Product of Importance	Ph Tolerance	Time to Double
Fiber Bacteria	Cellulose Hemicellulose	NH_3 Iso-acids	Volatile fatty acids	Neutral	8-10 hrs.
General Purpose Bacteria	Cellulose Starch	NH_3 Amino acids	Volatile fatty acids NH_3	Acid	6-8 hrs.
Starch & Sugar Bacteria	Starch Sugar	Amino acids NH_3	Volatile fatty acids Lactic acid NH_3	Acid	1/4-2 hrs.
Secondary Bacteria	Bacterial Fermentation Products	Amino acids	Iso-acids	Neutral	6-8 hrs.
Protozoa	Starch Sugars Bacteria	Amino acids	Volatile fatty acids	Neutral	15-24 hrs.

Table 5. Protein and Carbohydrate Composition and Degradability of Various Feedstuffs

Feed	Protein				Carbohydrate			
		Soluble						
	Total	NPN	True	Insoluble Available	Total	Sugars	Starch Pectins	Available Fiber
	% DM	- - - - % Total - - -			% DM	- - - - % Total - - - -		
Forages								
Alfalfa								
Hay	20	30	5(.9)[a]	60(.5)	69	22	7(.7)	36(.2)
Silage	20	60	0	30(.5)	65	46	15(.7)	38(.2)
Grass								
Hay	14	30	5(.9)	60(.5)	81	19	4(.6)	62(.1)
Silage	14	45	0	45(.5)	78	4	10(.6)	64(.1)
Corn Silage	8.5	45	0	55(.2)	84	10	27(.6)	55(.1)
Grains								
Corn								
Meal	8.5	8	4(.8)	88(.2)	82	6	85(.4)	10(.3)
High Moisture	8.5	50	0	48(.1)	79	13	76(.6)	10(.3)
Barley								
Ground	13	14	3(.9)	77(.4)	80	30	69(.6)	26(.3)
High Moisture	13	40	0	55(.4)	78	26	76(.8)	27(.3)
Proteins								
Soybean	54	7	15(.7)	75(.35)	41	41	44(.6)	27(.4)
Canola	39	14	14(.8)	69(.35)	47	21	38(.6)	23(.3)
Distillers	28	18	0	63(.1)	56	9	36(.4)	45(.3)
Brewers	24	8	0	79(.15)	62	16	16(.4)	32(.2)
Corn Gluten Meal	66	5	0	90(.1)	28	14	36(.4)	50(.3)

[a] 1.0 = rapidly degraded - NPN and sugars
0.5 = intermediate degraded
0.1 = slowly degraded

in cornmeal is slowly fermented and under certain feeding conditions will completely escape rumen fermentation and small intestine digestion. The approach would be to first balance the slowly and rapidly digested starches and then the fiber.

Maintaining an optimum carbohydrate to protein ratio in the rumen is important. If there is a deficit of degradable protein, the bacteria will digest carbohydrates slowly, and will not grow sufficiently. If the degraded protein is in excess, there will be protein wastage (excess ammonia absorption and excretion of urea) and microbial growth can be hindered. This concept is depicted in figure 1. We want to match different degradable fractions. At this point we cannot give exact numbers. For the present we want to provide enough degraded protein (slowly degraded) to sustain microbial growth on fiber. We also need to provide adequate degraded protein to ensure a rapid controlled growth of the non fiber digeters.

The preceding discussion allowed us to look at some of the basics. We now need to look at some applications. Do the following to assure a balanced rumen:

1. Formulate rations for adequate forage: concentrate ratio or use NDF (maximum dry matter intake will be achieved).

2. Formulate for adequate protein.

3. Recognize the degradability of carbohydrates and provide proteins of matching degradability.

4. Observe particle size of forages and concentrates, espcially homegrown grains make finer or coarser depending on grain in manure.

We indicated above some signs of rumen performance. This needs to be emphasized. Look for the following signs of rumen imbalance:

1. Cows not ruminating 2-3 hours after feeding. (70% should be).

2. Rumen contractions weak.

3. Manure

   Excess grain - corn kernels not cracked enough or not enough forage in the grain.

   Wet - protein too degradable/too much protein and grain too fine.

   Dry - low degradable protein or not enough protein.

4. Butterfat percent low - need more fiber in ration or more digestible fiber.

We have discussed at several points the importance of the forage and in particular the neutral detergent fiber (NDF). NDF fiber represents the cell wall (see figure 2) which is the slowest digesting fraction in the

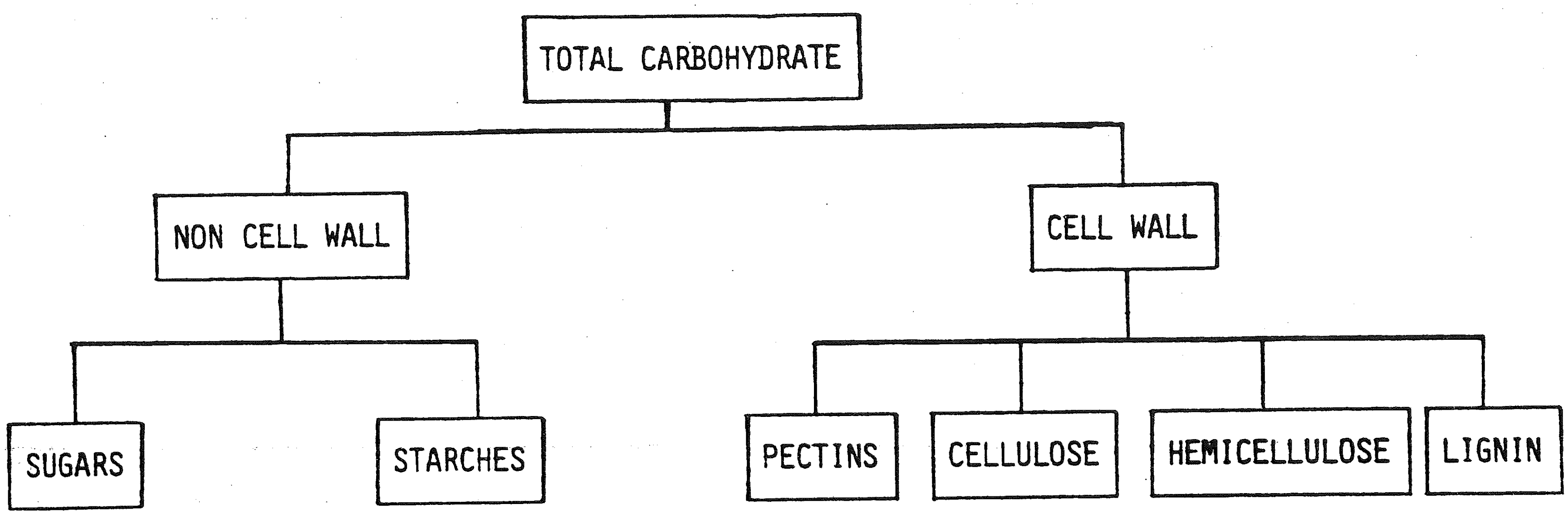

TOTAL CARBOHYDRATE
NON CELL WALL
CELL WALL
SUGARS
STARCHES
PECTINS
CELLULOSE
HEMICELLULOSE
LIGNIN

Figure 1.

feedstuff, is bulky, and stimulates rumination or cud chewing. The cow has a requirement for a minimum 30 percent of total feed as NDF. This should assure maximum dry matter intake and absence of butterfat depression. Of course, having the fiber in the rumen doesn't assure adequate digestion - there must be enough degradable protein which practically means enough soybean meal protein in the ration (at least 1/3 of the protein being supplemented should be from this source). Putting it in another way, about 28-30% of the ration should be NDF for the early lactation cow.

ECONOMICAL DAIRY CATTLE FEEDING

In this section we will discuss how to utilize the concepts discussed in the preceding sections to develop a nutritionally sound and profitable feeding program. Much of the discussion early in the section is fairly basic while later discussion uses newer concepts in economical dairy cattle feeding.

Assessing Your Current Feeding Program

Often one of the most important and difficult hurdles in improving a feeding program is assessing the current situation. Table 6 provides a means of assessing the current feeding program. The information required for all but the last two factors should be readily available. Each factor is discussed below.

Milk sold per cow (Holsteins): This is the most critical factor but not the only one. Feeding is often the limitation when production is unacceptable.

Tillable acres per cow: This factor provides a measure of the land resource available. When this is small, crop production is usually limited to forages.

Tons forage dry matter harvested per acre: Sum total hay crop and corn silage dry matter and divide by acres hay crop and corn silage. This is a measure of the productivity of the cropping program. The cropping program is basic to a good feeding program.

Lactation curve: It is critical that cows reach peak production at six to eight weeks of lactation and that production persists until the end of lactation. Cows should peak at a daily production that is 0.4 percent of total lactation and production should fall no more than eight percent per month. A rule of thumb is that an additional pound at peak increases the lactation total 250 pounds.

Purchased feed per hundredweight of milk: It is critical to keep purchased feed costs under control. The guidelines fit best for a farm producing some grain. If no grain is produced, under $3.50 would be good.

Forage analysis: It is impossible to formulate a good ration without forage analyses. Samples are best taken when feeds go into storage and whenever the quality of feed changes. Representative samples are critical.

Change in body condition between freshening and peak: If you are not familiar with body condition score, obtain a copy of a paper by Smith and Sniffen. Cows at peak should not be too fat or too thin nor should they have changed significantly since freshening.

Percent legume in hay crop: Hay quality is critical to successful and economical feeding programs.

