

Creating Space In Dairy Rations

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If you find yourself reading the title of this paper twice, wondering what “space” has to do with the diet of a dairy cow, you are not alone. Nutritionists and producers regularly discuss terms like “pounds” of dry matter intake or “percent” protein or “how many” mega-calories of energy or grams of calcium or what is the “ratio” of calcium to phosphorus or what is the cation-anion “balance” in our rations. None of these discussions even comes close to mentioning “space” as an important consideration when planning or troubleshooting a milking cow’s diet.

To understand the critical importance of space when it comes to feeding a cow, we need to shift our thought process from one of thinking about what makes up the diet to what happens to the diet – and all the ingredients of which the diet is comprised – once it is consumed by the dairy cow. In short we need to shift our thinking from diet ingredients to diet digestion.

What Happens to Feed Consumed by a Dairy Cow?

1. Once swallowed, feed first enters the reticulo-rumen (from here on called the rumen).
2. The rumen contains billions of microorganisms (I like to call them rumen bugs) that break down feed and build amino acids for the benefit of their own high-protein bodies.
3. Approximately 70% of digestion of feed (organic matter) takes place in the rumen, with the remaining 30% of digestion occurring in the omasum, abomasum, and small and large intestine.
4. Feed can only leave the rumen two ways: a) after being digested by the rumen bugs, the products of digestion are absorbed through the wall of the rumen and into the blood stream of the cow, or b) undigested particles can pass through the reticulo-omasal orifice where they continue through the abomasum and intestines (where digestion is similar to that of many simple-stomached animals including humans).

5. Digestion by rumen bugs takes time. Feeds and the different components, which make up feeds vary greatly in their rates of digestion. Fiber digests slowly.
6. AOTBE (all other things being equal), the larger the rumen, the more time feed will spend in the rumen.
7. AOTBE, the more time spent in the rumen, the greater the extent of digestion of any feed, particularly the fiber present in feeds.

Considering the above facts, I have come to - and attempt to adhere to - the following principles which have helped, over the years, direct my thinking and feeding philosophy.

Feeding Philosophy Principles

1. Since 70% of digestion occurs in the rumen, one must first and foremost cater to rumen digestion in order to maximize cow performance.
2. Rumen digestion requires a balance of fiber digestion and starch digestion to maintain a healthy rumen pH while also maximizing rumen bug growth.
3. Since fiber digestion takes time, it requires a lot of space, both space in the diet and space in the rumen.

Do I always adhere to the above philosophies when feeding cows? I wish I could! Without question, some situations make it easier than others to practice what I preach. The following is a fictional and extreme example of a no-win situation.

Imagine a herd of first lactation heifers that were raised on lush pasture and corn silage only. What do you suppose is the physical size of their rumens? Upon calving, the producer asks you to feed some overly mature corn silage that has few ears because of the drought and plenty of poorly digestible fiber along with 102 RFV hay that tested 16% protein. He also got a good buy on wheat middlings, distillers grains, and straw (he read that feeding straw is the latest thing). As long as you feed what he has on hand, you can add anything else to the ration to “make it work”.

Any experienced nutritionist laughs and cries at the same time while reading the example above. Although extreme, the example is not as fictitious as we would prefer. What we nutritionists do not always recognize, however, is the real enemy in this scenario. Most of us would quickly respond that the problem in the above example is “feed quality.” This is certainly true, but if I were to ask,

“Why is feed quality in a dairy ration so important?” the answer ultimately becomes “We run out of space to put in enough of the things we need in the diet to make it work”. If space in diets were unlimited, dairy nutrition would be easy.

Cows are ultimately limited as to how much feed they can consume and digest each day. Rumen fermentation of feeds requires time and space. When we can increase intake and/or increase digestion, cow performance is likely to improve.

I use the following thought process to help maintain or improve performance in the herds I work with.

