Feeding the Dry Cow

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The practice of dividing the cow's year into periods depending upon the stage of the gestation-lactation cycle should now be discarded. Feeding the dry cow is as much a factor during the first stages of lactation as the last stage of lactation is a factor during the dry period. For this reason, we cannot isolate one period and call it the dry period from a purely nutritional point of view. In terms of nutrition for the high producing dairy cow, modern feeding programs should feed the cow on a total year basis. The concept of "gestation-lactation" feeding is illustrated in Figure 1.

Traditional dairy feeding programs involve a table of nutrient requirements and tables of feed composition. The two parts must be in the same unit of measurement and their usefullness is dependent upon the precision of both. The practice of stating energy values in different ways (starch equivalent, oat unit, barley unit, net energy, total digestible nutrients, etc.) has necessitated the development of many standards and tables of feed composition. Despite many attempts to develop values for equating measures of energy and recommendations for the use of a single standard, arguments for and against standards remain.

In addition to the problems of expressions of energy, conventional systems fail to consider other important points such as feed intake and the end-products of rumen fermentation. Armstrong (1) pointed out the necessity for considering these end-products of digestion, and Kleiber (5) maintained that studies of milk formation are more of a chemical problem than a problem of energestics. Despite the known short-comings of conventional systems for feeding dairy cows, they served the dariy industry well for so long as feeding was done by experienced dairymen willing to provide considerable attention to individual cows within herds.

In recent years, several changes in dairying have taken place which created the need for a new philosophy in feeding dairy cows. Among these changes were the following: 1) The use of large herds where individual feeding cannot be properly practiced. 2) The breeding of cows for levels of production high enough to create constant problems with borderline nutrient deficiencies. 3. Feeding program which create stress conditions and result in rumen health problems.

This paper will review the theory and practice of a system for feeding dairy cows which was designed to overcome many of the problems encountered in traditional programs. The reader who is interested in a detailed listing of literature citations and a point-by-point consideration of the factors used in the program is referred to the book "Optimum Feeding of Dairy Animals" (7). In this review, general principles will be outlined instead of a detailed literature review.

What is an Optimum Ration?

When we began the research that developed the concept of "optimum rations," we defined our purpose as follows: "An optimum ration for dairy cows is one designed to provide adequate quantities of ration nutrients balanced to provide the necessary precursors for rumen fermenation which will, in turn, provide to the udder as needed precursors for the production of the inherited volume of milk with its normal content of milk constituents."