Feed and crop expense per hundredweight of milk: This is probably the best

Table 6. Guides to Assessing the Current Feeding Program[a]

Possible Definite Weak	Possible Weak	Average	Possible Strength	Possible Definite Strength	
11,000	13,000	14,000	15,000	18,000	Milk Sold Per Cow (Holstein)
3.0	3.3	3.5	3.6	3.8	Fat Percent
2.9	3.0	3.1	3.2	3.3	Protein Percent
2.0	2.5	3.0	3.2	3.5	Tillable Acres Per Cow
2.0	2.6	3.0	3.3	3.8	Tons Forage Dry Matter Harvested Per Acre
	No Peak	Drops too Fast		Normal	Lactation Curve
4.00	3.50	3.20	3.00	2.50	Purchased Feed Per Hundredweight Milk
Never		Out of Storage		Harvest & Feeding	Forage Analysis
Significant	Little		None		Change in Body Condition Between Freshening and Peak
20	40	60	70	85	Percent Legume in Harvested First Cutting
5.20	4.80	4.50	4.30	4.00	Feed and Crop Expense Per Hundredweight Milk

[a]Many of the values used for the five categories depend on other factors. Possible weaknesses require further investigation but may not be a problem upon further analysis.

cost of feed measure but is not always easy to obtain.

This checklist provides an objective means of assessing the overall strength and the relative strengths and weaknesses of a feeding program. The weaknesses indicated should be used as a place to start an analysis of the feeding program; however, the user must be careful not to assume that a possible weakness is necessarily a problem. Each farm is unique and a "weakness" on one farm may not be restricting at all on another farm.

It is absolutely imperative that the rations being fed provide the energy, protein, fiber, and minerals required without uneconomic excesses. Table 7 provides an example of a worksheet that can be used to record the quantities fed to production groups or by production levels. If fermented feeds are fed, a good quality moisture tester is critical to good ration balancing.

Once an accurate estimate of what is being fed is available, the required nutrients can be compared to those required, often initially for energy and protein, to assess the herd situation. The first problem is determining the production level for which rations should be balanced. For individual cow feeding situations, the actual production of a selected cow or cows can be used except prepeak when a higher target level should be used. For group feeding situations, the average production should be multiplied by a lead factor to avoid underfeeding up to half the cows. The lead factor depends upon number of groups, stage of lactation, body condition, range of production in group, proportion of first lactation cows, and other factors. Suggested ranges are in Table 8.

The simplistic assessment of the ration balancing can then be made using the worksheet in Table 9. An example for a group of cows averaging 1,300 pounds body weight and 3.6 percent fat test is included in Table 10. Table 11 contains the nutrient content of common feeds. The ration analyzed in Table 9 is supposed to be balanced for 65 pounds production. The actual ration then has some excess protein but is short on energy.

<u>Feed Inventory</u>

As has been discussed above, forage is the key to feeding the bugs in the rumen. Forage provides the fiber required by the bugs and is the most available and least expensive feed on most dairy farms. To utilize forages optimally one must know the quantities and qualities of forages and other feeds in inventory. The first step is to collect forage test samples as feeds to into storage and to separate and/or mark when quality changes occur.

The next step is to complete an inventory as barns and silos are filled or at the completion of harvest. Table 12 is an example of a worksheet that can be used for the inventory. Tables 13-15 are reference tables needed to calculate storage capacities. Remember that the dry matter capacities of silages are constant while wet weight varies and capacities of partially emptied silos are calculated by subtracting the capacity of a silo the size of the emptied portion from the original capacity.

Forages cannot be used optimally without forage analysis. Table 16 is an example summary sheet for forage analysis results.

Table 7. Example of a Worksheet to Quantify Feeds Being Fed

QUANTITIES FED WORKSHEET

Week of ______________________________

Feed	Percent Dry Matter	Production Group or production level ____	____	____	Dry Cows
		----------(pounds as fed)--------			
Hay Crops					
________	____	____	____	____	____
________	____	____	____	____	____
________	____	____	____	____	____
________	____	____	____	____	____
Corn Silage					
________	____	____	____	____	____
________	____	____	____	____	____
Other Forages					
________	____	____	____	____	____
________	____	____	____	____	____
Concentrates					
________	____	____	____	____	____
________	____	____	____	____	____
________	____	____	____	____	____
________	____	____	____	____	____
________	____	____	____	____	____

Complete this Weekly; include forage analysis with this form.

Table 8. Suggested Lead Factors

TYPE OF GROUP	LEAD FACTORS
Complete Herd	1.20 - 1.30
Two Groups	
Top Half	1.10 - 1.20
Bottom Half	1.15 - 1.25
Three Groups	
Top	1.10 - 1.15
Middle	1.12 - 1.17
Bottom	1.18 - 1.23
Four Groups	
Fresh	1.05 - 1.10
Peak	1.05 - 1.15
Mid Lactation	1.10 - 1.15
Tail End	1.10 - 1.15

Table 9. Worksheet for Assessing Ration Balancing

WHAT PRODUCTION LEVEL WILL PROTEIN AND ENERGY IN CURRENT RATION SUPPORT WORKSHEET

	Quantities Fed Per Cow Per Day (lbs. as fed)	Proportion DM (decimal)	DM Fed Per Day (lbs.)	Proportion Protein in Feed (decimal)	Total Protein Fed Per Day (lbs.)	Proportion NE_L in Feed (3x maint.) (decimal)	Total NE_L Fed Per Day (Mcal/lb.)
Hay Crops							
______	______	x ______	= ______	x ______	= ______	x ______	= ______
______	______	x ______	= ______	x ______	= ______	x ______	= ______
______	______	x ______	= ______	x ______	= ______	x ______	= ______
Corn Silage							
______	______	x ______	= ______	x ______	= ______	x ______	= ______
______	______	x ______	= ______	x ______	= ______	x ______	= ______
Other Homegrown Feeds							
______	______	x ______	= ______	x ______	= ______	x ______	= ______
______	______	x ______	= ______	x ______	= ______	x ______	= ______
______	______	x ______	= ______	x ______	= ______	x ______	= ______
Purchased Feeds							
______	______	x ______	= ______	x ______	= ______	x ______	= ______
______	______	x ______	= ______	x ______	= ______	x ______	= ______
______	______	x ______	= ______	x ______	= ______	x ______	= ______
Total Protein and Energy in Ration					______		______
x Proportion Consumed (1 - feeding loss)					x ______		x ______
TOTAL PROTEIN AND ENERGY CONSUMED					______		______
Maintenance Requirement (from Table A on back)					− ______		− ______
Amount Available for Milk					= ______		= ______
Per Pound Milk (from Table B on back)					÷ ______		÷ ______
POUNDS DAILY MILK PRODUCTION RATION WILL SUPPORT					______		______

Table A. Maintenance Requirements for Different Body Weights

Body Weight (lbs.)	Protein	Energy
1,000	.92	7.90
1,050	.95	8.19
1,100	.98	8.48
1,150	1.01	8.77
1,200	1.04	9.06
1,250	1.07	9.35
1,300	1.10	9.64
1,350	1.13	9.93
1,400	1.16	10.22
1,450	1.19	10.51
1,500	1.22	10.80

Table B. Protein and Energy Per Pound Milk for Different Butterfat Tests

Butterfat (%)	Protein	Energy
3.0	.074	.289
3.1	.075	.294
3.2	.077	.299
3.3	.078	.304
3.4	.079	.309
3.5	.080	.315
3.6	.081	.320
3.7	.083	.325
3.8	.084	.330
3.9	.086	.335
4.0	.087	.340

Table 10. Worksheet for Assessing Ration Balancing

WHAT PRODUCTION LEVEL WILL PROTEIN AND ENERGY IN CURRENT RATION SUPPORT WORKSHEET

	Quantities Fed Per Cow Per Day (lbs. as fed)	Proportion DM (decimal)	DM Fed Per Day (lbs.)	Proportion Protein in Feed (decimal)	Total Protein Fed Per Day (lbs.)	Proportion NE_L in Feed (3x maint.) (decimal)	Total NE_L Fed Per Day (Mcal/lb.)
Hay Crops							
Mixed Grass HCS	32	x .40	= 12.8	x .12	= 1.54	x .57	= 7.30
Corn Silage							
Corn Silage	26	x .33	= 8.58	x .085	= 0.73	x .73	= 6.24
Other Homegrown Feeds							
High Moisture Ear Corn	10	x .70	= 7.0	x .093	= .65	x .84	= 5.86
Purchased Feeds							
26% Protein	16	x .89	= 14.24	x .29x2	= 4.16	x .85	= 12.05
Total Protein and Energy in Ration					7.08		31.45
x Proportion Consumed (1 - feeding loss)					x 0.95		x 0.95
TOTAL PROTEIN AND ENERGY CONSUMED					6.73		29.88
Maintenance Requirement (from Table A on back) 1,300# Body Wt.					- 1.10		- 9.64
Amount Available for Milk					= 5.63		= 20.24
Per Pound Milk (from Table B on back) 3.6% Test					÷ .081		÷ 0.32
POUNDS DAILY MILK PRODUCTION RATION WILL SUPPORT					69.5#		63#

Table A. Maintenance Requirements for Different Body Weights

Body Weight (lbs.)	Protein	Energy
1,000	.92	7.90
1,050	.95	8.19
1,100	.98	8.48
1,150	1.01	8.77
1,200	1.04	9.06
1,250	1.07	9.35
1,300	1.10	9.64
1,350	1.13	9.93
1,400	1.16	10.22
1,450	1.19	10.51
1,500	1.22	10.80

