Feeding Heifers From Three Months to Calving

Heifers can grow at an adequate rate on high quality forage, but grain is needed if forage is poor or below average. Some liberties can be taken to use low quality feeds in feeding heifers from about 4 to 24 months. However, don't stunt skeletal and muscle growth. Moreover, the low quality ingredients should be fed for only limited periods to use them up and not included in heifer rations as routine practice. For a heifer to reach breeding size (800 lbs. for Holsteins) by 14 months, it must gain about 1.7 lbs./day from birth; so that poor quality feeds cannot comprise the major portion of the overall ration.

Feeding large amounts of grain to growing heifers (so they become fat) is both uneconomical and damaging to their lifetime productivity. Experiments and several research stations have demonstrated lower lifetime milk production and poorer longevity of heifers fed very high energy levels early in life. In addition to decreased milk yields, poorer conception rates and more calving problems have been associated with fat heifers.

Good heifer growth on corn silage systems (silage plus protein and minerals) has been shown. Silage treated with non-protein nitrogen (urea or ammonia solutions) have also produced good growth. In corn-growing areas feed costs for raising heifers using a maximum of NPN-treated corn silage are lower than the conventional hay-grain system. Table 9 gives the approximate amounts of feed consumed by a dairy replacement heifer raised on a hay or a corn silage regime. Perhaps the most desirable system is a combination of hay and corn silage.

Summary

1. **Feed at least four lbs. of the first colostrum to the calf by 12 hrs.**
2. **Colostrum must be the first material to enter the digestive tract.**
3. **Best calf growth resulted from feeding colostrum till weaning.**
4. **Saving in feed cost compared to whole milk is $20/calf.**
5. **Frozen colostrum appears superior to fermented.**
6. **Bathing the intestine with colostral antibodies gives defense against local infections.**
7. **A protein: energy ratio of 30-40:1 is best. Milk replacers with 20% protein and 20% fat achieve this.**
8. **Certain vitamins and minerals should be added to milk rations fed for long periods.**
9. **Use starter consumption and not age as criterion for weaning calves.**
10. **Starter should be palatable and high enough in energy and protein to keep the calf growing when weaned from liquid.**
11. **Keep heifers growing at 1.6 to 1.8 lbs./day. Don't overfatten. Have them large enough to breed (700-800 lbs.) by 14 months.**

Milk Replacers for Pre-Ruminant Calves, Formulations, Problems, Economics

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When marketing calf milk replacers, there are three prime concerns, (1) must meet the nutritional requirements of the calf, (2) must be more economical than whole milk, (3) must have physical characteristics that make it convenient to use. These concerns should be ranked in this order. However, they often are not by both manufacturers and consumers. All three must be achieved in such a way so as not to jeopardize the satisfactory fulfillment of the other two.

Milk has long been referred to as the most perfect food, and has and will continue to be widely used as human food. This has made milk a valuable human food. As a result, since right after the turn of the century, attempts have been made to develop replacements for milk to be fed to calves to both lower cost, and at the same time, free the milk for human consumption. Originally these formulas were based on such products as linseed oil meal, wheat middlings, wheat red dog, wheat flour, oat flour, and soybean meal. These early products were really not milk replacers, but rather milk extenders. They were often fed as a gruel. These milk extenders, to be successful, needed to be accompanied by large amounts of whole milk, or in those days when the majority of dairymen separated milk, skimmilk. Unless large amounts of milk were used, these milk extenders would be disastrous failures.

As time progressed, milk ingredients appeared in the milk extenders in ever increasing amounts. About 1950 the first true milk replacers were developed and marketed. About this time, because whole milk pric-

ing was tied very closely to butterfat, the by-products of the butter and cheese industry–dried skimmilk, dried buttermilk, and dried whey–were readily available at low prices. This, with the substitution of butterfat with other cheaper animal fats such as lard and tallow, made these products very price competitive with whole milk. In those early days, the fat was added directly to the milk ingredients–so called batch mixing. This method of addition restricted fat to a relatively low level. This necessarily made these early milk replacers too low in fat. When later, methods of fat incorporation were improved and it was realized that higher fat levels gave greatly improved results, fat levels in milk replacers were increased to 10% or higher.

During this period of developing the quality, all-milk, milk replacers, the other type of milk replacers, which were extensions of the original milk extenders, continued to be marketed. However, the overall growth in the industry was largely in the better type products because of better performance and the low cost of milk ingredients.

