La Qualité pour les Marchés et la Pérennité

Alimentation des brebis prolifiques*

(Feeding Prolific Ewes)

Woody LANE, Ph.D., consultant
Livestock Nutritionist
Lane Livestock Services
Roseburg, Oregon, États-Unis

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Feeding Prolific Ewes

SUMMARY

Prolific ewes are ewes that give birth to twins or triplets or more at lambing. Their nutritional requirements are considerably higher than other sheep, and a shepherd is challenged to feed them properly. The results of improperly feeding prolific ewes include lower milk production, reduced lamb growth, poor body condition, loss of reproductive efficiency, and increased expense for maintenance and veterinary problems. My presentation focuses on three main topics with high-producing ewes: (1) Research demonstrating that our underlying assumptions about intake and production of prolific ewes may be questioned. Early-lactation ewes raising triplets fed limited forage and free-choice grain for 41 days reared triplets that each gained more than 300 g/day while the ewes themselves simultaneously gained 250 g/day during this period. (2) The actual nutritional effects of providing grain supplement on pasture. Supplemental grain reduces the intake of forage and also the digestibility of that forage. This associative effect should be accounted for when the nutrient intake is calculated, and it explains why animals may not perform as well as expected when supplemented with grain on pasture. (3) Differences between the old and new nutrient requirement tables for prolific ewes. The new 2007 NRC (National Research Council) Reference Book lists lower energy, protein, and intake values than its predecessor, the 1985 NRC Reference Book. There is a discussion about how these numbers were derived and what these changes might mean.

1. A NEW TAKE ON INTAKE

When we devise a ration for sheep or cattle, we always first ask ourselves how much will the animals eat?” Then we decide on a likely level of intake and build a ration based on that decision. We’re not too surprised when the animals actually eat that amount of feed. But... but... our diet formulation was based on our estimate of the intake, and the intake was based on the formulation of the diet. Are we not in a logical box?

Let’s climb out of that box for a moment...

A few years ago at Cornell, Doug Hogue and some undergraduate students conducted a modest study with ewes raising triplets. Instead of guessing what the ewes would eat, they let the ewes tell them. The ewes were quite eloquent, and now we must question our own assumptions.

First, a little background on nutritional requirements: The 1985 NRC reference book *Nutrient Requirements of Sheep* (National Research Council — *the* reference source for diet formulation) lists the requirements only for ewes raising singles or twins, not triplets. We can, however, start with those numbers and then use our best judgment to adjust them for triplet lambs. In brief, the NRC requirements for 65-kg ewes raising twins during early lactation are 1.75 kg TDN and 413 g crude protein. The NRC tables also list the dry matter intake (DMI) at 2.7 kg, which equates to 4.2% of body weight. The underlying assumption of those NRC requirements is to maintain a ewe's weight throughout her production cycle except during early lactation, when she would experience a negative energy balance. During peak lactation, the NRC expects twin-rearing and single-rearing ewes *to lose* 60 g/day and 25 g/day, respectively. We would expect triplet-rearing ewes, of course, to lose even more weight than that.

Based on these NRC tables, many experienced sheep professionals suggest the following rule-of-thumb for feeding ewes in early lactation: Give the ewe 0.5 kg of 16% grain for each lamb that she is rearing, plus all the good alfalfa hay she can eat. A 65-kg ewe rearing triplets, for example, would receive a daily ration of 1.5 kg of grain plus 1.7–2.0 kg of alfalfa hay (assuming a DMI of 2.9 kg = 4.5% body weight).

But Doug and his students reversed this logic. Rather than feeding a limited amount of grain and allowing unlimited access to hay, they fed a limited amount of hay and allowed unlimited access to grain. And they found that, not only did those ewes *not* die of acidosis, but their performance... well, read on...

The trial consisted of fourteen ewes all rearing triplets (Finn-Dorset crossbred ewes averaging 65 kg). The ewes were fed a severely limited amount of hay at only 1.5 kg/day but they were allowed to consume *all* the 16% grain supplement they wanted. The trial lasted for 41 days, beginning a few days after lambing — i.e. during the peak period of lactation. The lambs were sired by good black-faced bucks, so we know that those lambs had a pretty good genetic potential for growth. The lambs did not have access to a creep feed. The hay was just an average quality grass-legume hay, and the grain pellet was a 16% commercial supplement. Let's assume, for the purposes of calculating DMI, that the hay and grain both contained 90% dry matter.

