The Digestive System of Lambs

by

Basil Bactawar, BSc., MSc., Animal Scientist/Nutritionist

Roraima Feeds (Summit Livestock Nutrition)

Racecourse Road, BUSH Lot Farm, Corentyne, Guyana

The digestive systems of mammals are broadly divided into two classes:

1. Monogastric –meaning one stomach, includes:
   human, horse, pig
2. Ruminant – includes sheep, cattle, goats, deer, bison

In order to understand some of the unique properties of the ruminant system, it will be helpful to briefly discuss the simpler monogastric system.

Monogastric Digestion

An outline of the human system is shown in figure 1. Food, upon entering the mouth, is subdivided by chewing. At the same time lubricating digestive juices containing enzymes are secreted from the salivary glands. These particular enzymes are responsible for initiating the breakdown of starches.

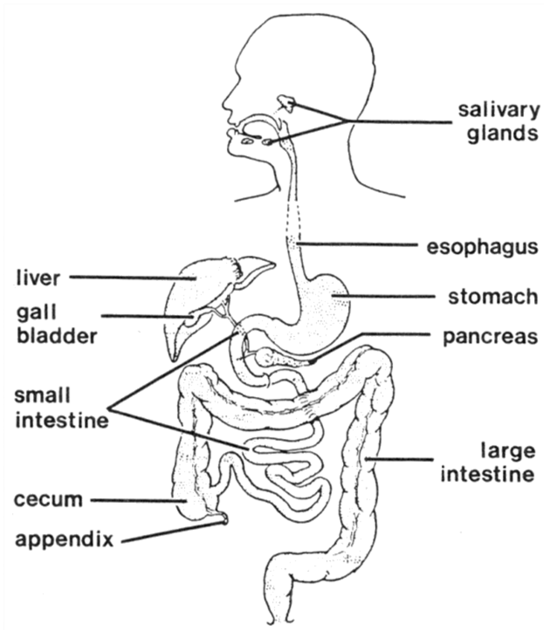

Figure 1. The human digestive system.

Food, now mixed with these secretions, passes down the esophagus into the stomach, where the digestion of protein, fats and oils is initiated by acid and other specific enzymes. In monogastrics, the stomach also serves as a reservoir for food which has been rapidly ingested.

When the initial stages of digestion in the stomach are completed, the contents pass into the small intestine. Here, bile from the liver and gall bladder, as well as enzymes from the pancreas is added. Breakdown continues as the digesta travel the 10-20 meter length of the small intestine, while at the same time the products of digestion are absorbed into the bloodstream.

Enzymatic breakdown of most of the organic constituents of food is complete by the time the unabsorbed digesta reach the large intestine. One of the main functions of this part of the system is the absorption of water and minerals of both dietary and secretory origin. In addition, further breakdown is carried out here by a permanent population of microbes (bacteria and protozoa) with some proportion of the products being absorbed into the blood. Food material which has escaped both enzymatic and microbial digestion is excreted.

Some monogastrics, like the horse and rabbit, have a relatively large capacity for microbial digestion in the large intestine and cecum. Table 1 compares the size of several parts of the both ruminant and monogastric digestive systems. Notice that where the large intestine and cecum make up only 19% of the digestive system in the human, they represent over 60% of the total volume in the horse. The implications of this will become clear when we discuss microbial digestion in the ruminant.

Table 1. A comparison of the relative sizes of digestive tract compartments in adult animals.

Digestive Compartment	Volume as % of Total Digestive Tract				
	Cattle	Sheep	Horse	Pig	Human
Rumen	56.9	52.9			
Reticulum	2.1	4.3			
Omasum	5.3	1.7			
Abomasum	6.5	7.7			
Total Stomach	70.8	66.6	8.6	29.2	18.8

Small Intestine	18.5	20.5	30.2	33.3	62.4
Caecum	2.8	2.6	15.9	5.6	
Large Intestine	7.9	10.3	45.3	31.9	18.8
Total Capacity (liters)	356.0	44.0	211.0	28.0	6.0

The Sheep's Digestive System

The main feature which distinguishes our own digestive system from that of the sheep is the complex stomach shown in figure 2. The first two sections, the rumen and reticulum comprise a large fermentation compartment. Ingested feed passes rapidly, with very little chewing, down a muscular esophagus into the rumen. Later, boluses (cuds) of feed are regurgitated, broken down by chewing and mixed with saliva. The sheep, in fact, produces large volumes of saliva, perhaps up to 25 liters per day. The absence of adequate fiber in the ration to permit cud formation may account for the wool picking and wood chewing which is sometimes seen in lambs on concentrate rations.

