# Nutrient Requirements of Sheep

## Sixth Revised Edition, 1985

Subcommittee on Sheep Nutrition
Committee on Animal Nutrition
Board on Agriculture
National Research Council

# Preface

This report is one in a series of reports entitled *Nutrient Requirements of Domestic Animals*, issued under the guidance of the Committee on Animal Nutrition, Board on Agriculture, National Research Council. It was prepared by the Subcommittee on Sheep Nutrition and updates the 1975 edition of *Nutrient Requirements of Sheep*.

The revisions made include the following:

- The values presented reflect new information available on sheep nutrition and are interpreted by the committee into useful form.
- The concentrations of nutrients in the diet for a specific stage of production are similar for all weights of sheep and include the ratio of concentrate to forage that would conventionally be fed.
- Specific diets and nutrient requirements are presented for ewe lambs during various stages of production.
- The energy requirements and energy concentration of the diet of ewes in the last 4 to 6 weeks of gestation with an expected lambing rate of 130 to 150 percent are reduced somewhat from the values reported in the 1975 edition of this report.
- The nutrient requirements and nutrient concentrations of the diet during the last 4 to 6 weeks of gestation for ewes with an expected lambing rate of 180 to 225 percent are a new addition and are distinctly different from requirements for ewes with lower lambing rates.
- The expected growth rate of light-weight finishing lambs was substantially increased, and dietary energy concentrations were increased for all weight lambs to accommodate these higher weight gains within the constraints of limited capacity to consume dry matter.
- Feed composition data are expressed on a dry matter basis.
- Feeds are named in accordance with nomenclature adopted by the Committee on Animal Nutrition (United States) and the National Committee on Animal Nutrition (Canada).
- Values for nutrient requirements are given in both the metric and English systems to broaden the application of the information.
- More husbandry information is included than in previous editions to better serve sheep producers who rely on this information source in managing their flocks.
- Formulas and tables have been developed to estimate energy requirements for maintenance and growth by animals of varying mature weight genotypes (see Table 3). Tables 1 and 2 were not developed from these formulas; thus, there may be some discordance between these estimates of average energy requirements.

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# 1 Introduction

The major nutrient requirements of sheep and the composition of typical diets that will supply those nutrients at specific stages of production are presented in Tables 1 and 2.

The values given are considered necessary for the levels of performance indicated in the tables for various stages of production and for the prevention of nutritional deficiencies.

When using these tables to determine feed rations, one should be aware of the following:

- Variation among sheep affects the utilization of and need for nutrients.
- Competition among sheep of different sizes, ages, and breeds may significantly affect the daily intake of an individual sheep, resulting in an excess intake by more-aggressive sheep and an inadequate intake by less-aggressive sheep.
- Dry matter (DM) intake is an important consideration in formulating sheep rations. Severely restricted DM intake often results in a 5- to 10-fold increase in salt and mineral intake when minerals are offered free choice. Restricted DM intake may result in wool picking or defleecing of self or penmates.

Conversely, feeds excessively high in fiber or water may restrict nutrient intake. This is particularly a problem during late gestation in twin- and triplet-bearing ewes, early weaned lambs, and finishing lambs fed for maximum gain.

- Performance level expected may differ from the levels indicated in the tables.
- Interrelationships among nutrients may affect need.
- Previous nutritional status of the sheep may influence requirements. Sheep previously fed carotene-deficient forage or sheep that are excessively thin or fat should be fed a diet different from sheep in average condition.
- Level of intake may affect utilization of nutrients (e.g., high intake, in general, depresses digestibility).
- Disease, parasites, environmental stress, and other less-obvious conditions may influence nutritional requirements.

Most of the values given in Tables 1 and 2 are based on research results. Some were determined by extrapolation from research data.

The nutrient values presented are for feedstuffs of average composition, digestibility, and quality. In special cases, adjustments in intake should be made. Amounts of feed refer to the amount actually consumed, not offered. Failure to account for wasted food may result in gross underfeeding.

Except for maintenance and early gestation diets, the amounts of dry matter indicated are near maximum without resulting in refusal. If higher levels or rates of production are sought via increased nutrient intake, an increase in the concentration of nutrients in the ration rather than an increase in the amount fed is necessary.

# 2 Nutrient Requirements and Signs of Deficiency

## ENERGY

The term energy, when used to describe diet attributes, actually describes the end product rather than the inherent characteristics of compounds found in feedstuffs. Energy results from the utilization of the absorbed nutrients from metabolic processes such as oxidation and synthesis. It is generally measured as heat of combustion. The specific term used to describe the unit of energy depends on many factors; the most common include calorie and joule.

In the United States the calorie is the most common unit for measuring energy in feedstuffs and is used throughout this report. A calorie is the amount of heat necessary to raise one gram of water from $16.5°$ to $17.5°C$. Since the calorie is a very small unit of measurement, energy values for feedstuffs are more commonly expressed as kilocalories (1 kcal = 1,000 calories) and megacalories (1 Mcal = 1,000,000 calories = 1,000 kcal). Internationally, the joule is frequently used (1 calorie = 4.184 joules).

The caloric values of individual constituents of feedstuffs are characteristic of their chemical compositions. The energy value of a constituent is measured as the heat released when the substance is completely oxidized to carbon dioxide and water. The amount of energy released is measured in calories and is referred to as the gross energy (E) contained in that constituent. For example,

| Compound | Heat of Combustion, kcal/g |
|---|---|
| Ethanol | 7.11 |
| Glucose | 3.74 |
| Starch | 4.18 |
| Acetic acid | 3.49 |
| Propionic acid | 4.96 |

| Compound | Heat of Combustion, kcal/g |
|---|---|
| Butyric acid | 5.95 |
| Palmitic acid | 9.35 |
| Stearic acid | 9.53 |
| Glycine | 3.12 |
| Tyrosine | 5.91 |

Generally, the proximate constituents of feedstuffs are considered to contain the following E:

| Feedstuff Component | kcal/g |
|---|---|
| Carbohydrate | 4.2 |
| Fat | 9.4 |
| Protein | 5.6 |

Although E is determined by burning a constituent in an atmosphere of oxygen, the yield of energy, whether via oxidation in biological systems or a furnace, is the same if taken to the same state of oxidation or end products.

### Terminology for Discussing Energy Values of Feedstuffs

Gross energy is not particularly descriptive of the energy an animal can derive from a feedstuff. When a feedstuff or combination of feedstuffs (diet) is fed, the digestive process is generally not able to make all the E consumed available to the animal for absorption; thus, there is a loss of energy in the feces. Subtracting the energy excreted in feces from the E consumed yields digestible energy (DE). Digestible energy can be expressed in absolute terms per unit of weight (kcal/g) or as a percentage of gross energy. The term total digestible nutrients (TDN) also is used, but feed energy values are expressed in units of weight instead of calories. TDN is determined by

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summing digestible crude protein, digestible carbohydrates (nitrogen-free extract and crude fiber), and 2.25 × digestible crude fat.

Although DE and TDN are frequently used to evaluate feedstuffs and to express nutrient requirements, the use of metabolizable energy (ME) instead of DE or TDN has important advantages for ruminants. Measuring only fecal energy losses does not accurately reflect the energy available to ruminants for use in productive processes. As feedstuffs are exposed to microorganisms in the rumen, a significant part of the E in the feedstuff is metabolized to methane (an end product of fermentation that is very high in energy but of essentially no caloric value to the host animal) that escapes from the rumen in eructated gases. Loss of gross energy as methane varies with the type of diet (high concentrate versus low concentrate) and the level of feeding and ranges from 3 to 10 percent. The energy lost in urine also is not accounted for if only fecal energy is measured. The energy content of urine is rather constant and represents 3 to 5 percent of the E value of a diet. The major factors influencing the fraction of dietary DE in the urine are diet protein level, diet roughage levels, and essential oil content. The last is high in some range plants such as sagebrush (Cook et al., 1952). To determine ME, subtract gaseous and urine energy losses from DE. The conversion of DE to ME generally is estimated as DE × 0.82. This estimation is accurate except for high-grain diets, where higher ratios are observed (Johnson, 1972).

Net energy (NE) is the most refined expression of the value of energy in a feedstuff. Although not as commonly used in evaluating feedstuffs and expressing requirements as ME, NE represents the amount of energy available to the animal for maintenance and productive processes. Determination of NE requires one measurement in addition to those required for calculating ME. This is the heat increment (HI), which is the increase in heat produced as a result of digestion and metabolic processes in response to increased ME intake. Thus, HI is the inefficiency of ME use for any given function. Subtracting HI from ME yields NE. This assumes that HI includes both the heat from fermentations in the digestive tract and the heat liberated during nutrient metabolism. Under most conditions, HI is of no value to the animal and frequently is a burden, since it requires that additional energy be dissipated. However, when ruminants are exposed to low environmental temperatures and must increase heat production to maintain normal body temperatures, then HI may be useful in maintaining body temperature. Heat increment varies with diet and physiological function of the animal and can range from 10 to 90 percent of the ME.

Net energy is subdivided into that used for maintenance ($NE_m$) and that recovered as some useful product

($NE_p$) (recovered energy [RE], body tissue, milk, or wool). $NE_m$ and $NE_p$ may be further subdivided.

Net energy for maintenance includes the NE for basal metabolism that relates to muscular activity, tissue repair and replacement, and involuntary metabolic processes such as maintenance of ionic gradients. Also included as $NE_m$ is the minimal voluntary activity necessary to sustain life. The amount of energy needed to satisfy voluntary activity needs (sometimes called the activity increment) varies widely depending on the availability of feed, water, and shade and the topography of the environment. Extreme examples of management systems—confinement versus arid range—may cause the activity increment to be a major factor in determining $NE_m$. During hot or cold weather, the animal uses ME to cool or heat its body; the energy required for this is also part of $NE_m$ and is widely variable depending on several environmental factors.

Net energy available to the animal in excess of that required for maintenance is used in a variety of productive processes. These include the net energy for growth ($NE_g$), lactation ($NE_l$), reproductive processes ($NE_y$), and production of wool and hair ($NE_v$). Where applicable, the net energy for physical work, in addition to that required by the activity increment, may also be included.

The efficiency with which metabolizable energy above maintenance is used as net energy for various functions varies with quality of diet and physiological function. For example, the process of milk production is more efficient than growth as empty body gain.

### Signs of Deficiency and Toxicity

Meeting energy requirements without over- or underfeeding animals is one of the producer's most difficult tasks. Energy deficiency or insufficiency is likely the most widely occurring nutritional deficiency within the sheep industry. Likewise, oversupplying energy to sheep is one of the most wasteful practices.

An energy deficiency will manifest itself in a variety of ways depending on its severity. In growing animals an early sign is reduced rate of gain, which progresses to cessation of growth, weight loss, and ultimately death. In reproducing females early signs of energy deficiency are reduced conception rate, reduced reproductive rate (i.e., reduced number of multiple births), and reduced milk production, with progressively worse deficiencies causing reproductive failure, cessation of or lack of initiation of lactation, and death. Similar problems develop in the male, with an initial reduction and eventual cessation in reproductive activity and performance and finally death. With restrictions in energy, wool growth slows; fiber diameter is reduced; total production of wool decreases; and in severe cases wool growth ceases, cre-

ating a "break" (weak spot) in the staple of wool. Energy deficiency will cause a reduction in the function of the immune system, resulting in a lowered resistance to disease. Undernourished sheep also will have an increased susceptibility to parasite infestation.

On the other hand, an animal consuming more NE than required must find a way to handle the excess. Excesses are stored as adipose tissue and are a valuable reserve until obesity ensues. Signs of NE toxicity are gross excesses in adipose deposits and ultimately a reduction in reproductive performance in both males and females. In pregnant, obese females, NE toxicity manifests itself shortly prior to parturition as ketosis.

### Maintenance

An animal's energy requirement for maintenance is that amount of dietary energy it must consume daily to neither gain nor lose body energy. Experimentally it is the amount of metabolizable energy resulting in zero change in body energy and zero product. Energy maintenance occurs when daily ME intake equals daily heat production. This ME requirement is not independent of kind or quality of diet fed, however. Fasting heat production is most commonly used as a baseline for describing the maintenance requirement of the animal independent of diet. This daily quantity of energy is defined as the net energy required for maintenance ($NE_m$). Measured fasting heat production is used to set maintenance requirements in some systems (ARC, 1980). However, because of the limited data base available and questions about the validity of fasting measurements, particularly on young animals, an extrapolated fasting heat production is used as the reference base for maintenance requirement in the present system (Rattray et al., 1973b). The experimentally derived kilocalorie value of 63 $kg^{0.75} \times d^{-1}$ has been adjusted from an empty body weight (EBW) basis to a live weight (W) basis assuming a 6.1-kg fill for a 40-kg sheep (ARC, 1980). The resulting daily $NE_m$ kilocalorie requirement is approximated as 56 $W^{0.75}$.

### Growth

Energy requirements for tissue deposition reflect the proportions of lipid, protein, and water deposited. Each kilogram of empty body gain requires between 1.2 Mcal (mainly protein and water) and 8.0 Mcal (mainly fat and water). Changes in the live weight of sheep also reflect changes in the weight of ingesta in the gastrointestinal tract, which can vary from 60 to 540 g/kg of empty body weight.

Chemical analyses of the empty bodies of 20- to 50-kg growing sheep representative of genotypes produced in the United States show that caloric densities of empty body weight gains (EBG) vary from 3 to 4 Mcal/kg gain in light-weight lambs to 5.5 to 7.5 Mcal/kg in heavier lambs. If these caloric densities of gain are scaled to the empty body weight of the animal raised to the 0.75 power ($EBW^{0.75}$), the variation within genotype drops perceptibly. Variation in caloric density from one genotype to another remains considerable, ranging from approximately 300 to 440 when expressed as kcal $\times$ EBG $\times$ $EBW^{0.75}$.

The requirement for growth across this 20- to 50-kg weight span appears to be closely related to the yearling ram weight of the genotype, which, in turn, is closely related to genotype mature weight (Parker and Pope, 1983). Relating the caloric densities of gains of nine genotypes (Reid et al., 1968; Burton and Reid, 1969; Drew and Reid, 1975b) to a measure of the yearling ram weights (Figure 1) of those genotypes (Parker and Pope, 1983) yields the following equation:

$$NE_g = 644 - 2.61W; r = -0.883$$

where $NE_g$ equals Mcal of retained tissue energy per day in empty body gains per kg EBG per $EBW^{0.75}$, and W equals the yearling ram weight of the genotype. This relationship extrapolated to an average mature ram weight genotype of 115 kg corresponds to an average requirement of 344 kcal $\times$ EBG $\times$ $EBW^{0.75}$.

Calculation of energy requirements for gain also requires extrapolation from an empty body basis to a live weight basis. Two adjustments are necessary, since requirements are described per kilogram gain per unit body weight. Live weight gains are predicted as 9 percent higher than empty body gains, and empty body weight is multiplied by 1.195 to predict live weight and to adjust for fill at a 30 kg EBW similar to ARC values (1980). Tissue energy retained, which is the net energy for growth ($NE_g$), can now be calculated from live lamb gains and weights. $NE_g$ (kcal $\times$ $d^{-1}$) equals 276 LWG $\times$ $W^{0.75}$ for medium mature ram weight (115-kg) genotypes. For every 10 kg mature weight less than 115 kg, the energy requirement increases by 21 kcal $\times$ LWG $\times$ $W^{0.75}$, or 7.6 percent. For each 10 kg over 115 kg, a like amount would be subtracted from this requirement for live weight gain (Table 3).

Rams deposit less energy than ewes of the same genotype at equal live weights (Bull et al., 1970; Ferrell et al., 1979). These limited data suggest that caloric densities of energy gains in rams can be estimated at 0.82 times those for ewes. Castrated males may also have somewhat lower requirements than females (Kelloway, 1973; ARC, 1980); however, the quantitative differences are not well established (Rattray et al., 1973a) and no adjustment is recommended at this time.