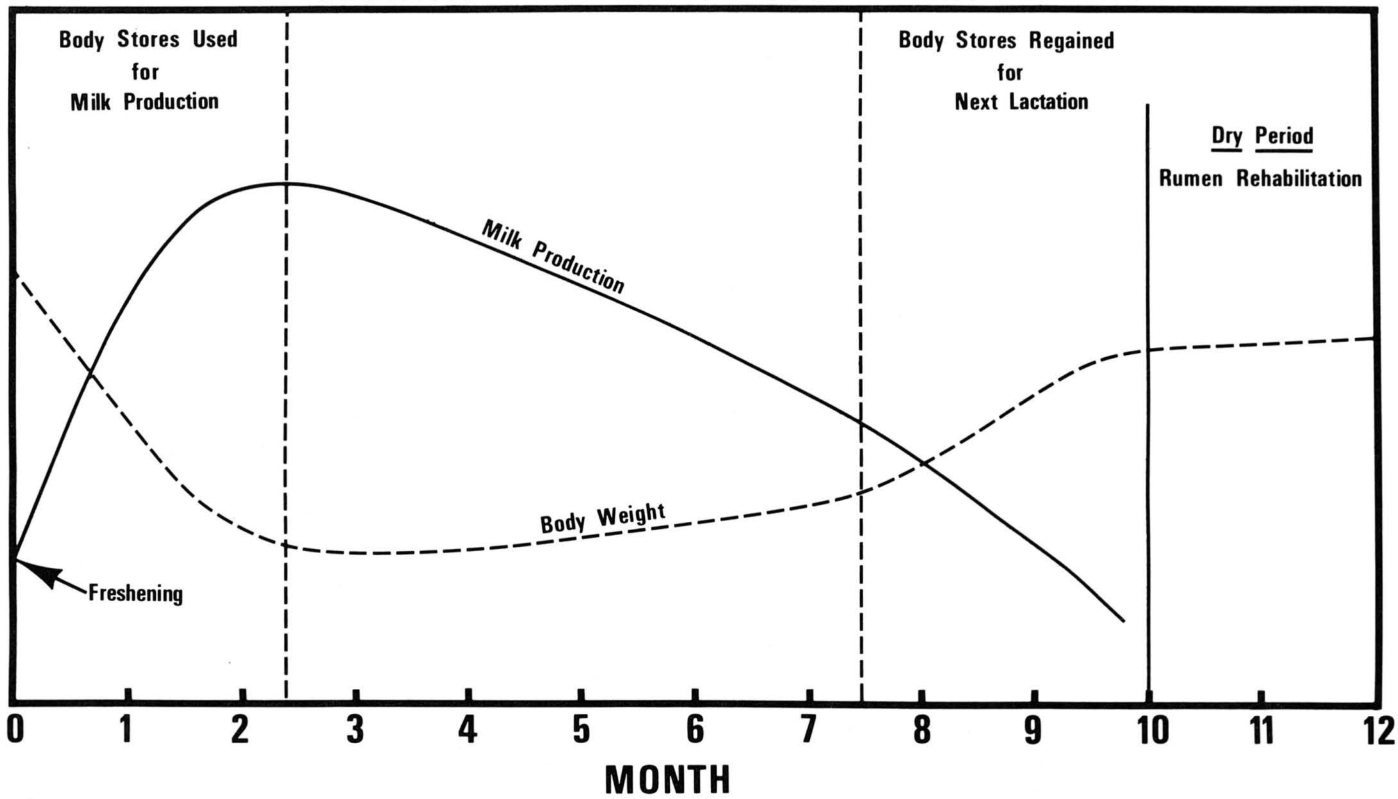
Thus, the ration was designed to have the following effects: 1) An influence on feed intake; 2) An influence on rumen fermentation; 3) An influence on efficiency of milk production; 4) An influence on the composition of milk; and 5) An influence on rumen health.

Although not included in the original defintion of optimum rations, the present generally accepted idea that feeding dairy cows is a gestation-lactation cycle problem and not simply a day-to-day matter has proven to be an important additional consideration.

Factors Considered in Optimum Rations

1. Feed intake. Since all other considerations in quantity and/or concentration of nutrients in rations depends upon intake, this is obviously the starting point. Of all the factors which influence feed intake, the one most subject to control by the feeder is the ratio of grain to forage in the ration. In terms of feeding cows, this ratio controls two of the important factors involved in feed intake by ruminants: digestibility of the total ration and volume density of the ration. It has been demonstrated by several workers that intake is limited by rumen fill or bulk so long as the dry matter digestibility is below 65-68%. Above this level of digestibility, intake is influenced by ration density, chemical products of digestion and other unknown or undefined factors. Thus, the first requirement of an optimum ration is the removal of intake restrictions imposed by dry matter digestibility.

GESTATION - LACTATION CYCLE DAIRY FEEDING



The second factor is the removal of the intake restrictions caused by density of the ration (weight per volume) where limited grain is being used, and the restriction of intake by stress on the digestive system when extremely high levels of grain are desired. This factor is usually removed or reduced to a low level by holding the grain-to-forage ratio between 40:60 and 60:40. These factors are illustrated in Figure 2.

The critical item in this area is the quality or energy concentration of the forage. Obviously, high levels of milk production demand high quality forages for the ration. Of equal importance is the form of physical nature of the forage. At the present time, no one can state a minimum amount of forage that must be present in dairy rations. This can only be done when future research demonstrates the relationship between forage-rumination-cud chewing-saliva flow, and other factors involved in maintaining the proper rumen fermentation for milk production. At our present stage of knowledge, ration density is apparently controlled by limiting the grain portion of the ration to between 40 and 60% of the total ration.