On entering the rumen, feed is immediately subjected to microbial digestion. An extremely varied population of bacteria and protozoa (figure 3) attach themselves to the feed and begin the breakdown process. This is facilitated by the secretion of enzymes onto the feed and into the fluid contents of the rumen. It should be noted that the microbial population which becomes attached to a particle of grain will be quite different from that which attaches to a forage leaf. This has important implications when changes in ration are contemplated. A slow transition is necessary to allow time for alternations in microbial populations. If there is no slow transition, then it may lead to digestive upset in the animal. The lining of the rumen is like pile carpet having innumerable small, flat projections called papillae. These serve two main functions. They vastly increase the area for absorption of nutrients and they also provide attachment sites for additional populations of bacteria. Figure 4 is an electron photo-micrograph of bacteria attached to rumen papillae. These bacteria, like the ones attached to feed particles, produce enzymes which are secreted into the fluid contents of the rumen. One of the important contributions of this particular population is the enzyme urease which is responsible for the breakdown of urea. Feed, then, is subjected to digestion both by enzymes dissolved in the general surrounding of the rumen and, more specifically, by those produced by attached microbes.

Continual mixing of rumen contents is essential to efficient fermentation. The muscular walls of the rumen and reticulum produce waves of contraction traveling their combined lengths at about half-minute intervals. This process, in addition to mixing the rumen contents, facilitates both regurgitation for further "cud-chewing" and belching, which releases gases produced by fermentation (mainly hydrogen and methane). Under some conditions (eg. grain overload) the muscular walls may stop contracting resulting in rumen stasis, which can place the animal at serious risk of bloating.

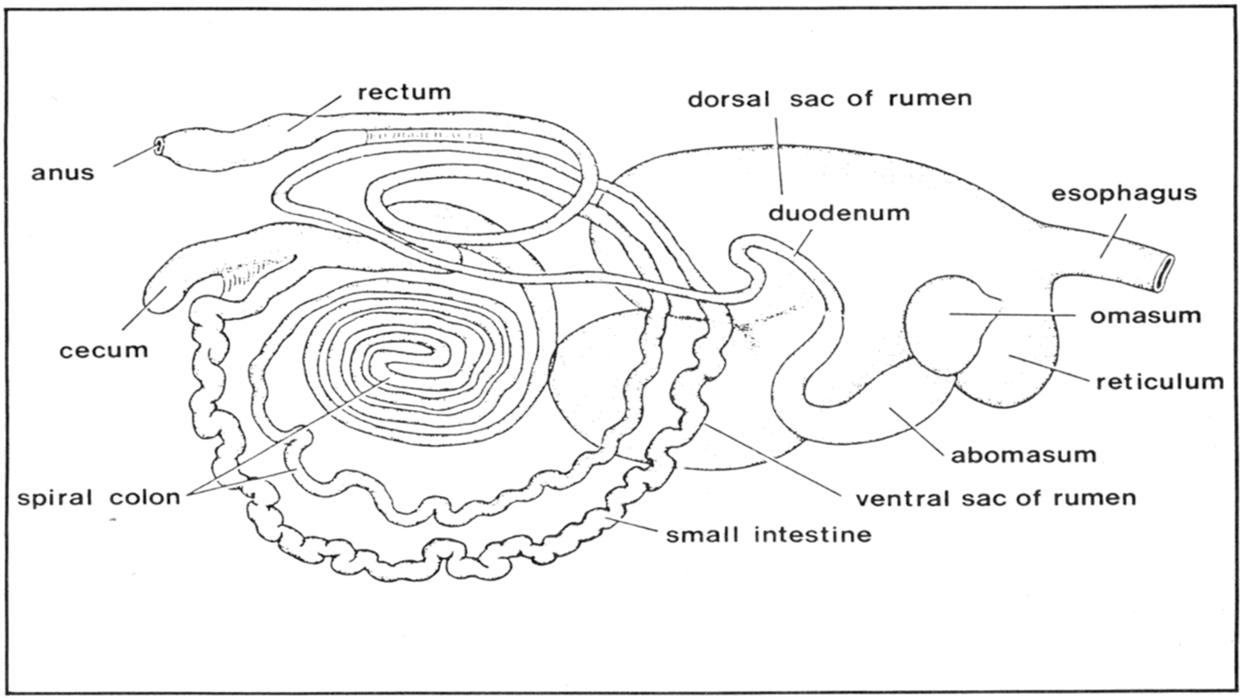

Figure 2. The digestive system of the sheep.