Level of diet intake, rate of gain, and concentration of
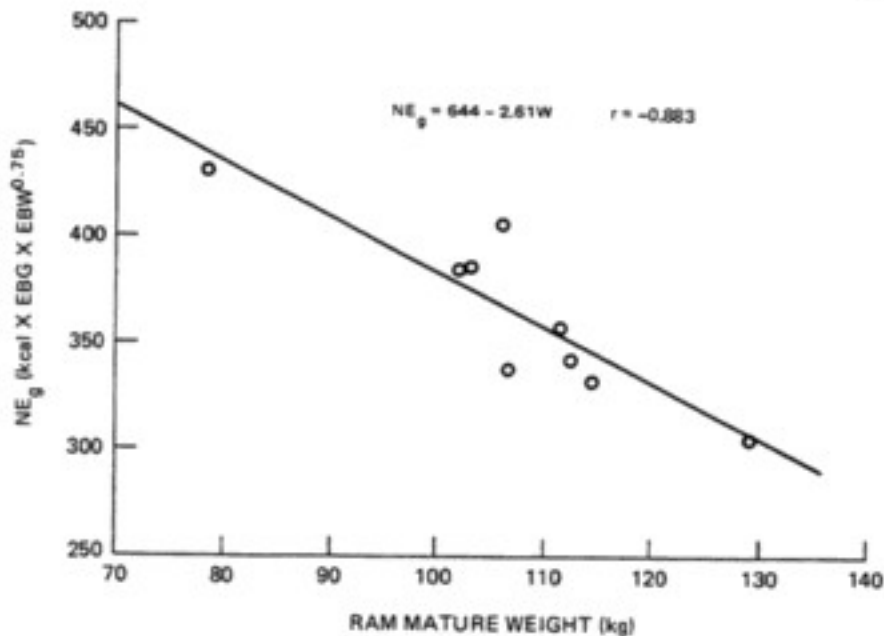
FIGURE 1    Relationship between the energy density of empty body weight gain ($NE_g$) and genotypic mature weight (W) as estimated by yearling ram weight.

dietary DE have generally had a small long-term effect, if any, on the composition of weight gain in growing lambs after weaning (Reid et al., 1968; Theriez et al., 1982a,b). Very low rates of growth may sometimes result in increased caloric density in body gains (Rattray et al., 1973a; Graham and Searle, 1982), presumably because of the demand for protein resources for wool growth. Very high rates of gain in milk-fed lambs have been associated with greater fat deposition (Black, 1974). On the other hand, high-protein diets in early weaned fast-growing lambs have been associated with depressed fat deposition (Andrews and Ørskov, 1970). The energy requirements for gain in castrated or ewe lambs from medium-sized genotypes are very similar under the present system to the ARC (1980) values for wethers (Figure 2). Increased requirements for small-genotype lambs are similar to increases that ARC (1980) relates to ewe lambs. Gain requirements per kg LWG increase linearly as animals get heavier in the ARC (1980) system and increase slightly curvilinearly in the present system.

*Pregnancy*

Sheep utilize metabolizable energy for conceptus development with an efficiency of 12 to 14 percent and for pregnancy (gravid uterus plus mammary gland development) with an efficiency of 16 to 18 percent for diets containing 2.4 to 2.6 Mcal ME/kg DM (Rattray et al., 1973b, 1974). (The efficiency of ME utilization may vary with diets that differ markedly from those used to establish the above values.) The $NE_y$ requirements (above $NE_m$ and $NE_g$) of ewes bearing single, twin, and triplet fetuses that have a total fetal weight of 5.0, 9.0, and 11.5

kg, respectively, are given in Table 4 for different stages of late pregnancy (Rattray et al., 1974). Actual NE requirements may differ from those listed if the fetuses or placental tissues differ markedly in size or composition from those studied by these workers.

Rattray et al. also obtained data indicating that the maintenance requirement of ewes and the efficiency of utilization of ME for maternal maintenance and gain were not changed by pregnancy. The extra heat production that occurs in pregnancy appears to be primarily fetal in origin.

Total feed requirements of pregnant sheep can be obtained by summing the various diet amounts needed to meet each NE requirement (e.g., feed for $NE_m$ + feed for $NE_g$ + feed for $NE_y$ for a pregnant ewe lamb or feed required for $NE_m$ + feed for $NE_y$ for a pregnant adult ewe). Fetal growth and pregnancy requirements are substantial in the last 6 weeks of pregnancy and average approximately 0.5 × maintenance for single-bearing ewes and 1.0 × maintenance for twin-bearing ewes. Total feed requirements would thus increase to 1.5 to 2.0 × maintenance for this physiological phase.

*Lactation*

Few estimates of the utilization of ME for lactation in sheep are available. Sheep have a relatively short lactation period, and the actual quantity and composition of milk produced by animals suckling young are difficult to determine. Gardner and Hogue (1964) have estimated that 65 to 83 percent of ME is converted to milk energy during 12 weeks of lactation. Higher values were obtained for ewes suckling twins than for ewes with single
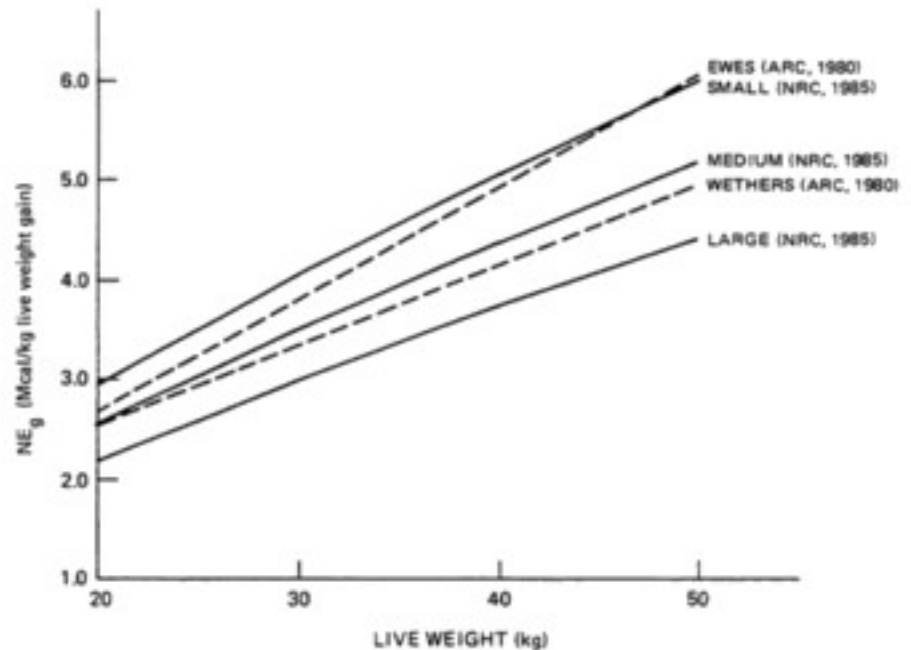
FIGURE 2  Energy density of live weight gains of large, medium, and small genotypes compared with ARC data (1980).

lambs. The average of these values is slightly above that calculated for dairy cattle.

## NE Value of Feedstuffs

The NE value of feedstuffs in meeting the $NE_m$ and $NE_g$ requirements of animals has been established from the following. The widest data base and the one most applicable to production situations was developed from the relationships established by Garrett (1980) relating $NE_m$ and $NE_g$ to the ME concentration of the diet:

$$NE_m = 1.37ME - 0.138ME^2 + 0.0105ME^3 - 1.12$$
$$NE_g = 1.42ME - 0.174ME^2 + 0.0122ME^3 - 1.65$$

The data reported by Rattray et al. (1973b) are applicable to pelleted diets. Pelleting changes the relationship between NE and ME, particularly when predicting $NE_g$ (Blaxter and Boyne, 1978). Ovine and bovine partial efficiencies of ME use for maintenance and gain can be interchanged (Blaxter and Wainman, 1964; Garrett et al., 1959; Rattray et al., 1973c; ARC, 1980). The $NE_y$ value of the diet can be estimated as 0.17 ME.

## Gut Fill Variation

The large and variable ingesta fraction of sheep weight and gain complicates requirement definitions. Gut fill varies from 6 percent of live weight in milk-fed lambs to 30 or 35 percent in forage-fed lambs soon after weaning. Gut fill assumptions used in this publication are typical for mixed-grain/forage-fed animals, unshrunk but before the morning meal. Gut fill will be higher on forage diets

and lower on very high concentrate diets. Animal handling procedures, feed processing, and quality will cause considerable variation.

## Environment

Ambient temperature, thermal radiation, humidity, air movement, contact surfaces, and precipitation may all have a positive or negative effect on a sheep's energy requirement, depending on where they put the animal in relation to its thermoneutral zone. For instance, environmental temperatures above or below the thermoneutral zone will increase energy needs. More specific information is available in *Effect of Environment on Nutrient Requirements of Domestic Animals* (NRC, 1981).

Wool is a very effective insulation against cold and heat; however, reports on the insulating effect of wool against heat are rare (Curtis, 1981). Several scientists (Blaxter, 1966; Ames, 1969; and Brink and Ames, 1975) have reported the influence of fleece on lower critical temperature (LCT) in sheep. Length of fleece and level of feeding (fasting, maintenance, or full feed) interact in influencing LCT. At a given level of feeding, the shorter the fleece the higher the LCT. Thus, shearing increases energy needs when the environmental temperature is below the LCT. NRC (1981) reports LCTs of 25° to 31°C for shorn sheep and −3°C for sheep with full fleece. Diet digestibility by shorn sheep generally declines approximately 0.001 units per degree centigrade fall in ambient temperature; however, unshorn sheep show no digestibility change between −10° and +20°C (Christopherson and Kennedy, 1983).

A distinct seasonal shift in the maintenance energy requirement of sheep, probably modulated by photoperiod, has been noted in thermoneutral environments (Blaxter and Boyne, 1982). The sine wave fluctuation increases to a peak (14 percent above average) in July and decreases a similar magnitude in winter. Parallel fluctuations in voluntary dietary intake also occur.

Level of energy intake or rate of gain to which a sheep has been accustomed has been shown to shift maintenance requirements (Koong et al., 1982). Fast growing, ad libitum-fed sheep have a fasting heat production 30 to 40 percent higher than those of matched weight and age but accustomed to zero gain and low intakes. High basal metabolism appears related to high vital organ mass (i.e., 30 to 40 percent higher liver and small intestine organ weights). These adaptations to low energy intakes are likely to be important to animal survival during periods of scarce feed supplies. Also, low metabolism and renewed increases in vital organ mass likely are important contributors to compensatory gains when animals are refed after a period of scarce feed supply.

## Management Considerations

Ewes that begin pregnancy in a very thin condition and weigh, for example, 60 kg (132 lb) are about as large physiologically (i.e., capacity of digestive tract, body fluids, and body surface) as they are when fat and weigh 70 to 75 kg (154 to 164 lb). When thin, they must be fed more energy and protein during gestation than the tables suggest for their particular weight. Feeding at levels suggested for a ewe 10 kg heavier would enable the thin ewe to regain some of the weight lost due to the stress of lactation and/or inadequate feed.

Conversely, an overly fat ewe whose weight suggests she is physiologically larger than she actually is can be fed less during the first 3.5 months of gestation without affecting lamb and wool production. Consideration of an ewe's initial body condition and its effect on subsequent nutrient needs is as vital as consideration of size and age. Figure 3 shows the daily and cumulative weight changes of a 60-kg ewe during various stages of production.

Depending on the desired response of the animals, their existing body condition, their appetite, and environmental conditions, the amount of feed given to sheep may be varied from the levels recommended in Tables 1 and 2. If diets are more concentrated than those indicated in Table 2, the level of dry matter fed may be reduced accordingly. Regardless of the concentration of energy in the diet, however, amounts of feed given should provide the suggested daily requirements of energy, protein, minerals, and vitamins. Figure 4 gives the approximate daily DE requirements of 65- to 70-kg ewes at various stages of production.
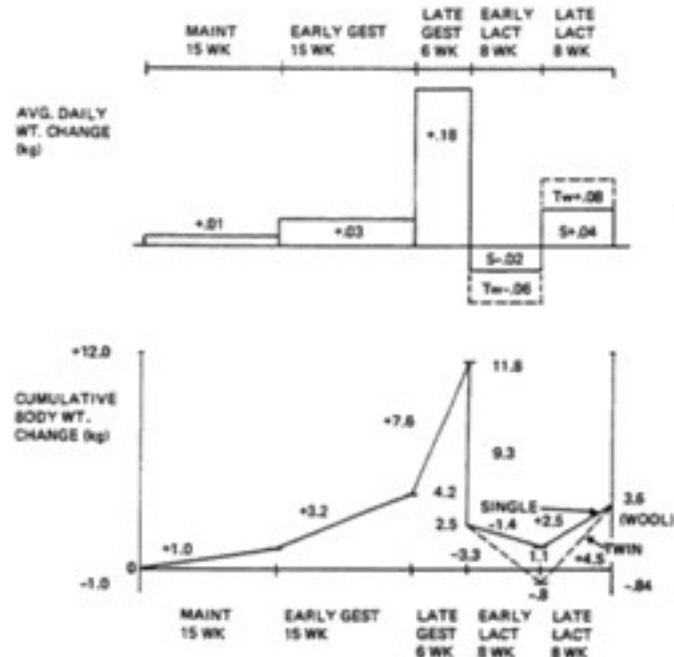


FIGURE 3   Daily and cumulative weight changes of a 60-kg ewe during maintenance, gestation, and lactation.

## EWES—FIRST 15 TO 17 WEEKS OF GESTATION

The requirements given in Tables 1 and 2 are intended to provide for maintenance, wool growth, and a small daily gain. If ewes are fat, a submaintenance diet is permissible during the first 3.5 months of gestation (noncritical period) to avoid overly fat ewes at lambing time. No allowance has been made for flushing the ewe to increase lamb production (see the subsection on Flushing, p. 30). The nutrients required for wool production depend on the genetic potential of the sheep to produce wool. The energy required for wool production represents a small fraction of the total energy consumed.

## EWES—LAST 4 WEEKS OF GESTATION

In early pregnancy, fetal growth is very small, and the total feed requirement of the ewe is not significantly different from the feed requirement during periods of maintenance. During the last 4 to 6 weeks of gestation, ewes need more energy to meet increased nutrient demands for fetal growth and the development of the potential for high milk production. The nutrient levels recommended in Tables 1 and 2 are adequate for normal fetal and mammary development in single- and twin-bearing ewes.

Excessive energy intake may lead to fattening with resultant birth difficulties in single-bearing ewes. Excessively low energy intakes can result in impaired milk
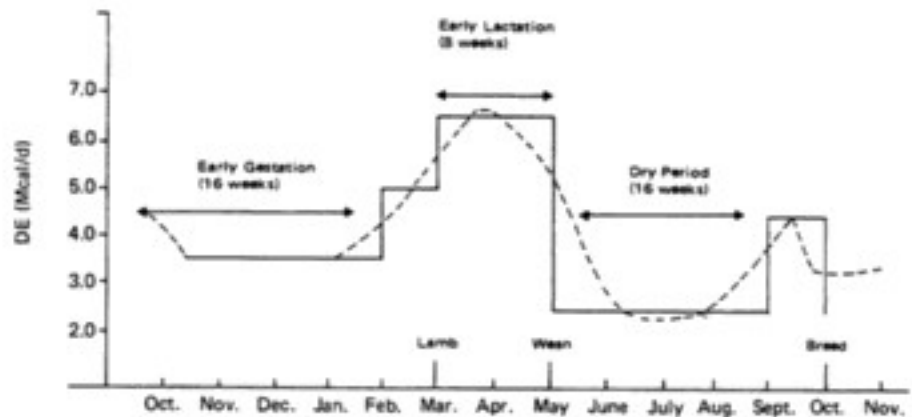
FIGURE 4 Approximate daily digestible energy (DE) requirements of 65- to 70-kg breeding ewes at various production stages.

production capability, reduced mothering instinct, and lower birth weights, leading to reduced viability in the lambs. Either low energy intakes or excessive fattening may result in pregnancy toxemia in the ewe (see the section on Pregnancy Disease, p. 28).

### EWES—LACTATION

In Tables 1 and 2, energy requirements are estimated for four groups of lactating ewes: those in the first 6 to 8 weeks of lactation, suckling singles; those in the last 4 to 6 weeks of lactation, suckling singles; those in the first 6 to 8 weeks of lactation, suckling twins; and those in the last 4 to 6 weeks of lactation, suckling twins.

A ewe nursing twin lambs produces 20 to 40 percent more milk than a ewe nursing one lamb. Within the genetic capability of the ewe, milk production responds to nutrient intake of the ewe and demand for milk by the lamb or lambs.

Requirements for the last 6 to 8 weeks of lactation are based on the assumption that milk production during that period is approximately 30 to 40 percent of the production during the first 8 weeks. Thus, nutrient intake during the last 6 to 8 weeks of lactation may be reduced. For example, the weaning weight of lambs nursing ewes fed 20 percent less total digestible nutrients for 6 weeks postpartum than suggested (NRC, 1975) was no different from that of lambs nursing ewes fed 115 to 120 percent of NRC-suggested requirements (Jordan and Hanke, 1977).

In preparing these tables, it has been anticipated that ewes will lose a small amount of weight during early lactation. The amount of weight loss varies greatly, depending on management factors (e.g., the quality and amount of feed available), the number of lambs suckled, the environment, and the ewe's genetic background. Under some range conditions, ewes lose weight in winter (during pregnancy) and gain weight during lactation when grazing high-quality summer ranges.

### REPLACEMENT LAMBS

Separate requirements are presented in Tables 1 and 2 for replacement ewes and rams. Ram lambs have the potential to grow at a faster rate than ewe lambs, especially after they reach 40- to 50-kg body weight.