The next phase in the milk replacer industry began on April 1, 1966. Prior to that date, the government support price on dried skimmilk was 14.6¢ per pound. To keep the skimmilk at that price level, the government was buying large quantities and then moving it back to the feed industry at reduced prices. Thus, up until this time, skimmilk was the primary source of protein for the quality milk replacers. On April 1, 1966, the support price for dried skimmilk was raised to 16.6¢ per pound; two months later it was raised to 19.6¢. This was the beginning of a series of further increases in the skimmilk support price. It also signaled the end of extensive uses of skimmilk as an animal feed ingredient. The support level has continued to increase to where it has reached nearly 60¢ per pound. Changes in demand and consumption have reduced butter and skimmilk production substantially to where, even with the high support price, very little skimmilk has found its way into government hands and in turn, into animal feeds.

With these rapid and substantial increases in skimmilk costs, the prospects were for substantially higher milk replacer costs unless some alternate proteins could be utilized. The most common alternate sources that were put into use were casein and newly developed soy proteins. Casein was the most logical choice for the quality product. The principle behind its use is that when casein is removed from skimmilk, the portion that remains is whey. So if the reverse is done and casein is combined with whey in the proper ratios, the resulting product, which is often referred to as simulated skimmilk or imitation skimmilk, would have the same nutrient make-up as skimmilk. Thus, when high quality casein was combined with high quality whey and incorporated in milk replacers, it resulted in animal performance equal to that of skimmilk at a more favorable cost.

At this same time, various specially processed soy proteins were being developed. Calf feeding trials conducted at that time indicated that these products showed improved performance over the conventional soy proteins and more nearly approached the performance of all milk protein, than any other non-milk protein tested up to that time. However, these special soy products did not find an immediate place in milk replacers because there was no significant economic advantage.

The use of casein-whey combinations (simulated skimmilk) remained the primary source of protein in quality milk replacers for the next six years. In late 1971, drastic changes occurred in the world milk market. World milk product supplies had been in a surplus supply for a long period of time and had offered on the world market at extremely low prices because of oversupply and government subsidy programs. Then suddenly, with government subsidized slaughter of dairy cows, subsidized government disposal programs, and drought in some major producing countries such as New Zealand and Austrialia, the surplus was turned into a shortage situation, driving world skimmilk prices soaring. Since casein is manufactured from skimmilk, its price was directly affected, and tripled in six months time. This immediately caused a crisis in the milk replacer industry as it appeared that casein would not be available at any price. Complicating the situation was the fact that the soy products that had become available and found relatively effective had found a home in the human food market and now were not readily available. The law of supply and demand and the ingenuity of our researchers have since rectified this situation so that we now have sufficient casein available at somewhat higher prices and some newly developed specially processed soy proteins at competitive prices. Unfortunately, the higher prices of ingredients has done one thing and that is that many poor quality products are again being promoted and used because of economics.

Before discussing the formulation of milk replacer, let's consider the composition of whole milk. (See Table 1.) The protein is broken down into three components–Casein, 80%; Lactalbumin, 18%; and Globulin, 2%–while the NFE is relatively all lactose. Another way to look at whole milk is that on a dry matter basis it would be 28% fat and 72% skimmilk, with skimmilk breaking down into 24.9% casein and 47.1% whey, or approximately 1:2. Casein is almost entirely composed of protein, while whey is largely lactose with little protein. (See Tables 2 and 3.) Thus, in formulating calf milk replacers, we are basically looking at the replacement or use of butterfat, casein and whey.

What is the status today of the various ingredients which are being used in the milk replacer industry? This will be somewhat of a review of my remarks of a year ago, with economic considerations.

