# Digestion and Nutrition

# The Digestive System

In order to make use of the nutrients stored in feedstuffs, all animals must first break down (digest) feed into a form that can be absorbed by the body. The focus of this chapter is to provide a basic overview of the structures, abilities, and limitations of the sheep's digestive system. Sheep belong to a group of herbivores called ruminants. Ruminants are able to digest a large portion of the nutrients contained in fibrous plant material due to their unique digestive system, which integrates a large microbial population with the animal's own system. Although this system is remarkably efficient, proper feeding management is needed to maintain healthy and productive animals. Mismanagement of a ruminant's diet can be disastrous.

## Structures of the Digestive System:

The digestive tract is composed of the mouth, esophagus, stomach, small and large intestines, and anus. Various other structures and organs, such as the salivary glands and liver, also aid in digestion. A few of the key structures are described below:

***Salivary glands*****:** There are three sets of glands that drain saliva into the mouth. The saliva mixes with the feed that is being chewed and is swallowed with the feed. Saliva, which has a high pH, is very important in maintaining the correct pH balance in the rumen and is a key component of rumen fluid. Therefore, the salivary glands in ruminants are extremely productive. An adult sheep, for example, may secrete over 25 litres of saliva per day.

***Esophagus****:* The esophagus is a long muscular tube that runs to the stomach. When feed is swallowed, muscles in the esophagus move the food to the rest of the system

***Stomach***

The stomach of ruminants greatly differs in structure and function compared to monogastrics (dogs, pigs, horses, humans etc.). Monogastrics have a relatively simple, single-chambered stomach. Sheep, like other ruminants, have three additional chambers (reticulum, rumen, and omasum) that feed passes through before reaching the 'true' stomach (abomasum).

**Reticulum:** The reticulum is a blind pouch of the rumen that acts as a holding area for feed after it passes down the esophagus. The reticulum receives material coming into the digestive system and will trap large inedible objects. As there is no distinct division between the rumen and the reticulum, they are often referred to together (reticulo-rumen).

**Rumen:** The rumen is a very large muscular pouch, which extends within the left side of the body cavity from the diaphragm to the pelvis. The rumen is a critical site for feed digestion in ruminants. The rumen has a complex environment composed of microbes, feed at various stages of digestion, gases, and rumen fluid. The microbes (bacteria, protozoa and fungi) number in the billions and are the basis of the fermentation (digestion) process. The rumen contents separate into three zones based on their density and particle size: gas (fermentation by-product) rises to the top; small, dense particles sink to the bottom (grain, well digested forage), and lighter, longer particles form a middle layer on top of the rumen fluid (recently eaten forage). Feed remains in the rumen until the particles are small enough to pass into the omasum.

Approximately 70% of the energy requirements of the animal are supplied through microbial activity in the rumen. As proteins vary in how easily they can be dissolved within the rumen fluid, the amount supplied through the rumen depends on the type of protein being provided in the diet. Some types of proteins will be completely dissolved and utilized by the microbes, while other types pass from the rumen intact (by-pass proteins).

**Omasum**: The omasum is much smaller than the rumen. It grinds feed particles (digesta) coming from the rumen/reticulum to reduce the particle size and to absorb excess moisture. As fermentation requires large amounts of fluid, it is important to recapture water to avoid dehydration. From the omasum, digesta proceeds into the abomasum.

**Abomasum:** The abomasum is called the 'true' stomach. It functions in a similar manner as the stomach of a monogastric, including the production of acids to aid in digestion of certain feed components. Protein that is insoluble in the rumen fluid, a small percentage of starch, and any fats in the diet are passed from the rumen into the abomasum relatively intact. As large numbers of microbes are also flushed from the rumen, the abomasum is specialized to break down the microbes. These microbes are an important source of nutrients for the ruminant.

***Small intestine***

The small intestine is the main site of absorption of nutrients that have by-passed the rumen. The small intestine is approximately 85 feet long in adult sheep. Bile and pancreatic juice drain into the small intestine to aid in digestion of certain feed components, such as dietary fat.

***Liver***

The liver is a large organ, about 1.5% of an animal's live weight. It is located towards the front of the animal's body cavity, just behind the diaphragm. Newly digested and absorbed nutrients are transported from the absorption sites to the liver for storage and/or further processing. The liver also produces bile that drains into the intestine to aid in the digestion of fats.

***Large intestine***

The mammalian large intestine consists of the caecum and the colon. The caecum is a blind pouch that opens into the digestive tract. In ruminants, approximately 10-15% of the animal's energy requirement is supplied through microbes in the caecum.

## The Digestive System in Lambs

When lambs drink milk, the rumen and reticulum are generally by-passed. Suckling causes a reflex action bringing the walls of the reticulum together to form an esophageal groove leading directly to the omasum. This reflex is very important in newborn lambs, to ensure that antibodies in the colostrum are transported intact to the abomasum. The esophageal groove generally does not form when lambs are fed milk by a stomach tube. Without the reflex, the milk will end up in the reticulum and may cause bloating, as the milk will be poorly digested.

During the first few weeks of a lamb's life, the rumen is very small and has no microbes. The rumen will become functional as the lamb begins to consume more plant material and the rumen is 'seeded' with microbes.

## Rumen Function:

*Rumen microbes*

Everything that the sheep eats is subjected to microbial digestion. The feed you see your sheep consume is actually, for the most part, being used to feed and maintain the rumen microbes. The microbes in turn provide nutrients to the sheep. Like any other organism, the microbes need to be fed. If an animal is held off feed for a few days, the microbial population will die. If this occurs the ruminant will be unable to utilize feed until microbes are reintroduced to the rumen.

Microbes secrete enzymes directly onto the feed particles and into the rumen fluid. Therefore, feed is broken down directly by the microbes and also by the surrounding fluid. Unlike many mammalian groups that rely on both carbohydrates and fats, the vast majority of energy in ruminant diets is supplied through plant carbohydrates. Plant carbohydrates are classified as either insoluble or soluble, based on how easily they can be digested. The rigid, fibrous plant cell wall is largely comprised of insoluble carbohydrates (mainly cellulose), while the inside of the cell contains more soluble forms (starch, hemicellulose etc.). The cell walls of different types of plant material and plants at different stages of development will vary in thickness and therefore contain different proportions of soluble and insoluble carbohydrates. Much of the nutritive value of plants with thick cell walls (forages) is unavailable to mammals without microbes to break down the cellulose. Feeds high in starch (e.g. grains) provide more readily available energy than feeds high in cellulose (e.g. forages).

As microbes are breaking down and utilizing carbohydrates in the rumen, they produce energy rich by-products called volatile fatty acids (VFA's). It is the VFA's rather than the original plant material that provide energy to the ruminant. The VFA's are absorbed by the animal through the rumen wall, after which they are carried through the blood system to the liver for further processing and storage. There are many types of microbes in the rumen. Although their functions vary and even overlap in some cases, they can be classified into two general groups based on the type of carbohydrate that they digest. One group is adapted to breaking down the fibrous cell wall (cellulose), while the other group digests soluble particles (starch).

Therefore, the composition of the microbe population (cellulose digesters vs starch digesters) will vary depending on the type of feed provided to the sheep.

*Rumen pH*

The normal environment of the rumen is neutral (pH of 6 to 7) and most rumen microbes can only thrive in this type of environment. Therefore, the acidic by-products of fermentation must be removed from the rumen continuously by absorption through the rumen wall and saliva (high pH) must be added to the rumen fluid frequently to maintain the proper pH. Many of the digestive problems in ruminants occur when the mechanisms regulating the pH balance are disrupted and the rumen becomes too acidic (acidosis). As discussed below, the diet and the microbe population have a direct influence on the rumen pH. Increased fermentation rates can lead to a rapid decline in rumen pH. The speed of digestion is dependent on the type of feed and the particle size.