Mature size for the breed will influence energy requirements. Smaller breeds tend to grow more slowly, whereas larger breeds grow more rapidly and have higher nutrient requirements.

Nutrients needed for gain by ewe and ram lambs have been compared. The performance of the ewe lambs fits the equations for maintenance and gain used in developing Tables 1 and 2. Ram lambs gain more rapidly than the equations suggest, have a higher feed intake, and use feed more efficiently for body weight gain. Gains in the body weight of intact males are higher in water and protein and lower in fat than in females.

Producers breeding ewe lambs to yearlings should feed at levels that will result in Finn cross ewe lambs weighing a minimum of 43 kg (95 lb) and other breeds weighing 50 kg (110 lb) at breeding. During the gestation period, sufficient additional feed should be provided to meet pregnancy requirements and weight gains of 0.12 to 0.16 kg daily. During lactation these ewes still require additional feed to ensure adequate milk production and continued growth. Usually this means providing up to 1 kg of grain per ewe daily in addition to a full feed of forage. Weaning at around 6 weeks coupled with sufficient feed postweaning will permit recovery of lactation weight loss and resumption of normal growth rates in preparation for subsequent breeding.

### PROTEIN

The lamb is born with a nonfunctional rumen that requires dietary protein be provided through milk or a

milk replacer until the rumen becomes functional. The rumen develops some degree of functionality by 2 weeks of age, primarily as a result of the consumption of dry feed (Poe et al., 1971, 1972). During early rumen development, creep feed should be provided to supplement milk or milk replacer. By 6 to 8 weeks of age, the functioning rumen has developed into a culture system for anaerobic bacteria, protozoa, and fungi. These microbes digest feedstuffs and synthesize protein to extents that allow efficient production without milk. Ruminal microorganisms can utilize either protein or nonprotein nitrogen to synthesize microbial protein. The microbial protein, along with undigested feed protein, passes from the rumen-reticulum through the omasum to the abomasum and small intestine where it is subjected to digestive processes similar to those of the nonruminant. Microbial protein reaching the small intestine usually accounts for 40 to 80 percent of the total protein reaching this area of the digestive tract (Owens and Bergen, 1983).

The requirements given in Tables 1, 2, and 5 apply to functioning ruminants and were determined factorially with the basic formula: Crude protein required in g/d =

$$\frac{PD + MFP + EUP + DL + Wool}{NPV}$$

(where PD = protein deposited, MFP = metabolic fecal protein, EUP = endogenous urinary protein, DL = dermal loss, and NPV = net protein value). Protein deposited in gain was estimated by applying the following equation (NRC, 1984): PD in g/d = daily gain in kg $\times$ (268 $-$ 29.4 $\times$ ECOG) when energy content of gain (ECOG) = $\dfrac{NE_g \text{ in kcal/d}}{\text{gain in g/d}}$ with $NE_g$ values taken from Table 3. Protein deposited was set at 2.95 g/d for early gestation and 16.75 g/d for the last 4 weeks of gestation (ARC, 1980) for ewes with single lambs and increased proportionately for higher lambing rates. A milk production of 1.74 kg/d for ewes nursing a single lamb and 2.60 kg/d for those nursing twins and a crude protein content of 47.875 g/liter of milk (ARC, 1980) were used to determine PD need for lactation. Ewe lambs were assumed to produce 75 percent as much milk as mature ewes. Metabolic fecal protein in g/d was assigned a value of 33.44 g/kg DM intake (NRC, 1984). Endogenous urinary protein in g/d was calculated as 0.14675 $\times$ body weight in kg + 3.375 (ARC, 1980). Dermal loss in g/d was estimated to be 0.1125 $\times$ kgW$^{0.75}$ (ARC, 1980). Crude protein in wool in g/d of ewes and rams was assigned a value of 6.8 g, assuming an annual grease fleece weight of 4 kg. For lambs, crude protein in wool in g/d was calculated as 3 + (0.1 $\times$ protein retained in the fleece free body) (ARC, 1980). A net protein value of 0.561 was used based on a true digestibility of 0.85 (Storm and Ørskov, 1982) and a biological value of 0.66 (NRC, 1984). Expression of requirements as crude protein is consistent with the dairy (NRC,

1978) and beef (NRC, 1984) reports, but contrary to ARC (1980). The potential advantages of digestible protein are negated by the use of standard factors for conversions between crude protein and digestible protein by both NRC (1975) and ARC (1980). Development of a more-comprehensive system of expressing protein requirements of ruminants is being intensively studied, but a consensus has not developed. Some of the key issues are summarized later in this section. Numerous reviews are available that treat these issues more extensively (NRC, 1976, 1984, 1985; ARC, 1980; Huber and Kung, 1981; Ørskov, 1982; Owens, 1982; Owens and Bergen, 1983; Chalupa, 1984).

## Microbial Nitrogen Requirements

Although a variety of anaerobic microorganisms inhabit the rumen, bacteria are most active in protein digestion and synthesis of microbial protein. Bacteria degrade dietary protein in the rumen to simpler nitrogen compounds such as ammonia, amino acids, and peptides and incorporate these materials into cellular protein. Ammonia also is derived from dietary nonprotein nitrogen sources such as urea. Ammonia is the nitrogen source preferred by the bacteria in the rumen for cellular protein synthesis (Bryant and Robinson, 1963; Hungate, 1966). Lack of ammonia in the rumen may limit microbial growth when the intake of protein or the ruminal degradation of the dietary protein is low. Although the concentration of ruminal ammonia-nitrogen required for optimal microbial growth is unclear, concentrations above 5 to 10 mg per 100/ml of ruminal fluid have not consistently increased bacterial protein production (Satter and Slyter, 1974; Pisulewski et al., 1981; Leng and Nolan, 1984).

## Nonprotein Nitrogen

Substitution of dietary nonprotein nitrogen (NPN) for plant and animal protein sources often will lower the cost of the complete diet fed to sheep. Urea is the most common source of NPN fed. It is useful only when it is needed to provide a source of ammonia to ruminal bacteria. Since urea is rapidly hydrolyzed to ammonia by bacteria in the rumen, strict management techniques are essential when high levels of urea or other NPN sources are fed to prevent decreased feed intake and ammonia toxicity. Urea is utilized most efficiently when thoroughly mixed in high-concentrate, low-protein diets that are fed continuously. Urea concentrations should not exceed 1 percent of the dietary dry matter or one-third of the total dietary protein. High-concentrate diets provide more energy than high-roughage diets for bacterial protein synthesis from ammonia (Owens and Bergen, 1983). The resulting decrease in ammonia absorption reduces the

likelihood of ammonia toxicity (Bartley et al., 1976). If NPN is substituted for dietary protein, special emphasis should be given to the supplementation of potassium, phosphorus, and sulfur, which are absent in urea. Particular attention should be given to sulfur supplementation, because wool contains a high percentage of sulfur-containing amino acids.

In attempts to reduce the threat of ammonia toxicity and/or improve the utilization of ruminal ammonia, other forms of NPN (biuret, triuret, and complexes of urea with formaldehyde or molasses) have been developed (Nikolic et al., 1980). These compounds have slower ammonia release, which should more nearly parallel energy availability and increase bacterial protein synthesis (Johnson, 1976). However, these slow release forms of NPN have not consistently improved nitrogen utilization (Owens and Bergen, 1983).

## Ruminal Degradation and/or Bypass of Dietary Protein

Dietary protein is either digested in the rumen or escapes undigested to the omasum and abomasum. If it is not digested in the rumen, it is described as "bypass" or "escape" protein (Owens and Bergen, 1983). Bypass protein is either digested postruminally or excreted in the feces. Dietary protein degraded in the rumen yields ammonia (Chalupa, 1975), which can then be incorporated into microbial protein. Chalupa (1975), Satter and Roffler (1975), and ARC (1980) have classified protein sources on the basis of the extent to which they bypass ruminal degradation (percentage of dietary protein that reaches the small intestine undigested). Low-bypass sources (< 40 percent) include casein, soybean meal, sunflower meal, and peanut meal; medium-bypass sources (40 to 60 percent) include cottonseed meal, dehydrated alfalfa meal, corn grain, and brewers dried grains; and high-bypass sources (> 60 percent) include meat meal, corn gluten meal, blood meal, feather meal, fish meal, and formaldehyde-treated proteins. Feed processing conditions, animal variations, dietary alterations, and changes in microbial population affect extent of dietary protein bypass, but these effects have not been well quantitated. When high-bypass protein sources are fed, supplementation with NPN will be needed to maintain adequate ruminal ammonia levels for microbial protein synthesis.

Increased bypass of dietary protein does not always increase production, because bypassed protein may be poorly digested postruminally, the balance of amino acids available for absorption from the small intestine may be poor, or other nutrients may limit production (Young et al., 1981; Owens and Bergen, 1983). Conversely, if microbial protein is the only protein reaching the small intestine, animal production may not be maximal (Satter et al., 1977). Presentation to the small intestine of a mixture of microbial protein and complementary dietary protein is desired. Striving to optimize this mixture will undoubtedly be the subject of much research activity in the future, as it has been in the past.

## Amino Acids

Amino acids available for absorption from the small intestine are supplied by microbial and/or bypassed dietary protein. The tissues of sheep require the same amino acids as those of the nonruminant (Black et al., 1957; Downes, 1961). In sheep, however, the relationship of dietary amino acid supply with tissue requirements has been difficult to define because of the intervention of the protein digestive and synthetic functions in the rumen. Also, amino acid requirements are difficult to quantitate because of variability in requirements for various productive functions. For example, wool growth responds to sulfur amino acid supplementation (Reis and Schinckel, 1963), whereas other functions do not. Hogan (1975) concluded that the amino acid composition of protein deposited in the tissues and that secreted in milk, plus the maintenance requirement, should equal the total needed by the animal. Owens and Bergen (1983) further concluded that the quantity, as well as the ratios, of amino acids required by the animal varies with both the productive function and the level of production.

Dietary amino acids are normally rapidly degraded in the rumen. To increase bypass, Neudoerffer et al. (1971) and Digenis et al. (1974) coated dietary amino acids so they would be ruminally stable but available for absorption postruminally, suggesting that the combination of amino acid and NPN supplementation may be feasible in the future.

## Protein Deficiency and Toxicity

Ammonia deficiency in the rumen reduces the extent and efficiency of rumen function. Deficiencies or imbalances of amino acids at the tissue level result in decreased protein synthesis, as well as reduced feed intake and lower efficiency of feed utilization. Growth rate and milk and wool production all react to inadequate protein intake. Extreme deficiency results in severe digestive disturbances, loss of weight, anemia, edema, and reduced resistance to disease. Increased feed intake after protein supplementation is a good practical indication that protein was deficient (NRC, 1984).

Excess protein becomes an expensive and inefficient source of energy, but rather large excesses can be fed without producing acute toxicity (Fenderson and Bergen, 1976). Excesses of NPN or highly soluble protein may

produce ammonia toxicity (Bartley et al., 1981). Affected animals may display nervousness, incoordination, labored breathing, bloating, severe tetany, respiratory collapse, and ultimately death.

## MINERALS

Although the body contains many mineral elements, only 15 have been demonstrated to be essential for sheep. Seven are major mineral constituents: sodium, chlorine, calcium, phosphorus, magnesium, potassium, and sulfur. The other eight are trace elements: iodine, iron, molybdenum, copper, cobalt, manganese, zinc, and selenium. Additional elements under investigation with other species may eventually prove to be essential for sheep. Fluorine is discussed (p. 22) because of its toxicity to sheep.

The multiplicity of interactions among minerals makes it difficult to determine the requirements of sheep for specific minerals, because a lack or abundance of one mineral may render others deficient or toxic. Tables 6 and 7 present the mineral requirements of sheep and the toxic levels when known. In both tables, values are estimates based on available experimental data.

### Sodium and Chlorine (Salt)

Sodium (Na) and chlorine (Cl) serve many functions in the body. They maintain osmotic pressure, regulate the acid-base balance, and control water metabolism in tissues. Sodium occurs primarily in extracellular fluids and bones. Chlorine is found within cells, in the body fluids, in gastric secretions such as hydrogen chloride, and in the form of salt (Underwood, 1981).

Animals that are deprived of adequate salt may try to satisfy their craving by chewing wood, licking dirt, or eating toxic amounts of poisonous plants. Inadequate salt may result in inappetence, growth retardation, inefficiency of feed use, and increased water consumption (Hagsten et al., 1975; Underwood, 1981). In addition, the concentration of sodium falls and that of potassium rises in the parotid saliva of sheep on low-sodium diets (Morris and Peterson, 1975). Signs of sodium deficiency occur without a significant decline in either plasma or milk sodium concentrations until a condition of extreme deficiency is reached (Morris and Peterson, 1975; Underwood, 1981).

Several feeding and metabolism studies have been conducted to determine the sodium and/or salt requirement of sheep. McClymont et al. (1957) reported that the addition of 1.2 to 2.6 g of sodium per day (as sodium chloride) to the diet of very thin wethers fed a low-sodium grain diet increased growth rate. They concluded that the sodium requirement was greater than 0.9 g/d (0.06 percent of the diet). From balance data, Devlin and Roberts (1963) estimated the sodium requirements for maintenance of wether lambs to be 1.01 g/d (0.18 percent of the diet). Hagsten et al. (1975) concluded that the dietary salt requirement for growing lambs ranged between 0.33 and 0.43 percent of the air-dry ration (90 percent dry matter). They further stated that since most sheep rations contain approximately 0.2 percent salt, a supplemental level of 0.2 percent is adequate. Based on the maintenance of a normal Na$^+$:K$^+$ ratio in the parotid saliva, Morris and Peterson (1975) concluded that a dietary sodium level of 0.09 percent met the requirements of lactating ewes. Apparently no feeding trials have been conducted in which the requirement for chlorine can be assessed independently of sodium; thus, the chlorine requirement is unknown.

When adding salt to mixed feeds, it is customary to add 0.5 percent to the complete diet or 1.0 percent to the concentrate portion. Range operators commonly provide 220 to 340 g of salt per ewe per month as a salt lick. Drylot tests show lambs consume approximately 5 to 10 g of salt daily (Denton, 1969). Mature ewes in confinement consume 15 to 30 g of salt daily when it is offered free choice (Jordan and Hanke, 1982). Salt may safely be used to limit free-choice supplement intake if adequate water is available. Such mixtures are usually 10 to 50 percent salt depending on the desired amount of ration to be consumed. Trace-mineralized salt should not be used for this purpose because of the possibility of excessive intake of various trace minerals, particularly toxic levels of copper. In many areas (commonly arid), feed and water may contain enough salt to meet the animal's requirements, and supplemental salt need not be offered.

On the basis of research conducted by Meyer and Weir (1954) and Meyer et al. (1955), the maximum tolerable level of dietary salt for sheep was set at 9.0 percent (NRC, 1980). Jackson et al. (1971), however, reported a linear decrease in weight and energy gains of growing-finishing lambs as salt content increased from 1.8 to 7.6 percent of the diet.

### Calcium and Phosphorus

Calcium (Ca) and phosphorus (P) are closely interrelated, particularly in the development and maintenance of the skeletal system. Approximately 99 percent of the body's calcium and 80 percent of its phosphorus are found in bones and teeth. Diets lacking in calcium or phosphorus may result in abnormal bone development, a condition known as rickets in young animals and osteomalacia in adults. The 1 percent of calcium and 20 percent of phosphorus not present in skeletal tissues are widely distributed in body fluids and soft tissues, where they

serve a wide range of essential functions (Underwood, 1981).

Signs of calcium deficiency due to a low intake of calcium develop slowly because the body draws on calcium in bone. Blood levels of calcium are normally not good indicators of calcium intake or status, as these levels are hormonally controlled (Care et al., 1980). Blood calcium levels below 9 mg/dl of plasma (hypocalcemia), however, suggest chronic low calcium intake or utilization at a rate that exceeds calcium mobilization from bone (as during lactation). In extreme cases, which may develop in lambs on high-grain diets, low intakes of calcium may result in tetany or precipitate an outbreak of urinary calculi in intact or castrated male sheep.

Sheep efficiently utilize phosphorus, partly by recycling considerable amounts in parotid and other salivary secretions. The phosphorus concentration of parotid saliva, rumen fluid, and serum is related to phosphorus intake (Tomas et al., 1967). In some cases, sheep recycle more phosphorus per day through parotid saliva than is required in the diet to maintain normal concentrations in body pools. This salivary phosphorus can moderate variations in rumen phosphorus due to diet, particularly at low phosphorus intakes (Cohen, 1980). A phosphorus deficiency may be manifested by slow growth, deprived appetite, unthrifty appearance, listlessness, low level of phosphorus in the blood (less than 4 mg/dl of plasma), and development of rickets (Beeson et al., 1944; Preston, 1977).