1. *Dried Skimmilk* - contains about 34 to 35% protein and 50% lactose. The protein quality is deter-

Table 1
Composition of Whole Milk

	Fresh	Dry
Dry Matter	12.6	100.0
Protein	3.5	27.8
Fat	3.6	28.5
Nitrogen Free Extract	4.8	37.9
Ash	0.7	5.8
Calcium	0.12	0.93
Phosphorus	0.09	0.75
Sodium	0.05	0.39
Chlorine	0.20	1.56

Table 2
Composition of Casein

	100% Dry Matter
Protein	90.0
Fat	0.9
Nitrogen Free Extract	5.7
Ash	3.4

Table 3
Composition of Dried Whole Whey

	100% Dry Matter
Protein	13.0
Fat	1.0
Ash	10.4
Lactose	75.6

mined by the amount of heat exposure during processing. The more heat, plus time, will cause protein denaturization and lowered quality. Unfortunately, most of the skimmilk powder produced in the United States is exposed to this type of processing and is really not ideally suited for milk replacer use. Secondly, the present price support level does not make dried skimmilk economically feasible. There is a small amount of animal grade skimmilk available at a lower price, most of which is unsuitable for milk replacer use.

2. *Dried Buttermilk* - can be used interchangeably with skimmilk. Because of the present butter manufacturing process, there is little dried buttermilk available and again, the cost is not economical for use in milk replacers.

3. *Dried Whey* - is a by-product of the cheese industry. Whey is the most widely used ingredient in the milk replacer industry. Dried whey takes in a wide range of qualities, of which only the top quality can be used in milk replacers. If the whey is kept from souring and is properly processed, the use of whey in milk replacers is only limited by its low protein content. However, if the whey is allowed to sour, which often happens at small installations, it must be neutralized before it can be spray dried. The souring of the whey will cause protein degradation while the neutralization process causes the ash level to rise beyond acceptable levels, which could cause toxic reactions, and in lesser amounts, scour problems and poor animal performance. Most whey today is spray dried. This is the desirable method of drying whey. In the past, much of the whey was roller dried. With this method, it is difficult to control temperature; also sour whey can be dried without neutralizing, allowing low pH whey. It is because of these reasons that roller dried whey is usually not of milk replacer quality. Whey availability is closely related to total cheese production. At the present time, whey is readily available to the milk replacer industry at relatively low costs. The future status will depend upon the total availability and the demands for whey for human consumption.

4. *Delactosed Whey* - takes in a variety of products. Delactosed whey is the result of removing a portion of the lactose. Depending on the amount of lactose removed, the protein can range from 16 to 28%, and the ash level will range from 13 to 23%. This immediately limits the amount of delactosed whey that can be used because of the ash level. The minerals can be removed but the cost usually is prohibitive. Today delactosed whey is readily available because of the overwhelming demand for lactose. The future supply of delactosed whey will depend somewhat on the world sugar market because lactose can replace dextrose in many candy and bakery products. It can be expected that delactosed whey will be available to the milk replacer industry for the immediate future.

5. *Casein* - is produced by coagulating the protein in skimmilk, or it may be described as the protein in cheese. Almost all of the casein used in the United States is imported. For animal use, this is limited to those countries which are free from hoof & mouth disease, e.g., New Zealand, Australia, Canada and Ireland. Most of the casein used in the milk replacer industry comes from New Zealand and Australia, who are just recovering from drought conditions. The future supply and price of casein will depend upon the world dairy products supply. gif those countries find that they can sell their skimmilk at a good price, they may not choose to produce casein.

6. *Milk Albumin* - is the protein of whey which can be isolated in the production of lactose. It is not commonly used in milk replacers, but milk albumin is a very good source of protein.

7. *Soy Proteins*. The acceptable soy proteins can be divided into three categories - soy isolates, soy concentrates, and specially processed soy flour. The proteins of all of these soy products are quite digestible, approaching that of milk protein. However, the carbohydrate portion cannot be used by the young calf. Thus, soy isolates would, in theory, be the best source of soy protein. However, this has not been the case in the field. It may be that in the processing, the amino acid balance has been changed. Both the soy concentrates and specially processed soy flour give about equal results when the carbohydrate portion is discounted. When the economics are considered, the

specially processed soy flour is by far the best buy, followed by soy concentrates. The soy isolates are the most expensive per unit of protein. Both the soy isolates and soy concentrates are widely used in human foods, accounting for their higher costs. Soy proteins will be used in greater amounts in milk replacers in the future. To what greater extent will depend on how they are improved and how the economics compare between milk and soy proteins. We will definitely be competing with the human food market for these proteins.