**Type of feed and changes in diet**

Ruminants can adapt to diets with different levels of forages and grains. However, sudden changes from forage to easily digestible feed can cause a major disruption in the microbe population of the rumen. For instance, the rumen microbe population of an animal fed only grass hay will be largely comprised of cellulose-digesting microbes. If the diet is suddenly switched to a high grain, low forage ration, it will take time for the population of MOST starch-digesting microbes to increase. This creates a favourable environment for a population explosion of one particular type of starch-digesting microbe. This microbe produces large levels of lactic acid. Although a small amount of lactic acid is a normal by-product of fermentation, very large levels will cause the rumen pH to drop below 5. This will kill the cellulose-digesting microbes, and prevent the growth of other types of starch-digesting microbes. As the lactic acid microbes are able to survive in a low pH environment, their population will continue to increase, further adding to the drop in pH. This is a very serious situation for a ruminant. At the very least, rumen function and feed utilization will be slowed, and the rumen will need to be re-populated with essential microbes. In severe cases, the animal could die, due to bloat or lactic acidosis. It is very important, therefore, to make changes to high-energy diets slowly. If grain is increased incrementally over a few weeks the transition in the microbe population will occur gradually, preventing an overpopulation of the lactic acid producing microbes. Even with animals adapted to high-energy diets, precautions should be taken to prevent disruptions in microbe populations (i.e. maintain a regular feeding schedule and prevent animals from ingesting very large amounts of easily digestible feeds at one time)

**Particle size**: Very small feed particles can be quickly surrounded and digested by microbes, increasing the fermentation rate. One way to moderate the digestion of small particles, such as grain, is to provide the animal with sufficient fibre. As mentioned earlier, the long fibres of recently consumed forages settle in the middle region of the rumen, where they form a structure known as a rumen mat. When a mat is present, it will entangle small particles (e.g. grain, alfalfa leaves), which helps limit their exposure to microbes and slows their digestion. It is important to note that in the case of very fibrous feeds (straw), particle size may need to be decreased. This type of feed may be chopped to reduce the particle size to help increase intake and digestion.

**Rumen Gases***:*

Large quantities of gas are produced within the rumen as a by-product of fermentation. (~5 litres per hour in a sheep). Ruminants need to frequently rid themselves of these gases, mainly through eructation (belching). Bloating occurs if the animal is unable to release gas or if gas is produced faster than it can be released. If bloating is severe, the rumen enlarges to the point that it pushes against the lungs, potentially suffocating the animal. The rate of gas production is dependent on the speed of fermentation, which (as noted above) varies with the type of feed and the particle size. Rumen pH is also a factor for gas release as it affects rumen motility (see below). There are two types of bloat:

- **Frothy bloat** occurs when the gas becomes trapped within the rumen fluid creating a frothy layer. As the gas is not in a 'free' form, it cannot escape the rumen. This type of bloat most frequently occurs when animals are fed high protein forages (legumes) that have a small particle size (e.g. alfalfa with a high percentage of leaves or finely chopped forage). Precautions should be taken when switching sheep to legume hay, and particularly, when first turning sheep into pastures with a high legume content.

- With **free gas bloat**, the gas forms a distinct layer, but the animal is unable to release it because of decreased rumen motility (see below).

*Rumen Motility*

Approximately every half-minute, the rumen and reticulum are subjected to strong muscular contractions which cause churning and mixing of the rumen contents. The highest frequency of contractions occurs during feeding. The rumen environment significantly affects motility, and motility will slow down or cease (rumen stasis) if rumen contents become overly acidic. Consequently, the type of diet will influence rumen motility, with high-fibre diets increasing motility relative to low fibre diets.

Rumen motility aids rumen function by:

a. Increasing efficiency of digestion: Churning of the rumen contents helps increase the exposure of feed particles to microbes.

b. Release of gas: As mentioned earlier, the gas produced during fermentation remains in the top portion of the rumen. As the rumen contents are moved by muscles contractions, the gas bubble is shifted to the esophageal opening, allowing for eructation. If the contractions are decreased by a low pH, gas release will be decreased and the animal may bloat (free-gas bloat).

c. Ruminating or 'chewing cud': Rumen churning also stimulates cud chewing. The passage to the omasum is narrow which limits the size of the particles that can be passed into the rest of the digestive system. While feeding, ruminants take fairly large bites and swallow the material with little chewing. Therefore, sheep must continue to physically break down the feed after it has been swallowed the first time. At regular intervals boluses of feed (cud) being held in the reticulum are brought back up to the sheep's mouth to be further chewed and then swallowed again. This process (rumination) reduces the size of the forage particles and greatly increases the surface area available for microbial digestion. Rumination also increases rumen pH by stimulating the release of saliva.

d. Digesta movement to the omasum: Rumen contractions help move digested rumen contents into the omasum. Impaction of the rumen may result if motility is suppressed for a significant length of time.

## Summary: Feeding for a Healthy Rumen

- **Feed sufficient fibre:** Ruminants are designed to consume and digest forage, and producers will generally have few problems if a high percentage of the diet consists of grass forages (~1.5% body weight). Although high grain rations can be successfully fed, animals receiving this type of diet must be managed carefully to avoid digestive disturbances. Providing forages together with grains helps to ensure that the high-energy feeds are not digested too quickly, by producing a rumen mat. A diet high in forages also aids in maintaining the rumen pH by increasing rumen motility and encouraging rumination.
- **Feed at regular intervals:** This will help maintain continuous fermentation and prevent acidosis by maintaining a consistent population of bacteria (i.e. no sudden die-offs or explosions in microbe numbers).
- **Make ration changes gradually:** Ration changes should be made over a two-week period to allow the rumen microbes time to adjust. This is particularly important when switching from a low energy diet to high energy feed (i.e. going from a grass forage diet to either a high grain or high alfalfa diet). Making ration changes too quickly can lead to digestive disorders such acidosis and bloat.
- **Take precautions with high-energy diets or feeds with fine particle size:** Even if an animal is adapted to a high-energy diet, a sudden intake of grain may cause digestive disturbance through a rapid decrease the rumen pH (acidosis), causing rumen stasis.
- **Feed forage before grain or provide free choice forage:** This helps ensure the formation of a rumen mat to slow the fermentation rate of grain and maintain rumen pH.
- **Do not severely limit energy:** Although most of the recommendations above deal with providing too much energy, only feeding very low energy, fibrous feeds (e.g. straw alone) may also cause problems. As the opening from the rumen/reticulum to the rest of the digestive system is small, feed particles must be small to pass through, and make space in the rumen for new feed. With very fibrous feeds, the rate of passage is too slow to meet the energy requirements of the animal. Although there may be lots of feed available, the animal will be limited by the capacity of the rumen. Very fibrous feed may also lead to rumen impaction, if the feed is unable to pass to the omasum.

# Nutrition

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## Introduction

Feed costs account for approximately 80% of the expenses for an average Ontario farm. Therefore, it is imperative that producers evaluate and manage their feed resources to maximize farm profit and flock productivity. To this end, producers should work with extension personnel and nutritionists to build a solid nutritional program that includes feed analysis and ration formulation to meet the needs of the flock.

## Feed Analysis

It is difficult to assess feed quality without performing a detailed chemical analysis to determine the quantity of nutrients present. A basic feed analysis will provide the producer with information on the dry matter (DM), fibre (neutral detergent fibre and acid detergent fibre), total digestible nutrients (TDN), protein, vitamin and mineral content of the feed. Knowing the level of nutrients that are available in a given feed allows for the formulation of rations that meet the nutritional requirements of animals in a given stage of production.

*Water*

It should be noted, however, that while formulating diets to meet the production needs of the flock is important in order to maximize productivity; all the planning and formulating can go to waste if water is not adequately supplied. It is essential that a fresh source of water be available to the flock at all times. This is particularly important for lactating ewes that require a large amount of water to produce adequate amounts of milk - and young lambs. It is recommended that one square foot of water surface be provided for every 40 ewes.