Calcium and phosphorus utilization are influenced by vitamin D. Dietary calcium is absorbed according to the nutritional requirements of the animal, and on a low-calcium diet the efficiency of absorption is increased. The efficiency of absorption also is increased in adult animals during pregnancy and lactation (Care et al., 1980; Scott and McLean, 1981; Braithwaite, 1983a). Differences have been observed in absorption of phosphorus within and between breeds of sheep. These differences appear to be partly heritable and vary as much as twofold (Field et al., 1983; Field, 1984). Adaptation to a low-phosphorus diet is due to an increase in the efficiency of intestinal absorption and a reduction in the salivary secretion of phosphorus (Care et al., 1980).

Calcium and phosphorus requirements were calculated using a factorial approach. First, a net requirement was calculated from estimates of the storage and excretion of these elements during growth, pregnancy, and lactation and of endogenous losses. The dietary requirement then was calculated by dividing the net requirement by the coefficient of absorption. Daily dietary requirements were converted to dietary concentrations (percent of diet) by dividing by daily DM intakes.

Endogenous fecal losses of calcium were assumed to vary in a linear relationship with DM intake, as described by Braithwaite (1982, 1983a). These values varied from 11.6 mg Ca/kg body weight per day for maintenance of mature ewes consuming 15.6 g DM/kg body weight per day to 43.2 mg Ca/kg body weight per day for a 10-kg, rapidly growing, early-weaned lamb consuming 60 g DM/kg body weight per day.

Total endogenous losses of phosphorus were assumed to be 20 mg/kg body weight per day for maintenance, early gestation, and growth. However, a higher value (30 mg/kg body weight per day) was used to calculate phosphorus requirements during the last 4 weeks of gestation and during lactation. ARC (1980) used a constant value of 14 mg P/kg body weight per day to calculate phosphorus requirements for all stages of production. The higher values used in this publication reflect the fact that there may be inevitable losses of phosphorus associated with the higher phosphorus intakes required to meet the demands of late gestation and lactation as suggested by Braithwaite (1984a), as well as evidence that the phosphorus levels recommended by ARC (1980) may be inadequate for pregnancy and lactation (Braithwaite, 1983b, 1984b) and growth (Field et al., 1982).

The calcium and phosphorus contents of gain were 11 and 6 g/kg empty body gain, respectively (ARC, 1980; Grace, 1983). Although it is recognized that numerous factors influence the birth weight of lambs, including breed, size, and age of ewe; breed of sire; season and type of birth; sex of lamb; and nutrition of the ewe (Neville et al., 1958; Jamison et al., 1961; Shelton, 1968; Rastogi et al., 1982; Stritzke and Whiteman, 1982), only the size of the ewe at mating and the type of birth (single or twins) were considered in estimating calcium and phosphorus requirements for gestation. It was assumed that single lambs were 22.6 percent and twins were 36.1 percent of the ewe's metabolic weight at the time of mating (Donald and Russell, 1970). Net calcium and phosphorus values for the gravid uterus were calculated as described in ARC (1980).

The calcium and phosphorus contents of ewes' milk, used to calculate nutritional requirements, were 0.18 and 0.14 percent, respectively. The milk production values used in estimating net calcium and phosphorus requirements for lactation in mature ewes were 1.74 kg/d, first 6 to 8 weeks of lactation suckling singles; 1.11 kg/d, last 4 to 6 weeks of lactation suckling singles; 2.60 kg/d, first 6 to 8 weeks of lactation suckling twins; and 1.67 kg/d, last 4 to 6 weeks of lactation suckling twins. The milk production of ewe lambs was 1.30 kg/d, first 6 to 8 weeks of lactation suckling singles, and 1.95 kg/d, first 6 to 8 weeks of lactation suckling twins (Langlands, 1973; Pert et al., 1975; Doney et al., 1979).

The values used for absorption of dietary calcium were 0.4 for maintenance, 0.5 for gestation, and 0.6 for lactation and rapidly growing lambs. These values were

based on data summarized by ARC (1980) and on subsequent research by Braithwaite (1983a). The values used for absorption of phosphorus were 0.6 for maintenance and for the first 15 weeks of gestation and 0.7 for the last 4 weeks of gestation, for lactation, and for growing lambs. These values were based on research reported by Grace (1981), Field et al. (1982), Braithwaite (1983b, 1984a,b), and Field (1983a, 1984).

The supply of calcium found in most pasture and range forages usually is adequate. However, areas have been reported in Florida, Louisiana, Nebraska, Virginia, and West Virginia in which calcium supplementation is required for sheep consuming pasture or range forage. Legumes are excellent sources of calcium. Corn silage and most grasses, including small grain forages, are fair to poor sources. In some areas of the West, soils are formed largely from calcium carbonate and dolomite, and forage in these areas may have a calcium content up to nine times greater than the level considered adequate. Excessive intakes of calcium, however, are normally not detrimental when adequate phosphorus is supplied. Finishing-lamb diets that contain nonlegume roughage or that are high in grain usually require calcium supplementation (see Urinary Calculi, p. 28).

Pasture and range forages in North America are commonly low in phosphorus (Preston, 1977). Consequently, ewes (especially lactating ewes) fed primarily forages receive an inadequate supply of phosphorus and need a diet supplemented with phosphorus when a legume forage is fed and with calcium and phosphorus when nonlegume hay is fed. Furthermore, species and stage of maturity of forage significantly affect concentration, apparent absorption, and retention of major minerals by sheep (Powell et al., 1978).

Several factors may influence the calcium and phosphorus nutrition of sheep, necessitating a reevaluation of present recommendations. For example, chronic internal parasitic infections can have a serious negative impact on calcium and phosphorus status (Sykes et al., 1979). Magnesium deficiency interferes with calcium absorption; low levels of dietary phosphorus also decrease the rate of calcium absorption. Both aluminum and iron at elevated levels will increase the need for phosphorus (Rosa et al., 1982).

Although the oral intake of calcium compounds generally does not produce toxicity problems, addition of extra calcium to an otherwise adequate diet may precipitate a deficiency of other elements, including phosphorus, magnesium, iron, iodine, zinc, and manganese (NRC, 1980). Assuming adequate levels of dietary phosphorus, however, ruminants can tolerate a wide calcium-to-phosphorus ratio (as wide as 7:1) and as much as 2 percent calcium in the diet. But the long-term intake of phosphorus at levels 2 to 3 times the requirement for main-tenance can cause increased bone resorption in adult animals, and a narrow calcium-to-phosphorus ratio (< 2:1) may contribute to an increased incidence of urinary calculi in intact and castrated male sheep (NRC, 1980).

### Magnesium

Magnesium (Mg) fulfills many physiological functions. It is a constituent of bone (approximately 60 to 70 percent of the total body magnesium is present in the skeleton) and also is necessary for many enzyme systems and for the proper functioning of the nervous system (Martens and Rayssiquier, 1980; Underwood, 1981; Larvor, 1983). Skeletal magnesium serves as a reserve that can supply magnesium to soft tissues during dietary deficiency. Although approximately 30 percent of skeletal magnesium can be mobilized from bone in young animals, the value for adults is only around 2 percent (Rook and Storry, 1962; Martens and Rayssiquier, 1980).

Tetany is the classic sign of magnesium deficiency in sheep. A lamb with hypomagnesemic tetany may fall on its side with its legs alternately rigidly extended and relaxed. Frothing at the mouth and profuse salivation are evident, and death may occur. The signs of magnesium deficiency in adults are similar to those in younger animals, but death may occur more rapidly after convulsions (Ammerman and Henry, 1983). Other signs of magnesium deficiency in young lambs include loss of appetite, hyperemia, and calcification of soft tissues (Underwood, 1981; Ammerman and Henry, 1983). Outbreaks of tetany occur most frequently in nursing ewes shortly after they are turned out to pasture in the spring (grass tetany). Incidence is highest during the first 4 or 5 weeks after lambing, when magnesium requirements for lactation are maximal. Cases are most common where the grass is high in nitrogen and potassium and low in magnesium (Egan, 1969; Martens and Rayssiquier, 1980).

Information on dietary magnesium requirements is limited. In magnesium-deficient sheep around 18 months old, the minimum amount of magnesium (as magnesium oxide) required to restore feed intake is 0.33 percent (Ammerman et al., 1971). When a semipurified diet containing 0.02 percent magnesium was fed to 4- to 8-week-old lambs, serum magnesium levels decreased to 0.5 to 0.7 mg/dl and most lambs exhibited convulsions within 45 days. Addition of magnesium carbonate to the diet to provide 0.08 percent total magnesium maintained serum magnesium levels of approximately 2.0 mg/dl (McAleese and Forbes, 1959). Sheep with serum magnesium levels < 1.0 mg/dl are severely hypomagnesemic; serum levels > 1.0 but < 1.5 mg/dl are considered mildly hypomagnesemic (Amos et al., 1975). Hypomagnesemic tetany was reported in a flock of ewes grazing spring grass

that was analyzed as 0.15, 4.1, and 2.6 percent magnesium, potassium, and nitrogen, respectively. In this case, dosing with magnesium alloy bullets (30 g) effectively controlled grass tetany (Egan, 1969). Lambs (6 to 12 months old), yearlings (1 to 2 years old), and adult sheep (2 to 3 years old) fed a semipurified diet containing 0.1 percent added magnesium exhibited a slight decrease in voluntary feed intake and plasma magnesium levels (Chicco et al., 1973a).

Although the results of the above studies vary, collectively they indicate that the levels recommended in the previous revision (NRC, 1975) for the magnesium requirements of sheep (0.04 to 0.08 percent) are too low. Therefore, the suggested minimum magnesium requirements are 0.12, 0.15, and 0.18 percent of dry matter for growing lambs, for ewes in late pregnancy, and for ewes in early lactation, respectively. Magnesium requirements may be increased when feeds contain high levels of potassium (Thomas and Potter, 1976; Greene et al., 1983a,b), calcium (Chicco et al., 1973b), and nitrogen in the form of nonprotein nitrogen or rumen-degradable protein (Fenner, 1979), since these dietary constituents decrease the efficiency of magnesium absorption and/or utilization. In situations where ewes in early lactation are grazing forage with high nitrogen and potassium contents, the minimum level of magnesium in the diet should be 0.2 percent.

Commonly used feedstuffs vary widely in magnesium content. Most cereal grains are fair sources of magnesium, varying from 0.13 to 0.22 percent Mg on a DM basis. Plant protein supplements are excellent sources (0.28 to 0.62 percent Mg), whereas protein supplements of animal origin are more variable (0.11 to 1.22 percent Mg). By-product feedstuffs derived from plants tend to be good sources of magnesium. The magnesium contents of forage plants vary but are normally higher in legumes than in grasses (NRC, 1982); magnesium fertilization has been used to increase the magnesium content of forages (Thompson and Reid, 1981; Fontenot, 1980). Based on absorption and retention data, magnesium in the forms of magnesium carbonate, magnesium oxide, and magnesium sulfate is well used by sheep. Magnesium in magnesite was essentially unavailable (Ammerman et al., 1972; Fontenot, 1980).

Magnesium toxicosis is unlikely except by accidental feeding of high levels. Oral administration of 0.5 percent magnesium to wethers did not produce toxicity, but administration of 0.8 percent or higher resulted in signs of toxicosis. Signs of magnesium toxicosis are lethargy, disturbance in locomotion, diarrhea, lower feed intake, lower levels of performance, and death (NRC, 1980).

## Potassium

Potassium (K) is the third most abundant mineral in the body, accounting for approximately 0.3 percent of the body's dry matter. Potassium is primarily present in intracellular fluids (skin and muscle), where it affects osmotic pressure and acid-base balance within the cell. It also aids in activating several enzyme systems involved in energy transfer and utilization, protein synthesis, and carbohydrate metabolism (Clanton, 1980; Underwood, 1981).

Suboptimal levels of potassium result in decreased feed intake and decreased live weight gain. Listlessness, stiffness, impaired response to sudden disturbances, convulsions, and death have also been reported. Deficient lambs had low potassium levels in whole blood, plasma, and red blood cells, and red cell sodium was increased (Telle et al., 1964).

Brink (1961) found that KCl added to a semipurified diet containing 0.17 percent potassium improved performance of lambs, with a 0.5-percent potassium level yielding maximum performance. Telle et al. (1964) reported that a potassium level of 0.34 percent of the dietary DM was borderline for growing-finishing lambs, and that lower amounts of potassium resulted in growth depression almost immediately. Values for average daily gain and feed efficiency were not significantly different for lambs fed either 0.46 or 0.68 percent potassium. Campbell and Roberts (1965) determined that the level of potassium necessary to promote optimum performance of lambs fed a semipurified diet was 0.52 percent (DM basis). All the above estimates of the potassium requirements of growing-finishing lambs involved the use of $KHCO_3$ and $K_2CO_3$ as sources of potassium in semipurified diets (Brink, 1961; Telle et al., 1964; Campbell and Roberts, 1965). Thus, part of the responses observed may have been attributable to the buffering effect of $HCO_3^-$. This possibility is supported by research with growing-finishing lambs fed a high-concentrate diet (10 percent roughage). In this instance, there was a positive response when 1 or 2 percent $KHCO_3$ was added to the basal diet (0.46 percent potassium, air dry basis) but not when KCl was the source of supplemental potassium (Calhoun and Shelton, 1983).

The potassium requirement for growth in lambs appears to be no more than 0.5 percent of the diet (DM basis). Since potassium is a major mineral element present in milk, slightly higher levels (0.7 to 0.8 percent) may be required for lactation and during periods of stress (Beede et al., 1983). Hutcheson et al. (1979) has shown that receiving diets for shipped, stressed calves should contain between 1.2 and 2.2 percent potassium. Potassium content of the diet appears to have a curvilinear effect on urolith formation. In wethers fed calculogenic diets, maximum urolithiasis occurred with 0.64 percent potassium in the diet and decreased at levels above and below that (Lamprecht et al., 1969).

The potassium content of most grains is 0.4 percent or greater and in most harvested forages exceeds 1.0

percent of the dry matter. Therefore, the possibility of potassium deficiency is slight under most feeding conditions. Nevertheless, attention should be given to potassium supply when lambs are fed high-grain diets and when sheep are grazing mature range forage during winter or drought periods. Potassium levels in mature range forage have been reported to decrease to less than 0.2 percent. Under such grazing conditions beef cattle have responded favorably to the addition of potassium to the range supplement (Clanton, 1980).

The maximum tolerable level of potassium for sheep is approximately 3 percent of the diet DM (NRC, 1980). Magnesium absorption was depressed 24.4 and 61.2 percent when diets containing 2.4 and 4.8 percent potassium, respectively, were fed to wethers. Increasing the level of potassium in the diet also depressed serum magnesium levels (Greene et al., 1983a). The negative effect of high levels of potassium on magnesium utilization can help precipitate magnesium tetany in sheep on diets marginal in magnesium (Field, 1983b). Increasing the level of dietary potassium from 0.7 to 3.0 percent linearly decreased energy and weight gains in lambs (Jackson et al., 1971).

*Sulfur*

The signs of sulfur (S) deficiency are similar to the signs of protein deficiency (loss of appetite, reduced weight gain or weight loss, and reduced wool growth). In addition, they include excessive salivation, lacrimation, and shedding of wool. In extreme cases, emaciation and death may occur (Goodrich et al., 1978). Because sulfur functions in the synthesis of the sulfur-containing amino acids (methionine and cysteine) and B-vitamins (biotin and thiamin) during microbial digestion in the rumen, rumen microorganisms that are deficient in sulfur do not function normally. Addition of sulfur in such cases increases feed intake, digestibility, and nitrogen retention (Bray and Hemsley, 1969; Bird, 1974; Guardiola et al., 1983). Sulfur levels of 0.15 to 0.20 percent (DM basis) appear adequate for normal rumen function (Goodrich et al., 1978).

Sulfur has functions in the body in addition to those concerned with protein structure. Sulfate sulfur is an important constituent of the chondroitin sulfates and of the mucins of the gastrointestinal tract (including saliva), the reproductive tracts, and other duct systems (Moir, 1979; Goodrich and Thompson, 1981). Because wool is high in sulfur, this element is closely related to wool production.

Much information has been obtained in recent years about sulfur metabolism in the rumen, sulfur losses, sulfur requirements of microorganisms, and the recycling of sulfur and nitrogen (Goodrich et al., 1978; Bull, 1979; Moir, 1979). This information generally supports the recommendation that a dietary nitrogen-sulfur ratio of 10:1

be maintained. The percentages of sulfur required in diet dry matter are 0.14 to 0.18 for mature ewes and 0.18 to 0.26 for young lambs.

Practically all common feedstuffs contain more than 0.1 percent sulfur. Mature grass and grass hays (especially those grown on granitic soils), however, are sometimes low in sulfur and may not furnish enough for optimal performance. Where forages are low in sulfur, or where diets contain relatively large quantities of urea, weight gains and growth of wool can be increased by feeding a sulfur supplement, such as sulfate sulfur, elemental sulfur, or sulfur-containing proteins or amino acids. Most grains contain 0.10 to 0.15 percent sulfur, so it is conceivable that lambs on high-concentrate diets could lack adequate sulfur.