Table B. Protein and Energy Per Pound Milk for Different Butterfat Tests

Butterfat (%)	Protein	Energy
3.0	.074	.289
3.1	.075	.294
3.2	.077	.299
3.3	.078	.304
3.4	.079	.309
3.5	.080	.315
3.6	.081	.320
3.7	.083	.325
3.8	.084	.330
3.9	.086	.335
4.0	.087	.340

Table 11. Nutrient Content of Common Feeds

Nutrient Code / Feed Description	Feed Name	Feed Code	01 Dry Matter	02 Adjusted Crude Protein	03 Soluble Protein	04 Unavailable Protein	06 NDF	07 ADF	08 Adjusted ADF	09 Net $Energy_L$*	10 Discount Factor**	11 Calcium
			%	% of D.M.	% of Protein	-----% of Dry Matter------				Mcal/lb. D.M.	%	% of D.M.
ROUGHAGES												
Legume Hay, early cut	LEGHAY E	101	87	21.0	25	1.0	40	30	30.0	0.72	3.2	1.50
Legume Hay Crop Silage, early cut[a]	LHCS E C	102	45	20.0	50	2.0	40	30	30.0	0.72	3.2	1.50
Legume Hay	LEG HAY	110	87	18.0	25	1.0	45	32	32.0	0.69	3.5	1.20
Legume Hay Crop Silage[a]	LEGHCS C	111	49	17.0	52	2.0	45	32	32.0	0.69	3.5	1.20
Mixed Mainly Legume Hay	MML HAY	120	87	15.5	25	1.0	51	38	38.0	0.65	4.0	1.10
Mixed Mainly Legume Hay Crop Silage[a]	MMLHCS C	121	47	14.5	52	2.0	51	38	38.0	0.65	4.0	1.10
Mixed Mainly Grass Hay	MMG HAY	130	88	12.5	22	0.8	58	40	40.0	0.62	5.5	0.71
Mixed Mainly Grass Hay Crop Silage[a]	MMGHCS C	131	46	12.0	45	1.5	58	40	40.0	0.62	5.5	0.81
Grass Hay	GRAS HAY	140	88	10.5	21	0.7	62	40	40.0	0.62	7.0	0.64
Grass Hay Crop Silage[a]	GRSHCS C	141	41	10.0	54	1.5	62	40	40.0	0.62	7.0	0.63
Corn Silage	CORN SIL	151	33	8.5	45	0.7	51	28	28.0	0.79	5.3	0.22
CONCENTRATES												
Barley	BARLEY	204	89	13.0	17	0.8	27	7	3.0	0.94	4.3	0.05
Corn, yellow, cracked	CSHCORN	216	89	10.0	12	0.6	13	3	1.4	0.91	5.0	0.02
Corn, yellow, ground	GSHCORN	217	89	10.0	12	0.6	13	3	0.5	1.01	3.3	0.02
High Moisture Shelled Corn, coarse grind, cracked post-ensiling	HMSC CPO	220	70	10.0	40	0.6	14	3	1.4	0.91	5.0	0.02
Ground Ear Corn (corn & cob meal)	EARCORN	222	86	9.3	16	0.6	28	12	3.0	0.91	5.8	0.04
Corn Distillers Grains, dry	DDISTIL	226	91	25.1	22	5.6	44	18	5.0	1.01	8.0	0.16
Oats, grain	OATS	244	89	12.9	30	0.8	31	17	7.0	0.80	3.7	0.07
Soybean Oil Meal-48	SOY-48	257	90	53.9	18	1.4	14	5	2.0	0.83	5.1	0.36

* 1 x maintenance.

** Percent discount per increment of maintenance.

[a] Course chop.

Table 11 continued

Nutrient Code / Feed Description	Feed Name	Feed Code	12 Phosphorus	13 Magnesium	14 Potassium	15 Sodium	16 Chloride	17 Sulfur	18 Iron	19 Zinc	20 Copper	21 Manganese	22 Fat
			-----------------	% of Dry Matter	-----------------				-Parts Per Million (PPM)-- of Dry Matter				% of D.M.
ROUGHAGES													
Legume Hay, early cut	LEGHAY E	101	0.35	0.27	3.50	0.010	0.20	0.25	200	24	8	45	3.0
Legume Hay Crop Silage, early cut, coarse chop	LHCS E C	102	0.35	0.27	3.50	0.010	0.20	0.25	300	24	8	45	3.0
Legume Hay	LEG HAY	110	0.27	0.22	2.20	0.020	0.20	0.25	164	21	7	43	3.2
Legume Hay Crop Silage, coarse chop	LEGHCS C	111	0.27	0.22	2.30	0.020	0.20	0.25	325	28	7	46	3.3
Mixed Mainly Legume Hay	MML HAY	120	0.26	0.20	2.10	0.010	0.20	0.25	184	27	7	48	2.7
Mixed Mainly Legume Hay Crop Silage, coarse chop	MMLHCS C	121	0.26	0.20	2.10	0.020	0.20	0.23	303	32	7	49	2.7
Mixed Mainly Grass Hay	MMG HAY	130	0.20	0.16	1.70	0.010	0.20	0.05	148	26	5	62	2.7
Mixed Mainly Grass Hay Crop Silage, coarse chop	MMGHCS C	131	0.23	0.18	1.90	0.020	0.20	0.24	297	28	6	61	2.7
Grass Hay	GRAS HAY	140	0.20	0.16	1.70	0.010	0.20	0.26	166	27	5	86	2.7
Grass Hay Crop Silage, coarse chop	GRSHCS C	141	0.23	0.17	1.90	0.020	0.20	0.13	261	31	5	71	2.7
Corn Silage	CORN SIL	151	0.20	0.13	0.85	0.010	0.10	0.13	184	25	4	31	3.0
CONCENTRATES													
Barley	BARLEY	204	0.37	0.15	0.45	0.030	0.02	0.18	150	30	3	30	2.1
Corn, yellow, cracked	CSHCORN	216	0.30	0.13	0.36	0.002	0.03	0.14	30	21	4	6	4.4
Corn, yellow, ground	GSHCORN	217	0.30	0.13	0.36	0.002	0.03	0.14	30	21	4	6	4.4
High Moisture Shelled Corn, coarse grind, cracked post-ensiling	HMSC CPO	220	0.30	0.13	0.36	0.002	0.03	0.14	30	21	4	6	4.4
Ground Ear Corn (corn & cob meal)	EARCORN	222	0.24	0.10	0.44	0.010	0.03	0.14	80	20	3	8	3.7
Grains, dry	DDISTIL	226	0.79	0.07	0.10	0.020	0.20	0.32	200	80	49	30	8.0
Oats, grain	OATS	244	0.39	0.18	0.42	0.002	0.06	0.38	80	33	7	43	4.5
Soybean Oil Meal-48	SOY-48	257	0.75	0.30	1.90	0.002	0.01	0.45	130	48	40	31	1.0

Table 12. Example Forage Inventory Worksheet

INVENTORY OF FARM PRODUCED FEEDS WORKSHEET

FORAGES

	Weight/Bale & No. Bales or Size & Capacity of Storage Structure	Dry Matter	Nutrient Content		Quantity	
			Protein	Energy	As Is	Dry Matter
		%	%	NEL	---- Tons	----
HAY CROP						
HAY						
______	______	______	______	______	______	______
______	______	______	______	______	______	______
______	______	______	______	______	______	______
Total Hay					______	______
HAY CROP SILAGE						
______	______	______	______	______	______	______
______	______	______	______	______	______	______
______	______	______	______	______	______	______
Total Hay Crop Silage					______	______
CORN SILAGE						
______	______	______	______	______	______	______
______	______	______	______	______	______	______
______	______	______	______	______	______	______
Total Corn Silage					______	______

INVENTORY OF FARM PRODUCED FEEDS WORKSHEET (continued)

FORAGES

	Weight/Bale & No. Bales or Size & Capacity of Storage Structure	Dry Matter	Nutrient Content		Quantity	
			Protein	Energy	As Is	Dry Matter
		%	%	NEL	- - - - Tons	- - - -
CORN						
HI MOISTURE CORN						
________	________	____	____	____	____	____
________	________	____	____	____	____	____
Total Hi Moisture Ear Corn					====	====
HI MOISTURE SHELLED CORN						
________	________	____	____	____	____	____
________	________	____	____	____	____	____
Total Hi Moisture Shelled Corn					====	====
EAR CORN						
________	________	____	____	____	____	____
________	________	____	____	____	____	____
Total Ear Corn					====	====
DRY SHELLED CORN						
________	________	____	____	____	____	____
________	________	____	____	____	____	____
Total Dry Shelled Corn					====	====
OATS						
________	________	____	____	____	====	====
OTHER GRAINS						
________	________	____	____	____	____	____

APPROXIMATE DRY MATTER CAPACITY OF SILOS*

Table 13.