*Dry Matter (DM)*

Dry matter analysis actually measures the amount of moisture in the feed and is widely variable depending on the feed source. Hay and grain usually contain roughly 10% moisture, silage can contain anywhere from 50-75% and pasture plants are often 80-85% moisture. DM content is an important measurement, as it affects animal intake. For example, a ewe is that is capable of consuming 2 kg (4.4 lb) of leafy grass hay (10% moisture; 90% DM) can also consume 9 kg (19.8 lb) of leafy grass pasture (80% moisture; 20% DM). In both cases 1.8 kg (4 lb) of DM will be consumed. Therefore, expressing feed analysis, animal intake and nutrient requirement on a DM basis eliminates moisture as a variable in the comparison of different feeds and in the calculation of balanced rations.

*Fibre*

The fibre content of feed is expressed as Neutral Detergent Fibre (NDF) and Acid Detergent Fibre (ADF). NDF is a chemical estimate of the plant cell wall. The plant cell wall is composed largely of difficult to digest cellulose, whereas the inside of the cell contains much more soluble carbohydrates (e.g. starch). Although the animal can make use of both cellulose and soluble carbohydrates, cellulose is a more complex carbohydrate and takes longer to break down. Various types of plants will vary in proportion of cell wall versus cell contents, and generally as a plant matures the percentage of wall content will increase. A high NDF indicates that the feed has a large percentage of cell wall material. As NDF increases the animal's intake will decrease. This is because the more fibrous the feed, the bulkier it is and the sooner the rumen will reach capacity. Very fibrous feed will also take longer to break down and be passed from the rumen. Therefore, feed intake will be restricted by the size of the rumen. If only very fibrous feeds (high NDF) are fed, the animal may not be able to eat enough to maintain production. ADF is a measure of the digestibility of the feed (i.e. how much of the feed can actually be used by the animal). ADF values are used to calculate other measures of energy content such as total digestible nutrients.

*Total Digestible Nutrients (TDN)*

TDN is a measure of the energy content of the feed and is reported as a percentage. How much energy an animal requires in their diet will depend on their age, sex and stage of production. The energy content can also be expressed as digestible energy (DE), which is measured in megacalories per kg (Mcal/kg). Energy is the nutrient that is most often below the level required for production (limiting nutrient) and energy usually accounts for the largest portion of feed costs. Most energy in sheep diets comes from the cellulose and hemicellulose in forage and the starches in grain. Fats and oil are very high in energy, but are not often used in sheep diets.

*Protein*

It is the quantity and not necessarily the quality of protein that is important in sheep rations. Proteins vary in how easily they can be broken down in the rumen, from being completely insoluble to 100% soluble. Most types of proteins fed to sheep are relatively soluble, meaning that the rumen bacteria can digest them. During bacterial digestion the nitrogen in the protein is released and used to maintain growth and reproduction of the microbe population. Microbes are constantly being passed out of the rumen into the abomasum and intestine, where they are broken down by the sheep's digestive enzymes. Once they are digested they are absorbed and utilized by the animal as a protein source. Therefore, the quality of protein fed to sheep can vary, but the quality of the microbial cell protein is consistent. Hence, relatively low quality (low cost) proteins can at times be used to supplement sheep rations. This includes non-protein nitrogen (NPN) sources, such as urea, which provide nitrogen to the rumen microbes, without having to be first broken down from a more complex true protein. In order for rumen microbes to utilize NPN, however, sufficient soluble carbohydrates (e.g. starch) must included in the diet. If there isn't enough energy or if the NPN is fed in excess of the microbes ability to use it, the animal may suffer from toxicity. NPN use as a protein source should be restricted to maintenance diets, as it will generally not meet the protein requirements for late gestation, lactation, or lamb growth.

Protein that is not soluble in the rumen passes intact to the lower digestive tract, where it will be digested and absorbed. This type of protein is called 'bypass protein' as it bypasses the rumen bacteria. Bypass protein is efficiently utilized and is a means of providing protein directly to the animal, rather than indirectly through the microbes. Bypass proteins tend to be higher quality and generally more expensive. Feeding a very high percentage of bypass protein and little soluble protein, however, is not advisable as it would result in poor microbe performance.

*Minerals*

Calcium (Ca), phosphorus (P), potassium (K), magnesium (Mg), salt (NaCl), cobalt (Co), iodine (I), copper (Cu), and selenium (Se) are the minerals most commonly analysed and are reported as percentages or parts per hundred (Ca, P, K, Mg, NaCl), parts per million (Co) or parts per billion (Se).

**Calcium and phosphorous** are expressed on feed tags as a ratio (Ca:P). Sheep can handle a Ca:P ratio anywhere from 1:1 to 7:1 as long as the minimum requirements of available calcium and phosphorous are being met. It is important that the Ca level is at least as high as the P in the diet. This is necessary as P interferes with the absorption of Ca, creating a deficiency in the animal even if the actual level in the diet is adequate. This is particularly important in growing animals and lactating ewes. Most grass and legume hays contain an adequate level of Ca while grains tend to have relatively high P levels. Ca and P are required for the maintenance of bone structure and proper muscle and nerve function. Signs of deficiency include abnormal bone development (rickets), knock knees, slow growth, "runtiness", listlessness, depraved appetite (chewing on rocks, wood and bone) and "downer ewes". Ewes in late pregnancy should not be fed very high levels of dietary Ca (e.g. only alfalfa hay), as this may interfere with the release of body reserves of Ca required at the onset of lactation causing hypocalcaemia.

**Magnesium** is closely associated with the metabolism of Ca and P and is required for proper nervous system function. Normally feeds contain adequate levels of magnesium, however, deficiency can cause grass tetany.

**Cobalt** is an essential trace mineral that is needed in order for vitamin B2 to be manufactured by the rumen microbes. A deficiency in cobalt may cause sheep to become thin, unthrifty and anaemic. Co is often included in salt (blue salt block)

**Iodine,** another trace mineral, is required by the thyroid gland for regulation of food utilization. Deficiency in iodine can cause goiter, which is commonly seen in newborn lambs born to iodine deficient ewes. Goiter can be recognized in young lambs by abnormal swelling under the throat due to an enlarged thyroid gland, abnormal wool coat at birth, still births and neonatal mortality (also frequently added to salt blocks).

**Copper** is widely distributed in natural feedstuffs and deficiency is rare as the recommended daily intake is low (8-15 mg/kg DM). However, copper poisoning and toxicity are common. For this reason it is not advisable to feed mineral supplements for other livestock to sheep, as the tolerance for copper is generally higher in other species. Under normal conditions, the copper supplied in feed is adequate for sheep, however, high levels of molybdenum, iron and zinc can interfere with copper uptake.

**Selenium** is important because of its role, along with vitamin E, in the prevention of nutritional muscular dystrophy (white muscle disease). The minimum requirement of selenium for sheep is 100 parts per billion, and when fed to ewes at this level it will prevent white muscle disease in young lambs.

*Vitamins*

Vitamins can be broken down into two main groups: fat-soluble and water-soluble. Fat -soluble vitamins include vitamins A, D, E, and K, which can be stored in the liver and body fat during periods of abundant supply and rationed out from these organs when supplies become scant. Water-soluble vitamins, which cannot be stored for future use, include B-complex vitamins and vitamin C. B-complex vitamins are manufactured by rumen bacteria in adequate amounts on a daily basis, provided the animals are supplied with enough energy, protein and minerals to enable the bacteria to do so. Vitamin C is manufactured in the animals' tissue.

Vitamin A is not synthesized by ruminants and, therefore, needs to be supplemented in the diet. It is essential for sight and the maintenance of tissues (the lining of the digestive tract and the reproductive tract), lungs, eyes and skin. Vitamin A is provided through green forages. However, it is lost as stored hay ages. Therefore, vitamin A supplementation may be needed if you are feeding hay older than ~4-5 months.