The results: The ewes consumed 1.5 kg of hay *and 3.5 kg of pellets each day* — a DMI of 4.5 kg/day (after adjusting for DM percentage), which equals *6.8% of body weight*. During those 41 days, the lambs *each* gained 322 g/day and — hold on to your hats — *the ewes also gained 250 g/day*. And this was during early lactation, when the NRC expects ewes to *lose* body weight. Instead, those ewes supported 966 g of total lamb growth each day while simultaneously adding 250 g to their own weight. Not bad.

You might ask about the grain pellet. Well, the pellet was *not* a special formulation from the depths of Cornell's laboratories. It was simply a commercial 16% high energy lamb pellet, right off the feed store shelf. It contained mostly grain, with 15% forage as fiber source, some

Bovatec® to control coccidiosis, 2% limestone to balance the calcium-phosphorus ratio, and 0.5% trace mineral salt. In other words, a fairly reasonable and routine formulation. Its fiber component, however, was primarily soy hulls. Soy hulls are high in pectin, which is a type of fiber that digests quite rapidly in the rumen but still retains the fermentation characteristics of other types of fiber. This may have helped, but it wasn't the whole picture.

Now turn on your calculator. If that "average" hay contained 13% protein "as fed" — a reasonable assumption — correcting for percent dry matter gives a crude protein value of 14.4% on a dry matter basis. That kind of hay would probably contain 60% TDN. Similarly, the 16% high-energy supplement (on a dry matter basis) would contain approximately 17.7% crude protein and 85% TDN. Applying these values to a DMI of 4.5 kg means that those ewes consumed 3.45 kg of TDN and 745 g of protein, which are 97% and 80% higher, respectively, than the NRC requirements for twin-rearing ewes. Even if we allow an extra cushion for the higher requirements of triplet lactation, it's obvious that those ewes ate quite a bit, maybe 50% or more than their requirements, *as the NRC has defined those requirements*. But did the ewes get fat? No, they just reared triplets successfully and gained weight at the same time.

So are the 1985 NRC requirements wrong? Probably not —the committee of scientists originally derived those requirements from lots of careful, solid experimental evidence. However, the underlying assumption of those requirements — i.e. that ewes cannot maintain body condition during early lactation — is patently wrong. Those fourteen ewes told us that. Apparently, those ewes had not read the NRC book.

It's a good thing, too, because the NRC book does not list the nutritional requirements for ewes in early lactation rearing triplets where the ewes gain 250 g per day *while* providing enough milk for *each* of their three lambs to gain more than 300 g per day.

Perhaps we should think about reevaluating the nutritional requirements for lactating ewes, or at least our strategies for feeding ewes during early lactation. And also reevaluating our assumptions about what a ewe can really accomplish. A 300% lamb crop without any orphan lambs or loss of body condition — that's a wonderful goal for any flock of ewes. Especially when we know how to feed them.

2. GRAIN ON GRASS – LET'S DO THE NUMBERS

Okay, raise your hand — how many of you have supplemented grain to animals while they were grazing on pasture and were disappointed with the response? Don't be shy. Keep your hands up. Well, you're not alone. Twice during the past year I've read scientific papers that reported the same thing, and those researchers were not only disappointed but also puzzled. After all, why wouldn't extra grain provide enough surplus energy to overcome intake problems and increase daily gain or milk production?

Because you wouldn't expect it.

First, the standard answer. In every university course called "Livestock Nutrition 101", in one lecture during this course, the instructor carefully intones students about feeding extra grain to grazing animals. Essentially, the message is that grain will "replace" some of the forage and therefore will not provide as much extra nutrition as you'd expect. Therefore, the instructor continues, if a ewe was consuming 3 kg of forage, adding 1 kg of corn will not simply boost her intake to 4 kg. Most of the corn will *replace* some of the forage, and total feed intake will rise only 250 g or so. Since the TDN value of corn is 88% (all nutritional values are on a dry matter basis), and the TDN value of the forage is, say, 65%, the net effect of all this supplement is only a modest increase in nutrient intake — and certainly not as much as the 792 g of TDN that you'd expect from 1 kg of corn (90% DM at 88% TDN). The students dutifully write this down and perhaps ask a question or two. Then the instructor then moves on to the next topic, maybe something about the effects of chewing gum on hippopotamus growth or whatever.