Depth of Settled Silage (feet) \ Inside Diameter of Silo	10	12	14	16	18	20	22	24	26	28	30
2	0	1	1	1	2	2	2	2	3	3	4
4	1	2	2	3	4	5	5	6	8	9	10
6	2	2	3	4	5	7	8	10	11	13	15
8	3	4	5	7	9	11	13	16	18	21	24
10	4	5	7	9	11	14	17	20	24	28	32
12	5	7	9	11	14	18	22	26	30	35	40
14	5	8	11	14	17	22	26	31	36	42	48
16	6	9	12	17	21	26	32	37	44	51	58
18	7	11	14	19	24	29	35	42	49	57	65
20	8	12	16	21	27	33	40	47	56	65	74
22	9	14	19	24	30	38	48	54	64	74	85
24	11	15	21	27	34	43	52	61	72	83	96
26	12	17	23	30	38	48	58	68	81	94	107
28	13	19	26	35	44	53	64	76	90	104	119
30	15	21	29	38	47	59	71	84	99	115	132
32	16	23	32	41	52	65	78	93	109	127	145
34	18	25	34	45	57	70	85	101	119	137	158
36	19	28	37	48	62	76	92	109	129	150	172
38	21	30	41	53	67	82	100	118	139	161	185
40	22	32	44	57	72	89	107	127	150	173	199
42	24	34	47	61	77	95	115	137	161	186	214
44	26	37	50	65	82	102	123	146	172	200	229
46	27	39	53	69	88	108	131	155	183	212	244
48	29	42	56	74	93	115	140	166	195	226	260
50	31	44	60	78	99	122	148	175	206	239	274
52	32	47	64	83	105	129	157	186	219	254	291
54	34	49	67	88	111	137	165	197	231	267	306
56	36	51	71	93	117	144	174	207	243	282	324
58	38	54	74	98	123	151	183	218	261	297	339
60	40	56	78	102	129	159	192	228	273	309	357
62					135	167	201	239	287	324	374
64					142	174	210	250	301	339	391
66					149	182	219	260	314	354	407
68					155	190	228	271	328	369	424
70					162	198	237	282	342	384	441
72								293	356	400	458
74								305	371	415	476
76								316	385	431	493
78								328	400	446	511
80								339	462	462	528

To find the tons remaining in a silo after part of the silage is removed: (1) find the tons of silage when the silo was filled, (2) find the tons in a silo filled to the height equal to the depth of silage removed, (3) subtract the number of tons in Step (2) from the number of tons in Step (1). Example: A 20 foot silo filled to a settled depth of 60 feet and 22 feet were fed off. (1) 20 x 60 equals 159 tons (2) 20 x 22 equals 38 tons (3) 159 minus 38 equals 121 tons remaining

* This table was adapted by the Departments of Agricultural Engineering and Agricultural Economics from a silo capacity table developed by the National Silo Association, 1201 Waukegan Road, Glenview, Illinois and added to by the Departments of Agricultural Engineering and Agricultural Economics, the University of Wisconsin.

Table 14. Approximate Capacity of Horizontal Silos

The following tables give approximate capacity of horizontal silos in tons based on 70 percent moisture silage, good packing practices, and level full condition after settling. Allowance should be made for sloping end(s), i.e. the capacity indicated is for full length of average depth, so for design purposes add depth of silo to this length.

Avg. width in feet	Length in feet 60	80	100	120	140	160	200	Amount of silage per slice 4" thick	12" thick
	8' deep, 40 pounds per cubic foot:								
				tons				tons	
20	192	256	320	384	448	512	640	1.1	3.2
30	288	384	480	576	672	768	960	1.6	4.8
40	384	512	640	768	896	1,024	1,280	2.1	6.4
50	480	640	800	960	1,120	1,280	1,600	2.7	8.0
60	576	768	960	1,152	1,344	1,536	1,920	3.2	9.6
80	768	1,024	1,280	1,536	1,792	2,048	2,560	4.3	12.8
	10' deep, 42 pounds per cubic foot:								
20	252	336	420	504	588	672	840	1.4	4.2
30	378	504	630	756	882	1,008	1,260	2.1	6.3
40	504	672	840	1,008	1,176	1,344	1,680	2.8	8.4
50	630	840	1,050	1,260	1,470	1,680	2,100	3.5	10.5
60	756	1,008	1,260	1,512	1,764	2,016	2,520	4.2	12.6
80	1,008	1,344	1,680	2,016	2,352	2,688	3,360	5.6	16.8
	12' deep, 44 pounds per cubic foot:								
20	317	422	528	634	739	845	1,056	1.8	5.3
30	475	634	792	950	1,109	1,267	1,584	2.6	7.9
40	634	845	1,056	1,267	1,478	1,690	2,112	3.5	10.6
50	792	1,056	1,320	1,584	1,848	2,112	2,640	4.4	13.2
60	950	1,267	1,584	1,901	2,218	2,534	3,168	5.3	15.8
80	1,267	1,690	2,138	2,521	2,957	3,379	4,224	7.0	21.4
	14' deep, 46 pounds per cubic foot:								
20	386	515	644	773	902	1,030	1,288	2.1	6.4
30	580	773	966	1,159	1,352	1,546	1,932	3.1	9.7
40	773	1,030	1,288	1,546	1,803	2,061	2,576	4.3	12.9
50	966	1,288	1,610	1,932	2,254	2,576	3,220	5.4	16.1
60	1,159	1,546	1,932	2,318	2,705	3,091	3,864	6.4	19.3
80	1,546	2,061	2,576	3,091	3,606	4,122	5,152	8.6	25.8

Table 15. Corn Grain Conversion Worksheet

	Percent Moisture	Tons as Harvested[1]		Conversion Factor[2]		Dry Shell Equivalent
Ear Corn:	____%	____T	÷	____	=	____bu.
	____%	____T	÷	____	=	____bu.
	____%	____T	÷	____	=	____bu.
Shell Corn:	____%	____T	÷	____	=	____bu.
	____%	____T	÷	____	=	____bu.
	____%	____T	÷	____	=	____bu.
		Total (enter on opposite page)				____bu.

[1] Use Table 1 below.
[2] Use Table 2 below.

TABLE 1. TOWER SILO CAPACITIES FOR HIGH MOISTURE CORN

Settled Depth	Tons High Moisture Ear Corn[1] Inside Diameter in Feet				Tons H.M. Shelled Corn[2] Sealed Storage 20 ft. Diameter
	14	16	18	20	
15	47	62	78	97	113
20	65	84	107	132	154
25	83	108	137	169	192
30	102	133	168	207	235
35	121	158	200	247	274
40	142	185	234	289	320
45	163	213	269	332	360
50	185	241	305	377	407
55		271	342	423	448
60		302	381	471	498
65			421	520	
70			462	571	

[1] Based on 33 percent moisture content.
[2] Based on 28 percent moisture content.

H.M.E.C. stored in horizontal silos will range from 40 to 42 pounds per cubic foot.

TABLE 2. CORN GRAIN CONVERSION TABLE

Percent moisture in kernel	Tons of shelled corn needed to equal one bushel of dry shelled[1]	Percent moisture in whole ear	Tons of ear corn needed to equal one bushel of dry shelled corn[1]
14.0	.0275	14.2	.0335
15.5	.0280	16.0	.0342
16.0	.0282	16.6	.0345
18.0	.0289	19.7	.0357
20.0	.0296	22.6	.0370
22.0	.0300	25.2	.0384
24.0	.0312	27.9	.0399
26.0	.0320	30.0	.0414
28.0	.0329	32.6	.0428
30.0	.0338	34.6	.0443
32.0	.0348	36.4	.0457
35.0	.0364	39.3	.0479

[1] One bushel of No. 2 corn at 15.5 percent moisture content.

Importance of Forage Quality

As an introduction to the allocation of forages, we look again at the critical importance of forage quality. Much research and discussion has been devoted to forage quality. On the following pages, however, we will look at forage quality from a new perspective.

This perspective entails looking at the farm produced feeds, particularly forages, as a resource to be optimally allocated to maximize productivity and profit. In other words, the forage inventory is explicitly allocated to production levels or groups and replacements to maximize production and/or minimize purchased feed costs.

In the following example used to illustrate the critical importance of forage quality, a fixed dry matter quantity of forage is available to feed to attain a fixed production. The objective of the analysis is to utilize the fixed forage dry matter to minimize purchased feed costs. This allocation is conducted for alternative hay qualities and the resulting rations and purchased feed cost used to measure the importance of quality.

The specific situation analyzed is a 120 cow herd with three production groups (Table 17). The rations are formulated and the forages allocated by simultaneously solving four least cost balanced rations with constraints attached to each ration to limit the forage to the quantities available. Each ration is balanced with constraints for maximum dry matter, minimum energy, minimum crude protein, minimum calcium, minimum phosphorus, and minimum and maximum calcium to phosphorus ratios according to National Research Council (NRC) requirements. In addition the dry matter intake constraint is increased slightly as legume is included in the ration (based on work of Mertens at Georgia), fiber is maintained using minimum neutral detergent fiber (NDF) of 1.1 percent of body weight (based on work of Mertens and Sniffen) and a maximum soluble protein of 35 percent of crude protein is allowed.

Forage available is limited to 1.5 tons dry matter per day for the 120 cows (average of 25 pounds per day or 4.56 tons per year). Although crucial to allocation, replacements are not included in the present analysis. One-half of this dry matter is corn silage. The other half is hay (baled). In order to compare hay qualities, five alternative qualities of the hay are considered: early cut legume, legume, mixed mainly legume, mixed mainly grass, and grass.

The increase in purchased feed costs as hay quality declines is startling (Table 18). Remember the quantity of farm produced forage remains constant; however, mixed mainly grass hay can be and is purchased. The value of the improved quality has three sources:

1. Increased nutrient quantities result in less nutrient being required through purchase.

2. The increased quality allows more forage to be utilized thus allows purchase of forage rather than concentrate.

3. The increased intake with higher quality legumes again allows more forage to be utilized and, therefore, purchased.

Table 16. Example Forage Analysis Summary[a]

Storage Facility or Field Name or #	Date		Analysis (DM Basis)					
	Harvested	Sample Taken	Protein			ADF	NDF	NE_L
			Total	Bound	Soluble			

[a]Minerals could be kept on a similar sheet.