Non-Numerical Goals for Building a Good Ration

1. Keep the ration healthy, i.e. balance fiber and non-fiber carbohydrate levels, both chemically and physically.
2. Manipulate physical form of feeds to maximize digestion in the rumen without significantly depressing dry matter intake (give digestible feeds time to digest).
3. Do everything possible to maximize dry matter intake so long as it does not break rules 1 and 2 (many of these issues are management related, not formulation related).
4. Select feeds that work well together and bring “rumen positives” to the table and not “rumen negatives”.

Depending on the situation, some feed choices can be either a rumen positive or negative. In fact, most feeds qualify as rumen positive in some ways and rumen negative in others. I simply try to be conscious of choosing ingredients that bring as many positives and as few negatives to the table as possible. I will attempt to list criteria I use to help put feeds in the rumen positive or rumen negative category.

Characteristics of Rumen Positive Feeds

1. Fresh and mold free
2. Will aid in the formation of a rumen mat
3. Contains fermentable non-fiber carbohydrate
4. Contains fermentable fiber carbohydrate

5. Supplies rumen available protein in the form of ammonia to the rumen bugs
6. Supplies rumen available protein in the form of amino acids to the rumen bugs
7. Supplies rumen available protein in the form of peptides to the rumen bugs
8. Additives that aid in rumen fermentation such as buffers and yeast

Characteristics of Rumen Negative Feeds

1. Moldy
2. Contains significant amount of “ballast,” i.e. indigestible residue (can apply to protein, fiber and non-fiber carbohydrate)
3. High in bypass protein
4. Contributes significant amounts of free oil or free fat to the rumen environment

To further explain the lists above, it becomes important for me to explain, for example, that I do include some feeds high in bypass amino acids in my diets, but I try to do so by using as little space as possible, leaving as much space as possible for rumen positive feeds. Remember that this is based on the principle that maximizing rumen fermentation is 70% of “the game”.

Below are two examples of one poor and one good feed choice based on the above criteria.

Rumen Negative and Space Negative Example: Distillers Grains

Minnesota leads the nation in ethanol and distillers grain production. I use very little, if any, in the rations I help put together for clients. Why? What does distillers bring to the table? It does contain some bypass methionine, but it takes 2 to 3 pounds of distillers dry matter to get the same amount of bypass methionine I can get from 10 to 25 grams of a commercially manufactured bypass methionine product. The “rest” of the distillers contains some fiber, fat and phosphorus, the physical form of the fiber being of no advantage and the digestibility of the fiber is questionable. The cooked liquid vegetable fat definitely belongs in my rumen negative list, and the extra phosphorus is becoming more and more of an issue from a manure management standpoint. I prefer to use as little space as possible to meet my bypass methionine needs, leaving more space in the diet for rumen positive feeds that bring fewer rumen negatives into play.

Rumen Positive and Space Positive Example: Corn Gluten Feed

At first glance, corn gluten feed (CGF) does not look like a space-efficient feed choice. It is a medium protein feed (18-22% CP) with medium fiber levels and medium NFC levels. It's true, CGF is not strong in any one nutrient, but each of the nutrients it contains is very digestible and contribute positively to rumen fermentation. The protein (nitrogen) is very available to rumen bugs, the fiber is very digestible due to the chemical and physical processing the corn has undergone. It is also important that CGF brings no big negatives with it. I often explain CGF to producers as a feed that has nearly the energy of corn with the protein thrown in for free (my clients typically buy CGF for less than the price of ground corn.) The free protein is also an advantage for me, in that I will not have to tie up as much space in the diet with other supplemental proteins. For several years, I have used CGF in rations at rates of 6-10 pounds dry matter/head/day and I continue to consider it a space efficient and economically efficient feed.

Quality Generalists

There are several other obvious examples of feeds that are not necessarily strong in any one contribution to the diet, yet they are space efficient because they bring with them several rumen positives. High quality alfalfa and grass forages contribute rumen nitrogen, amino acids and peptides along with digestible non-fiber carbohydrate and digestible fiber. Corn silage brings digestible non-fiber and digestible (we hope) fiber to the ration. Fuzzy cottonseed provides protein, digestible fiber, and rumen friendly (we think) fat all in one efficient package. Soybean meal could be viewed as a bit more specific in its contribution to diets (mostly a source of protein,) but it does efficiently help accomplish several of my goals as a good rumen bug source of nitrogen, amino acids and peptides with good bypass protein quality, i.e. containing a decent amount of lysine.