Elementary, my dear Watson, elementary.

Now, let's move beyond this simplistic explanation and look at grain supplementation in more depth. Grain doesn't just "replace" forage. Grain also profoundly changes the rumen environment, and these changes can sometimes offset much of the extra energy supplied by the grain. Nutrition textbooks typically list this phenomenon as the *Associative Effects*, but here let's see what these effects really mean. Oh yes, you can put your hands down now.

We need to make four assumptions: (1) the supplement consists of corn or barley or a multi-grain mixture and does not contain any added buffer such as sodium bicarbonate, (2) a significant amount of grain is offered, (3) the pasture is reasonable quality with a TDN value of 65%, and (4) the grain is offered only once each day, which is the typical procedure on most farms. These assumptions, of course, imply the following: that the grain supplement is primarily starch, that the supplement does not contain lots of salt to limit intake, and that the supplement is consumed rapidly. The last assumption is fairly obvious to anyone who has ever fed corn on pasture. Aside from protecting yourself against being run over, you'll always observe that the animals will nearly *inhale* the supplement — they gobble it up as fast as their mouths can move. No dainty manners here. In all the years of feeding supplements, I've *never* seen animals step back to save some grain for a future late-night snack.

So here's what happens when this grain is supplemented to grazing ruminants: The starch in the grain enters the rumen and ferments at a very fast rate, much faster than fiber. The rumen bacteria that ferment this starch produce end-product acids (*VFAs – volatile fatty acids*) so quickly that these acids overcome some of the buffering capacity of the rumen, driving down the rumen pH from its normal level of 6.2–6.5 to less than 5.8, at least for a few hours each day.

The lower rumen pH causes problems for the species of bacteria that ferment fiber. The lower rumen pH reduces their populations and activities, thus slowing down the rate of fiber digestion. Because the undigested fiber remains longer in the rumen, sensors in the rumen wall alert the animal's neural feedback system that the rumen is still full. Which tells the animal to reduce its feed intake. Since we assume that the animal eats all its supplemental grain, any reduction of feed intake must come from the amount of grazed forage.

Therefore, grain supplementation on pasture results in a lower intake of forage *and also a lower digestibility of that forage*. And for those who are still following me, this effect would be more pronounced with grass than with a legume such as clover or alfalfa. Why? Because grass contains higher levels of potentially-digestible fiber than legumes, and it's the fermentation of this potentially-digestible fiber that is most depressed by the feeding of starch.

Let's do the numbers. Our example will be a 70-kg ewe suckling twins in early lactation (using the 1985 NRC Nutrient Requirements). This ewe requires 1.82 kg of TDN to support her milk production and minimize her early-lactation weight loss. If she grazes pasture containing 65% TDN with a daily dry matter intake of 4.0% of her body weight, she would eat 2.8 kg of dry matter (= 4% of 70) containing 1.82 kg of TDN, which nicely meets her requirements.

But... let's say that we want to increase milk production or prevent loss of body weight, so we'll offer this ewe a daily supplement of 1 kg of corn (= 0.9 kg of dry matter). Since corn is 88% TDN, this supplement will provide 0.792 kg TDN. And of course, our ewe will gladly eat all the corn quite rapidly.

If we assume that the ewe's dry matter intake will rise slightly — to 3.1 kg — then her forage intake will be 2.2 kg (= 3.1 minus 0.9 of corn). If we *ignore* the associative effects of the starch and assume that the original nutritional value of the forage remains unchanged at 65% TDN, we calculate that 2.2 kg of forage will provide 1.43 kg TDN (= 65% of 2.2), giving a total TDN intake of 2.22 kg — which is a 22% increase of digestible energy intake due to grain supplementation. Hmm, so far, 22% looks pretty good.

But we can't ignore the associative effects of starch on fiber digestion, can we? Of course not. Therefore, if we accept that associative effects apply to our situation, then we must reduce the TDN value of the forage from 65% to, say, 55%. Now let's *redo* the numbers with this new TDN value.