## Ration Formulation

The goal of ration formulation is to prepare a feeding program which meets the animal's nutrient requirements, is properly balanced, palatable, promotes or discourages intake (depending on the purpose of the ration), is suitable for a given management situation and is reasonably priced. To this end, there are a number of questions that need to be asked:

- What type, age, weight of sheep is being fed?
- What is desired production level and rate of gain?
- What feeds are available for use for the formulation?
- Are these feeds home-grown or are they purchased?

**Most Feed Companies offer a Sheep Ration Formulation Service.**

## Feedstuffs

Sheep can utilize a wide variety of feedstuffs. Feeds are classified into groups based on their nutrient content and physical form. Most common feeds can be placed in one of the following groups:

**Roughages (forages):** (Note: Most mature sheep will require ~4-5lbs of hay/day through the winter)

Grass forages (hay or pasture)

- high in fibre (cellulose) and usually low to intermediate in energy
- protein content varies, depending on the plant species and stage of maturity, typical range in crude protein could be as varied as 5 to 12% (i.e. grass are highest in protein

and lowest in fibre early in the growth period, as the stem matures and after 'setting seed' the protein level will drop significantly)

- examples are timothy, crested wheat, fescues, etc.

Legume forages (hay or pasture)

- fibre dependent on stage of growth and leave content (e.g. mature alfalfa has a high stem to leaf ratio)
- protein content is higher than grass forages, generally above 16-20% (legumes are able to fix nitrogen in the soil)
- because of particular proteins in legumes, caution should be taken when first feeding legume forages (i.e switching from grass hay, or turning onto pasture in the spring) to prevent frothy bloat.
- Examples are alfalfa, clovers, etc.

Silage

- silage is produced when green forage is preserved using fermentation (acidification in the absence of oxygen)
- the major advantage of silage is that the crop can be harvested when it is ready in almost all weather conditions (hay must be dried to ~90% dry matter before baling to prevent spoilage, whereas silage is stored with a dry matter content of 40-60%).
- when exposed to oxygen, silage may spoil. Improperly stored silage may cause problems such as listeriosis in sheep
- ensiling is not restricted to grasses and legumes; silage can be made from a wide range of crops including corn, barley etc
- compared to hay, harvesting, storing, and feeding silage can require a greater capital investment in equipment and facilities.

Green Feed

- forage is not dried thoroughly before baling
- may be used as a means of making use of a poor harvest or if conditions are poor during haying
- mildew and moulds can be a problem

**Concentrates** (grains and commercially mixed rations)

- high in energy and relatively low in fibre
- fibre level depends on processing of the grain; grains that are pelleted or crushed will have a much lower fibre content than whole grains with the hull included (some studies indicate that lamb performance is better and there are fewer digestive upsets with whole grains)
- most have a moderate protein content (~12% crude protein)
- examples are corn, barley, oats, commercial mixes

**Protein Supplements**

- high in protein, usually high in energy
- variable fibre content
- examples are oilseeds (soybeans, canola meal)

**Mineral Supplements**

- may be included in a commercially mixed ration or supplied by free choice access to mineral blocks or loose mineral
- do NOT purchase cattle mineral supplements, as the copper is often too high for sheep

A list of the energy and protein content of some common feeds is contained in Table 1. Remember that although these figures will give you a good idea of nutrients in different feeds, you must have your feed analysed for accurate values.

***Table1. Energy and Protein Content of Some Common Ontario Feeds****

| Feed | % Dry Matter | % Crude Protein (dry matter basis) | % Estimated TDN (dry matter basis) |
|---|---|---|---|
| 1st cut legume hay | 86.7 | 15.8 | 58 |
| 1st cut grass hay | 87.7 | 9.7 | 55 |
| 1st cut mixed hay | 87.7 | 12.2 | 56 |
| 2nd cut legume hay | 86.8 | 17.7 | 59 |
| legume hay silage | 46.9 | 17.6 | 59 |
| grass hay silage | 38.8 | 13.0 | 57 |
| mixed hay silage | 49.4 | 15.8 | 58 |
| corn silage | 36.5 | 8.0 | 66 |
| oats | 88.5 | 12.1 | 74 |
| barley | 88.6 | 12.2 | 82 |
| mixed grain | 88.4 | 12.3 | 77 |
| grain corn | 86.6 | 9.6 | 90 |
| soybean meal 44% | 89.0 | 47.8 | 81 |

***Source: OMAF Feed Advisory Program (table taken from OMAF Factsheet** Basic Beef Cattle Nutrition)

## Feeder Space and Design

In confinement production systems, adequate feeder space is a must in order to ensure that all animals have an equal opportunity to consume their daily ration. Feeder space requirements vary according to sheep size, fleece length and type of feed. The amount of space required is lower when feed is available free-choice than when sheep are hand fed. When hand feeding is practiced, feeder length should allow all the sheep in a group to feed at one time. When free-choice feeding occurs, sheep have access to the feed at all times.

It is recommended that that 400 mm (16”) of feeder space be provided for ewes and rams if all animals are hand fed. When free choice feed is offered, 150 mm (6”) per animal is required for ewes and rams. Feeder lambs that are hand fed require 300 mm (12”) per animal; whereas, when fed free-choice the animals require only 100 mm (4”) per animal.

The type of operation and feeding space required will influence feeder design. Other considerations include:

- obtaining feed is natural and comfortable for all sheep
- feed does not become contaminated by animals defecating or jumping into feeders
- openings are sized to allow easy access to feed but prevent sheep being injured or trapped
- the sheep cannot be injured by sharp corners, nails etc.

For more information, please refer to the Codes of Practice for the Care and Handling of Sheep available from the OSMA office 519-836-0043 or at http://www.nfacc.ca/codes-of-practice/sheep

## Body Condition Scoring

Body condition scoring is an aspect of flock nutrition that is often overlooked. It is important to condition score the flock in order to determine how it is responding to the current feeding regime. If body condition scoring is not done, it is difficult to determine if the current feeding program is meeting the production needs of the flock.

Body condition scoring is easy to use and implement. The system is based on a scale of 0 to 5, where 0 depicts the thinnest animals and 5 the fattest. The score is based on the amount of fat present at key points on the animal – specifically around the vertebrae and the loin region. Visual assessment for condition can be obscured by differences in individual conformation and wool. Therefore, to accurately determine an animal's body condition it is often necessary to actually feel for fat cover by hand. A description of each condition score is listed in the Code of Practice at the back of this binder. If you are undecided between two values, it is recommended that you assign a half score. For example, if undecided about whether an animal is a 3 or a 4, you should assign a condition score of 3.5.

Body condition scoring is a subjective means of categorizing animals - in that people may have differing opinions for what type of fat cover will constitute a particular score. For instance one person may consistently rank a particular fat cover as a '4', while another may rank it as a '3.5'. As long as you are relatively constant in your assessment of your sheep, this variation between people is not overly important. It is advisable, however, to have the same person scoring the same group of animals each time they are assessed.