Table 17. Characteristics of Representative Herd for Comparison of Five Hay Qualities When Equal Quantities of Hay and Corn Silage are Allocated to Three Production Groups and Dry Cows

Herd Characteristics

Herd Size: 120 Cows

Production: Approximately 14,000 pounds per cow per year

Groups

	Number	Production Level Balanced
High	35	70
Medium	35	50
Low	35	30
Dry	15	--

Farm Produced Roughage

1.5 tons dry matter per day available to cows (4.56 tons DM/cow/year)

50% Corn Silage = 2.25 tons per day

50% Hay Crop

One of Five Qualities

Purchased Feeds

Corn Grain at $4.20 per bushel

Soybean Meal at $360 per ton

Mixed Mainly Grass Hay at $60 per ton

Table 18. Ration Composition and Economic Comparison of Five Hay Qualities When Equal Quantities of Hay and Corn Silage are Allocated to Three Production Groups and Dry Cows[a]

Hay Quality		Daily	Daily	Daily	Value of	Value
Description	Percent Protein	Forage Fed	Concentrate Purchased	Purchased Feed Cost	Early Cut Legume Hay[b]	of Corn Silage[b]
		tons DM	pounds	$	$/ton	$/ton
Early Cut Legume	21.0	2.17	531	94.74	123.36	16.25
Legume	18.0	2.07	733	117.62	135.82	16.71
Mixed Mainly Legume	15.5	1.91	977	138.68	141.88	20.63
Mixed Mainly Grass	12.0	1.84	1,158	160.84	152.04	27.14
Grass	10.0	1.77	1,278	173.78	150.30	31.70

[a]Characteristics of herd and feeds are in Table 17.

[b]This is the value of one more ton as fed of each of these forages when the forage would be optimally allocated were it available.

Table 19. Ration Composition Comparison in the High Group of Five Hay Qualities When Equal Quantities of Hay and Corn Silage are Allocated to Three Production Groups and Dry Cows[a]

Hay Quality		Roughage Dry Matter			Concentrate, pounds	
Description	Percent Protein	Total	Percent Hay	Percent of Ration	Corn Grain	Soybean Meal
Early Cut Legume	21.0	36.7	62	76	13.5	1.6
Legume	18.0	30.7	49	65	15.8	5.2
Mixed Mainly Legume	15.5	26.6	55	56	19.1	6.2
Mixed Mainly Grass	12.0	23.2	48	49	21.0	7.6
Grass	10.0	22.0	45	47	21.5	8.2

[a]Characteristics of herd and feeds are in Table 17.

The dramatic results of these adjustments are illustrated by ration composition of the high group rations (Table 19) and the forage versus concentrate quantities (Table 18).

As dramatic as these results are, they are an underestimate of the value of quality forages for two reasons. First, the increased quality would almost certainly result in increased production resulting in greater return from the increased quality. Second, most farms have adequate inventories of forage; consequently, the increased usage would come from inventories rather than from purchases.

These results support the proposition that the most important component of the feeding program is the cropping program. It is crucial to the success of a dairy farm business to integrate the cropping and feeding programs. The keys to the success of the feeding program then becomes planning crop rotations that provide the feeds required by the herd and producing the highest quality feeds possible on the available land resource. To this end the authors have suggested the following definition of a high quality forage: A high quality forage is a forage which complements the farm's land resource, prompts maximum dry matter and nutrient intake, and maximizes farm business profitability.

Allocation of Forages

In the preceding section, we introduced the concept of allocating forages by using allocation of forages to groups. We now wish to return to the situation at the end of the section on inventories. We now know what our inventory consists of; we now need to consider three allocations:

1. Allocation through the year or lactation to avoid shortages and/or unneeded carryover of inventories.

2. Allocation to production levels or groups of a given daily quantity of farm produced feeds.

3. Allocation within the day.

The third allocation, often referred to as feeding strategy, is discussed in the last section of this report.

Table 20 contains an example of a worksheet to use to determine the quantity available for daily use based on the forage inventory. Two points need emphasis. The first is that the daily allocation may be different from the average daily supply. This potential difference is reflected in the final two columns and could result from seasonality of milk production, minimum quantities to avoid spoilage, and extra allocation until another forage is harvested. The final deviation will be necessary at times but should be minimized since large ration changes should be avoided if at all possible.

The second point is that this worksheet should be updated every month or two and with increasing frequency as harvest approaches. Estimation of silage inventories and measurement of quantities are both subject to major

Table 20. Example of a Worksheet to Calculate Daily Allocation Available to Herd

INVENTORY ALLOCATION WORKSHEET

Date ____________________

Feed Ingredient	Unit	% Dry Matter	Total Quantity Available	Days Before Next Harvest	Daily Supply (Total/Days)	Amount to be Allocated Daily*

*Daily supply adjusted for circumstances that would warrant feeding daily supply: seasonality of production, minimum quantities to avoid spoilage, etc.

errors. Only with frequent checking will allocation continue to work effectively.

We are now ready to allocate the daily allowance. Although replacements must eventually be an integral part of forage allocation, for now their daily feed requirement should be subtracted from the daily inventory available. Although generalizations are dangerous, we are suggesting the following allocation procedure until more rigorous techniques are available.

Allocate high quality hay and hay crop silage first, corn silage second, and low quality hay crops third. Each should be allocated to higher producing groups first. In order to provide maximum flexibility in allocating hay crops, different qualities; whether they result from species composition, rain damage, or harvest date; should be stored separately to the extent possible.

Two guidelines should be followed when allocating high quality hay crops. When quantities are limited, priority should be given to early lactation, high producing cows. When large quantities of hay crop silage, especially when it is low dry matter, are available; careful attention must be given to the soluble protein level of the total ration.

To quantify the importance to productivity and profitability of forage allocation to production levels or groups, we will use the same herd characteristic (Table 17) and solution procedure that we used to quantify forage quality.

The dailry allocation of farm produced forage is:

1.0 tons corn silage dry matter
0.5 tons legume hay dry matter
0.5 tons mixed mainly grass with additional available at $60 per ton.

We will compare three situations similar to those used to analyze increases in dry matter intake. The situations are:

1. Proportional Allocation: This is the base situation with all groups being fed the same roughage proportions.

2. Minimize cost: The forage is allocated in the proportions that minimize cost given the current production.

3. Increased production: Production responds to the availability of better feed for early lactation cows. In this example production increases from 13,900 pounds to 14,800.

The economic importance of allocating the scarce resource and utilizing the highest quality forages where they do the most good is illustrated in Table 21. The purchased feed (additional hay and grain) is reduced more than $15 per day ($5,700 per year with 120 cows) by allocating the forage with production unchanged. Table 22 illustrates why this is the case with forage intake increasing more than 10 percent and concentrate decreasing nearly 20 percent in the high group when the forage is optimally allocated with no increase in production. For the total herd, concentrate requirement decreases over 30 percent.

An even more dramatic return is found when the improved ration to the early lactation cows results in a production response. In this example, a 900 pounds per cow per year response increases return over feed after the assessment and milk marketing $13,644 or $114 per cow (Table 21). With the optimal allocation of forage this increase can be produced without increasing purchased feed costs. Remember, farm produced forage quantities are constant at 2.0 tons dry matter per day (6.08 per cow per year).

Purchasing Feeds to Match Your Forages

This section suggests six steps to follow in matching purchased feeds to forage while maximizing productivity and minimizing purchased feed costs. In not all situations are the steps separable and in some situations another order may be required. The separation into steps is based on the premise that only one major ration change should be made at once; otherwise success or failure cannot be explained.

Step 1: Calculate dry matter intake and check frequently. Just as maximum intake is the key to productivity and profit, an accurate knowledge of intake is essential to determining concentrate needs. Intake must always be carefully monitored.

Step 2: Check to be certain the current ration is balanced for the correct production level. A ration analyzer can be utilized or the ration can be checked by hand calculation using a procedure similar to that in Table 9. An accurate estimate of dry matter intake is essential to a balanced ration. A shortfall in nutrient requirements will reduce production and profitability immediately or in the long-term. Levels of nutrients consumed above the requirement means you are spending money with no return and in most cases the nutrients above the requirement have deleterious results either in the short or long run. As an example, extra energy results in overconditioning which increases the probability of problems early in the next lactation.

If ration changes are made, wait until production adjustment discontinues before going to Step Three.

Table 23 provides an actual farm example where simply correctly balancing the ration reduced costs and especially purchased feed cost significantly. The third column illustrates that additional savings were made when it was determined that intake was higher than it had been estimated.

Step 3: Allocate Forages and Optimize Dry Matter Intake. Utilize the ideas and procedures described in previous sections to maximize the utilization of forages. Do Step Four simultaneously.

Step 4: Rebalance rations. If changes are made in Step 3, rebalance the ration for the new roughage composition, intake, and/or production using purchased feeds similar to those being used. This is not the time to make major changes in purchased feeds. If both forages and concentrates are changed drastically, it will not be possible to assess gains or losses.