Our ewe consuming 2.2 kg of this forage will now only receive 1.21 kg of TDN from it (= 55% of 2.2). Adding the 0.792 kg TDN from the corn gives her a total daily intake of 2.00 kg TDN, *which is only 10% above her original energy requirements*. Not exactly something to write home about. In the highly variable world of real-time grazing, a TDN boost of only 10% would be lost in the normal background variation.

Let's put this in perspective. In our example, the supplementary grain provided +400 g TDN when we *didn't* include associative effects in our calculations but only +180 g TDN when we *did* include them. The difference between these two numbers represents a 55% drop in supplemental TDN from the corn (= 220 as a % of 400). Which number is correct? Well, how many times have you been disappointed by the performance of grain-supplemented animals on pasture?

But even if the animals didn't perform as well as expected, at least we can be assured that they were happier with all that corn.

3. DIETS, NEW AND OLD

When I recently used the new sheep nutritional requirements to balance some ewe rations, I noticed something disturbing. The new reference values seemed very different from the previous numbers I had used for years. So I opened both reference books and investigated, calculated, estimated, and reiterated. And I found some things that were very interesting indeed.

The *National Research Council (NRC*) publishes the American reference tables for livestock nutrient requirements. The newest sheep requirements are listed in the 2007 book *Nutrient Requirements of Small Ruminants*. Although it covers sheep, goats, alpacas, and deer, this book contains an impressive 25 pages of tables for sheep requirements. The previous NRC book on sheep — *Nutrient Requirements of Sheep, 6^th^ Revised Edition* — was a slim 1985 volume that listed its nutrient requirements on only seven pages. The copy on my bookshelf is dog-eared and heavily creased, like a well-worn pair of leather boots. Anyway, I'll refer to these two books as the *2007 NRC* and the *1985 NRC*.

Each book explicitly lists the nutrient requirements for ewes and lambs in various stages of production. The 2007 NRC contains more categories and wider ranges of body weights than the 1985 NRC, which is to be expected. The 2007 NRC also addresses some concepts in different ways, such as listing three different requirements for crude protein based on the proportion of *rumen bypass protein* in the diet. But we won't go off on these tangents. In this month's article, we'll just focus on comparing the old numbers with the new numbers.

Let's approach this question in a practical way. Instead of jumping around the chapters and comparing different formulas, kind of like kicking the tires of a new car, let's examine one typical feeding situation and compare the nutrient requirements listed in each edition. Specifically, let's choose a mature 70-kg ewe raising twins in early lactation. We'll assume that our ewe is in moderate body condition and not under any stress from weather or disease, so the numbers in these tables don't need any adjustments.

First, the old values. The 1985 NRC defines early lactation as the first *eight* weeks after lambing, and it assumes that during this period, a ewe raising twins will lose 60 g per day. To support milk production and not lose additional weight, the 1985 NRC lists this ewe's daily requirements for energy and protein as 1.82 kg TDN and 418 g crude protein, respectively. For the main minerals and vitamins, our ewe needs 11.0 g calcium, 8.1 g phosphorus, 7,000 IU vitamin A, and 42 IU vitamin E. Based on these requirements, the 1985 NRC expects her daily dry matter intake (DMI) to be 2.8 kg, which is 4.0% of her body weight. A ration supplying her requirements at this level of intake would test at 65.0% TDN and 15.0% crude protein.

Now, the new values. As a literary device (what, in this article?) to make comparisons easier, I'll try to duplicate the exact sentence structure and wording from the previous paragraph. (Also, I've calculated my percentages from the original metric values, which may cause some rounding differences here).

The 2007 NRC defines early lactation as the first *six* weeks after lambing, and it assumes that during this period, a ewe raising twins will lose 31 g per day. To support milk production and not lose additional weight, the 2007 NRC lists this ewe's daily requirement for energy as 1.31 kg TDN. Protein is a bit more complex because the 2007 NRC lists *three* different crude protein values determined by the percentage of rumen bypass protein in the diet (the 2007 NRC refers to bypass protein as *UIP – Undegradable Intake Protein* – but we will still call it bypass protein here). For diets containing bypass protein at 20%, 40%, and 60% of the total protein, the ewe's daily requirements for crude protein are 306 g, 292 g, and 279 g, respectively, which equates to dietary protein levels of 15.5%, 14.7%, and 14.1%. For the main minerals and vitamins, our ewe needs 7.9 g calcium, 6.9 g phosphorus, 12,500 IU vitamin A, and 392 IU vitamin E. Based on these requirements, the 2007 NRC expects her daily DMI to be 1.98 kg, which is 2.8% of her body weight. A ration supplying her requirements at this level of intake would test at 66.2% TDN.