**See Appendix B of the Code of Practice for details on how to condition score sheep. Codes can be requested from OSMA 519-836-0043 or downloaded at http://www.nfacc.ca/codes-of-practice/sheep**

## Ewe Nutrition

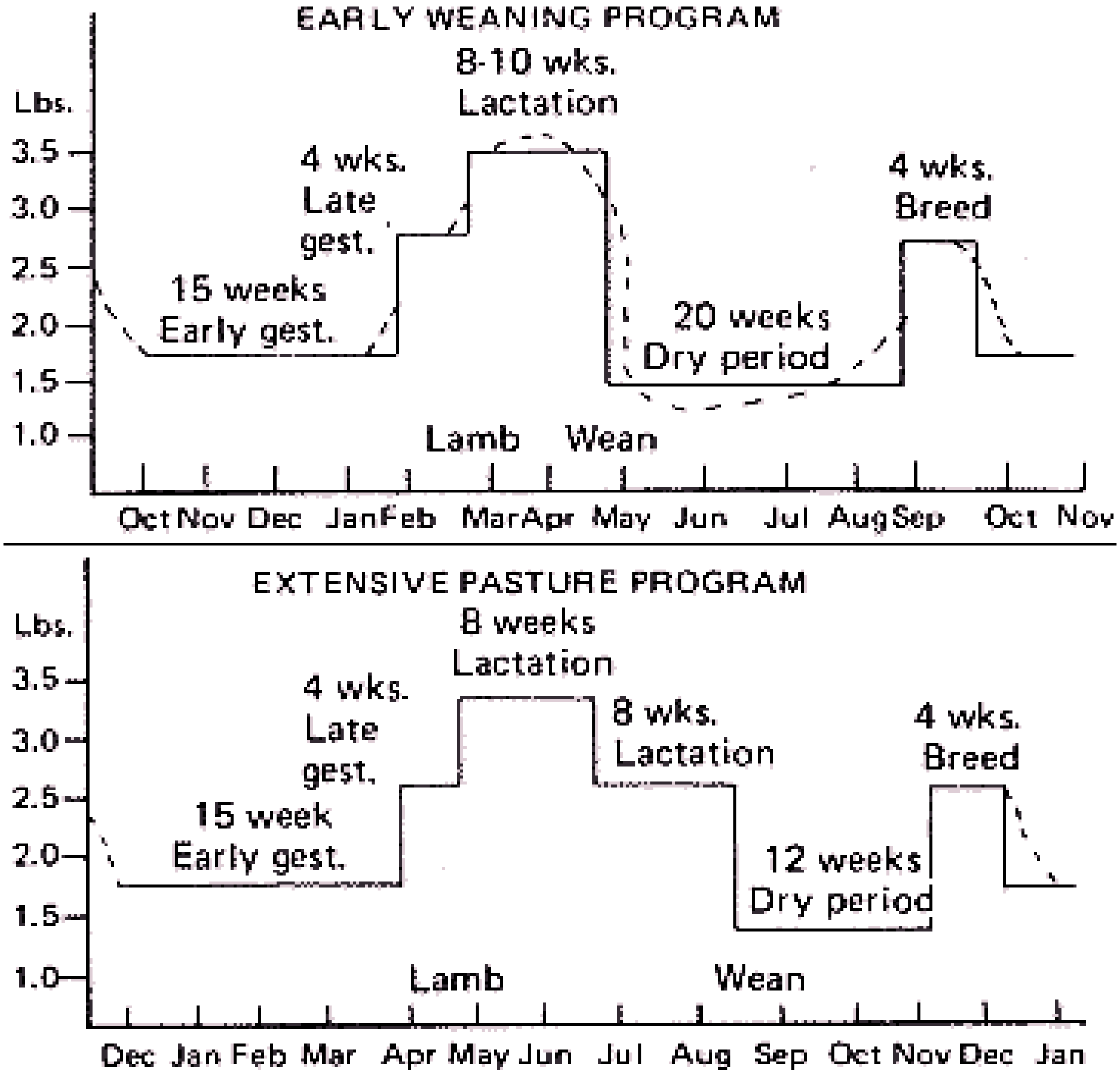
Ewe nutrition is one the most important aspects of production, as ewes that are fed well-balanced diets are more fertile, produce more milk and are more likely to wean a greater number of faster growing lambs. As well as producing more pounds of lambs per year, well-fed ewes are also healthier and, as a result, have a greater resistance to disease than ewes that are under nutritional stress. The nutritional requirements of a ewe, however, depend on her age and stage of production. For example, ewes in late gestation have different nutritional requirements than ewes, or ewe lambs that are lactating.

Ewe lambs have different nutritional requirements than mature ewes since they have not yet reached their adult body size at the time of first breeding. When first bred, ewe lambs should have achieved 75% of their expected mature body weight with a condition score of 3.5. If these objectives are not met, it will be difficult for the ewes to maintain condition in late pregnancy and to stimulate sufficient milk production to meet the requirements of the offspring. During pregnancy a ewe lamb will not only be supporting the growth of a fetus, but can also be expected to gain a further 10-15% of her mature body weight. Therefore, increased intakes of energy and crude protein will be required.

A ewe's production cycle can be broken down into seven stages: maintenance, flushing, early gestation, mid gestation, late gestation, lactation and post-weaning. Management in general, and nutritional management specifically, must change for each of these production stages if a producer is to have a successful lamb crop and, more importantly, good returns for market lambs.

The nutritional requirements for ewes are least during maintenance and early gestation; and are greatest during late gestation and lactation (especially for ewes carrying multiple fetuses or nursing twins). The diagram below indicates the changes in nutrient requirements as a ewe goes through the various stages of production. During all of these stages, ewes should be provided with a good source of trace minerals (mineral block or free choice) and ample amounts of fresh water.

**Figure 1. Daily TDN requirement year round of 154 pound Ewe**




**Maintenance**

The term ‘maintenance’ means that the animal is not producing heavily (i.e. reproducing, lactating, growing, etc) and, subsequently, does not have any extra energy requirements above normal body functions. The maintenance period for ewes lasts from the time the lambs are weaned to ~2-3 weeks prior to breeding (flushing period). Pasture grazing, or if in confinement, a mixture of hay and straw should be sufficient to keep ewes in good condition. The ewe’s body condition score at weaning will largely determine the amount of feed that she will need during this time. For example, animals that are over conditioned should lose some weight (an excellent opportunity to utilize low quality feeds), while those that are under-conditioned should be allowed to gain weight. Each ewe should be assessed individually at weaning and penned or pastured with ewes in similar condition. Midway through the maintenance period ewes should be condition scored again and the leanest ewes separated for preferential treatment. The goal for the producer is to have the ewes with a condition score of 3, three weeks before breeding begins.

**Flushing**

Flushing is the practice of increasing nutrient intake and body condition during the 2-4 weeks leading up to breeding (i.e. increasing from body condition score of 3 to 3.5 when the ram is turned-out). Its purpose is to increase a ewe’s ovulation rate and therefore increase the chances of multiple births. How successful flushing is depends on the age of the ewe (mature ewes show a greater response than yearlings), its breed, body condition when flushing commences, and the stage of the breeding season. For autumn breeding, the greatest response to flushing is seen early and late in the breeding season. During mid-portion of the breeding season, when ewes are naturally most fertile, flushing less effective in increasing lambing percentage. Ewes that have not recovered from previous lactation receive the most benefit from flushing, while the practice is least effective (i.e. no response) on ewes with a fatter than normal body condition.

Flushing is generally accomplished by providing ewes with an increased plane of nutrition for 2-4 weeks prior to introducing the ram and continuing 2-4 weeks into the breeding season. This can be accomplished by providing fresh pasture, supplemental harvested forage, or by feeding ½ to 1 lb/head/day of a grain mix (oats, barley, and corn), depending on environmental stress (time of year), availability of forage, and body condition of ewes.

After breeding, the ewe flock is best maintained on good pasture, or if they are in a confinement feeding system, they should be fed enough to allow the ewes to maintain their body weight. Hay and/or silage fed *ad libitum* should be sufficient, however, poorer quality roughage during this period requires some supplementation with grain.

**Early Gestation** (15 weeks)

In early pregnancy, while fetal growth is minimal, the total feed requirement of the ewe is not significantly different from the maintenance period. However, nutritional management in the first month is still important for minimizing early embryonic losses. Ideally, the target for nutritional management in the first month of pregnancy would be maintenance to a slight increase in weight.

Early in pregnancy, ewes should be fed a similar ration to ewes on maintenance rations, with a slight increase in the amount offered. The National Research Council (NRC) suggests a post flushing weight gain of 0.03 kg (0.07 lb) / day.