After the feed has been sufficiently chewed and broken down by microbial action, the digesta enters the omasum. Flow into this third segment of the ruminant stomach is regulated by a small opening called a reticulo-omasal orifice which prevents large particles from leaving the rumen. It is the small caliber of this orifice which makes it possible for sheep to utilize whole grains. The larger orifice in cattle allows particles the size of whole grain to pass into the lower gut and be excreted.

The omasum itself is a muscular organ which is thought to have two main functions. The first is the extraction of water from the rumen fluid yielding a product for further digestion which has a significantly higher proportion of dry matter. Secondly, the omasum serves as a pump, propelling digesta from the rumen and reticulum into the fourth segment of the stomach, the abomasum.

The ruminant abomasum is analogous to the true stomach of the monogastric with its digestive processes being very similar to those described earlier for the human. Digestion and absorption of its products progress as the digesta passes down the small intestine.

The large intestine and cecum of the sheep represent only about 12% of the total volume of its digestive system. This may seem quite insignificant in comparison with the horse (table 1). However, fermentation in this area can make a significant contribution to overall digestion.

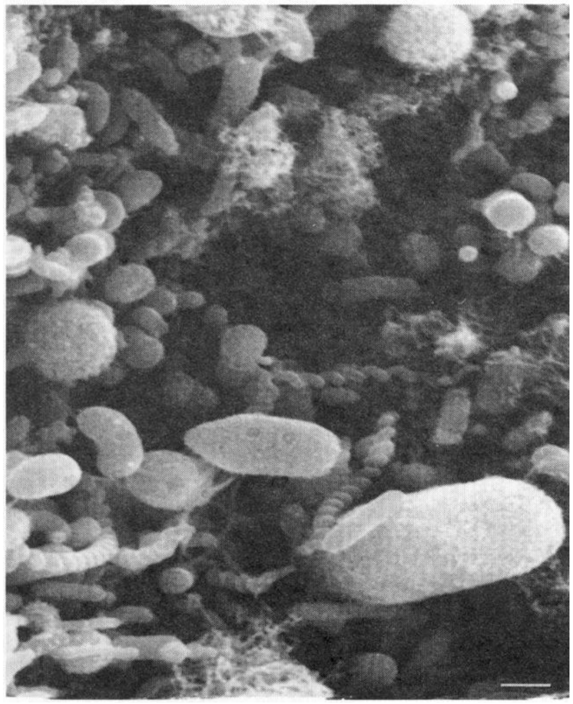

Figure 3. The varied population of bacteria and protozoa found attached to feed particles in the rumen and reticulum.

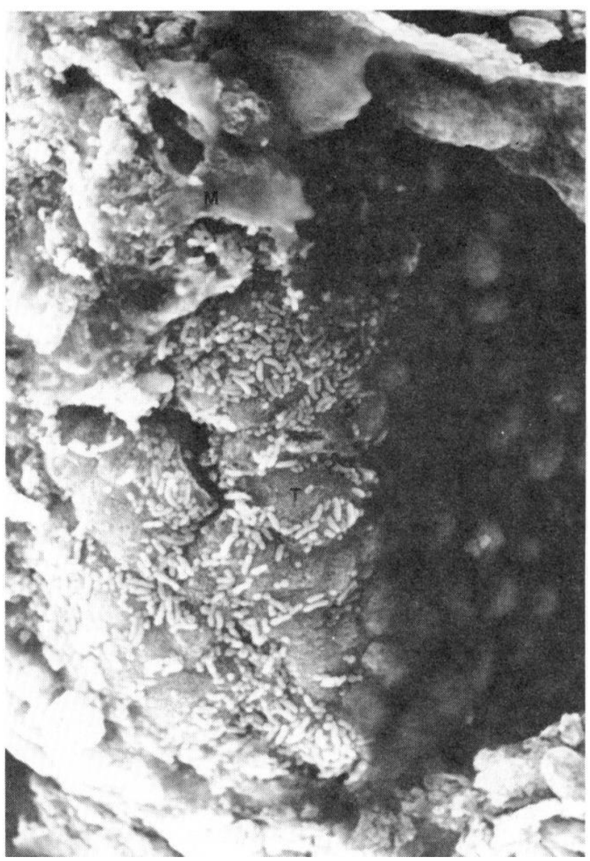

Figure 4. Bacteria attached to the lining of the rumen.