8. *Meat Solubles.* This is a soluble protein that is a by-product of the packing industry. It is largely composed of collagen. It is an undesirable source of protein for milk replacers because of an improper balance of amino acids. Also, meat solubles are not well accepted by the calf and need to be masked by flavors or odors. Meat solubles are often used in milk replacers because of their physical characteristics–going into solution readily and having no fiber content. When used, the claim, "no cereal added" is commonly made, or it sometimes is referred to as "all milk" or "milk base" product. These statements are misleading because this product is actually nutritionally inferior to the improved soy products.

9. *Others.* Other products such as fish protein concentrates, distillers dried solubles, brewers dried yeast and wheat flour are used in inferior milk replacers, but have little value and should not be used. Looking ahead, there may be new products developed such as alfalfa protein concentrate, which has recently been tested with promising results.

In formulating milk replacers, fat is the one nutrient where the economics favor milk replacer over whole milk. There are several sources of fats used in milk replacers, with choice white grease and tallow being the most commonly used. Both choice white grease and tallow are readily available because they are by-products of the red-meat industry. Coconut oil has been used, largely in veal feeds, but the cost is quite high. Other vegetable oils such as soy oil have been used, but have not given good performance. Soy lecithin, the phospholipid portion of soy oil, is used routinely in milk replacers for its emulsifying properties. This emulsification, along with homogenization of the fat, results in digestibility of the choice white grease and tallow which approaches that of butterfat.

There are only two carbohydrates that are readily used by the young calf. These are lactose and dextrose (glucose). So we must rely almost entirely on milk products for carbohydrate sources in milk replacers. Dextrose or glucose are not practical sources of carbohydrates in milk replacers because of the cost. Starch and sucrose (table sugar) cannot be used by the young calf because of the lack of amylase, maltase and sucrase activity in the young calf. Vegetable carbohydrates such as are found in soy products are very complex and cannot be used by the young calf.

The question is asked, "Why use a milk replacer?" It can be answered with the following: 1. Economics - allowing a dairyman to sell all of his milk; 2. It is a product that is consistent day after day; and 3. When no whole milk is available.

Economics has certainly been the prime reason for the use of milk replacers over the years. Surprisingly, today, even with the high cost of ingredients, the economics of using a milk replacer are better than they ever have been. Let's take a look at an example:

100 lbs. Whole Milk (Oct. 1974 Avg. price)	$8.21
100 lbs. Reconstituted Milk Replacer (12.5% solution 20-20 All Milk)	4.15
Difference	$4.06
If you use 250 lbs. of whole milk:	$10.15

Many dairymen use more than 250 lbs. of whole milk or reconstituted milk replacer today.

The fact that using milk replacer allows one to feed a consistent product day after day is often overlooked by the dairyman. By feeding a milk replacer, the dairyman can feed a product that has the same solids content, protein, fat, carbohydrate, vitamin and minerals levels, plus feed at the same temperature. If the dairyman uses colostrum, these factors will vary considerably because of the large variability of colostrum, depending on when after calving the colostrum is collected. These variations have been seen to cause trouble in the field. Field reports by several veterinarians I have visited with have confirmed the fact that they have observed more consistent results with good quality milk replacers than with colostrum and hospital (unmarketable) milk. In addition, there is less opportunity for bacterial contamination when using milk replacer. If the milk replacer bag remains intact, the opportunity for bacterial contamination is almost nil.

Calf milk replacers are needed when no milk is available. This includes specialized calf raising operations and fancy veal raisers. Today this amount being fed is drastically reduced because of the depressed calf industry. Under normal conditions, this market would account for about 25% of the total milk replacer sales.

Let us look at the problems of milk replacers. The main problem is that if we want to most closely simulate whole milk, we have the highest cost product. Our best ingredients - milk products - are the most expensive. Even with the most expensive ingredients, we have not been able to completely simulate whole milk. This may sound contradictory to a previous statement, but this is not true because here we are comparing milk replacer to marketable milk as compared to colostrum or unmarketable (hospital) milk. Because of the high cost of the best milk replacer ingredients, many manufacturers are encouraged to use less desirable ingredients which results in poor performance. This, in turn, gives all milk replacers a black mark because many people

consider these poor quality products the norm for the industry. Another problem for the milk replacer industry lurks on the horizon - this is government intervention. The Canadian Department of Agriculture recently jumped on the bandwagon of Naderism and decided to cure all the ills of the calf raiser of Canada and proposed regulations that must be met on a milk replacer. I agree in principle with the majority of these proposals. However, as consumer oriented regulations often tend to be, they have gone overboard. Some of the criteria in their proposal are backed only by theory and not by calf performance. The loser will be the dairyman who the Canadian Government is so gallantly trying to protect. In addition, nutrition is only one factor in the success of a calf raiser. We cannot legislate the calf raiser to do a good job of management and sanitation, which are most important for a calf raising operation to be successful. The reason this action has been proposed in Canada is that certain milk replacer manufacturers have insisted on merchandising poor quality milk replacer. If we continue to do this in this country, we may face the same action.