**Mid Gestation** (up to 100 days)

Five weeks after breeding, the embryos are well established in the uterus, although their weights are insignificant. A live weight increase for the ewes of approximately 2 kg (4 lb.), in months two and three, equates to a 1 kg loss from the ewe's own tissues. While such a loss is tolerable, severe under-nutrition for even short periods can profoundly affect fetal development. Any degree of under-nutrition will have greater impacts on ewes that are already in poor condition.

Over-feeding during mid-pregnancy can also be detrimental. Increasing a ewe's body condition score above 3.5 at this time is wasteful, and increases feed costs. In addition, excessive abdominal fat combined with the increased uterus size can physically restrict the ewe's feed consumption in late pregnancy.

It should be noted that when weight is lost at any time during the ewe's reproductive cycle, it must ultimately be regained at a later date. In terms of total nutrient requirements it is more costly to lose and regain weight than to simply maintain it.

**Late Gestation** (last 4 weeks)

Next to lactation, the late gestation period has the greatest nutrient demands for fetal growth, with approximately 70% of fetal growth occurring in the last six weeks of pregnancy. This is also when the ewe starts to put nutrients towards milk production. Inadequate nutrition, especially low energy levels, during this time will have detrimental effects on milk production of the ewe and the birth weight and vigour (survivability) of the lambs.

During this stage of production the plane of nutrition should be increased gradually until lambing. Ewes should be fed good quality hay or silage and grain rations should be increase from 0.23 kg (0.5 lb) grain per day at six weeks before lambing to 0.68 kg (1.5 lb) at lambing.

**Lactation** (6 to 12 weeks)

This stage of production is the most physiologically demanding for ewes and, therefore, nutritional requirements are at their highest. A lamb in the first four weeks of life is totally dependent upon the nutrients provided by the ewe's milk, so optimizing milk production is critical. Body fat reserves of the ewe may contribute as much as 25-30% of the energy required to produce milk during the first month after lambing. Therefore, even with an increase in dietary energy ewes will generally lose condition during this period.

Although body protein does not contribute greatly to milk production, additional protein should be added to the ration at this time, to help the ewe's system recover from lambing. Good quality hay should be available free choice. In addition, grain should be fed at 0.7-0.9 kg (1.5 – 2.0 lb) for single lamb ewes and 0.9-1.4 kg (2.0 – 3.0 lb) for ewes supporting twins or triplets.

It is recommended that ewes nursing multiple lambs be segregated from the rest of the ewe flock, as their nutritional needs are significantly higher than ewes nursing singles. Milk production of ewes that are nursing multiple lambs peaks earlier and declines faster, and so it is also recommended that an effort be made to introduce their lambs to creep feed as soon as possible.

Providing ample amounts of fresh water is particularly important during this stage, as the ewe's requirement will increase significantly.

### Post Weaning

After weaning the nutritional requirements of the ewe are no longer as critical. A maintenance ration is all that is required for the period between weaning and flushing.

## Nutrient Requirements of Lambs

### Colostrum

It is important that lambs receive at least 170 ml (6 oz) of fresh or frozen colostrum as soon as possible after birth. Lambs that do not receive colostrum will generally die. Colostrum is yellow and thick in appearance compared to milk that is produced later during lactation. Ewes will have a limited amount of colostrum that will gradually be depleted by the lambs during the first day after birth. Colostrum may be saved and frozen for up to a year for emergencies. Colostrum contains antibodies from the ewe, which will help protect the newborns from various diseases. Colostrum is also higher in energy than milk. As lambs are born with few body reserves, it is essential that they need energy soon after birth.

### Feeding lambs on milk replacer

Orphan lambs or lambs that have been removed from ewes with multiple births (e.g. triplets), will either have to be fostered onto other ewes or raised on milk replacer. Lambs less than four weeks of age that are being bottle fed, require a replacer that is high in milk fat and good quality protein. Since lambs at this age are essentially non-ruminants, it is the quality of protein, not the quantity that is important. Remember that the lamb actually has to suckle to prevent the milk from entering the rumen. Therefore, ensure that the nipple opening on the bottle is small enough to force the lamb to suck, otherwise the lamb will not be able to digest the milk properly and will become bloated

### Pre-weaning

During the first weeks of life, lamb growth and development is dependent upon the ewe's milk production. Lambs not receiving adequate milk during the first month of life are more prone to contracting infectious diseases and will show a poor overall growth performance. Although they will start nibbling on feeds within a few days of birth, lambs less than four weeks of age are non-ruminants; and will consume high levels of milk and very little in terms of dry matter. Although feed intake is minimal during these first weeks, it is important to introduce creep feed to the lambs at roughly 10 days of age. If using a commercial creep feed, it is best to begin with an 18% crude protein ration. Having lambs adapted to eating creep feed will greatly lessen the stress of weaning. Always offer the creep free choice to the lambs, but devise a means of preventing ewes access to the ration (creep feeder). It is also advisable to provide lambs with good quality hay that is leafy and

Lambs at a creep feeder

tender. Lambs can compensate for inadequate milk supply to some extent by increasing consumption of solid feed. However, they cannot consume significant amounts of feed during the first two to three weeks of life. As lambs consume more dry feed their digestive systems develop further so they are better able to digest and utilize dry feed. Once lambs are consuming at least ½ pound per day of dry feed, weaning can be considered. Weaning usually occurs anywhere from 8 to 20 weeks of age, depending on the type of reproductive management system (e.g. once per year spring lambing operations will generally weaning as animals come off pasture, whereas those with accelerated lambing need to rebreed sooner).

**Weaning**

Weaning can be a stressful time for the lambs and may lead to a decrease in feed intake. To minimize stress it is recommended that the lambs are left in the same pens and that the ewes be removed so that they are out of sight and hearing range. Continue to feed the lambs the same creep ration. Any changes in the ration should be done gradually and over several days.

**Post-weaning (feeder lambs)**

Dry matter intake for feeder lambs varies between 3.5% and 4% of their body weight. Actual intake, however, depends on several factors, including.

- Age
- Size and condition
- Growth rate
- Amount of feed offered
- Competition for available feed
- Palatability
- Physical form of feed (long, chopped, rolled, pelleted, etc.)
- Energy and fibre content of feed
- Ambient temperature and humidity
- Availability and quality of water

Lambs may be marketed at weaning (new crop lambs), as light weaned lambs or as heavy finished lambs (>95lbs). Your marketing strategy will determine how quickly you will want the lambs to grow (rate of gain) and how soon they will finish. For some producers the answer is easy, the lambs are left on pasture until the fall and marketed straight from the field. Rate of gain in these lambs will be slow, but the fed costs will be minimal. Many producers supplement a forage diet with concentrates to improve the rate of gain. In some cases, concentrates will total 50% of the ration. If you are pushing lambs for very fast growth, know the signs of rumen acidosis, and take precautions when making feed changes. Table 2 shows examples of diets for two rates of gains.

The nutrient requirements for lambs will not only be influenced by the desired rate of gain, but also by the weaning weight of the lambs, their sex and their breed. In terms of weight, lambs weaned at 11 – 16 kg (25-35 lbs) tend to gain at an accelerating rate with increased weight. At a practical level, this means it is much more efficient to feed a pound of grain to a two-month-old lamb than to a six-month-old lamb.

Ewe lambs have lower voluntary feed intakes than either ram lambs or wethers and tend to deposit more fat than males. As a result they grow slower and are less efficient converters of feed to live weight gain.

Marked variability has been seen in the growth rates between breeds. The differences are partially due to differences in feed consumption and efficiencies in feed utilization for fat and lean deposition. Breeds also vary in their mature weights. Breeds with low adult weights will mature at a lighter body weight than large breeds. Therefore, light breeds will tend to fatten (finish) at lighter weights.

