

EWE FLOCK NUTRITION



BASICS

OVERVIEW

- The nutrient requirements of sheep are highly dependent on physiological state (i.e. pregnancy, lactation, growth, etc.).
- Current nutrient reserves or body condition of the flock are also an important consideration in developing a feeding program. Therefore, additional adjustments may need to be made to compensate when reserves are excessive or insufficient.
- The nutritional status of sheep also has profound impacts on both maternal behavior and immunological status which are considerations that are often overlooked in flock health management.

INCIDENCE/PREVALENCE

- Metabolic diseases occur as the result of poor flock nutritional management and can affect up to 20% of a flock under severe conditions.
- The typical incidence of metabolic disease is much less however, and is generally <3% in well managed flocks and often dependent on feed resource management rather than feed scarcity.
- The prevalence of metabolic disease can increase in adverse weather conditions such as unexpected snow storms during early spring in pasture-based production systems.
- Disease related to nutritional deficiencies can have a high incidence within a flock, with potentially upward of 50% of a flock expressing clinical signs.

GEOGRAPHIC DISTRIBUTION

- Production systems and feed management strategies vary greatly and are influenced by climate and available feed resources.
- Knowledge of local soil nutrient deficiencies and feeding and production practices are important.
- Soil micronutrient levels including selenium, iodine, manganese and cobalt can vary markedly within and between geographical areas which may create the need for supplementation to avoid deficiency related disease.

PATHOPHYSIOLOGY

- Alterations in nutrient metabolism and aberrant metabolic adaptation during late pregnancy underlie two common production diseases: ketosis and parturient paresis.
- Anemia during lactation in particular is also common in pasture-based production due to gastrointestinal nematode infection with severity highly influenced by the plane of maternal nutrition.

- Micronutrient deficiency diseases are relatively common without supplementation and knowledge of the pathophysiology of these disorders is important for effective prevention strategies.

HISTORICAL FINDINGS

- The advent of supplementation strategies in the 1960s for key limiting micronutrients such as selenium has greatly reduced the incidence of flock nutritional deficiency diseases. In some regions however a large amount of variation may be present in soil levels of critically limiting micronutrients, and monitoring of farms on an individual basis may be required.
- Improved understanding of fiber digestibility of various feedstuffs has helped to reduce both metabolic acidosis and ketosis through the substitution of high energy fiber sources for starch in ewe flock nutrition.

PHYSICAL EXAMINATION FINDINGS

- Body condition scoring is an effective and important tool for assessing nutritional status and is based on palpation of both the spinous and transverse processes of the lumbar vertebrae. Body condition scores (BCS) vary from 1 to 5 (1=thin and 5=fat).
- Anemia scoring by observation of the color of the ocular mucous membranes (FAMACHA©) is an effective means of monitoring parasitism and should be an integral part of an effective flock management plan. Failure to effectively control internal parasites will undermine any nutritional management plan. Plane of nutrition and susceptibility to parasites are tightly coupled, and anemia scoring is important in routine flock management.
- Detailed physical examination is less important in developing and monitoring a whole flock nutritional plan but is useful in the diagnosis of nutritional disorders and deficiency related diseases.

GENETICS

- Prolificacy has a profound influence on flock nutritional management and is heavily influenced by genetics.
- Mature body size is highly influenced by genetics and has a large impact on feeding budgets and nutritional management.

CAUSES AND RISK FACTORS

- Risk factors for metabolic diseases in the ewe flock:
 - Litter size
 - Body composition entering late pregnancy
 - Excessively thin (BCS <2)
 - Excessively fat (BSC >4)
 - Stress events leading to sustained/substantial cortisol or catecholamine release (i.e. shearing, winter storms, feed deprivation, excessive cold challenge, predator pressure)
 - Energy intake
 - Feed availability
 - Energy concentration in diet
 - Fiber content and/or digestibility

- Form of energy (starch, fat, highly digestible fiber)
- Risk factors for nutrient deficiencies:
 - Soil content of micronutrients
 - Consistent supplement intake
 - Dietary factors that influence absorption, digestive function, metabolism, tissue transport/uptake
- Risk factors for nutritional disorders:
 - Sudden changes in diet leading to shifts in gastrointestinal flora biota and subsequent changes in gut nutrient biosynthesis or degradation capacity



DIAGNOSIS

DIFFERENTIAL DIAGNOSES

Differential diagnoses for ewes with neurological symptoms during the periparturient period include listeriosis, polioencephalomalacia, parturient paresis and ketosis.