Although inorganic compounds are generally more convenient and economical for supplemental feeding, sulfur availability is greatest from methionine followed by sulfate sulfur and then elemental sulfur. Sulfur from sodium sulfate is around 80 percent as available as sulfur from methionine, and sulfur from elemental sulfur is about half as available as that from sodium sulfate (Johnson et al., 1970).

Available data do not allow the establishment of a safe upper limit for the different sulfur sources for sheep, but it appears that 0.4 percent is the maximum tolerable level for dietary sulfur as sodium sulfate (NRC, 1980). At levels slightly above 0.4 percent, there is a decrease in DM intake and rumen motility. At higher levels, complete anorexia, ruminal stasis, impaction, and a foul odor of hydrogen sulfide on the breath of sheep are observed. Since the availability of elemental sulfur is only 50 percent that of sodium sulfate, a correspondingly higher level of elemental sulfur would be required to induce signs of sulfur toxicosis (Johnson et al., 1970). Sulfur forms insoluble complexes with copper and molybdenum and decreases their utilization (Suttle and McLauchlan, 1976; Grace and Suttle, 1979; Suttle, 1983a). It also decreases selenium retention (Pope et al., 1968).

*Iodine*

Iodine (I) is necessary for the synthesis of the thyroid hormones, thyroxine and triiodothyronine (Underwood, 1977). In newborn lambs, the most common sign of iodine deficiency is enlargement of the thyroid gland. If the condition is not advanced, lambs may survive. Other signs are lambs born weak, dead, or without wool (Underwood, 1981). Signs of iodine deficiency in mature sheep seldom take the form of a change in the animal's appearance. Through the impairment of physiological functions, however, deficiency may result in reduced yield of wool and reduced rate of conception (Potter et al., 1980; Underwood, 1981).

Iodine requirements of sheep have been estimated

from heat production (Underwood, 1977), thyroxine secretion rate (Henneman et al., 1955; Singh et al., 1956; Falconer and Robertson, 1961; Robertson and Falconer, 1961; Falconer, 1963), and serum triiodothyronine levels (Barry et al., 1983). Based on heat production the minimum iodine requirement is between 0.05 and 0.10 mg/kg diet DM. Values based on the rate of thyroxine secretion vary from 0.05 to 1.25 mg/kg diet DM. Levels of 0.18 to 0.27 mg I/kg diet DM are necessary to maintain serum triiodothyronine levels in growing lambs.

The previous NRC (1975) publication for sheep reported the iodine requirement as 0.10 to 0.80 mg/kg diet DM in diets not containing goitrogens, the higher level being indicated for pregnancy and lactation. These levels are also being recommended in this revision. When goitrogens such as the glucosinolates found in kale (*Brassica oleracea*) or other thioglycosides found in cruciferous plants are present, the dietary iodine should be increased (Underwood, 1977; Barry et al., 1983).

Areas in the United States deficient in iodine are the northeastern section of the country and the Great Lakes and Rocky Mountain regions (Underwood, 1981). Serious losses of lambs can be prevented in these areas by feeding iodized salt to ewes during gestation. Iodized salt generally is formulated by adding 0.0078 percent of stabilized iodine to salt (Perry, 1982). Stabilization is necessary to prevent losses from exposure to sunlight or moisture. Iodized salt should not be used in a mixture with a concentrate supplement to limit feed intake, since the animals may consume an excessive amount of iodine.

Signs of iodine toxicosis are depression, anorexia, hypothermia, and poor body weight gain (McCauley et al., 1973). According to NRC (1980) the maximum tolerable level of iodine for sheep is 50 mg/kg diet DM. McCauley et al. (1973), however, reported that levels of 267 mg iodine (as ethylenediamine dihydroiodide) and 133 mg iodine (as potassium iodide) per kilogram had no effect on live weight gain and feed intake of lambs during a 22-day treatment period.

## Iron

Iron (Fe) deficiency in animals is characterized by poor growth, lethargy, anemia, increased respiration rate, decreased resistance to infection, and in severe cases high mortality (Underwood, 1981). A primary iron deficiency in grazing sheep is very unlikely because of the iron content of pasture plants and the contamination of plants by soil (McDonald, 1968). Loss of blood resulting from parasite infestation, however, can produce a secondary iron-deficiency anemia (Silverman et al., 1970). Experimentally, iron-deficiency anemia has also been produced in milk-fed lambs (Thomas and Wheeler, 1932) and in lambs raised on slotted wooden floors and fed a semipuri-

fied diet (Lawlor et al., 1965). Anemia in suckling lambs can be prevented by administering intramuscular injections of iron-dextran or by offering a commercial oral iron compound free choice in the creep area. Two injections, 150 mg of iron each, given 2 to 3 weeks apart are preferable to a single injection (Holz et al., 1961; Mansfield et al., 1967).

The addition of 13 mg Fe/kg diet DM was reported to increase blood hemoglobin levels and total red cell volume in artificially reared lambs given a liquid diet of skimmed milk plus fat (Brisson and Bouchard, 1970). In another study, acute iron-deficiency signs were observed in lambs fed a semisynthetic diet containing 10 mg Fe/kg diet. A 25-mg Fe/kg diet did not support maximum growth, but 40 mg Fe/kg seemed adequate to meet the dietary requirement (Lawlor et al., 1965). Hoskins and Hansard (1964) estimated the gross requirements of ewes to be at least 34 mg iron per day during the final stages of pregnancy. This value is equivalent to about 20 mg iron Fe/kg diet DM. Based on the limited information available, 30 mg/kg would appear adequate to meet the dietary iron requirements for all classes of sheep.

Signs of chronic iron toxicity are reductions in feed intake, growth rate, and efficiency of feed conversion. In acute toxicosis animals exhibit anorexia, oliguria, diarrhea, hypothermia, shock, metabolic acidosis, and death (NRC, 1980). Feeding 1,600 mg Fe/kg of diet as either ferrous sulfate or ferric citrate reduced feed intake below maintenance in lambs (Standish and Ammerman, 1971). The ferrous sulfate diet was less palatable than the ferric citrate diet. In another study (Lawlor et al., 1965) an unexplained diarrhea occurred among lambs receiving diets containing 210 and 280 mg Fe/kg. A maximum tolerable level of 500 mg Fe/kg of diet has been suggested for sheep (NRC, 1980).

## Molybdenum

Although molybdenum (Mo) occurs in low concentrations in all tissues and fluids of the body and is a component of three metalloenzymes, unequivocal evidence of molybdenum deficiency in sheep, unrelated to copper, has not been reported (Underwood, 1977; 1981). A significant growth response to added molybdenum and an improvement in cellulose digestibility were reported in one study with lambs fed a semipurified diet containing 0.36 mg Mo/kg (Ellis et al., 1958). This observation, however, was not substantiated in three subsequent experiments with semipurified and practical-type pelleted diets (Ellis and Pfander, 1960).

The minimum dietary requirements for molybdenum are not known but appear to be extremely low. Although the 1975 edition of this report stated the requirement as

> 0.5 mg Mo/kg diet DM, sheep regularly graze pastures containing less molybdenum with no adverse effects other than increased copper retention in the tissues (Underwood, 1981). The major concern about the level of molybdenum in the diet involves its interaction with copper and sulfur. Molybdenum forms insoluble complexes with copper and sulfur and decreases the utilization of dietary copper (Suttle, 1975, 1983a; Suttle and McLauchlan, 1976). Copper absorption is inhibited most by 4 to 6 mg Mo/kg diet DM. Higher levels of molybdenum inhibit sulfide production and may give rise to a recovery in copper absorption (Suttle, 1983a). The rates of absorption, retention, and excretion of molybdenum are inversely related to the level of dietary sulfur (Grace and Suttle, 1979; NRC, 1980).

Sheep appear more resistant to molybdenosis than cattle and tolerate plasma molybdenum levels of 0.1 to 0.2 mg/dl (approximately 20 to 40 times the normal plasma level), providing dietary sulfate is at least 0.1 percent (NRC, 1980). High levels of molybdenum induce a copper deficiency, and the signs of molybdenosis in sheep are the same as those described for copper deficiency ("stringy" wool, lack of pigmentation in black sheep, anemia, bone disorders, and infertility). Several of the western states have extensive areas where forage plants have 10 to 20 mg/kg or more of molybdenum (Kubota, 1975).

Sheep start to scour a few days after being turned on pasture with a high molybdenum content (5 to 20 mg/kg on a DM basis). The feces become soft, the fleece becomes stained, and the animals lose weight rapidly. When the dietary copper level falls below normal (5 to 8 mg/kg) or the dietary sulfate level is high (0.40 percent), molybdenum intake as low as 1 to 2 mg/kg may prove toxic. Molybdenum toxicity is controlled by increasing the copper level in the diet by 5 mg/kg.

## Copper

A condition known as neonatal ataxia or "swayback" is characteristic of copper (Cu) deficiency in young lambs. Most often ataxia is apparent immediately after birth, but it may be delayed several weeks. Signs of ataxia, generally seen in suckling lambs, include muscular incoordination, partial paralysis of the hindquarters, and degeneration of the myelin sheath of the nerve fibers. Lambs may be born weak and may die because of their inability to nurse, a condition that occurs when the central nervous system develops during a time of maternal copper deficiency (Howell, 1970; Underwood, 1977; Miller, 1979a).

Sheep suffering from copper deficiency have "steely" or "stringy" wool, lacking in crimp, tensile strength, affinity for dyes, and elasticity. Lack of pigmentation of the wool of black sheep also occurs and appears to be a sensitive index of copper deficiency (Underwood, 1977). The condition is similar to that noted in black sheep on high levels of molybdenum. Anemia, bone disorders (osteoporosis in lambs and spontaneous bone fractures in adult sheep), and infertility have also been associated with copper deficiency in sheep (Underwood, 1977).

Copper requirements of sheep are so dependent on dietary and genetic factors that it is difficult to state requirements without specifying the conditions for which they apply. Concentrations of sulfur and molybdenum are the major dietary factors influencing copper requirements. These minerals form insoluble complexes with copper, thereby reducing its absorption and increasing dietary levels needed to meet requirements. Sulfur appears to exert an independent effect on the availability of copper, but the effect of molybdenum is sulfur dependent (Suttle, 1975; Underwood, 1981; Suttle and Field, 1983). The relationship for the effects of sulfur and molybdenum on the true availability (A) of dietary copper for sheep fed semipurified diets is described by equation (1):

$$\log (A) = -1.153 - 0.76S - 0.013\,(S \times Mo) \quad (1)$$

This relationship is based on the data from 10 repletion experiments with sheep fed semipurified diets varying from 0.8 to 4.0 g S/kg and from 0.5 to 1.5 mg Mo/kg (Suttle and McLauchlan, 1976). The relationship for summer pasture is given by equation (2):

Copper Absorption (percent) =        (2)

$$5.71 - 1.279\,S - 2.785 \log_e Mo + 0.227\,(S \times Mo)$$

where S and Mo are herbage concentrations of sulfur and molybdenum in g/kg and mg/kg, respectively (Suttle, 1983a). This equation differs substantially from that describing the effects of sulfur and molybdenum in semipurified diets and should be used to estimate the absorption of copper from pasture. Sulfur and molybdenum concentrations did not exceed 4g/kg and 6 mg/kg diet DM, respectively, in the data from which equation 2 was derived, and the equation should not be used to extrapolate to higher concentrations. High concentrations of zinc (Campbell and Mills, 1979), iron, and calcium (Miller, 1979a) have also been shown to decrease copper absorption.

Differences in copper metabolism within and among breeds also cause variation in the minimum copper requirements of sheep (Wiener, 1979; Woolliams et al., 1982; Wiener and Woolliams, 1983; Field, 1984). These differences, which are partly heritable, appear to be due to differences in absorption and are reflected in differences in blood and liver copper concentrations and in the incidence of copper deficiency (swayback) and toxicity exhibited by different breeds of sheep (Wiener and Wool-

liams, 1983). In fact, it has been shown that dietary amounts of copper that are adequate for some breeds are deficient for others and possibly toxic to some (Wiener and Woolliams, 1983). Finnish Landrace ewes have lower copper concentrations in their blood than Merino ewes, and the values for Merino ewes are lower than for some British breeds (Hayter and Wiener, 1973).

Although it is impossible to give exact requirements for copper, several estimates have been made of the amounts of copper that should be provided in the diet of sheep. In the 1975 revision of this report, 5 mg/kg diet DM was suggested for sheep fed diets with normal levels of sulfur and molybdenum. Merino sheep are less efficient in absorbing copper from feedstuffs than British breeds and therefore need an additional 1 to 2 mg/kg in their diet. Using a factorial approach, the ARC (1980) estimated the requirements of sheep for copper as follows: for growing lambs ranging from 5 to 40 kg live weight, 1.0 to 5.1 mg Cu/kg diet DM; for maintenance of adult sheep, 4.6 to 7.4 mg Cu/kg diet DM; for gestation, 6.2 to 7.5 mg Cu/kg diet DM; and for lactation, 4.6 to 8.6 mg Cu/kg diet DM. These recommendations do not take into account individual or genetic differences but do suggest adjustment factors for diets not containing normal levels of sulfur (2.5 g/kg DM) and molybdenum (2 to 3 mg/kg DM). More recently Suttle (1983c) recalculated the ARC (1980) estimates using a new value for the net copper requirement for growth and lower estimates of copper absorption that varied depending on the molybdenum content of diet as follows:

Recommended Copper Allowance

| Mo Content of Diet (mg/kg) | Recommended Cu Allowance (mg/kg diet DM) | | |
|---|---|---|---|
| | Growth | Pregnancy | Lactation |
| < 1.0 | 8-10 | 9-11 | 7- 8 |
| > 3.0 | 17-21 | 19-23 | 14-17 |

Available data (Grace, 1975; Stevenson and Unsworth, 1978) suggest a variable availability of copper from natural sources. Availability from all forage diets ranged from 10 to 35 percent (Grace, 1975), whereas lower values were reported when high-concentrate diets and straw-based low-concentrate diets were fed (Stevenson and Unsworth, 1978).

Copper is found in adequate amounts over most of the United States, but deficient areas have been reported in Florida and in the coastal plains region of the Southeast. Also, in several of the western states there are areas where an excess of molybdenum induces copper deficiency (Kubota, 1975). (For additional discussion of molybdenum and copper interrelationships, see the section on Molybdenum on p. 16.) Copper can be provided conveniently in deficient areas by adding copper sulfate to

salt at a rate of approximately 0.5 percent. Stores of copper in the body serve as a reserve for as long as 4 to 6 months when animals are grazing copper-deficient forage.

The differential between copper requirement and copper toxicity is very narrow. Errors in feed mixing frequently result in mortality due to copper toxicity. Complete manufactured feeds for sheep in the United States may contain 25 to 35 ppm copper. When vitamin-mineral preparations are added to feeds, the copper content of the diet may be excessive (Buck and Sharma, 1969). These levels of copper can be extremely harmful if the molybdenum level of the diet is low. In fact, if the molybdenum level is extremely low (< 1 ppm), forage with a normal copper content of 8 to 11 ppm can produce toxicity.

The normal concentration of copper in whole blood is 0.7 to 1.3 ppm and in liver (fresh basis) 12 ppm (Pope, 1971). The concentration of copper in liver gives a reliable indication of the copper status of sheep. The concentration in the kidney cortex provides an even better criterion for diagnosing copper poisoning. In most cases of copper poisoning, concentrations of copper, on a DM basis, exceed 500 ppm in the liver and 80 to 100 ppm in the kidney cortex (Pope, 1971). Hemolysis, jaundice (easily detected in the eyes), and hemoglobinuria are characteristic signs of toxicity and result in very-dark-colored liver and kidneys (Todd, 1969).

In treating copper toxicity, both molybdenum and sulfate should be administered. Dietary inorganic sulfate alone has less effect on uptake or reduction of copper in the liver and on utilization of copper for synthesis of ceruloplasmin (Ross, 1966). High dietary concentrations of zinc protect against copper intoxication. A diet of 100 ppm of zinc on a DM basis reduces liver copper storage (Pope, 1971).

An effective treatment for copper toxicity in lambs is to drench each lamb daily with 100 mg of ammonium molybdate and 1 g of sodium sulfate in 20 ml of water. Adding equivalent amounts of molybdenum and sulfur to the daily feed is equally effective. Either treatment usually requires a minimum of 5 to 6 weeks (Ross, 1966, 1970). The Food and Drug Adminstration does not recognize molybdenum as safe, and the law prohibits adding it to feed for sheep unless prescribed by a veterinarian. Copper toxicity can be prevented by reducing or eliminating extraneous sources of copper in the diet.