2. Balance of nutrients. Using a ration with the above restrictions for digestibility and density, and building the ration around high quality feedstuffs will provide a ration with an energy concentration between 2.6 and 2.8 Mcal/kg of metabolizable energy. Such a ration will be consumed on a total lactation basis at an average daily rate of about 3% of body weight. On this basis, concentration of individual nutrients can be calculated which will meet the demands of all but exceptionally high milk producers. These exceptional cows will either have great capacities for feed or unusual abilities to use the weight gain-weight loss phenomenon for milk production.

Since a significant portion of the energy and protein supplied in ruminant rations undergoes fermenation in the rumen, several studies have demonstrated the importance of all ration constituents being consumed as one ration and in several small meals throughout the 24 hours. For this reason, optimum rations are designed to be fed as a single mixed ration (forage + grain) which is offered on a free choice basis around the clock. In practice, this insures at least four major feeding times at approximately six-hour intervals.

Based on the need for insuring maximum intake, a proper balance of nutrients and a necessary level of minerals and vitamins, the parameters of "optimum rations" can be stated. (All values are on a dry matter basis.)

1. Crude protein	12% - 14%
2. Crude fiber	16% - 20%
3. Grain	At least 40%
4. Roughage	At least 40%
5. Dry matter digestibility	68% or above
6. Calcium	0.7%
7. Phosphorus	0.5%
8. Magnesium	0.2%
9. Potassium	0.7%
10. Salt	0.5%

Since optimum rations are a mixture of forage and grain fed as a single ration, their use largely precludes the use of pasture. The feeding system is best used with silage, using the moisture content to keep the ration intact. The principle has been successfully used with hay by mixing the grain and roughage and then cubing the mix.

3. Rumen health. In recent years, levels of milk production have been pushed higher and higher. This desirable change has been accompanied by an increasing incidence of metabolic problems such as ketosis, displaced abomasa, fat cows and ulcerated rumina. This complex of events is related to the level of grain fed and the feeding programs involved. Feeding heavy grain rations during lactation and the dry period usually accompanies a high incidence of these problems.

Using optimum rations within the gestation-lactation cycle has proven to be a useful solution to many of these problems. Using the last third of the lactation to restore body weight and condition the cow for the subsequent lactation permits the feeding of heavy roughage rations during the dry period. This allows the rumen to recover from the stress of grain feeding during lactation. Since the cow freshens in excellent condition, body stores can be used to support high levels of production during early lactation without the feeding of levels of grain high enough to produce sub-clinical or short periods of acidosis.

Optimum Rations - In Practice

Since the optimum rations theory was first introduced, several research centers have done research that evaluated one or more parts of the program.

Basic to the idea of feeding all cows the same ration is the question of distribution of nutrients within the gestation-lactation concept. Davenport and Rakes (4) compared the feeding of equal daily amounts of TDN with the feeding of 60.8% of the annual total during the first 180 days postpartum. The experiment covered three lactations and the researchers concluded "the results of this study provide evidence that moderate under-feeding in early lactation is not detrimental if mid-lactation, late lactation, and dry period feeding is adequate for persistent production and the regaining of body tissues lost in early lactation."

Perhaps the most troublesome question encountered in field application of the optimum feeding program was the idea that high producers would be penalized, while low producers would overeat. The data in Table 1 compare the performance of very high potential cows with medium and low potential producers when all were fed the same total ration on a free-choice basis (2). The high potential cows consumed 3.13% of body weight while the low potential group consumed 2.24%. The high potential group was more efficient users of feed and the total weight gains were quite similar. The data clearly illustrate the principle that high producing cows are capable of consuming needed nutrients when offered rations

Table 1

Performance of Cows Fed a Free-Choice Mixed Ration with 40% Hay and 60% Concentrates*