Table 21. Ration Composition and Economic Consequences of Improved Allocation of Forages -- Daily Results for a 120 Cow Herd with Three Production Groups

	Proportional Allocation	Minimize Costs	Increased Production
Annual Milk Production	13,900	13,900	14,800
Daily Forage Fed, tons dry matter	2.00	2.11	2.12
Daily Concentrate Purchased, pounds	888	615	747
Daily Purchased Feed Cost			
Total	$103.94	$88.16	$102.93
Change	---	-$15.76	-$1.01
Daily Return Over Purchased Feed Cost			
Total	$456.86	$472.64	$494.24
Increase	---	$15.78	$37.38
Annual Increase in Return Over Purchased Feed Cost	---	$5,760	$13,644
Percent of Legume Hay			
High	27.2	22.8	22.6
Medium	33.9	77.1	76.6
Low	29.5	0	0.7
Dry	9.4	0	
Value of Additional Ton of Legume Hay	$49.78	$99.86	$99.86

Table 22. Ration Composition and Economic Consequences of Improved Allocation of Forages -- Daily High Production Group Results for a 120 Cow Herd[a]

	Proportional Allocation	Minimize Costs	Increased Production
Milk Production, Daily Average	64	64	67
Ration Balanced for[b]	70	70	73
Dry Matter Intake	48.4	48.3	49.2
Roughage Dry Matter			
Total	31.1	34.5	32.8
Corn silage	15.5	28.0	26.3
Legume hay	7.8	6.5	6.5
MMG hay	7.8	0	0
Percent of ration	64.3	71.4	66.7
Concentrate			
Corn grain	15.8	10.4	12.9
Soybean meal	5.9	7.2	7.6

[a]35 cows in group for average of first one-third of lactation.

[b]Lead factor of 1.1. See Table 8 and associated discussion.

Table 23. Savings from Correctly Balancing a Ration for 65 Pounds of Milk

	Price	Current Ration (lbs.)	Least Cost Balanced (lbs.)	Increase Intake 1 lb.
Mixed mainly grass hay crop silage	$25/ton	32	22.3	32.0
Mixed mainly grass hay	$55/ton			
Corn silage	$20/ton	26	40.5	35.9
High moisture ear corn	$50/ton	10	10.0 (fixed)	10.0 (fixed)
26% commercial concentrate	$180/ton	16	14.8	13.3
Soybean meal	$240/ton	--		
Corn grain	$100/ton	--		
Minerals		0	.12	.15
Feed cost per cow per day		$2.35	$2.28	$2.24
Purchased feed cost per cow per day		1.44	1.35	1.23
Savings Per Year Over Current Ration:[a]				
Total Feed Cost		--	$894	$1,405
Purchased feed		--	$1,150	$2,683

[a]80 Cow herd with these savings only from high group of a two production group system.

Allow time for adjustment and rebalance as necessary.

Step 5: Check the protein solubility and degradability of the ration. Degradability and solubility problems must be considered separately because the solutions are much different. Protein degradability problems can normally be corrected by changing feed ingredients in the concentrate while protein solubility problems often require changes in forage allocation and even crop rotation changes.

Protein Degradability

Protein degradability problems can be corrected by altering the protein source (see Table 5) in the the concentrate; the question is whether the change is profitable. In the unlikely event that distillers grains, dry brewers or corn gluten meal are the main protein source and the ration protein is too slowly degradable, the problem can be solved by switching to soybean meal. This change will result in a less expensive concentrate, and the change will increase profitability.

The more likely protein degradability problem is that soybean meal is the grain protein source and the ration protein is rapidly degradable. In this situation the problem can be corrected by replacing the soybean meal with corn distillers, brewers or corn gluten meal. Caution must be exercised here; there can be an amino acid deficiency resulting from using too much corn based products. Caution must also be used in balancing minerals. Depending upon the protein level and relative prices, this substitution will cost $10 to $40 per ton of concentrate. For the increased cost to be profitable, milk production must increase, proportion concentrate must decline or dry matter intake must increase.

The following procedure can be followed to test whether the substitution of this more expensive concentrate source will increase profitability:

1. Replace the soybean meal or commercial high solubility grain for one load of low solubility feed and feed the same amount of concentrate and roughage. When it is time to order another load of feed (at least 10 days to two weeks), check for increased milk production (be sure to balance for cow entry and removal). If production has increased, compare increased income from milk to increased feed cost:

   a. Increased milk: Pounds increase per cow per day * $0.12 (or other milk price less marketing cost).

   b. Increased feed cost: Pounds concentrate fed * Increased concentrate cost per ton ÷ 2,000.

   If a. exceeds b., the substitution is profitable.

2. If milk production did not increase or did not increase enough to justify the substitution (1b > 1a), the substitution may still be profitable because of more efficient protein utilization or increased dry matter intake due to improved rumen function. If either occurs, less concentrate will be required. The second step is, therefore, to try feeding less concentrate and check whether production is maintained. If

concentrate or protein supplement can be reduced without production loss, you must compare:

a. Increased income from milk.

b. Change in feed cost: Pounds concentrate fed with new ration * price per pound of new concentrate + cost of increased roughage intake - pounds of concentrate fed with old soybean meal ration * price per pound of old concentrate.

If a. is greater than b., the substitution is profitable.

3. If neither steps 1 nor 2 proved profitable, the degradability problem is not great enough that it is profitable to correct.

Protein Solubility

If ration protein solubility is too low (usually hay or corn silage diets), it usually means that the protein supplements being fed are too low in solubility. This usually can be corrected with less expensive supplements, such as lower priced commercial concentrates, urea, soybean meal or corn gluten feed.

Table 24 illustrates the potential severity of excess protein solubility which is the more common problem. Large quantities of excellent quality hay crop silage are usually high in protein solubility, usually from high moisture silage (bunker), and create the biggest problem. Rations with high quality hay crop silage as the only forage may exceed the soluble protein requirement from the forage alone.

Most dry concentrates average 5 to 50 percent solubility. Those with high moisture grains are 35 to 60 percent. When high moisture grains are being fed, they should not be allocated to the high group if that is possible. If distillers are being fed, a minor reduction in solubility can be obtained by switching to dry brewers or corn gluten meal.

The solution to most solubility problems requires an adjustment in the forage composition. This change often requires a sacrifice in forage quality as measured by crude protein and net energy for lactation; consequently, we are once again increasing concentrate cost. The increased cost must be recouped by increased milk production, increased protein efficiency, and/or increased dry matter intake.

Adjustments in the forage usually are not easy and often impossible in the short-run. The solubility can be decreased by increasing dry hay and corn silage quantities while decreasing hay crop silage quantities. In some situations these adjustments can be made with little cost by allocating the high quality, high solubility hay crop silage to other production groups or more uniformly throughout the year. In other circumstances, where large quantities of high quality, high solubility hay crop silage are the predominant forage available, little can be done until the next harvest.

In these situations, a major and costly change in the forage system may be required. Available options for the change include harvesting more of

Table 24. Percentage of crude and soluble protein in the forage for an 80 pound production level with 50-50 forage to concentrate[a]

Forage and Crude Protein of Hay Crop Silage	Percent of Required Protein	Percent of Max. Soluble Protein	Percent Soluble in Grain
70% Sol Prot HCS			
24%	73.2	122.0	
20%	61.0	146.4	
16%	48.8	97.6	1.6
12%	36.6	73.2	14.8
50% Sol Prot HCS			
24%	73.2	104.5	
20%	61.0	87.1	11.6
16%	48.8	69.7	20.7
12%	36.6	52.3	26.4
70% Sol Prot HCS + 50% Sol Prot CS[b]			
24%	51.9	95.0	3.7
20%	45.8	82.8	11.1
16%	39.7	70.6	17.1
12%	33.6	58.4	21.9
50% Sol Prot HCS + 50% Sol Prot CS[b]			
24%	51.9	74.1	18.9
20%	45.8	65.3	22.4
16%	39.7	56.6	25.2
12%	33.6	47.9	27.4
50% Sol Prot CS	30.5	43.6	28.4

[a]46 pounds dry matter intake, 7.45 pounds adjusted crude protein minimum and maximum of 2.64 pounds of soluble protein (35% of adjusted crude).

[b]Equal dry matter quantities from each.

the hay crop silage with a lower moisture content probably requiring a silo investment and growing and harvesting more corn silage and less hay crop silage. These changes should be made only after careful ration analysis and experimentation.

A procedure similar to that used to evaluate degradability changes can be utilized with the additional consideration of changes in roughage costs.

Step 6: Determine whether the purchased nutrients can be obtained less expensively. When considering several feeds, a computerized procedure is almost a necessity due to the complex interactions of intake, energy, protein, fiber, and minerals. The following considerations should be helpful in using your own, extension agent's, feed representative's or nutritional consultant's ration balancer or least cost balanced ration program:

1. Use the actual dry matter intake measured for your production levels or groups. Intake varies so widely that only your intake is satisfactory.

2. Lower energy feeds are almost always cheaper per pound and may be cheaper per unit of nutrient, but they may not be a good buy. This is especially true for high producing cows where intake is a limiting factor. Two suggestions to determine whether lower energy feeds would be worth considering follow:

   a. Given current concentrate prices, a pound of protein costs about four times as much as a Mcal of energy. We can, therefore, calculate what we will call the relative nutrient value (RNV) of a currently purchased and a lower energy alternative and compare to their prices. RNV is calculated as:

   RNV = Proportion Protein in dry matter x 4 + Mcal energy per pound dry matter

   We can then calculate

   $$\frac{\text{Price per pound dry matter}}{\text{RNV}}$$

   for each. If this result is smaller for the lower energy alternative, further consideration should be given to the feed using a ration balancer or least cost balanced ration program.

   b. Table 25 contains break-even prices for several feeds at several price levels. For the given price, these feeds show little promise unless they are priced below the break-even price.

3. Balancing a ration is an ongoing procedure; not something that is done once and left unchanged. Ration changes must be made slowly, adjustments in plans must be made as production responds, rebalancing is required as production or intake change, and rebalancing is required as forage quality changes.