Wow, that's a lot of numbers. Now let's compare them.

Interestingly, the main nutrient *percentages* are rather similar — both diets contain approximately 65% TDN and 14–15% crude protein. But these percentages are deceptive because they mask major differences in required *amounts* of nutrients. And when we do the calculations to balance diets, we usually try to supply the appropriate *amounts* to the animals, and the percentages are just byproducts of these calculations.

When we compare the required *amounts* of nutrients, we see stark differences. Compared to the 1985 NRC, the 2007 NRC requires 28% less TDN and approximately 30% less crude protein (for simplicity, I averaged the three 2007 crude protein values to 292 g). Calcium and phosphorus requirements are 28% and 15% lower, respectively. And the 2007 NRC requires 79% more vitamin A and a whopping 833% more vitamin E. Actually, these last four values for minerals and vitamins are based on lots of new research, so I have little reservation about *those* differences.

Also, the 2007 NRC assumes our ewe would lose weight at only 31 g, which is 48% less weight loss than indicated in the 1985 NRC.

But one item of real interest is the dry matter intake. The 1985 NRC predicts a DMI of 2.8 kg, while the 2007 NRC predicts only 1.98 kg — a 29% reduction in feed intake. These DMIs represent 4.0% and 2.83% of the ewe's body weight, respectively.

What gives? Well, let's see how these numbers were derived.

In the early 1980s, the scientists in the NRC Sheep Nutrition committee examined all the research to date, evaluated the pros and cons of these trials, looked at the outliers and averages and special circumstances, and poured through thousands of studies. The committee scientists were all experienced sheep men. Based on these studies and their own personal experiences, they tried to extrapolate these research results to practical situations and come up with reasonable numbers for each requirement.

In contrast, the Small Ruminants Nutritional committee for the 2007 NRC pursued their task in a different way. Sure, the committee members looked at previous research and carefully evaluated the numbers. But these scientists *also* relied quite heavily on a complex computer model — the *Cornell Net Carbohydrate and Protein System for Sheep (CNCPS-S*). A computer model is nothing but an extensive set of interlocking equations, with coefficients and variables, and behind each equation lies a set of assumptions. The CNCPS-S model is complex and flexible; it's designed to predict responses when the inputs are known. For the beef cattle and dairy industries, similar models have provided some reasonable results.

Each number in the 2007 NRC reference tables was built step by step from component parts, with this computer model contributing input at various steps along the way. Particularly for energy, protein, DMI, and weight loss.

But I wonder... the discrepancies are larger than I expected. Compared to the 1985 NRC numbers, the new 2007 NRC reduces energy and protein requirements by 30%. Do these smaller amounts of energy and protein really provide enough nutrition to support milk for two lambs while simultaneously reducing the ewe weight loss — especially in the face of lower feed consumption? My experience tells me that ewes will consume 4% or more of their body weight during lactation. This new model predicts less than 3%. If this model is accurate, the wide differences in recommendations between the two NRC books implies that those scientists in 1985 were rather inaccurate in *their* judgments.

In the 22 years between editions, have modern ewes changed so much? Or have we learned so much more? Or have we just altered our approach to estimating nutritional requirements, so that these editions reflect changes in the technique rather than actual requirements? Or don't we know?

We need some good research. Animal Science Departments and USDA Experiment Stations throughout the country should conduct dozens of bread-and-butter studies in which sheep are fed diets formulated for the requirements listed in these two NRC editions. Head-to-head comparisons, so to speak. The results should reveal which assumptions are correct and which requirements are accurate.

Otherwise, without such comparisons, we may be in a situation best described by paraphrasing a quote from the 1995 movie *Apollo 13*: "*Houston, we may have a problem.*"