Specific Space Savers

There are other feeds that can be used effectively to conserve ration space by doing one thing and doing it well without any additional ballast along for the ride. Below is a list of feed ingredients that I call "specific space savers" with a brief description of what each does best.

Straw – emergency rumen mat maker, a little goes a long way
Beet Pulp – best floating digestible fiber on the market
Fine ground/flaked corn, barley, starch – fermentable NFC becomes rumen bug protein
Rumen Inert Fat – only when absolutely necessary; post-ruminal calories only
Urea – provides fast ammonia nitrogen to fiber digesting bugs in the rumen
Blood Meal – best concentrated source of bypass lysine – no synthetics yet available
Smartamine, MetaSmart, Mepron – synthetic bypass methionine sources
Nitrosure – slow consistent and complete rumen release ammonia

Recent Trends in the Space-Saving Concept

Several space-saving strategies have been around for years, whether or not we nutritionists have recognized them as such. It is no accident that high quality forages, steam-flaked or finely ground corn, soybean meal and cottonseed have been used successfully by nutritionists and dairy producers for several years. In the last two or three years, saving space or making space has been taken to the next level by our industry due primarily to two manufactured feed ingredients; rumen escape amino acids and slow release nitrogen.

Amino Acids Rumen escape methionine products have been available for several years. Initially, supplemental amino acids were evaluated by adding them on top of already well-balanced rations. This always resulted in increased ration expense and only resulted in improved performance if methionine supply was most limiting for milk production. Many of us tried these supplements in a herd or two only to abandon them when we saw no improvements in cow performance. The more recent approach of using these expensive but very concentrated synthetic supplements to remove other space-inefficient ingredients and even lowering ration crude protein levels has given amino acids new life. In more than one way, using synthetic amino acids to “make space” in the diet is what has made them attractive, once again, to nutritionists and producers.

Nitrosure, slow release nitrogen: My colleagues and I have been using Nitrosure since the day it was available to us. We had always recognized the benefits of using urea in lactating diets, particularly in high corn silage diets. We also realize the limitations to using urea as a protein source for dairy cows. I think it is fair to say that most producers have become more reliant on corn silage in

recent years. This trend has forced us to find more space in our diets for supplemental rumen available protein. Using Nitrosure in addition to urea has given us the space we need to make difficult rations decent and make good rations even better. Several of us continue to use Nitrosure to create one to three pounds of “space” in the diet regardless of market prices of the traditional protein sources that Nitrosure displaces in our diets. There is value in having space to insert the rumen positive ingredient(s) of our choice that goes beyond comparing cost per pound of nitrogen.

Economics

Dairy ration economics are important, yet I see the popularity of “least cost” rations dwindling. I do not do a ration or select an ingredient without knowing, or at least having a feel for, what it will cost the producer. That said, I am also aware (and producers know this better than we do) that producers get paid, in recent years, between 12 and 18 cents per pound of milk produced. Every producer I know would (at least should) accept a 10-cent increase in feed costs if he/she could also get a 25- or 30-cent increase in milk income. Even allowing a large range for feed costs from 5 to 8 cents/pound of dry matter (5 is minimum in the Midwest; 8 is maximum in the West), producers will usually trade more milk for more feed costs. If I successfully follow the principles discussed in this paper, assuming that feeds are well digested, creating a pound of space and filling it with high quality ingredients should result in two to four pounds of milk production. If it costs me a nickel or dime per head per day to manipulate a diet so that it is space efficient, I have done the job I have been hired to do by my clients.

Implications

I have purposefully left most of the numbers out of this somewhat philosophical, one-sided discussion about creating and managing space in dairy rations. Regardless of what software program we use, the numbers will work themselves out on their own. Our job as nutritionists is to use the space between our ears to create as much space as we can for the right combination of rumen-positive ingredients when planning and building dairy rations for our clients.