## Cobalt

The only known function of cobalt (Co) in sheep nutrition is to promote synthesis of vitamin $B_{12}$ in the rumen. Thus, signs of cobalt deficiency are actually signs of vitamin $B_{12}$ deficiency. These are lack of appetite, lack

of thrift, severe emaciation, weakness, anemia, decreased estrous activity, and decreased milk and wool production (Ammerman, 1981; Underwood, 1981).

For mature sheep grazing grossly cobalt-deficient pastures, the amount of cobalt necessary to ensure optimum growth is 0.08 mg/d when supplementary cobalt is administered orally 3 times per week. For young, rapidly growing lambs the requirement is greater and during the first few months is probably as much as 0.2 mg/d (Lee and Marston, 1969). With sheep confined to pens and fed a cobalt-deficient diet, 0.07 mg cobalt per day is required for maintenance of normal growth rate; however, for maintenance of maximum vitamin $B_{12}$ status, based on serum and liver vitamin $B_{12}$ concentrations, a supplement of between 0.5 and 1.0 mg Co/d is necessary (Marston, 1970).

Although levels of vitamin $B_{12}$ in the contents of the rumen and in the blood and liver are indicators of the cobalt status of sheep, the vitamin $B_{12}$ content of the feces is an indicator that can be used advantageously. Jones and Anthony (1970) developed an equation for estimating oral intake of cobalt on the basis of concentration of vitamin $B_{12}$ in the feces:

$$Y = 0.0779X - 0.0757$$

where Y represents the oral intake of cobalt expressed as mg/kg in the dry feedstuff and X represents the concentration of vitamin $B_{12}$ in the feces expressed as µg of vitamin $B_{12}$ per gram of dry feces. In the study no signs of cobalt deficiency were observed in lambs fed a diet containing 0.09 mg Co/kg diet DM for a 7-month period. The corresponding level of vitamin $B_{12}$ for this level of cobalt in the diet was 2.13 µg/g of dry feces.

In the 1975 edition of this report, the recommended amount of cobalt was 0.1 mg/kg diet DM. The same value is proposed here for all classes of sheep; however, young, rapidly growing lambs may have a slightly higher requirement, as suggested by Lee and Marston (1969).

Areas deficient in cobalt have been reported in the United States and Canada. The most severely deficient areas in the United States include portions of New England and the lower Atlantic Coastal Plain. Moderately deficient areas include New England, northern New York, northern Michigan, and parts of the Central Plains (Ammerman, 1981).

Research has demonstrated that cobalt should be ingested frequently (MacPherson, 1983). This can be accomplished by adding cobalt to salt at a rate of 2.5 g Co/ 100 kg salt using either cobalt chloride or cobalt sulfate. Other effective methods are the addition of cobalt to the soil (Griffiths et al., 1970; Burridge et al., 1983) or the administration of cobalt pellets (MacPherson, 1983) or a soluble glass containing cobalt that dissolves slowly in the reticulum (Telfer et al., 1984).

Sheep have been fed 350 mg Co/100 kg of live weight for short periods of time without ill effects. Levels of approximately 450 mg/100 kg of live weight have been suggested as toxic (Becker and Smith, 1951). The National Research Council (1980) suggests 10 mg Co/kg diet DM as a maximum tolerable level for ruminants.

## Manganese

Manganese (Mn) deficiency in animals results in impaired growth, skeletal abnormalities and ataxia of the newborn, and depressed or disturbed reproductive function (Hidiroglou, 1979a; Underwood, 1981). The minimum dietary manganese requirements for sheep are not exactly known; however, it appears that the requirement for growth is less than for optimal reproductive performance. Requirements may also be increased by high intakes of calcium and iron (Underwood, 1981). Bone changes similar to those seen in other manganese-deficient animals were observed when early-weaned lambs received a purified diet containing less than 1 ppm of manganese over a 5-month period (Lassiter and Morton, 1968). When a diet containing 8 ppm of manganese was fed to 2-year-old ewes for a 5-month period prior to breeding and throughout gestation, more services per conception (2.5 versus 1.5) were required than for ewes fed a diet containing 60 ppm manganese (Hidiroglou et al., 1978). Levels of manganese in wool appear to be sensitive to changes in the manganese status of lambs (Lassiter and Morton, 1968).

The growth of female goats fed 20 ppm of manganese for the first year of life and 6 ppm during the following year was not affected, but the onset of estrus was delayed and more inseminations were required per conception (Anke and Groppel, 1970). No goats aborted in the control group (100 ppm), but 23 percent of those on the low-manganese diet aborted. The low-manganese diet also resulted in a 20-percent reduction in birth weights, the birth of more male than female kids, and the death of more female than male kids. Bone structure was not affected. In mature goats the manganese content of the hair was a better indicator of manganese status than the manganese content of any other part of the body.

Although the exact requirements of sheep for manganese are not known, 20 mg/kg, on a DM basis, should be adequate for most production stages. With a well-balanced diet, it appears that 1,000 mg/kg of dietary manganese is the maximum tolerable level for sheep (NRC, 1980).

## Zinc

Zinc (Zn) deficiency in sheep is characterized by a decrease in appetite and a reduction in the rate of growth.

Other signs are brief periods of excessive salivation, parakeratosis, wool loss, reduced testicular development (or testicular atrophy), defective spermatogenesis, and delayed wound healing. In addition, all phases of the reproductive process in females from estrus to parturition and lactation may be adversely affected (Smith et al., 1962; Hidiroglou, 1979b; Miller, 1979b; Underwood, 1981).

Ott et al. (1965) found that a diet containing 18 mg Zn/kg diet DM did not support maximal live weight gains of lambs fed a purified diet. Mills et al. (1967) estimated that a dietary zinc level of 7.7 mg/kg diet DM satisfied the growth requirements of lambs but did not maintain the plasma zinc levels within the normal range. Data presented by Underwood and Somers (1969) indicate that a diet containing 2.4 mg Zn/kg DM is grossly inadequate for growth and metabolic requirements of ram lambs. A similar diet supplying 17.4 mg Zn/kg DM was adequate for body growth and for the maintenance of normal appetite, although this level was not adequate to permit normal testicular development and spermatogenesis. Histological and other evidence suggest that dietary zinc at a level of 32.4 mg/kg DM is adequate for maximal testicular development and function (Underwood and Somers, 1969). Pond (1983) concluded that a zinc level of 19 to 26 mg/kg DM was adequate for growth of lambs. Based on these reports it appears that the zinc requirements of ram lambs for testicular growth and development and for spermatogenesis are greater than the requirements for body growth.

Zinc requirements for pregnancy and lactation have not been established. The few studies that have been conducted indicate that the lactating ewe is clearly susceptible to zinc deficiency, but whether zinc is necessary for normal parturition in sheep (as it is in rats) requires further study (Apgar and Travis, 1979; Masters and Moir, 1983). Under Australian field conditions, Egan (1972) obtained an increased conception rate when grazing ewes were given supplemental zinc. The zinc content of the forage varied between 17 and 28 mg/kg DM.

The suggested minimum requirements are 20 mg Zn/kg DM for growth and 33 mg Zn/kg DM for maintenance of normal reproductive function in males and for pregnancy and lactation in females. Diets high in calcium (1.2 to 1.8 percent calcium) have been reported to adversely affect zinc utilization (Mills and Dalgarno, 1967).

Although there appears to be a wide margin of safety between requirements for zinc and amounts that are toxic, zinc toxicity has been described for growing lambs (Ott et al., 1966; Davies et al., 1977) and for pregnant sheep (Campbell and Mills, 1979). One gram of zinc per kilogram of diet caused reduced consumption of feed and reduced gain in lambs (Ott et al., 1966), and 0.75g Zn/kg diet induced severe copper deficiency in pregnant

ewes and caused a high incidence of abortions and stillbirths (Campbell and Mills, 1979).

## Selenium

In the northwestern, northeastern, and southeastern parts of the United States, there are extensive areas where the selenium (Se) content of crops is below 0.1 ppm (Figure 5), which is the level considered adequate for preventing deficiency in sheep. Thus, selenium-responsive diseases are most likely to occur in these regions. In an area extending roughly from the Mississippi River to the Rocky Mountains, the selenium content of crops is predominantly in the nutritionally adequate but nontoxic range of selenium concentration. Parts of South Dakota, Wyoming, and Utah produce forage that causes selenium toxicity in farm animals (Kubota et al., 1967; Muth, 1970; NRC, 1983).

The most commonly noticed lesion in sheep resulting from an inadequate supply of selenium is degeneration of the cardiac and skeletal musculature (white muscle disease), but unthriftiness, early embryonic death, and periodontal disease are also signs of a possible selenium deficiency (McDonald, 1968; Muth, 1970; Underwood, 1981). Lamb production is seriously affected; the major manifestations of deficiency in lambs are reduced growth and white muscle disease, which affects lambs 0 to 8 weeks of age (Pope, 1971). Selenium-responsive infertility has been described in Australia (Godwin et al., 1970; Piper et al., 1980) and New Zealand (Hartley, 1963) but not elsewhere (Pope, 1971; Phillippo, 1983).

Supplementation with 0.1 mg Se/kg DM (as sodium selenite) of the diet of ewes during gestation through weaning consistently provided essentially complete protection against white muscle disease in their lambs (Schubert et al., 1961). Feeding ewes a natural diet containing 0.07 mg Se/kg DM or the addition of 0.1 mg Se/kg DM to a low-selenium diet (< 0.02 mg Se/kg DM) prevented white muscle disease in their lambs (Oldfield et al., 1963). Oh et al. (1976) concluded that the selenium requirement of reproducing ewes and their lambs fed a practical diet was 0.12 mg/kg DM. This conclusion was based on the dietary selenium level required to reach a plateau in tissue glutathione peroxidase levels. In contrast, Moksnes and Norheim (1983) found that tissue glutathione peroxidase activity plateaued above a level of 0.23 mg Se/kg diet. Glutathione peroxidase was the first selenoenzyme to be identified in animal tissues. The level of this enzyme in tissue and red blood cells can be considered a more sensitive indicator of dietary adequacy for lambs than tissue selenium content (Oh et al., 1976; Paynter et al., 1979).

An extensive review of New Zealand data indicated selenium-responsive unthriftiness in grazing lambs oc-

LOW—APPROXIMATELY 80% OF ALL FORAGE AND GRAIN CONTAIN <0.10 PPM SELENIUM

VARIABLE—APPROXIMATELY 50% OF ALL FORAGE AND GRAIN CONTAIN >0.10 PPM SELENIUM (INCLUDES ALASKA)

ADEQUATE—OVER 80% OF ALL FORAGES AND GRAIN CONTAIN >0.10 PPM SELENIUM (INCLUDES HAWAII)

FIGURE 5   The regional distribution of forages and grain, containing low, variable, or adequate levels of selenium, in the USA and Canada.

curred where the selenium content of spring pastures was < 0.02 mg/kg DM. Pastures containing > 0.03 mg/kg DM were apparently adequate, whereas intermediate levels were probably marginally deficient. An occasional positive response was obtained, however, with pastures having selenium levels in the range of 0.09 to 0.10 mg/kg DM (Grant and Sheppard, 1983). Whanger et al. (1978) have proposed that the selenium requirements for sheep be raised to at least 0.2 mg/kg diet DM when legume forages are fed.

Schubert et al. (1961) and Pope et al. (1979) found an antagonistic effect of dietary sulfur on selenium absorption and retention. Thomson and Lawson (1970) reported an interaction between selenium and copper in sheep. Adding selenium to the diet improved the copper status of sheep on deficient or marginally adequate copper diets.

A number of methods can be used to prevent white muscle disease in lambs caused by a selenium deficiency. The Food and Drug Administration has approved the following uses of selenium for ewes and ewes with lambs up to 8 weeks of age: (1) selenium can be added to a complete feed at a level not to exceed 0.1 mg/kg diet; (2) selenium can be added to a feed supplement at a level that, when consumed with the base feed, will not exceed an intake of 0.23 mg Se per sheep per day; and (3) up to 30 mg Se/kg diet can be added to a salt-mineral mixture for free-choice feeding at a rate not to exceed an intake of 0.23 mg Se per sheep per day (Federal Register, Vol. 43. pp. 11700-11701, 1978). These uses of selenium have been shown to be safe and effective (Paulson et al., 1968; Rotruck et al., 1969, Ullrey et al., 1977, 1978). One may also inject a commercial pharmacological product containing selenium and vitamin E (see the subsection on Vitamin E on pp. 24 for levels).

Other experimental methods of supplying selenium to sheep include an oral drench (Whanger et al., 1978; Paynter et al., 1979; Piper et al., 1980; MacPherson, 1983), subcutaneous or intramuscular injection (Kuttler et al., 1961; Whanger et al., 1978), application of selenium to the soil (Allaway et al., 1966; Watkinson. 1983), introduction of a heavy selenium pellet (composed of finely divided metallic iron and elemental selenium in a

proportion of 20 to 1) into the reticulum (Kuchel and Buckley, 1969; Handreck and Godwin, 1970; Whanger et al., 1978; Paynter, 1979; MacPherson, 1983), and introduction of a soluble glass containing selenium to the reticulum (Telfer et al., 1984).

Chronic selenium toxicity occurs when sheep consume over a prolonged period of time seleniferous plants containing more than 3 ppm of selenium. Signs include loss of wool, soreness and sloughing of hooves, and marked reduction in reproductive performance (NRC, 1980; Underwood, 1981; Howell, 1983).

Toxicity of forage depends somewhat on its protein and sulfur content. The extent to which plants take up selenium varies greatly. Some species of plants grown on seleniferous soils contain as much as 1,000 ppm of selenium, whereas other species grown on the same soils contain only 10 to 25 ppm. The most practical way to prevent livestock losses from selenium poisoning is to manage grazing so that animals alternate between selenium-bearing and other areas.

Selenium is a cumulative poison, but mild chronic signs can be overcome readily. The mineral is eliminated rapidly from the body of an affected animal when it is fed selenium-low forage. Small amounts of arsanilic acids are effective in reducing the toxicity of selenium.

## Fluorine

Fluorine (F) exerts a cumulative toxic effect. Signs may not be observed until the second or third year of intake of high levels of fluoride. Affected animals usually exhibit anorexia; the normal ivory color of their bones gradually changes to chalky white; bones thicken because of periosteal hyperostosis; and the teeth, especially the incisors, may become pitted and eroded to such an extent that the nerves are exposed (Underwood, 1977; NRC, 1980).

Fluorine rarely occurs free in nature but combines chemically to form fluorides. In some parts of the world fluoride occurs in the water supply in amounts that may be high enough to have deleterious effects. Another danger lies in the use of rock phosphate that contains fluorine in amounts sufficient to be toxic (O'Hara et al., 1982). Proper defluorination procedures are necessary to make rock phosphate safe for animal supplementation. Forage growing near manufacturing units processing minerals containing fluorides may be highly contaminated with fluoride.

Finishing lambs can tolerate up to 150 ppm of fluorine in the diet on a DM basis (Harris et al., 1963). Acute toxicity can occur at 200 ppm. Data are not available on lifetime tolerance levels for sheep; however, breeding sheep should not be fed diets containing more than 60 ppm fluorine on a DM basis (NRC, 1980).

## VITAMINS

### Vitamin A

In the previous revision of *Nutrient Requirements of Sheep* (NRC, 1975), 17 IU/kg of body weight for vitamin A alcohol (retinol) or 25 µg/kg of body weight for β-carotene were the values used to calculate the vitamin A and β-carotene requirements. An IU is defined as 0.300 µg of retinol or 0.550 µg of vitamin A (retinyl) palmitate. Requirements for late pregnancy, lactation, and early-weaned lambs were calculated by multiplying these values by 5; those for replacement lambs and yearlings were obtained by multiplying by 2.5; and those for finishing lambs and for ewes during maintenance and the first 15 weeks of gestation were calculated by multiplying by 1.5. These values were based on the amounts of retinol or carotene required to prevent night blindness in sheep and the amounts required for storage and reproduction (Guilbert et al., 1937, 1940).

Recent studies with growing calves have effectively demonstrated that elevated pressure in the cerebrospinal fluid (CSF) is a more sensitive indicator of vitamin A status than is night blindness. For example, Eaton (1969) reported that the minimum β-carotene or retinol requirement of calves (µg/kg live weight per day) based on prevention of night blindness was 24 to 35 µg for carotene and 5.1 to 6.4 µg for retinol (17 to 21 IU), whereas for prevention of elevated CSF pressures, the values are 66 to 73 µg for β-carotene and 14.1 µg for retinol (47 IU). Increased CSF pressure has also been observed in sheep deficient in vitamin A (Eveleth et al., 1949; May, 1982). Based on increased CSF pressure the minimum requirement for growing-finishing lambs appears to be between 8 and 16 µg of retinol/kg live weight per day (May, 1982). This is supported by the work of Faruque and Walker (1970), who reported that 14 µg retinyl palmitate or 69 µg β-carotene/kg live weight per day permitted the establishment of a small liver reserve of retinol in young lambs.