What should we look for in a high quality milk replacer? First of all, all ingredients should be of top standards and at the same time, meet the nutritional needs of the calf. The milk replacer needs to have an adequate protein level which is digestible by the young calf. The fat must be completely homogenized and emulsified and added at a level which is adequate. The vitamin and mineral levels must not only meet the requirements of the calf, but be added in a form that goes into solution to insure their being consumed by the calf. After meeting the nutritional requirements of the calf, the physical characteristics of the milk replacer must be considered. Ideally, a milk replacer disperses readily and stays in solution forever. Unfortunately, these two characteristics do not usually go together. Those milk replacers that disperse easily usually do not stay in solution very well and tend to settle out in a short period of time. Some milk replacers contain roller dried whey to improve their dispersibility. Roller dried whey has a larger particle size, allowing it to disperse quite easily, but it will settle out. As was mentioned previously, roller dried whey usually is of poor quality. Another gimmick has been introduced in the recent past–instantizing. This is a method of increasing particle size to make it disperse more easily. It does not add nutritionally and may detract because the product is exposed to additional processing. In addition, this further processing adds to the cost just for adding a minor convenience in improving dispersibility while lessening the solubility and nutritional value.

We can classify milk replacers into four categories: (1) Optimum, (2) Acceptable, (3) Passable, and (4) Inferior.

The optimum milk replacers are those that contain only protein from milk. The protein level should be at least 20%. The N.R.C. suggests a protein level of 22%. However, there is enough research evidence and field experience to indicate that 20% protein is sufficient when all of the protein is derived from high quality milk products. The fat level should be at least 10% and preferably be 20%. In fact, at the present time we are merchandising products with fat levels as high as 30% with excellent results. The higher fat levels tend to reduce diarrheal problems and give overall better performance, especially through the weaning stress. Sometimes it is difficult to measure any difference in weight gains when using higher fat milk replacers. However, this may be the incorrect way to judge performance and we should consider livability and the health of the calf, which would both favor the high fat milk replacers. It has been demonstrated that with higher fat levels, fat is deposited in the body of the calf. Thus, during the weaning stress, the calf can call on these body stores and better overcome the stress of weaning. All of the ingredients in a milk replacer in the optimum category must be of top standards.

The milk replacers in the acceptable range differ from those in the optimum in that a portion of the protein may be derived from the specially manufactured soy protein or soy concentrates. Also, the protein should be raised to 22% because of the alteration in the protein source. The protein level is raised because the protein digestibility would be somewhat lowered and the protein equivalent per unit of nitrogen in soy protein is lower than that of milk protein. The fat level in a milk replacer in the acceptable range would be a minimum of 10%. Milk replacers in the acceptable range, when combined with good management and environmental conditions, plus healthy calves, will result in reasonably good calf performance, but not necessarily as good as when an optimum range milk replacer is fed.

The passable category of milk replacers encompasses those milk replacers that have a portion of the protein provided by a non-milk protein source. This alternate protein source does not necessarily have to be, and usually is not, specially manufactured soy protein or soy concentrate. Again, the protein level must be at least 22% and the fat level, a minimum of 10%. Another difference in the passable category as compared to the two previous categories, would be that the milk ingredients would not necessarily be of top standards. With a milk replacer in the passable range, and with all conditions excellent, a dairyman may be able to keep a calf alive until the calf can exist on dry feed, but the results would not be satisfactory. The passable milk replacer cannot be recommended.

The last category, inferior milk replacers, are those that do not fit any of the above categories. These products may be described as having a "license to kill" and should not be used under any circumstances.

Always tell your clients to buy milk replacer because of quality rather than price. Secondly, if your client uses a milk replacer, encourage him to follow

the manufacturer's directions, as both underfeeding or overfeeding can be equally harmful.