- Polioencephalomalacia: initial signs include partial blindness, “star gazing” behavior eventually advancing to recumbency, seizures and coma. When identified early, clinical response to thiamine administration can be rapid and often successful however some animals may require several days of treatment for recovery.
- Listeriosis: initial signs include facial paralysis, drooping ear and drooling on the affected side following by circling to the affected side. The clinical course is fast sometimes leading to death by 48 h. Prompt and aggressive antibiotic therapy may lead to recovery, however, the prognosis is guarded and recovery somewhat dependent on the antibiotic susceptibility of the *Listeria* strain involved.
- Ketosis: initial signs include poor appetite that progresses over a few days to aimless walking and grinding of the teeth. Occurs almost exclusively during late pregnancy in sheep rather than during lactation, and is particularly prevalent in sheep with multiple fetuses. Increased plasma/serum beta hydroxy butyrate (BHBA) and decreased serum glucose concentrations are key diagnostic findings.
- Parturient paresis: initial onset is sudden and most common in late pregnancy associated with short bouts of fasting or severe weather changes. Affected sheep often quickly assume sternal recumbency with their hindlegs extending behind. Diagnosis is supported by fast and often lasting response to IV calcium administration. This disease and ketosis often occur concurrently.

CBC/BIOCHEMISTRY/URINALYSIS

- Animals with ketosis may have reduced serum/plasma glucose concentrations, and increased serum BHBA concentrations (>0.8 mmol/L in subclinical ketosis; >3.0 mmol/L in clinical ketosis).
- Urine ketones may be elevated as measured by qualitative testing strips.
- Animals with parturient paresis will have low serum total calcium concentrations (<2 mmol/L)

IMAGING

- Trans-abdominal ultrasonography is commonly used to diagnose pregnancy and to determine litter size in sheep and goats. The optimal window for this procedure to achieve fetal counting is 40-70 days post breeding. This allows more precise nutritional management of does and ewes according to litter size and pregnancy status to help prevent metabolic disease or over-feeding

OTHER DIAGNOSTIC PROCEDURES

- Body condition scoring is used to monitor flock nutrition and feeding programs.
- Forage analysis and ration evaluation are useful in determining flock plane of nutrition
- Serum or whole blood samples can be submitted from adult ewes for assessment of vitamin E and selenium concentrations respectively.
 - Serum vitamin E concentrations are typically 0.65 to 1.5 ug/ml and are greatly influenced by feeding practices of the flock.
 - Normal blood selenium concentrations for adult ewes are 90 to 120 ng/ml
 - Vitamin E concentrations drop precipitously when ewes are removed from pasture and placed on dry, stored feed since the fat soluble vitamin content of stored forages in general is markedly diminished even under ideal harvest conditions.

PATHOLOGIC FINDINGS

- Polioencephalomalacia: cerebrocortical autofluorescence under ultraviolet illumination and necrosis of cerebrocortical neurons.
- Listeriosis: congestion of meninges, and microscopic lesions in pons, medulla oblongata and anterior spinal cord.
- Ketosis: Enlarged, yellow, fatty liver and enlarged adrenal glands.



TREATMENT

THERAPEUTIC APPROACH

- **Micronutrient and micromineral disorders:**

- Granular sheep trace mineral salt mixes are used to deliver micronutrients and other supplements to grazing sheep or those on 100% roughage diets.
 - Common additives to sheep trace mineral salt (TMS) include micro minerals, macro minerals, vitamins, and coccidiostats.
 - Adult ewes regularly consume about one-half ounce of salt/head/day however intake can be variable and should be monitored to determine if the supplementation program is effective.
 - Vitamin E is normally added to a salt or grain mix in the form of a vitamin E premix containing 20,000 IU of vitamin E/pound of product.
 - Thiamine treatment for polioencephalomalacia is 10 mg/kg bodyweight administered IV (slowly) on day 1 followed by 3-5 days of subsequent doses given IM.
- **Metabolic Disorders**
 - Parturient paresis: 50-150 mL of 23% calcium borogluconate administered IV over 10 minutes. Can be combined with 1 liter of 5% dextrose for enhanced therapeutic value and greater ease and safety of administration.
 - Ketosis: Prompt oral dosing of propylene glycol at 60-100mL per day for at least three days following first indication of inappetence. Administration of dexamethasone (20 mg IV or IM per adult ewe) in advanced cases during late pregnancy (> day 140) to induce parturition.