In the absence of more definitive information, the minimum carotene and vitamin A requirements of sheep are assumed to be 69 µg of β-carotene/kg live weight per day or 47 IU of vitamin A/kg live weight per day. These values were used as the basis for establishing requirements for vitamin A for all categories (Tables 1 and 2) except ewes in late gestation and during lactation, in which cases the requirements are 125 µg/kg live weight per day for β-carotene and 85 IU/kg live weight per day for vitamin A. During the first 6 to 8 weeks of lactation, the requirements for ewes suckling twins were further increased to 147 µg/kg live weight per day for β-carotene and 100 IU/kg live weight per day for vitamin A. Ewe milk contains about 1,500 IU vitamin A per liter and

conceivably these additional amounts should be added per day to compensate for what is produced in milk.

Plant products do not contain preformed vitamin A, and sheep meet their vitamin A needs mainly from carotenoid precursors in the diet (Moore, 1957). Vitamin A compounds and carotenoids exist in many forms, each with different biological activity. The all-*trans* forms exhibit the highest biological activity.

The international standards for vitamin A activity as related to vitamin A and β-carotene are as follows: 1 IU of vitamin A = 1 USP unit = vitamin A activity of 0.300 μg of crystalline all-*trans* retinol, which is equal to 0.344 μg of all-*trans* retinyl acetate or 0.550 μg of all-*trans* retinyl palmitate (Anonymous, 1963). All-*trans* β-carotene is the reference standard for provitamin A. It is the major carotenoid pigment in most plant feeds. Although the vitamin A equivalence used for β-carotene in this publication is 681 IU of vitamin A/mg of β-carotene, this value probably only applies to all-*trans* β-carotene fed at a level to meet the minimum requirement. The biological potency of β-carotene, relative to preformed vitamin A, is not a single standard value but is dependent on a number of factors, such as the level of supplementation, the previous nutritional history of the animal, and the response criteria used to determine the relative potencies (Myers et al., 1959; Faruque and Walker, 1970). Other factors that have been reported to influence the biological availability of carotene in natural feedstuffs are the mixture of carotenoid isomers present, the digestibility of the diet, the presence of antioxidants, and the protein and fat contents of the diet (Ullrey, 1972). Both vitamin A and β-carotene are subject to loss by oxidation. Stabilized vitamin A, which is resistant to oxidation, may be added to diets of low-carotene content.

The vitamin A value of carotene from artificially dehydrated alfalfa meal ranged from 254 to 520 IU/mg in a study with growing lambs (Myers et al., 1959). The vitamin A activity of carotenes in corn silage fed to lambs was 436 IU/mg (Martin et al., 1968). Sun-cured hay is usually lower in carotene than dehydrated hay. With the exception of yellow corn, grains are poor sources of vitamin A activity.

Vitamin A is fat soluble and is stored in the body. Approximately 200 days are required to deplete entirely the vitamin A stores in the livers of ewe lambs previously pastured on green feed. Because of this storage, animals that graze on green forage during the normal growing season perform normally on low carotene diets for periods of 4 to 6 months. In situations where sheep are grazing forage low in carotene for extended periods, however, vitamin A deficiency can be prevented by intramuscular injection with a commercially available vitamin A preparation or by the addition of preformed vitamin A to the diet as part of a salt mixture or as a pasture supplement.

Vitamin A is involved in a number of physiological functions in animals. It is essential for the stimulation of growth, the proper development of skeletal tissues, normal reproduction, vision, and the maintenance of normal epithelial tissue (Moore, 1957; Weber, 1983). Consequently, vitamin A deficiency results in clinical deficiency signs such as growth retardation; bone malformation; degeneration of the reproductive organs; night blindness; increased CSF pressure; and keratinization of the respiratory, alimentary, reproductive, urinary, and ocular epithelia (Moore, 1957; Weber, 1983). Also, a deficiency can result in the production of lambs that are weak, malformed, or dead at birth. Retained placenta also is encountered with ewes deficient in vitamin A.

Available high-potency vitamin A preparations and the common practice of vitamin A fortification of sheep diets necessitates caution because acute and chronic vitamin A toxicities have been reported for several animal species. For example, growing calves fed daily retinol intakes in excess of 2,200 μg/kg live weight (150 times the requirement) for 12 weeks exhibited changes in serum constituents and bone composition (Hazzard et al., 1964).

### Vitamin D

Vitamin D activity is measured in international units (1 IU = 1 USP unit = antirachitic activity of 0.025 μg crystalline $D_3$) (Windholz et al., 1983). The vitamin D requirement for all classifications of sheep except early-weaned lambs is 555 IU/100 kg live weight per day; for early-weaned lambs, it is 666 IU/100 kg live weight per day. These are the same values used in the 1975 publication on sheep (NRC, 1975) and are based on the research of Andrews and Cunningham (1945). These values are only slightly higher than those proposed by ARC (1980) for all classes of sheep (520 IU/100 kg live weight).

Sheep use vitamin $D_2$ (ergocalciferol) and vitamin $D_3$ (cholecalciferol) equally well (Church and Pond, 1974). Recent research indicates that cholecalciferol is converted to active forms in the liver and kidney and acts in metabolism by affecting calcium absorption, deposition, and mobilization from bone (DeLuca, 1974; 1976). Vitamin D is fat soluble and stored in the body and therefore is less important in mature animals, except in the case of pregnancy, when demands are greater. Congenital malformations in the newborn may result from extreme vitamin D deficiencies. Vitamin D is required in addition to calcium and phosphorus for preventing rickets in young lambs and osteomalacia in older sheep, but newborn lambs are provided with enough vitamin D from their dams to prevent early rickets if their dams have adequate storage (Church and Pond, 1974).

Animals exposed to sunlight generally obtain sufficient vitamin D through ultraviolet irradiation. Animals with

white skin or short wool receive more vitamin D activity through irradiation than animals with black skin or long wool. Sheep on pasture seldom need additional vitamin D, but under some conditions rickets has been observed (Fitch, 1943; Crowley, 1961; Nisbet et al., 1966). The question of adequacy arises if the weather is cloudy for long periods (Crowley, 1961) or if sheep are maintained indoors (Hidiroglou et al., 1979). Under these conditions, it is especially important that attention be given to the vitamin D content of diets of fast-growing lambs.

Sun-cured hays are good sources of vitamin D. Dehydrated hays, green feeds, seeds, and by-products of seeds are poor sources. Vitamin D is subject to loss by oxidation. Although it oxidizes more slowly than vitamin A, its stability is poor when it is mixed with minerals (and especially poor when it is mixed with calcium carbonate).

Use of high-potency vitamin D preparations in animal feeds requires caution. Excess vitamin D causes abnormal deposition of calcium in soft tissues and brittle bones subject to deformation and fractures (Church and Pond, 1974). Nevertheless, the amounts of vitamin D necessary to produce signs of toxicity are many times greater than the amounts required for nutritional purposes.

### Vitamin E

Vitamin E is essential for all sheep, but unlike vitamin A, it does not appear to be stored in the body in appreciable concentrations (Rammell, 1983). On a practical basis, vitamin E fortification of the diet is more critical for young lambs than for older sheep. Recent estimates of the vitamin E requirements of ruminants vary from 10 to 60 mg/kg diet DM (NRC, 1975; ARC, 1980; NRC, 1984). This is not unexpected, since there are few studies specifically designed to determine requirements and actual requirements depend on the levels of selenium, polyunsaturated fatty acids, and (possibly) sulfur in the diet, as well as on the physiological status of the sheep and measurements used to assess deficiency (Muth et al., 1961; Hintz and Hogue, 1964; Rammell, 1983).

Rousseau et al. (1957) reported no signs of vitamin E deficiency in lambs fed 51.3 mg of $d$-$\alpha$-tocopheryl acetate per kilogram DM. Ewan et al. (1968) found that 11.0 mg/kg live weight of $dl$-$\alpha$-tocopherol added weekly to lamb diets containing 0.1 to 1.0 ppm selenium prevented deaths due to white muscle disease (WMD) and maintained serum enzymes within the normal range. For a 10-kg lamb consuming 0.6 kg of feed per day (DM basis), this is equivalent to a dietary tocopherol concentration of 26.2 mg/kg DM. Dietary supplementation with 20 IU of vitamin E/kg of feed was successful in preventing nutritional muscular dystrophy (NMD) in rapidly growing (> 300 g/d) early-weaned lambs fed a dystrophogenic diet (Sharman, 1973). Data summarized by ARC (1980) in-

dicated that the minimum requirements for vitamin E in the diet of growing or pregnant sheep were between 10.0 and 15.0 mg/kg DM. If dietary selenium levels are below 0.05 ppm, however, even 15 to 30 mg of vitamin E/kg DM may prove inadequate. For young beef calves (NRC, 1984), 15 to 60 mg of $dl$-$\alpha$-tocopheryl acetate per kilogram DM is suggested. In the absence of more definitive information on the vitamin E requirements of sheep, the following levels are recommended: lambs under 20 kg live weight should receive 20 IU/kg DM and lambs over 20 kg live weight and pregnant ewes should receive 15 IU/kg DM. (The IU is defined as 1 mg of $dl$-$\alpha$-tocopheryl acetate; 1 mg $dl$-$\alpha$-tocopherol has the biopotency of 1.5 IU of vitamin E activity.) The above recommendations assume that dietary selenium levels are > 0.05 ppm.

Vitamin E is now recognized as an important biological antioxidant. It functions in the body's intracellular defense against the adverse effects of reactive oxygen and free radicals (Rammell, 1983) and, as such, plays an important role in maintaining the integrity of biological cell membranes. Its mode of action is not well defined, but it is closely associated with selenium in metabolism. Some signs of vitamin E deficiency, such as WMD or NMD, may respond to either selenium or vitamin E or may require both (Hopkins et al., 1964; Ewan et al., 1968). Vitamin E and selenium also appear to have an additive effect on reducing serum levels of glutamic-oxalacetic transaminase (GOT), increasing survival time, and decreasing the level of urinary creatine excretion in deficient lambs less than 8 weeks old (Ewan et al., 1968).

The signs of WMD in nursing lambs are stiffness (especially in the rear quarters), tucked-up rear flanks, and arched back. On necropsy, the disease is shown as white striations in cardiac muscles and is characterized by bilateral lesions in skeletal muscles. Serum levels of the enzymes glutamic-oxalacetic transaminase and lactic dehydrogenase are elevated, indicating muscle damage. Blood levels of the selenium-containing enzyme glutathione peroxidase are reduced. Affected lambs often die of pneumonia, starvation, or heart failure (Suttle and Linklater, 1983). Vitamin E blood plasma levels of 0.3 mg $\alpha$-tocopherol/dl are considered marginal in cattle, and similar values may apply to sheep (Adams, 1982).

Wheat germ meal, dehydrated alfalfa, some green feeds, and vegetable fat are good sources of vitamin E. Grains and grass hays are fair to good sources, but variations in levels are considerable. Protein-rich feeds such as fish and meat meal and solvent-extracted soybean and cottonseed meals are relatively poor sources. The level of vitamin E in ensiled forages is questionable (Bunnell et al., 1968; Kivimae and Carpena, 1973).

Reports by Bunnell et al. (1968) and Adams (1982) suggest that $\alpha$-tocopherol levels in feedstuffs may be lower than previously reported. Furthermore, the ex-

treme variations in α-tocopherol levels in the same kind of feeds as affected by stage of harvest, storage (oxidation may reduce levels 50 percent in 1 month), length of time between cutting and dehydrating, grinding of grains, stresses (such as adding minerals or fat in mixed feeds), and pelleting detract measurably from the reliability of book values for α-tocopherol content of rations. For example, the α-tocopherol content of 12 samples of 17 and 20 percent dehydrated alfalfa ranged from 28 to 141 mg/kg. Adams (1982) reported a range in plasma α-tocopherol values of 0.01 to 2.2 mg/dl among feedlot cattle. Of 286 plasma samples, 60 percent were below 0.3 mg α-tocopherol/dl, a level generally considered borderline between adequate and deficient.

Based on average α-tocopherol contents of feedstuffs (Bunnell et al., 1968) generally used in lamb growing-finishing rations (corn, soybean meal, and alfalfa hay), the typical ration may contain less than 15 mg α-tocopherol/kg, which could result in inadequate intake of vitamin E. In addition, preintestinal destruction of vitamin E increases from 8 to 42 percent of an orally administered dose as the corn content of the diet increases from 20 to 80 percent (Alderson et al., 1971). Many sheep rations, heretofore believed adequate in vitamin E, may be inadequate, explaining the sporadic outbreaks of WMD in areas considered adequate in selenium.

Values for the vitamin E requirements of sheep are presented in Tables 1, 2, and 9. The values presented in Table 1 were calculated from values per kilogram of dry feed consumed, given in Table 2. Table 9 presents daily vitamin E requirements for lambs and the suggested amounts of α-tocopheryl acetate to add to rations to provide 100 percent of these requirements.

## Vitamin B Complex

The B vitamins are not required in the diet of sheep with functioning rumens, because the microorganisms synthesize these vitamins in adequate amounts. Lambs fed a niacin-deficient diet for 8 months have developed normally (Winegar et al., 1940). Mature sheep fed a diet low in thiamin, riboflavin, pyridoxine, and pantothenic acid have synthesized these vitamins in their rumens (McElroy and Goss, 1940 a,b; 1941 a,b). Cobalt is necessary for the synthesis of vitamin $B_{12}$ (cyanocobalamin) in the rumen (see the section on Cobalt, p. 18).

There is no evidence that supplementation with the vitamin B complex affects the performance of ewes during breeding and pregnancy (Miller et al., 1942). Before their rumens are developed, young lambs (up to 2 months of age), if early weaned, have a dietary need for B vitamins.

A thiamin-responsive disease condition has been reported in feedlot lambs fed diets with high levels of grain and little roughage (see the section on Polioencephalomalacia, p. 27) (Barlow, 1983).

## Vitamins $K_1$ and $K_2$

Vitamins $K_1$ (phylloquinone) and $K_2$ (menaquinone) are fat soluble, and one or the other is necessary in the blood-clotting mechanism. Green leafy materials of any kind, fresh or dry, are good sources of vitamin $K_1$ (Church and Pond, 1974). Vitamin $K_2$ is normally synthesized in large amounts in the rumen, and no need for dietary supplementation has been established (McElroy and Goss, 1940a; Matschiner, 1970).

# $\mathit{3}$ Water

Sheep obtain water from snow and dew and by drinking; metabolic water is obtained from oxidation of nutrients in feed. The exact amount of water required by sheep is not known and varies considerably depending on body metabolism, ambient temperature, stage of production, size, wool covering, amount of feed consumed, and feed composition (Forbes, 1968).

Voluntary water consumption is two or three times dry matter consumption and increases with high-protein and salt-containing diets. Available snow, high-moisture feeds, and infrequent watering tend to reduce daily water consumption.

Forbes (1968) has confirmed that there is a significant relationship between total water intake (TWI) and dry matter intake (DMI) that can be represented by the formula

$$TWI = 3.86DMI - 0.99$$

Producers feeding pelleted rations note the obvious increase in water intake accompanied by increased urine output as a result of increased DMI. Conversely, sheep denied water for more than 24 hours ate little or no dry feed containing 15 percent protein, but intake was little affected when fed 2 percent protein hay (Forbes, 1968).

The relationship between water intake and mean temperature over 1°C also is significant (Forbes, 1968):

$$TWI/DMI = 0.18T + 1.25$$

where TWI/DMI is the average total water intake per unit of dry matter intake (kg/kg) and T is the average temperature in °C for each week.

Pregnancy and lactation also increase water intake. Water intake increases by the third month of gestation, is doubled by the fifth month, and is greater for twin-bearing ewes than for ewes carrying a single fetus. A lack of water accompanied by a severe depression in feed intake predisposes ewes to pregnancy toxemia. Forbes (1968) noted that water intake during early lactation is greater than the sum of water intake for nonpregnant ewes and the water in the milk, due to a higher metabolic rate and greater excretion. It is estimated that lactating ewes require 100 percent more water than nonlactating ewes.

Sheep may consume 12 times more water in summer than in winter; subsist on once-a-day watering when temperatures are below 40°C; and suffer no reduction in weight gains, feed intake, or digestibility of dry matter when snow is available and the temperature ranges between 0° and 21°C (Butcher, 1970). Lactating ewes would likely be stressed under a similar regime.

Adequate intake of good-quality water is essential for sheep to excrete excess toxic substances such as oxalates, ammonia, and mineral salts (phosphates that cause urinary calculi).