Table 25. Prices Below Which Consideration Should be Given to Selected Feeds for Selected Prices of 16 Percent Commercial Dairy Feed

Feed	Nutrient Content: Dry Matter %	Nutrient Content: Energy Mcal/ lb. DM	Nutrient Content: Crude Protein % DM	Price Per Ton Considered Given Price of 16% of: 160	180	200	220
Low Energy Feeds							
Oats	89	0.86	12.9	123	136	150	164
Wet Brewers Grain	22	0.84	25.0	25	27	29	30
Ground Ear Corn	86	0.91	9.3	103	113	125	135
High Moisture Ear Corn	70	0.91	9.3	82	90	98	106
Similar Energy Feeds							
Ground Corn	89	1.01	10.0	154	174	194	213
Ground High Moisture Corn	70	1.01	10.0	118	133	148	162
Cracked High Moisture Corn	70	0.91	10.0	88	97	107	115
Barley	89	0.94	13.0	141	158	175	192
Wheat	89	1.01	14.6	176	199	222	245

Daily Allocation of Feeds

Perhaps the single most important consideration in feeding dairy cattle is the allocation of feeds during the day. Up to this point in time, our discussion has been centered around the acquisition and allocation of feeds for the feeding year and for the different production groups. When we look at high producing herds, we commonly attribute their success to feed quality, genetically superior cattle, and the combinations of feeds being offered to cows. Little attention is given to the one area that many times sets these herds apart from others and that is how they feed during the day.

The objective is to feed the cow during the day in such a manner as to minimize fluctuations in the rumen, maximize digestion, and ensure a steady flow of nutrients to the bloodstream. The microbial mass requires a continuous supply of nutrients. The cow's tissues will also respond to a continuous supply of nutrients. This would mean feeding 24 times a day. This obviously is not possible. Feeding of dairy cattle is a intermittent process which is affected by physical limitations such as housing, feeding equipment, animal numbers, and labor availability. We have to work within the existing framework and try to achieve a situation where the fermentation is even and under control, the digestion maximum and nutrient requirements of the microbial mass and cow are met.

Grouping

Regardless of the type of physical facilities we should group our animals. They should be grouped based on their physiological status at unique-points in their life cycle. We would suggest the following:

Replacement Program

		Final Weights		
Age (months)	Time	Jersey	Ayrshire	Holstein
0-1	Preweaning	90	130	180
1-9	Rapid Growth	400	475	575
9-16	Breeding	625	750	850
16-25	Pregnancy	850	1,000	1,200

Lactation/Dry Program

Period	Stage (days)	Condition Score
Fresh	0-14	3+ to 3
Early lactation	14-60	3- to 3
Peak	60-120	3- to 3
Mid lactation	120-210	3
Late lactation	210-305	3+ to 4-
Dry period	305-346	3+ to 4-
Prepartum period	346-360	3+ to 4-

In most cases it will not be possible to acheive grouping dairy animals based on the above physiological groups. However, it is most important to recognize the importance of the requirements of these groups. The rapid growth and early/peak lactation periods are similar in their high energy/protein requirements. This means that dry matter digestion in the rumen must be at a maximum. The allocation of forages and feeds becomes important. High quality forages are necessary for maximizing digestion, dry matter intake, and animal production. Mertens of Georgia has shown that alfalfa will give a 10-12 percent increase in dry matter intake and milk production when compared to corn silage. The reasons for this are involved in greter rumen microbial growth and faster fiber digestion cresting "room" for more feed. Grouping cows allows you to allocate the excellent quality forages to the rapidly growing heifers and the early lactation cows. The other contrast is to allocate the intermediate quality grasses to the dry cow. Grass is low in protein and energy and high in fiber. This forage can be fed <u>ad libitum</u> to appetite and keep rumen volume to a maximum which is important for preparation for early lactation.

Feeding Behavior

The allocation of the forages over the lactation is very important. The previous discussion of the economic implications brings out the consequences of not doing this.

The advantages of grouping and proper allocation of forages can all be lost if the daily feeding management isn't in balance.

First, let's talk about the cow's feeding behavior. A study was done at the University of Maine where they measured the early lactation cow's feeding behavior using a blended ration. They found that when the cows were restricted to cleaning up their feed versus allowing them truly ad libitum access to feed (10 percent in excess of consumption or when the feed not eaten looks like the feed offered) they consumed their feed in six meals versus 12 meals. Also, they found that when the cows were fed they "lined up at the bunk" and consumed a high percentage of their feed in the first 2 meals; this was especially apparent for those cows not being offered feed at an ad libitum rate.

Referring to our earlier discussion on maintaining a rumen balance, this means that there will be a high level of rumen fermentation in the first part of the day right after feeding, and as we have discussed earlier because of the more rapid growth, of the starch and sugar digesters when compared to fiber digesters there will be a tendancy toward an imbalance of the rumen, resulting in lower pH, increased acidoses, low butter fat, and irregularity of feed consumption.

In order to minimize fermentation imbalances it is necessary to plan the daily feeding schedule carefully. A form to help you do this is shown in Table 26.

Increasing feeding frequency maximizes digestion in the rumen through reducing passage and also increasing frequency decreases paeaks and valley in fermentation. However, the benefits of feeding frequency can be compromised by the order of feeding. The best examples of this are feeding finely ground high moisture corn first thing in the morning, feeding round high moisture grain in parlor or feeding a high concentrate blended ration once per day to an empty bunk, the starch digesting bugs will predominate and protozoa will be absent.

The major challenge is when cows are fed individually, separate feedstuffs and where a part of all of the grain is fed in the parlor. The latter is particularly a problem because of a restriction of physical facilities.

The following recommendations (Table 27) are made based on the concept of controlling fermentation and maximizing feed retention in the rumen. The order of feeding is based on our knowledge of the relative fermentation rates of the fiber, starch, sugars, and proteins. The suggested orders can be repeated and the frequency of feeding needs to be incorporated as shown in Table 27. When you make feeding strategy (use feeding strategy chart) changes monitor the following:

Table 26. Fermentation Balance Chart

Group	Forage Allocation: Alfalfa 20[a]	Alfalfa 16/20	Alfalfa less than 16	Grass 14 +	Grass 11/14	Grass less than 11	Corn Silage Low Grain	Corn Silage High Grain	Feeding Frequency of Feed: Forage Solubility[b] High	Forage Solubility[b] Low	Grain Solubility[c] High	Grain Solubility[c] Low	Grain/Suppl.[d] High	Grain/Suppl.[d] Med	Grain/Suppl.[d] Low
Fresh	++	+	-	++	+	-	-	++	4	3	4	3	3	2	2
Early	++	+	-	++	+	-	-	++	4	3	4	3	3	2	2
Peak	+	++	-	++	+	-	-	++	4	3	4	3	3	2	2
Mid	+	+	+	+	+	-	+	+	3	2	3	2	2	2	1
Late	-	-	+	-	+	+	++	-	2	1	2	2	2	2	1
Dry	-	-	-	-	+	+	+	-	1	1	1	1	-	-	-
Prepartum	-	-	-	+	+	-	+	+	2	2	2	2	2	2	2

[a]Protein level.

[b]High protein solubility greater than 55 percent. Bunk - reduce by one or to one.

[c]High protein/carbohydrate solubility (moisture level over 30 percent or finely ground or rolled grain or barley or wheat as grain source. Bunk - reduce by one or if in bunk feed with forage frequency.

[d]Protein solubility: High > 30, degradibility < .4
Medium 20-30, degradibility .3-.4
Low < 20, degradibility < .3.
If bunk feeding, frequency = forage frequency.

1. Milk volume change.

2. Butter fat change (send milk sample to plant for testing at each pick-up).

3. Eating irregularity.

4. Manure consistency change and grain particle passage.

5. Change in dry matter intake.

Fine tune the feeding program based on the changes observed. Remember that feed should be in front of cows at all times and the daily ration has to be balanced for NDF, energy, protein, and minerals.

The major problem of grain feeding in the parlor is not getting forage into them before coming into the parlor and only feeding grain two times per day. Grain can be mixed with the forage in the bunk but should only be done if you can measure the amount mixed accurately. If a little hay or the bunk mix can be fed before going in the parlor it will be beneficial. The new electronic technology will be potentially a large advantage in controlling fermentation. Transponders can be put on each cow and grain intake set for production. The two major advantages are controlling feeding frequency and knowing what the cows are consuming. It is worth considering when physical facilities are limited. The important thing to remember is to balance the fermentation initially on adequate NDF (1.1 percent of body weight) in the ration and then combining degradation, productivity, and feeding frequency and meet the cows requirements for nutrients.