Precautions

- Appropriate milk and meat withdrawal times must be followed for all compounds administered to food-producing animals. The Minor Use and Minor Species Animal Health Act of 2004 defines conditions that allow for extra-label use of drugs not approved for sheep which are a minor species. The Food Animal Residue Avoidance Databank is an excellent resource to refer to when needing to establish withdrawal times for drugs to insure the safety of products from food animals (www.farad.org).



FOLLOW-UP

EXPECTED COURSE AND PROGNOSIS

- Prognosis is generally poor for severe metabolic disease, and if recognized late, it is difficult to improve energy intake safely and rapidly during late pregnancy.

CLIENT EDUCATION

- A critical component of preventative medicine, focus should be on:
 - Understanding body condition benchmarks for a given stage of production
 - Understanding the micronutrient deficiencies present in soils in which the majority of the flock's feedstuff are grown.
 - Understanding the importance of forage quality in determining feed intake and flock nutrition and sourcing or managing forage quality appropriately to meet production requirements.
 - Identifying metabolic disease symptoms early in the course of disease

PATIENT CARE

- Focus should be on the whole flock as profitable sheep production requires population level management.
- In the case of individual sheep requiring care that escape the preventative medicine shield, monitoring of food and water intake is important as is provision of quality, highly digestible forage to maintain a healthy rumen.

PREVENTION

Energy insufficiency is the basis for several metabolic diseases especially during late pregnancy in prolific sheep. Careful nutritional management aimed at attaining the appropriate BCS benchmarks for a given stage of production will prevent the vast majority of metabolic issues.



MISCELLANEOUS

ASSOCIATED CONDITIONS

- Metabolic diseases and nutritional disorders of sheep can often be multifactorial and occur concurrently. For example, ketosis and parturient paresis are commonly linked with one more dominant than the other.

AGE-RELATED FACTORS

- Ewes less than approximately 18 months of age have not reached full mature size and therefore high a nutritional requirement for growth that must be accounted for in a feeding program especially during late pregnancy and lactation.

PREGNANCY

- The nutrient requirements of pregnancy are significant in prolific sheep during late pregnancy. Therefore both stage of pregnancy and litter size are key considerations in developing a feeding program to optimize flock health, productivity and well-being.

PRODUCTION MANAGEMENT

Forage Feeding system

- Sheep production systems are forage-based but diverse in that they are highly adaptable to a multitude of forage feeding opportunities ranging from extensive systems grazing land at a low animal density, to intensive production utilizing precision feeding of a total mixed ration. Forage feeding systems are dictated by climate, land value, facility infrastructure, labor and producer experience.
- Forages constitute the majority of a feed budget and are therefore the greatest expense within a production system. Forage quality is a critical determinant of flock productivity and also determines the extent to which concentrates may be needed to meet the nutrient requirements

of a flock. Knowledge of how to allocate forage within a given forage inventory according to the production state/requirements of a flock is critical in optimizing production efficiency.

- The key objective is to formulate rations to meet the nutrient requirements of the flock within the constraints of a given production system.
- Basic production systems: Production systems vary largely according to forage feeding method and to birth management system.
- Examples of common production systems include:
 - Winter lambing systems (*Figure 1*): In these indoor birth programs, the major flock requirements of late pregnancy through lactation are met with stored forage and concentrate. This feeding system is relatively labor intensive as are the feed components.
 - Spring lambing systems: In Spring pasture birth systems the high energy requirements of late pregnancy and lactation are met with quality pasture. Pasture birth systems have the lowest labor inputs. Spring drop lot birth systems are a variant of spring lambing and are used extensively in the western USA. In these systems, the ewe flock is fed stored feed near facilities during late pregnancy. As the ewes give birth, they are moved into nearby lambing facilities to bond with their lambs for a few days before being placed on pasture for lactation. In drop lot birth programs, the nutrient requirements of late pregnancy are met with stored feed while that of lactation is met with quality pasture.