Table 2: Feeder lambs rations (**Please note: the following are examples only – contact your OMAF specialist or consult with a nutrition company representative to develop balanced, cost effective rations for you farm**)

| Lamb Weight | Average Daily Gain | |
|---|---|---|
| | 0.9 lbs gain/day | 0.6 lbs gain/day |
| 66 lbs | Barley grain (2.4 lb)<br>Canola meal (0.2 lb)<br>Alfalfa hay (1.0 lb)<br>Limestone (0.02 lb) | Barley grain (1.6 lb)<br>Canola meal (0.4 lb)<br>Grass hay (1.7 lb)<br>Limestone (0.02) |
| 88 lbs | Barely grain (2.8 lb)<br>32 % protein supplement (0.4 lb)<br>Alfalfa hay (0.6 lb) | Barley grain (3.0 lb)<br>Alfalfa hay (1.0 lb)<br>Limestone (0.02) |

## Growing Replacement Ewe Lambs

Once replacement ewes have been selected from the lamb crop, they should be fed a high quality forage-based ration. The end goal is to have them at 75% of the mature body weight, with a body condition score of 3.5 at the time of their first mating. Although the diet must be sufficient to allow for optimal growth, it is not advisable to feed ewe lambs on high-energy rations. Very fast growth may decrease longevity and there are indications that high body fat during development may decrease milking ability later in life.

## Nutrient Requirements of Rams

Similar to feeding replacement ewes, the breeding target for ram lambs is 75% of mature weight at a condition score of 3.5 to 4. Once rams are allowed to run with the ewes, they spend very little of their time actually eating. This can result in a weight lose of up to 12% of their body weight during a 45 day breeding period. In many cases, forage alone is not adequate nutrition for placing rams in proper body condition for the breeding season. At the very least, rams should be evaluated for body condition six weeks before breeding. Thin rams should receive grain supplementation as a means to increase body weight and condition. Mature rams can be maintained on pasture or wintered on good quality hay. Six to 8 pounds of mixed grass and clover hay is sufficient to meet the daily energy requirements of a 250-pound ram. All rams should have fresh, clean water available at all times, as well as salt and minerals.

**Feeding Systems for Sheep**

**FACTSHEET**

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**Table of Contents**



**Introduction**

Choosing a feeding system requires several considerations: labour efficiency, animal diets and such other animal factors as bunk space, number of head to be fed, as well as mechanical assets and needs.

**Rules of Thumb**

- Forage feeding will be a bottleneck. It forms the bulk of the diet by volume, weight and feeding time. Efficient delivery of the forage component should be a primary goal.
- One person should be able to feed forage in a system with no additional help.
- Walk-though or drive-through feeders are the most time and labour efficient.
- Feeding time (forage only) should be no more than 8 sec. per ewe. This is the time from storage to delivery completion. This means it takes 800 sec. or 13 min., 20 sec. to feed 100 ewes.
- Deliver concentrates even more quickly than forages. Target for 1 sec./ewe or less of actual feeding time, and allow an extra few seconds per animal staging time (e.g. the time to fill carts or pails used in feeding).
- Dry ewes (maintenance) are animals that require proportionately very little time (feeding and management).
- Employ safe feeding practices. Avoid any feeding system that requires the animals be underfoot or in contact with machinery during forage or concentrate delivery. Such systems increase risk to shepherd and sheep, as well as reduced efficiency. See Table 1, *Space Allowances and Bunk Space Requirements for Sheep*, for proper space allowances per sheep to ensure intake and safety.

**Planning a System**

Simulate one year's feeding needs. Include all rations that might be fed. See Table 2, *Sheep Rations Commonly Fed Over a Production Year and Their Commodity Components* for a sample plan. Your first decision is what format to use feed forage. Will it be bales or bulk? Silage or dry hay? Assuming bales, are they big or small, round or square? This affects feeder choices and designs, as well as the method of delivery. Forage is assumed to be the cornerstone of the diet, except for lamb rations.

Some common ration and concentrate permutations are given in Table 3, *Commodity Options by Concentrate Feeding System***.** Several variations of feedstuffs are named for each ration to allow you to determine feed and equipment needs. This factsheet assumes an accelerated breeding and lambing system using prolific ewes. The production system allows for confinement or outdoor housing of the flock.

- Molasses is recommended in lamb rations to promote intake. Wet molasses is preferred, but dry molasses will suffice.
- Supplemental minerals are required in each ration. You can make it available either as free-choice, or in the supplement pellet or in the ration as a premix. If used as a premix, it will separate with the fines, and is not suitable for any feeding system other than bunks/mangers, unless a binding agent is used (e.g. molasses).
- The range of crude protein (CP) and total digestible nutrients (TDN) values for the pasture supplementation scheme is a reflection of pasture variability. Understand the forage quality of each pasture being consumed by the sheep.
- Corn vs. Small Grains: In many cases cost determines which grain to use. In general, corn is lower in protein and higher in energy (9% CP and 90% TDN) than barley (12% CP and 82% TDN) and oats (11% CP and 73% TDN). The combination of grain economics and pasture quality affects which grains to use for pasture supplementation, and may cause any one ingredient to be removed from the mixture.
- Quantities of ration ingredients can only be determined with information on the nutrient content of the forage component of the ration.

Table 3 is a listing of the various options available to achieve the recommended crude protein and energy content of supplements for various classes of lambs and sheep. Formulate an appropriate ration to ensure its suitability for a given class of animals.

**Choosing a Feeding/Mixing System**

At a certain farm size, many producers consider mixing their own feed. Consider the following points in deciding whether mixing feed on-farm is economical.

1. Calculate the cost of a farm-made diet for the permutations planned. Establish the cost of the commercial alternative. Subtract the two to determine the differential.
2. If the differential indicates home mixing may be economical, estimate the tonnage you would mix per year. The more the better, so using the farm mill for many different livestock groups is beneficial.
3. Calculate the equipment required above and beyond what is needed for purchased, complete feeds: commodity storage bins, augers, complete diet bins, feed carts plus the mill. Some of the systems to be considered:
    - Total Mixed Ration (TMR) - silages, hay and grain fed at once. Stationary and mobile mixers available. TMR mixers work in a batch-mixing manner. They require specialized feeding arrangements (drive-through feeders for mobile units, conveyor belts or wagons for stationary units). Daily time requirement includes loading, mixing and dispensing.

- Tractor Drawn Mix-mills - are large batch mixers, which can process dry hay by grinding into concentrate rations. They are run off power-take-off (PTO) power, and have their own dispensing auger. These allow bins to be filled at one or more locations. Daily time requirement includes loading, mixing and dispensing.
- Stationary Volumetric Mills - use feed proportioners; feed ingredients are stored in overhead bins and flow by gravity into separate compartments located on top of a stationary mill. They produce a steady flow of the desired ration by controlled ingredient flow rate, but require calibration upon receiving a new commodity. Furthermore, they can only be used for concentrate diets. Daily time requirement includes bin level checks, timer setting and dispensing.
- Blending boxes - use the same stationary principle as the Stationary Volumetric Mills but have no motorized parts. They are based on flow rates through slides; are probably less accurate; have no potential for rolling or grinding, and also lack self-contained augers. Daily time requirement includes bin level checks, supervised mixing and dispensing.

4. Decide on an appropriate amortization period for the extra equipment. It should reflect the lifetime of the machinery (5-10 years).
5. Does the differential multiplied by the tonnage over the amortization period cover the entire farm mixing related cost? Remember to factor in your additional labour costs.