Development of the Ruminant Stomach

At birth, the lamb's rumen and reticulum have a capacity roughly equal to that of the abomasum (figure 5). They contain no micro-organisms and, as a consequence, are not capable of functioning as they do in the adult. Bacteria begin to populate the rumen shortly after birth as the lamb begins to nurse and explore its environment. However, it takes several weeks before a stable microbial population is established which is capable of efficient digestion.

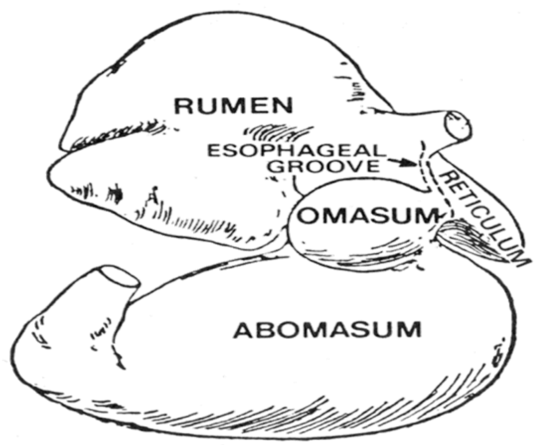

Figure 5. The stomach of the newborn lamb.

By inoculating the rumen and reticulum with a more appropriate microbial population, the digestive tract can be protected from the adverse effects of such contaminants through competition.

The second reason for attempting to establish a functional population is to hasten the ability of the rumen and reticulum to digest solid feed. This would make it possible to wean lambs earlier, a particular advantage when accelerated lambing is being attempted.

The Esophageal Groove

Since the rumen and reticulum are non-functional in the newborn lamb, a mechanism has evolved which allows milk to flow directly to the omasum. A reflex reaction causes a muscular fold on the wall of the reticulum to form a closed tube leading from the end of the esophagus to the reticulo-omasal orifice (figure 5). This fold is called the esophageal groove and an appreciation of its function will affect some of the management aspects of feeding newborn lambs.

The esophageal groove closes in response to behavioral stimuli associated with the ingestion of liquid feed such as nursing from the ewe or feeding from a nipple pail. Even the sight of a nipple bottle may elicit the response in an orphan lamb. The reflex, however, requires some degree of training. Therefore, it is used to best advantage when feeding routines are well established.

If at all possible, weak newborn lambs should be encouraged to suckle either from the ewe or from a bottle. Although feeding by stomach tube may be the only alternative in many cases, this will invariably result in milk being deposited in the reticulum. A similar situation arises when milk is ingested too rapidly to be accommodated by the esophageal groove. This can occur when milk replacer is fed from a bottle or from the bottom of a nipple pail where a round-holed (rather than a cross-cut) nipple is used.

Milk which finds its way into the rumen and reticulum is subjected to fermentation by bacterial contaminants early in life. Such fermentation may result in significant gas production resulting in a typical pot-bellied lamb. The young lamb cannot expel this gas efficiently since the belching mechanism is poorly developed.

Lambs being fed through a rubber nipple should be encouraged to suck. Frequent feedings of small volumes are usually more successful than large volumes fed infrequently.

Effect of Feeding Management

Between birth and maturity, the rumen and reticulum increase tenfold in volume in relation to the abomasum; the rate at which this proceeds can be significantly altered by nutritional management.

Most newborn lambs show little interest in consuming solid feed before they are two or three weeks of age. Consequently, until that time they must be nourished exclusively by milk or milk replacer. After this time it is possible to accelerate rumen development through feeding practices.

The closure of the esophageal groove only occurs when liquid feed is ingested. Therefore when solid feed is consumed it travels directly to the rumen where it is fermented to produce volatile fatty acids. The presence of volatile fatty acids (VFA) has a direct effect on rumen development and, furthermore, higher rates of VFA production will accelerate this development. These observations have a direct bearing on management practices in feeding young lambs.

Creep feeding has become common practice in most successful sheep operations. The aim is to provide palatable, high quality solid feed to encourage consumption as early in life as possible. Restriction of milk intake after solid feed consumption is well established. This further promotes the intake of creep ration. The higher the quality and the greater the quantity consumed, the higher will be the rate of VFA production and the more rapid will be the rate of rumen development. Creep feeding is an essential practice in maximizing lamb growth potential through increasing the ability of the lamb to consume nutrients. It also facilitates early weaning in accelerated lambing systems.