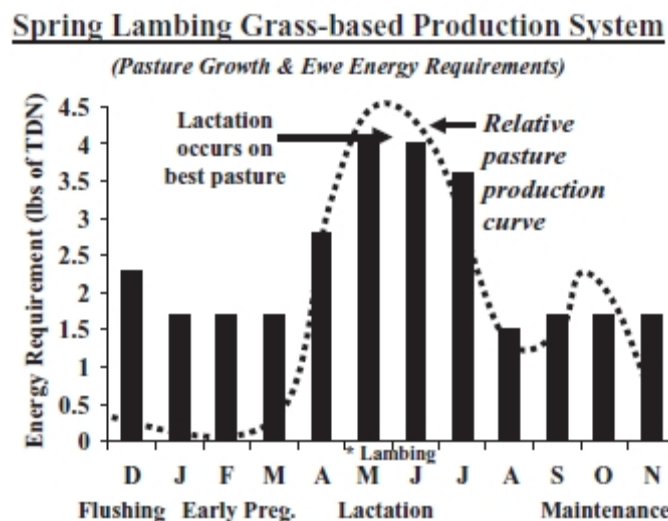


Figure 1. Basic schematic of a spring lambing system comparing pasture resources to energy requirements for a commercial ewe raising twins.

Nutrient requirement of the ewe according to production state

- Major production phases include:
 - Pre-breeding and breeding season, commonly called “flushing”
 - Mid-pregnancy
 - Late pregnancy
 - Lactation
 - Dry period-period between lactation and the next pre-breeding period
- Production levels are further defined by mature size, prolificacy and birth interval. The requirements for highly prolific sheep with litters (≥ 2 lambs) are much greater than for those raising singles. The requirements of ewes on annual birth programs differ from those on

accelerated birth programs (interval between birth of <12 months) as the dry period is shorter. Therefore, accelerated ewes should be on a higher plane of nutrition than annual lambing ewes to minimize body condition loss.

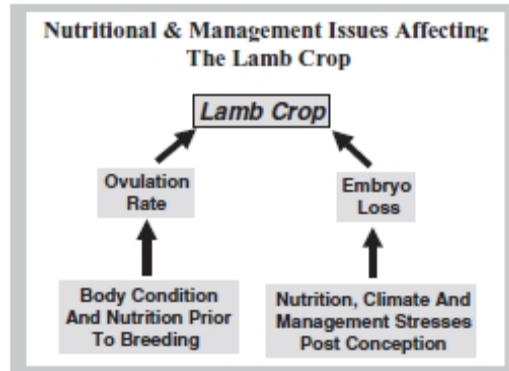
Water requirements

- Water requirements of adult ewes vary considerably according to ambient temperature and stage of production (range of 0.5 to 1.5 gallons/day) with adequate supply essential to maintain feed intake and animal well-being. Water needs can be supplied in a variety of forms including that found in dew, forage water content, soft snow and supplied as supplemental water in a water tank/fountain or pond, etc.
- Water needs of grazing sheep do not necessarily have to be met with supplied fluid water under some common grazing conditions (cool weather, non-lactating ewes before late pregnancy, when forage water content is high).

Nutrition during the pre-breeding and breeding seasons

- To simplify feeding programs, the pre-breeding, breeding season and early pregnancy nutrition programs can be lumped together which is also the most practical route in terms of flock management.
- Nutritional management during this period is central to determining the subsequent lamb crop via its impact on ovulation rate and embryo survival (*Figure 2*).
- Ewes are commonly exposed to rams for two heat cycles (~ 34 days) so this feeding program will last this period plus 2-3 weeks before ram exposure; so a maximum of 7-8 weeks.
- The goal of this feeding program is to place the ewes in a state of positive energy balance and weight gain which will improve ovulation rate and embryo survival. This is accomplished by improving flock energy intake so the animals gain weight which can also be monitored by improved body condition score. The level of energy nutrition to accomplish this is typically 1.2 - 1.4 times that required for weight maintenance. This recommendation is given as a range because the body condition of the ewe flock is another consideration. Thin ewes of BCS ≤ 2.0 will require a high plane of nutrition while those in very good body condition ≥ 3.5 BCS do not need the same degree of increase in energy intake. The goal of feeding during this period is for all ewes to improve to a BCS ≥ 2.5 by mid pregnancy.
- At the farm level, this increase in energy intake can be accomplished in a variety of ways according to farm resources. Supplementation with concentrates such as barley or corn (0.5 to 1.5 lb / adult ewe / day) can be effective however this level of increase in energy nutrition can also be met more efficiently and often more economically with improved pasture allowance and/or improved pasture quality in grazing programs. Some farmers graze specialty high energy annual forages such as forage brassicas to meet this need. Protein nutrition is rarely a limiting factor during this period for mature ewes, with a dietary crude protein concentration 10% the requirement threshold which is below that found in most forages.
- In grazing flocks, parasite management is also an important consideration when trying to increase flock energy balance. Therefore, good flock parasite control must be in place or the impact of the feeding program will be minimized. Parasite control should involve an integrated approach of proper grazing management and judicious partial or selective flock treatment using effective anthelmintic agents.