### Diet Supplementation for Ewes Grazing Pasture

Many producers use lightweight mangers located in the pasture area and deliver feed to the manger in pails or bags. Although this particular strategy may work for a small group of animals, the labour and physical risk to the shepherd usually hinders the success and life span of this practice in larger animal groups. An often overlooked fact is that sheep, because of their mouth structure, can retrieve feed particles from within the pasture sward. Provided the feed is delivered on a clean surface (clean grass, sod or snow) and the grains are whole or pelleted, ewes will very quickly and effectively learn how to thoroughly clean up the feed mixture. Refer to OMAF Factsheet *Diet Supplementation for Grazing and Outwintering Ewes*, Order No. 02-045. Available at: http://www.omafra.gov.on.ca/english/livestock/sheep/facts/02-045.htm

#### Conclusion

In choosing a feeding system, several factors need to be considered. Most importantly are labour efficiency, safety and cost. Using a feeding or supplementation system that is fast, effective and safe will ensure the proper feed is delivered at the proper time. This in turn will improve animal performance and flock success.

**Table 1**. Space Allowances and Bunk Space Requirements for Sheep

| Accommodation | | Ewes and Rams | Feeder Lambs |
|---|---|---|---|
| **Feedlot** | hard surfaced | 15 sq. ft. per head | 6 sq. ft. per head |
| | soil* | 70 sq. ft. per head | 30 sq. ft. per head |
| **Open front shed** | floor area | 15 sq. ft. per pregnant ewe<br>10 sq. ft. per dry ewe | 6 sq. ft. per head |
| | ceiling height | 9 ft. minimum | 9 ft. minimum |
| **Slotted floors**** | area per animal | 7 sq. ft. | 4 sq. ft. |
| | % slotted floor area | 100 | 100 |
| | slot width | 3/4 inch | 5/8 inch |
| | slat width | 2 to 3 inches | 2 to 3 inches |
| **Lambing pens (not slotted)** | claiming pen only | 4 x 4 ft. minimum | |
| | lambing and claiming pen | 4 x 5 ft. minimum | |
| **Feed rack** | length per head | 16 inches group feeding | 12 inches group feeding |
| | | 6 inches self-fed | 4 inches self-fed |
| | height at throat | 12 inches small breeds | 10 inches small breeds |
| | | 15 inches large breeds | 12 inches large breeds |
| **Feed storage** | hay | 3 lb./head/day (small breeds) | 2 lb./head/day |
| | | 5 lb./head/day (large breeds) | 2 lb./head/day |
| | grain | 1/3 lb./head/day | 1/2 lb./head/day (maintenance)<br>1 to 2 1/2 lb./head/day (finishing) |
| **Bedding storage** | | 3/4 lb./head/day | 1/4 lb./head/day |
| **Water** | surface area | 1 sq. ft./40 head | 1 sq. ft./40 head |

*Use soil surfaced feedlots only where annual precipitation is less than 20 in. With soil surface, provide a paved feeding strip adjacent to each feed bunk. This paved strip should be at least 6 ft wide, or as wide as the tractor used for cleaning, and the strip should slope at 1/2 in./ft away from the feed bunk.

** An alternative to slotted floors, for ewes, rams or lambs is 1 by 2 in 10-gauge expanded and flattened metal mesh. Expanded metal mesh floors may be covered with a solid panel to retain bedding for lambing.

Source: Adapted from Canada Plan Service, *Sheep Housing and Equipment*, Plan M-4000.

**Table 2**. Sheep Rations Commonly Fed Over a Production Year and Their Commodity Components

| Animal | | Typical Ration Specifications | | | Concentrate Presentation | | |
|---|---|---|---|---|---|---|---|
| **Class** | **Subclass** | **Overall Specifications** | **Forage Content %** | **Grain Content %** | **TMR** | **Meal-fed[1]** | **Ground-fed[2]** |
| **Lamb** | Up to 65 lbs. | Creep/starter<br>17-18% CP<br>80-85% TDN | 0-40 | 100-60 | Yes | No | No |
| | 65 lbs. + | Grower/finisher<br>15-16% CP<br>78-82% TDN | 0-30 | 100-70 | Yes | Yes | 15-16% CP<br>82+% TDN |
| **Replace-ment** | Ewe lamb | 14-17% CP<br>65-68% TDN | 65 | 35 | Yes | Yes | 9-14% CP<br>80+% TDN |
| | Ram lamb | 14-17% CP<br>65-68% TDN | 70 | 30 | Yes | Yes | 9-14% CP<br>80+% TDN |
| **Ewe** | Maintenance | | 100 | 0 | N/A | N/A | N/A |
| | Flushing | 10-15% CP<br>68-70% TDN | 85 | 15 | Yes | Yes | 9-13% CP<br>80+% TDN |
| | Late gestation* | 15-18% CP<br>68-75% TDN | 85-60 | 15-40 | Yes | * | 9-14% CP<br>*<br>80+% TDN |
| | Lactation* | 14-17% CP<br>70-80% TDN | 70-50 | 30-50 | Yes | * | 9-14% CP<br>*<br>80+% TDN |
| **Ram** | Maintenance | | 100 | 0 | N/A | N/A | N/A |
| | Conditioning | 10-15% CP<br>68-70% TDN | 85 | 15 | Yes | Yes | 9-13% CP<br>80+% TDN |
| | Breeding | 10-15% CP<br>68-70% TDN | 85 | 15 | Yes | Yes | 9-13% CP<br>80+% TDN |

1 Meal-fed - When grain is fed all at one time in a bunk, i.e., slug feeding, pail feeding.
2 Ground-fed - When grain is fed all at one time but it is delivered on the ground.
* Acidosis risk

**Table 3.** Commodity Options by Concentrate Feeding System

| Bunk | Pasture and Ground Feeding |
|---|---|
| Soybean meal, mineral, whole corn, whole small grains and processed grains and byproducts<br><br>or<br><br>Supplement pellets, whole corn, whole small grains | Soybean meal pellets, whole corn (whole small grains). Note - free choice mineral<br><br>or<br><br>Whole corn (whole small grains). Note - free choice mineral<br><br>or<br><br>Supplement pellets, whole corn (whole small grains) |

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## Pasture Management

**Graze at the correct stage of growth**
The grass must be long enough to have built its root reserves, yet short enough not to have gone to seed. When the sheep are moved out of the paddock, the grass should still have some leaf to assist the root reserves in boosting growth.

**Vary grazing interval**
Spring growth is much faster and more vigorous. The sheep should be quickly rotated, just 'topping' the pasture at this time. During the summer months, the rotation slows, just as the grass growth dose. Sheep are eating more of the grass. It takes longer for the grass to re-grow and hence, the rotation is slower. In the late summer, the grass begins to grow faster. Often paddocks can be saved for fall pasture.

Each area (and year) has its particular climate. If it is very dry, then paddocks need to be rested longer. In general, the more severe the climate the larger the rewards from controlled grazing, but also the greater the risk from doing it wrong. Each grass species responds differently to grazing. Pasture height and rest periods need to be adjusted. For instance, if there is not enough alfalfa in the pasture, keeping the grasses shorter will encourage the alfalfa. If there is too much alfalfa, let the grass grow longer and some will be smothered out.

**Aim for good utilization**
You want the grazing to be as even as possible, with no un-grazed clumps or overgrazed areas. If you have difficulty achieving this, consider reducing the size of the paddock. Grazing with another species may also help clean up un-grazed areas.

**Graze quickly**
The best-controlled grazing systems involve having the flock in a different paddock each day, or different section of a paddock each day. Some producers may use portable electric fencing to move the flock through the pasture gradually.

**Do not over graze, particularly just prior to winter**
Late in the season, plants that have been eaten down almost completely will have little opportunity to manufacture sufficient food for transfer into the roots as a reserve. Early growth in the spring as well as during a dry period relies on plant nutrient reserves.

**Recognize surpluses early and conserve**
If the grass is going to get away from you (i.e. go to seed before you can get the sheep into that pasture) consider cutting it for hay or silage. Silage (or greenfeed) may be preferable because it can be cut from shorter grass, which is easier on the pasture

**Harvest before fibre content gets to high**
Try to feed the sheep hay that is the same quality as the feed they consume on pasture. This reduces supplemental feed costs, is better for the pasture as the grass has not grown too long, and is better for the sheep. Bales per acre is not a good measure of hay yield.