	Production Group		
Item	High	Medium	Low
Milk (kg/308 days)	10,995	6,944	4,560
Fat (%)	2.9	3.0	3.2
Fat (kg/308 days)	320	206	145
Dry matter intake (% BW)	3.13	2.45	2.24
Body weight (kg)	650	656	631
Change in body weight (kg)	+48	+33	+59
Kg milk/kg feed	1.88	149	1.16

*Bath (2)

Table 2

Influence of Ratio of Grain to Hay on Milk Production (305 days)*

	Grain:hay ratio fed			
Trial	15:85	23:77	33:67	40:60
Yield				
Milk, kg	6308	6664	7249	7342
Fat, kg	227	238	261	254
FCM, kg	5920	6238	6818	6753

*Lamb, et al. (6)

that do not restrict intake through low digestibility of dry matter. The data also indicate that cows with low potential for milk production have correspondingly low appetites for feed.

The importance of a minimum ratio of grain to roughage to insure adequate energy intake for milk production was demonstrated in recent research reported by Lamb, et al. (6). The data in Table 2 illustrate the results. Grain consumed accounted for 55% of the variation in milk production. The two variables, grain consumed and rate of grain feeding, accounted for 90% of the observed variation in milk production. The small increase in total milk which accompanied the change from a grain-to-forage ratio of 33:67 to 40:60 indicated that a ration density had been reached where ration intake was no longer limiting milk production.

Many dairymen questioned the ability of cows to consume adequate nutrients under group feeding programs. A study by Coppock, et al. (3), indicated that group-fed cows actually consumed an average of 7% more feed than cows fed the same 60:40 roughage-to-grain ration on an individual basis. The data are summarized in Table 3. Since milk production and body weight gain were similar, the group-fed cows apparently used the extra feed for increased maintenance.

Finally, the question of grouping cows according to production vs. feeding cows with varying levels of

Table 3

Response of Cows Fed the Same Ration on an Individual or Group Basis*

Item	Individual	Group
Feed intake (% body weight)	3.09	3.32
Milk production (kg/day)	16.03	15.91
Milk fat (%)	5.16	5.26
4% fat-corrected milk (kg/day)	18.73	18.94
Mean body weight (kg)	547	545
Mean weight change (kg/day)	+ .47	+ .44

*Coppock, et al. (3)

Table 4

Production of Grouped vs. Non-grouped Cows Fed a Total Mixed Ration*

	Herd 1 Non-grouped	Herd 2 Grouped
1. Number cow years	60.8	62.2
2. Production:		
a. Milk/cow/year (kg)	5372	5385
b. % cow days in milk	82.0	78.9
c. Milk/cow/day (kg)	14.7	14.7

*Yoder (8)

production in the same group was studied by Yoder (8). The non-grouped cows consisted of a herd of cows in all stages of lactation, while the grouped herd was divided into high and low producers plus dry cows. The results are shown in Table 4. The data clearly illustrate the lack of need for grouping cows by production level for feeding purposes.

In addition to the research reports presented here, many dairy farmers have used the optimum feeding system in part or total for several years. Field observations have confirmed the theory and research results.

Summary

An new concept for feeding dairy cows a total ration based on factors known to influence feed intake, rumen fermentation and milk production has been developed and tested in controlled research and under field conditions. The concept of "optimum rations" eliminated the need for tables of nutrient requirements and permits ration formulation from universally used measures of feedstuff components. Thus, the program is equally useable regardless of the system of energy evaluation currently in use in a given country or geographical area.

References

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Review Questions

1. The dry period nutrition of the dairy cow is unrelated to other stages in her yearly feeding program. True ____ False ____
2. An optimum total ration for a producing dairy cow should contain ____ Mcal/kg of metabolizable energy.
3. Long roughage should constitute the major feed during the dry period. True ____ False ____
4. Cows consume feed in direct proportion to their ____ and ____.
5. It is essential that cows be grouped for feeding according to level of milk production. True ____ False ____