Figure 2. *Nutritional and Management Factors Influencing Lamb Crop*



Nutrition during mid-pregnancy

- This period is defined as the period between approximately days 40-110 of pregnancy, after the placenta is established and placentation is complete and before the quantitatively significant nutrient demands of late pregnancy occur. During this period maintenance of body condition is the goal with ewes at a BCS of 3.0 as they enter late pregnancy. Minor loss of body condition during this period can occur with little consequence in otherwise well fed ewes however loss of greater than 0.5 BCS should be avoided. This is a production period when slightly lower forage quality can suffice. In grazing programs this may be a period when stockpiled pasture or crop residues are grazed.

Nutrition during late pregnancy

- Late pregnancy is a period of high absolute growth of the fetus(es) and also when placental function is maximal. Collectively these processes require a large increase in the plane of nutritional energy to support fetal growth, mammary development and colostrum supply to ensure optimal pregnancy outcome.
- The body condition target for late pregnancy ewes is BCS 3-3.5. Obese ewes entering late pregnancy are at risk for ketosis and should be managed prior to late pregnancy to keep BCS <4. Reducing energy intake during late pregnancy in obese ewes commonly leads to ketosis and must be avoided. Strive to prevent obesity especially in the non-pregnant state.
- The nutrient requirements of late pregnancy vary markedly depending on litter size. The energy requirements of late pregnancy when expressed relative to maintenance requirements are 1.5, 2.0 and 2.3 times maintenance requirement (the amount of energy required to maintain non pregnant body weight) for ewes carrying singles, twins or triplets respectively. The protein requirements of this period are also dependent on litter size as intake must increase to meet the needs of fetal tissue accretion. Increased protein intake in late pregnancy may also have benefits for milk production in early lactation by increasing the labile protein reserve in skeletal muscle used for milk synthesis before feed intake expands to support this need. Recommended dietary crude protein concentrations according to litter size during late pregnancy are 11%, 13% and 14.5% for ewes carrying single, twin or triplets, respectively.

- The challenge is to improve the nutritional plane when feed intake may be limited by gastrointestinal capacity in prolific ewes due to the increasing size of the gravid uterus and/or by metabolic factors. Voluntary matter intake in prolific ewes during late pregnancy rarely exceeds 3% of body weight so this must be considered when examining and creating feeding programs for this period. The energy density of the diet must be increased, however this must be done carefully to prevent depression in dry matter intake. Increasing energy density without depressing intake requires an improvement in forage quality using forages of high digestibility. Energy concentration can also be improved by the feeding of energy concentrates however concentrate intake should not exceed 50% of total dry matter intake. When quality forages are difficult to source during this period, non-forage fiber can be substituted such as that found in soy hulls, a by-product of the soy milling industry. The fiber from this source is a highly digestible, high energy source and therefore an excellent supplement for late pregnancy.
- In grazing programs, the requirements of late pregnancy in twin bearing ewes can be met with quality pasture offered at a high rate of allowance. In ewes bearing triplets or greater however the capacity for adequate energy intake may not be possible. Therefore pasture supplementation may be needed in highly prolific ewes with a litter size of 3 or more.
- As producers continue to seek to improve lifetime ewe productivity, the practice of breeding ewe lambs to give birth during their first year of life is becoming more common. These ewes are still growing and require a diet with slightly higher energy and protein density in late pregnancy than needed for mature ewes. These young ewes are also less competitive at the feed bunk so it is advised to group them separately so that their intake is not limited by competition with older ewes.
- Shearing ewes 3-6 weeks prior to parturition is also recommended as a means of increasing feed intake. Ewes exhibit a “shearing-specific” increase in voluntary dry matter intake above that expected due to loss of insulation. Shearing also has benefits by creating drier conditions in the microenvironment of young lambs and allows better access of newborns to the udder. Another benefit is that ewes are more likely to seek shelter at lambing if they are shorn. Ewes that are overly thin should not be shorn in late pregnancy as this may lead to exaggerated weight loss. All sheep housed in cold winter conditions should be sheared so as to leave adequate wool stubble which minimizes heat loss.