In conclusion, what is the future of the milk replacer industry? It is very obvious that our future is very closely allied to the future of the dairy industry. We feel that we have a very viable future because the milk replacer industry will continue to free whole milk for human consumption. At the same time, we can provide a successful product for less cost than whole milk. In the future, the milk replacer industry will continue to investigate for use, and use ingredients that cannot be used for human consumption. The milk replacer industry will be in existence as long as there is a dairy industry.

Panel Discussion

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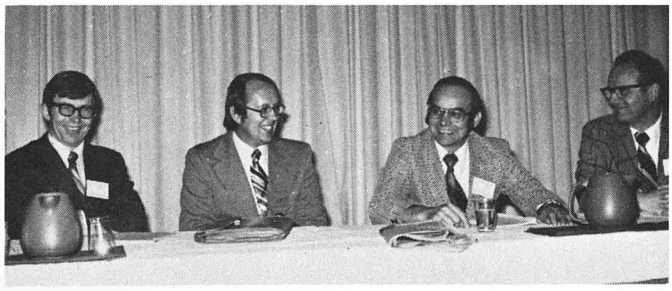

Moderator: This particular subject, as many of you know, interests me. I've been a disciple of Dr. Huber's for a long time. I have been quoting his work for some time now since he did some very fundamental work in digestive enzymes in calves. Perhaps I could start the discussion off by asking Dr. Schugel, how does the veterinarian in the field assess the quality of the milk replacer that is being fed to calves that may be suffering a variety of diseases? Let's say persistent intractable diarrhea in a veal calf operation or in a large dairy herd where the man is using milk replacers? How does the veterinarian say yes, this is a high quality milk replacer; I'm confident that it is. Therefore, I can tentatively remove it as a factor in making my diagnosis or investigating why these calves have diarrhea. This has been one of my chief problems in trying to investigate why these calves are scouring. Is it salmonella? Is it BVD? Is it reovirus? Is it a wet barn? What is it?

He took some aim at the Canadian government for government intervention on milk replacers. I don't want to get into politics. I just wish, personally, that we had a Ralph Nader in our country, and I hope he doesn't choke on a seat belt! I happen to be a consumer and I'm interested in the quality of my cars, my drugs and the foods I eat. I don't want to say anymore about that. As far as we're concerned, our veterinarians, our producers, and particularly our veterinary students in veterinary cults are saying, "Why isn't someone doing something about quality control in milk replacers?" If I look at a label on a milk replacer bag and it says protein, fiber, fat and then it lists all the ingredients, that does not help me assess its quality one bit. Now I'd like to open some discussion on how the veterinarian decides on quality? Does he take blind faith in the company?

Answer: That's an excellent question; a very valid question, and I wish I could give you a blanket answer. There is no secret way of looking at a tag because you can do a lot of things with tags and come up with many, many different results. There are large variations in quality. It is phenomenal! You just wouldn't believe it. I guess without regulations your next best bet is probably the integrity of the people you are working with. I don't know what better method you could have. Sure, there are some broad outlines you could make, such as the fat level being high. As far as the protein quality, there is no way you can put that on the tag. I do not have a good answer for it really.

Question: What is the significance in knowing the protein–energy ratio in a milk replacer or in any feed? How do we use that information in the field?

Answer: An overage of protein is not going to hurt; it is just going to cost more! Here, I think this 30:40 protein ratio - what we're trying to achieve - will give you a milk replacer which will do you the best job for the amount of money you put into it. You go higher in protein and it is the protein ingredients that are the more expensive ones. You're just throwing your money away. I guess that would be my primary response.

Question: What is the importance, based on today's information, of the milk clot in the abomasum of calves fed either whole milk or more particularly milk replacers? There was some work done some time ago which suggests that maybe the milk clot was not that important in the abomasum. What is the current state of information?

Answer: I don't know. You're quoting Foster Allen who completely eliminated the milk clot. He had very high quality ration though. In that case you didn't need the clot to slow down the passage of that milk. Now, I presume over a heated milk replacer you probably benefit from a milk clot. Over a milk solid you'd benefit from a milk clot. You'd benefit with less digestible protein, too, because you would slow down the passage and increase the digestibility of that particular material. High quality products, and these are the ones where we can be assured of the clot. I'm not sure we really need it that much if we believe the work done at Iowa years ago.

Question: How does pre-milking affect the com-