Table 27. Order of Feeding

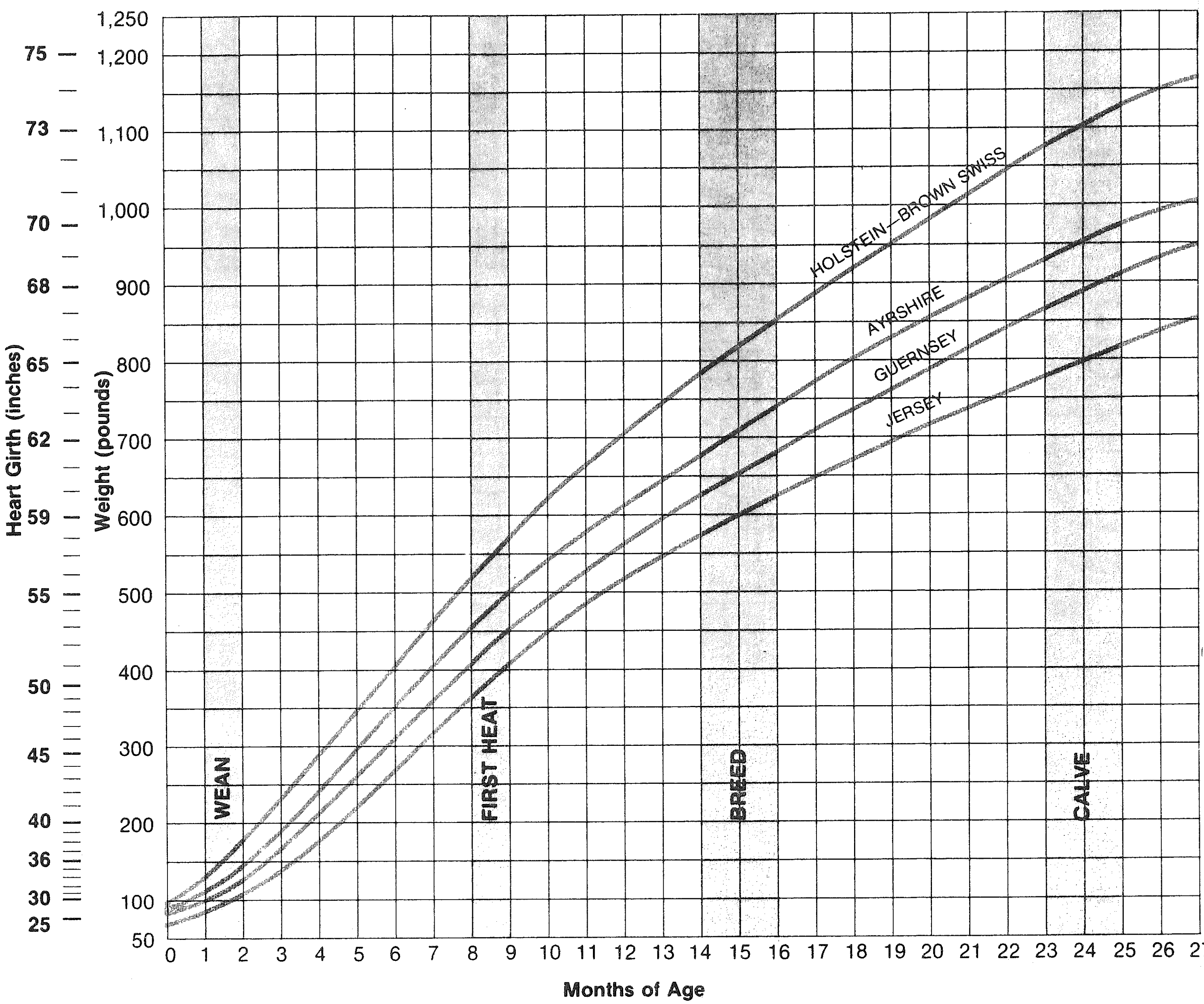
	Forages to be Fed			Grain		
Feeding Program	Alfalfa	Grass	Corn Silage	Fermented	Dry	Protein Supplement
Individual Fed						
Dry forages	4	1	—	—	2	3
Dry grains	3	1	—	—	—	2
	—	1	3	—	—	2
	1,4[a]	—	3	—	—	2
	1,3	—	—	—	—	2
Wet forages	4	1	5	2	—	3
Wet grains	—	1	4	2	—	3
	1	—	4	2	—	3
	—	1,4[b]	—	2	—	3
	1,4	—	—	2	—	3

[a]First feeding not to exceed more than 2-3 pounds.

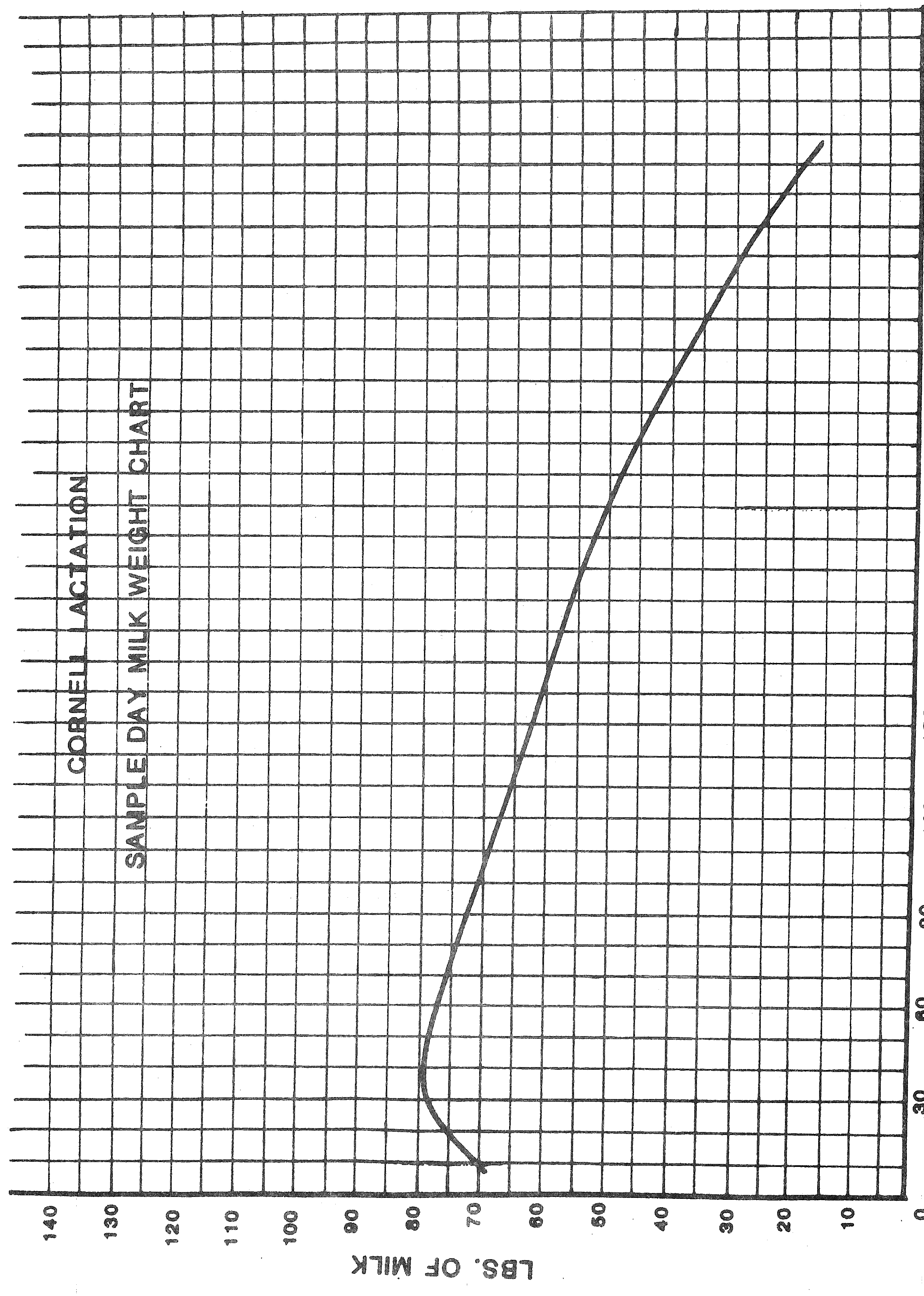
[b]First feeding should be long particle size and preferably dry hay. Feed 2-3 pounds of dry matter.

Minimum Growth Curve
for Dairy Heifers

Name/number ______________________
Other ID ______________________



	Date	*Heart Girth Inches*	*Weight*	*Body Condition Score*
Birth	________	________	________	________
Weaning	________	________	________	________
4 months	________	________	________	________
6 months	________	________	________	________
8 months	________	________	________	________
Breeding	________	________	________	________
20 months	________	________	________	________
Freshening	________	________	________	________



CORNELL LACTATION
SAMPLE DAY MILK WEIGHT CHART
DAYS IN MILK
0
30
60
90
120
150
180
210
240
270
300
330
360
LBS. OF MILK
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140

CORNELL CONDITION SCORE REPORT

DATE ____________________

ANIMAL NAME/NO.	AGE	STAGE OF LACTATION	CONDITION SCORE	COMMENTS
	(months)	(days)		

DAILY FEEDING AND ACTIVITY SCHEDULE

TIME		WHAT	FEED (#)	% DM	# DM	# REFUSED	# DM REFUSED
A.M.	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
NOON	12						
P.M.	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
MIDNT	12						
A.M.	1						
	2						
TOTAL					DM FED		DM REFUSED

Prepared By: David W. Arnold, Columbia County
12/81

(Over)

1) If complete feed list:

	Feed	# FED	x	% DM	=	# DM
1.	__________	_______	x	_______	=	_______
2.	__________	_______	x	_______	=	_______
3.	__________	_______	x	_______	=	_______
4.	__________	_______	x	_______	=	_______
5.	__________	_______	x	_______	=	_______
6.	__________	_______	x	_______	=	_______
7.	__________	_______	x	_______	=	_______
8.	__________	_______	x	_______	=	_______
9.	__________	_______	x	_______	=	_______
10.	__________	_______	x	_______	=	_______
TOTAL						_______

2) If cows are grouped, how many cows in group? __________

3) __________ DM FED – __________ DM REFUSED = __________ DM CONSUMED

__________ DM CONSUMED ÷ __________ #COWS = __________ #DM/COW/DAY

4) Linear feet of bunk space ________ Linear feet of bunk/cow ________

5) Is water source adequate? ____yes ____no