Nutrition during lactation

- In typical sheep breeds selected for meat production, lactation peaks at approximately 30 day after birth and feed intake increases fairly quickly, increasing at least 25% by the second week of lactation. Dry matter intake improves to 4% of body weight or slightly more during lactation.
- The expansion of DMI during lactation allows for greater energy intake so typically the energy concentration of the diet does not need to be increased from late pregnancy to lactation to meet the higher energy needs of lactation. Protein requirements increase during lactation reflecting the requirement for milk protein synthesis. To meet this higher requirement, the protein concentration of the diet may need to be increased from late pregnancy to lactation. Dietary protein concentration for prolific ewes should range from 14.5 to 16% depending on how many lambs are being reared (rearing percentage range of 160 to 200%). Lactation diets for ewes fed stored feed are expensive due to their

relatively high protein and energy concentration. Therefore, careful consideration in not overfeeding protein is important in controlling feed cost.

- In very early lactation, ewes housed indoors are typically fed in a lambing pen to facilitate bonding for a few days. Care must be taken not to overfeed energy concentrate during this period if ewes are fed a component diet (grain plus hay or silage). It is advised not to feed grain during this 1-3 day bonding period to prevent overfeeding and the onset of acidosis. A diet of high quality forage is sufficient for this very early lactation period with concentrate feeding ensuing as ewes are brought to small group pens (often called mixing pens) after the 1-3 day bonding period is over.
- Decreasing energy and protein intake just prior to weaning is advised to minimize the risk of mastitis. A common practice is to reduce both energy and protein intake significantly starting 5-7 days before weaning. In farms with component feeding programs (concentrate and forage fed separately) this involves tapering off concentrate feeding and then decreasing forage quality. In accelerated production systems that strive to get ewes rebred soon after weaning, energy and protein intake are limited to a lesser duration and degree otherwise body condition loss may be too excessive to allow for optimal out of season conception.

Nutrition during the dry period.

- The length of the dry period depends on the production system. In accelerated production, the dry period may be less than one month whereas in annual lambing programs the dry period may be in the range of 3-5 months. In annual production, ewes are maintained on often a lower quality forage based-diet with the goal of reducing feed cost. Sheep are fed to maintain weight and perhaps increase a small amount. Excessive weight loss should not be allowed during this period however as it is expensive to regain. In accelerated systems, this period is very short and the goal is to get ewes rebred quickly following weaning. In these systems, dry period feeding may only last a week or so before the plane of nutrition is increased prior to the subsequent mating period.

Vitamin and mineral flock nutrition

- The need to supplement vitamins and minerals is dictated mainly by their concentration in forages consumed by the flock. This in turn is dictated largely by soil concentrations, and whether the forage is fed fresh or has been stored.
- Macro minerals consist of Ca, P, Na, Cl, Mg, K, and S.
 - Generally, forage content of macro minerals is adequate however occasionally Ca or Mg require supplementation
 - Ca and P are more important in young, growing animals than adults
 - Adults are more tolerant of wide Ca:P ratios than lambs
 - Ca and P are an important issue for lamb feeding rations: keep Ca:P at 2:1 to 3:1 in feedlot diets
 - High-concentrate, low-roughage diets are often high in P and low in Ca
 - Low Ca:P ratio (usually 1.5:1 or less) can lead to urinary calculi in feedlot lambs
 - Ca (as feed grade limestone) is routinely supplemented in feedlot rations to create a 2.5:1 ratio.
 - Ca- and P-based mineral supplements are usually unwarranted in ewe diets
 - Ca and P content is usually satisfactory unless feeding:

- Poor-quality, mature forages (forage test <0.2% P or <0.5% Ca) especially if forage is grass, not legume (legume forages higher in Ca)
 - Unsupplemented corn silage, small grain silage, sorghum silage products, or unusual local byproduct feeds (beet pulp, seed corn husklage, etc.)
- Forage testing and ration evaluation is needed to document adequate mineral content and avoid costly supplementation of Ca and P.
- Micro minerals consist of Co, Cu, F, I, Fe, Mn, Mo, Se, and Zn.
 - Common micro mineral deficiencies in sheep are Se and I but this pattern is very much regional with certain regions have high levels and in the case of Se, consequent toxicity issues.
 - Cu toxicity is a common problem in sheep as the threshold for toxicity is lower than in other food animal species. Cu and Mo are antagonists so the concentration of one determines the availability of the other. In general, sheep feed should never be supplemented with Cu as forage contents are adequate and any additional Cu can lead to toxicity. The exception is lamb milk replacer as lambs do not consume forage and can therefore become Cu deficient.
- Fat soluble vitamins (A, D, E, K)
 - Fat soluble vitamin content of stored forage drops precipitously following harvest even under ideal conditions. Therefore, supplementation of A, D and especially E are advised when feeding stored forage.
 - In contrast, fat soluble vitamin content is rarely limiting on pasture.
 - **Vitamin A**
 - Vitamin A requirements for commercial ewes range from about 3,000 IU/day for maintenance to up to 7,000 IU/day for lactation
 - Deficiencies are rare unless green forages unavailable for long periods of time
 - Stored in liver for 4 to 6 months
 - Supplementation may be warranted under the following feeding conditions:
 - Prolonged periods of drought
 - Forages stored for lengthy periods (allowing vitamin A degradation)
 - Sun-bleached or severely water-damaged forages
 - Flocks housed in total confinement
 - **Vitamin D**
 - Abundant in sheep exposed to sunlight, supplementation usually unnecessary except perhaps in fast growing lambs housed indoors in northern regions.
 - **Vitamin E**
 - Vitamin E content of stored feeds fed to sheep is nearly always inadequate
 - Daily vitamin E requirements of sheep are suggested to be 5.3 IU per kg body weight.
 - Supplemented through feed or free-choice TMS salt mix: Vitamin E premix commonly sold as a 20,000 IU/lb. product

- ***Delivery of micronutrients in salt***
 - Micronutrients are typically delivered via salt fed free choice in North America with consumption regulated by sodium intake. These salt mixtures are commonly referred to as trace mineralized salt (TMS).
 - Adult ewes usually consume salt at rate of 0.5 oz/head/day however this can vary by close to 100% depending on the sodium content of forage.
 - The ingredients of TMS vary according to species, local issues, and suppliers
 - Most livestock TMS contains NaCl and various levels of Co, Cu, F, I, Fe, Mn, Mo, and Zn
 - TMS will not contain selenium (Se) unless specifically listed on the label as selenized-TMS or as TMS with selenium
 - Selenium is often adequate in some areas and deficient in others
 - In geographic areas where deficiency occurs, selenium may be added to TMS
 - Added as the ingredient sodium selenite
 - Maximum Se content allowed in selenized-TMS for sheep is 90 ppm Se
 - Maximum Se content allowed in selenized-TMS for cattle is 120 ppm Se
 - Sheep are extremely sensitive to copper toxicity and should not receive TMS containing copper (unless a copper-deficient area)
 - Copper at 6 to 8 ppm required in sheep diets: forage levels meet or exceed this requirement
 - Dietary Cu levels greater than 15 ppm (with Mo less than 1 ppm) can lead to copper toxicity (Cu:Mo ratio >10)
 - Mo often added to sheep feeds to prevent copper toxicity as Mo prevents copper uptake
 - Cattle and swine TMS contain high levels of copper (in excess 330 ppm Cu); can contribute to toxicity
 - TMS manufactured for sheep is usually referred to as sheep TMS and contains no added copper.
 - Trace mineral salt (TMS) supplied in a granular or block format with the granular form is best for sheep
 - Allows mixing various products for supplementation on pasture
 - Selenium, vitamins and coccidiostats are commonly added to TMS
 - One-half ounce/head/day TMS consumption level is used as a reference to regulate and restrict medication intake.
 - Due to salt consumption and concentration differences, medicated TMS salt/mineral products formulated for cattle should not be used indiscriminately for sheep
 - Granular format less likely to damage teeth
 - TMS should be available to the flock at all times.
 - Caution should be exercised when supplying salt to severely salt deprived sheep.

Suggested Reading

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