The effect of water temperature on rumen temperature, digestion, and rumen fermentation in sheep was studied by Brod et al. (1982), who reported that rumen temperatures were affected by temperature of water consumed, with 0°C water depressing rumen temperature more than 10°, 20°, or 30°C water. It required 108, 96, 96, and 72 minutes at water temperatures of 0°, 10°, 20°, and 30°C, respectively, to regain initial rumen temperature. Water temperature had no significant effect on nitrogen balance or on DM, protein, or crude fiber digestibility, although digestion coefficients tended to be lower with 0°C water. Water temperature had no significant effect on rumen pH, but water at all temperatures depressed rumen pH 2 to 4 hours postfeeding. Volatile fatty acids (VFA) and ammonia-nitrogen concentrations increased 1 to 4 hours postfeeding. Brod et al. concluded that 0°C water suppresses rumen microbial activity as evidenced by (1) elevated pH at 4 hours postfeeding for 0°C water compared with pH values for 10°, 20°, and 30°C water and (2) by depressed concentrations of VFA and ammonia-nitrogen and lower digestibility values compared with the other water-temperature treatments.

# *4* Nutrition Disorders

## ENTEROTOXEMIA

Enterotoxemia (overeating disease, pulpy kidney disease) is a feed-related malady that causes sudden death in sheep due to a toxin produced by the bacterium *Clostridium perfringens* type D (although occasionally type C also occurs, particularly in 2- to 4-week-old suckling lambs). The organism appears to be widespread in nature and has been isolated from pastures, manure, and the gastrointestinal tract of healthy sheep (Jensen, 1974; Buxton, 1983).

Under conditions of high carbohydrate intake (high-grain diet; high milk intake; and rarely, high intake of immature forage) the causative bacteria multiply rapidly and produce a toxin. Thus, it is a disease that afflicts suckling lambs, creep-fed lambs, growing-finishing lambs, and ewes fed high levels of grain. Anything that interferes with the normal passage of feed through the gut, such as a heavy burden of parasites, exacerbates the situation (Jensen, 1974; Buxton, 1983).

Protection of lambs against enterotoxemia can be achieved by vaccinating twice (at least 10 days apart) with *Clostridium perfringens* type D toxoid. Approximately 2 to 4 weeks is required for the development of immunity after vaccination. Vaccinating pregnant ewes 2 to 4 weeks before parturition will transfer sufficient passive immunity to their lambs to protect them for the first 4 to 6 weeks postpartum. Lambs should receive a protective dose of antiserum at this age to protect them until market (Oxer et al., 1971; Jensen, 1974).

## POLIOENCEPHALOMALACIA

Polioencephalomalacia (PEM), first described in the United States by Jensen et al. (1956), and cerebrocortical necrosis (CCN), first described in England by Terlecki and Markson (1959, 1961), are now considered synonymous terms for the same disease (Loew, 1972; Edwin and Jackman, 1982). Polioencephalomalacia has since been reported in most areas of the world and affects both cattle and sheep (Loew, 1972; Edwin, 1975). Clinical signs include disorientation, dullness, aimless wandering, loss of appetite, circling, progressive blindness, extensor spasms, and occasionally head pressing (Loew, 1972; Edwin, 1975; Edwin and Jackman, 1982). Final diagnosis is dependent on histopathological examination (Loew, 1972; Edwin et al., 1979; Spicer and Horton, 1981).

Following the finding that thiamin therapy could be used with marked success (Davies et al., 1965), it was established that affected animals were indeed thiamin deficient (Pill, 1967; Edwin, 1970). Although the precise etiology of the disease is still not known, it is now accepted that the thiamin deficiency, probably associated with cofactors and antimetabolites, is initiated by rumen-produced thiaminases (Roberts and Boyde, 1974; Mueller and Asplund, 1981; Edwin and Jackman, 1982; Edwin et al., 1982). The disease has been reported in most ages and classes of sheep, but it occurs most often in feedlot lambs (Loew, 1972; Mueller and Asplund, 1981). Animals affected with PEM can be successfully treated with 200 to 500 mg of thiamin injected intravenously, intramuscularly, or subcutaneously (McKenzie and Steele, 1980; Chick et al., 1981; Spicer and Horton, 1981; Edwin and Jackman, 1982). Although response is often dramatic, if significant brain damage has occurred the recovered animals rarely regain satisfactory levels of productivity. Therefore, very early treatment is critical. The thiamin injection can also be used to protect sheep at risk—for example, the remainder of a group in which PEM has been diagnosed (McKenzie and Steele, 1980; Chick et al., 1981).

## PREGNANCY DISEASE

Pregnancy disease, also referred to as ketosis, aceto-nemia, and pregnancy toxemia, is associated with un-dernourishment and particularly with over-fat condition among ewes. It occurs in ewes in late pregnancy and usually is restricted to those carrying multiple fetuses. Stress factors such as shearing, transporting, severe weather exposure, and predator attacks, in addition to undernourishment, can precipitate outbreaks of the dis-ease.

Clinical features of the disease include high blood lev-els of ketone bodies and hypoglycemia. The affected an-imals appear depressed, lack appetite, have a staggering gait, separate from the flock, and exhibit nervousness (Reid, 1968). In the final stages of the disease (prior to death), vision is impaired and ewes are unable to rise or stand because of weakness, stiffness, or partial paralysis. Ewes that give birth during the early stages of the syn-drome usually recover.

During late pregnancy there are high glucose demands (about 1.5 times maintenance levels) placed on the ewe by the rapidly developing fetuses. With reduced rumen capacity due to increasing fetal size, feed intake is im-paired. The ewe mobilizes adipose tissue in an attempt to meet glucose needs, the liver produces less glucose, a metabolic acidosis develops, and ketone bodies accu-mulate in the blood. The disease is not related to lack of exercise. It can be prevented by ensuring adequate nutrient intake in late pregnancy so that increases in weight occur. A drench of 200 to 300 ml of propylene glycol or glycerol can be used when signs first appear, as an energy source for ewes refusing to eat sufficient feed.

## URINARY CALCULI

Urinary calculi (uroliths) are mineral deposits occur-ring in the urinary tract (Field, 1969). Although these deposits form in all breeds and sexes of sheep, blockage of the flow of urine generally only occurs in intact or castrated male sheep. The blockage may rupture the urinary bladder, resulting in a condition commonly called water belly, and cause death. Difficult or painful uri-nation as evidenced by straining, slow urination, stomp-ing of the feet, and kicking at the area of the penis are signs of calculi problems (Jensen, 1974).

Under feedlot conditions, this disease appears to have a nutritional or metabolic origin; affected animals excrete an alkaline urine that has a high phosphorus content (Crookshank, 1968; Jensen, 1974). Dietary intakes of cal-cium, phosphorus, magnesium, and potassium appear to play a major role in the incidence of calculosis in feedlot lambs, and an equation that uses intakes of these four minerals has been used to predict calculi formation in wethers (Lamprecht et al., 1969). The incidence of uri-nary calculi in growing-finishing lambs can be greatly reduced by preventing an excessive intake of phosphorus and by maintaining a calcium-to-phosphorus ratio greater than 2:1 (Emerick and Embry, 1963). Reducing the al-kalinity of the urine by feeding acid-forming salts is also effective (Crookshank, 1968, 1970). Ammonium chloride or ammonium sulfate added to the complete diet at 0.5 percent has been used successfully; ammonium chloride appears to be more effective than ammonium sulfate (Crookshank, 1970). Ammonium chloride has also been used to drench sheep at a level of 7 to 14 g per sheep per day for 3 to 5 days. Reasonable success has been achieved with this procedure so long as animals were still able to pass a small amount of urine. Injection with a smooth muscle relaxant is helpful in these cases.

In range sheep, the disease is associated with the con-sumption of forages having a high silica content (Emerick et al., 1959; Bailey, 1978). Sodium chloride, fed at a level of 4 percent or more of the total diet, helps prevent urinary calculi, especially in range animals. Sodium chlo-ride increases consumption of water and the amount of urine produced. It may be fed to range animals as a part of the protein supplement, provided adequate water is available.

Availability of a plentiful supply of clean water is im-portant in minimizing calculi problems under range and feedlot conditions.

# 5 Other Aspects of Sheep Nutrition

## PASTURES

Optimum utilization of pastures by sheep is very difficult to attain. As pasture forage matures, the protein content declines, fiber increases, and both forage intake and digestibility decline. The combination of internal parasites and the inability of young lambs to consume adequate dry matter invariably results in weight gains on pasture being 40 to 60 percent less than when lambs are grain-fed in drylot (Jordan and Marten, 1968a). Lambs 4 to 6 weeks old are particularly sensitive to heavy internal parasite infestation with which their dams normally infect the pasture. Pasture forage is best suited for maintenance of ewes who are significantly more tolerant of internal parasite infestation.

In some areas of the country, pastures are often underutilized and much forage is trampled and wasted. Limiting grazing time to a few hours a day or restricting grazing time to around 60 percent of normal (Jordan and Marten, 1968b) reduces selective grazing, reduces forage intake, increases pasture carrying capacity by 50 to 100 percent, and prolongs the period of available feed.

Legume forages rotationally grazed provide more nutrients over a longer growing period than nonlegume forages, although in some areas bloat precludes their use by sheep of any age. Where nonlegumes are the major forage they must be augmented with supplementary annual pastures.

Rape, a cool-season species, is an excellent summer and fall pasture for both ewes and lambs, resulting in an average daily gain of 0.20 to 0.25 kg. Forage peas have a low carrying capacity. Sudan grass or sudan-sorghum crosses produce high yield but result in very selective, spotty grazing and low lamb performance and are far better suited for mature sheep, in which maintenance rather than increases in weight is paramount (Wedin and Jordan, 1961).

Timothy, fescues, wheat grasses, and blue grass become unpalatable on reaching maturity in early summer. Orchard grass is less palatable than brome grass in midsummer but produces far more forage (Table 10). New varieties of low-alkaloid-containing canarygrass produce more digestible nutrients over a long grazing season than either orchard grass or brome grass and appear very promising (Marten et al., 1981).

## RANGE SHEEP

Range sheep do not differ physiologically from pen-raised sheep; however, the nutrient needs of the two types differ widely.

Type and composition of plants at any one location on pasture or range is dependent on type and composition of the parent soil, as well as moisture, radiant energy available for growth, and previous and present management of the area. Soils inherently low in a given element often will produce plants low in that element, and thus, deficiencies of the element may occur. Where high levels of specific elements exist in soil (plants may accumulate these elements), it is likely that if they are toxic to sheep, toxicities will be seen. Although maps of states or of the United States are available that describe areas of mineral deficiencies and toxicities, it is important to understand that local environmental and topographical factors can influence the occurrence of toxicities and deficiencies.

Typically, range land is evaluated based on its stage of ecological succession toward climax vegetation for a specific type of vegetative community. Although range land classification is used in allocating forage for game and livestock, classification or score may not accurately predict animal performance. Important considerations for range use and expected animal performance on range are distribution of water, topography, season of use, pres-

ence of poisonous plants, occurrence of predation, and system of grazing management.

Range sheep must frequently be supplemented with phosphorus, protein, and energy for optimum performance. For example, forage available to range sheep during gestation (late fall, winter, and early spring) is often at its lowest concentration of nutrients (Cook et al., 1954; Huston, 1983; Huston et al., 1981). Ranges classified as fair to poor are unlikely to provide adequate energy, protein, or phosphorus. Excellent to good ranges generally supply adequate energy (except when snow covered), but sheep may need supplemental protein and usually are lacking in phosphorus (Bryant et al., 1979).

It has been estimated that maintenance requirements for energy of grazing sheep are 60 to 70 percent greater than for comparable pen-fed sheep (Young and Corbett, 1972). The greater need for energy by grazing sheep results largely from the impact of environmental factors and an increased activity increment. The environmental factors are discussed elsewhere in this publication and by NRC (1981). The higher energy requirement due to an increased activity increment for grazing sheep results from the energy costs of grazing, horizontal movement, vertical movement, and other activities such as rumination time. As range changes from essentially flat to rolling, the change in energy needs for travel will change because the energy cost of vertical travel is approximately 10 times the energy cost for horizontal travel (6.86 cal/m/kg body weight versus 0.59 cal/m/kg body weight; Clapperton, 1964). Also, as density of grazable forage decreases or distance to water increases, energy needs to satisfy daily requirements increase.

Because it is difficult to measure feed intake and selectivity by range sheep, management must rely on knowledge of nutrient composition of range forages at various stages of growth and during various seasons of the year, as well as on the ability of the sheep to achieve adequate quantity and quality of forages. Ewe condition in relation to previous condition and projected desired condition and the sheep's general vigor and activity are the usual criteria used to assess adequate feed intake. Although proper nutritional management may indicate supplementation, it is at times physically impossible to get sufficient supplemental feed to sheep; under these conditions sheep must rely on body stores to sustain them through periods of shortages. To be economically successful the range sheep operator must manage sheep so they meet their nutrient needs largely from grazing rather than from supplements, grain, and hay.

*Formulating Supplements for Range Ewes*

In formulating supplements for range ewes it is necessary to assess the composition of the available diet and the condition, status, and stage of production of the ewe. A diet consisting largely of dead grass will require a different supplement composition than one consisting of sage and browse.

Alfalfa hay, which may contain a good source of energy, protein, and β-carotene, discourages grazing. Its use is more suitable when the range is snow covered and there is a need for increased DM intake as well as for energy and protein. The usual supplement is fed as cubes that provide in a concentrated form whatever nutrients are deficient in the range forage (Weir and Torell, 1967). This type of supplement will generally encourage grazing and enhance the utilization of the nutrients provided by the range feed. The usual amount fed per ewe per day is 0.1 to 0.2 kg to provide 30 to 50 percent of the protein requirements, 75 percent of the vitamin A and phosphorus requirements, and 20 to 30 percent of the energy requirements. To avoid consumption of poisonous plants when trailing sheep or when feed is snow covered, the amount of supplement fed daily may be increased 2 to 4 times.

The usual supplements include 30 to 40 percent protein equivalent, 1.5 to 2.0 percent phosphorus, 3.5 to 4.0 Mcal DE/kg, and 15 to 20 mg carotene/kg.

Although range ewes must be managed quite differently than intensively raised sheep, their physiological needs and responses to nutrients are no different from those of confined sheep. Range ewes respond to flushing, are equally susceptible to pregnancy disease, and lactate at levels dictated by nutrient intake. Thus, they should be managed so that either grazing or a combination of grazing and supplementation will meet their needs during those critical periods. Table 11 presents formulas for range supplements for different ranges and nutrient needs.

## FLUSHING

The practice of increasing nutrient intake or the dynamic effect that influences body weight (BW) change and condition prior to and during breeding is called flushing. Its purpose is to increase the rate of ovulation and, hence, the lambing rate. Although flushing is a husbandry practice used in major sheep-producing countries, the response to flushing is variable and an explanation for the response is not evident. A high level of hepatic steroid metabolizing enzymes (SME) is thought to be associated with an increased clearance rate of steroids, and a decrease in steroids is associated with an increase in gonadotropins and thus an increase in ovulation (Thomas et al., 1984). Increased intake of nutrients, particularly protein, effectively increases levels of hepatic SME. Phenobarbital is also an effective inducer of hepatic SME. Thomas et al. (1984) reported that 1 g phenobarbital daily

per ewe increased the ovulation rate 0.24 ova per ewe, whereas 0.45 kg grain per ewe per day had no effect.

Lambing rate, as affected by nutritional alteration prior to and during breeding (flushing), is influenced not only by the number of ova fertilized but by embryo survival, which affects the number of ewes lambing. The first month after fertilization is very critical to embryo survival. Robinson (1983) divides that period into two, a preimplantation period of 15 days and a 14-day embryo implantation phase. During the first 15 days after conception, a balance in the distribution of embryos between the two horns of the uterus is accomplished and the implantation process is initiated linking the rapidly developing trophoblast and the epithelial cells of the maternal caruncles (Boshier, 1969). Loss of fertilized ova during this preimplantation period results in a high incidence of repeat estrous cycles occurring at normal intervals or a lowered lambing rate. Unless the ewes are subjected to severe undernutrition at this time, nutrition is likely to be only a minor factor affecting embryo survival (except very high levels of energy intake have detrimental effects on embryo survival) (Robinson, 1977; Doney, 1979). Nutrition does exert some effect on the concentration of progesterone in maternal plasma (Parr et al., 1982), and progesterone does influence embryo growth during this preimplantation period (Lawson, 1977).

During the implantation period (14 to 28 days), nutritionally related deaths have a wider range of effects on pregnancy. These include a higher-than-normal number of ewes returning to estrus at more than 19 days after a fertile mating, a reduced lambing rate, and reduced lamb birth weights. The last effect is due to embryo death in the third and fourth weeks of pregnancy disturbing the balance in the distribution of the fetuses between the two uterine horns. This increases within-litter variability in fetal growth as a result of the surviving embryos' inability to utilize the vacated maternal cotyledons and also reduces the birth weight of the fetuses that do survive (Robinson, 1983). Extremes in nutrition are detrimental to embryo survival, suggesting that ewes should be kept at maintenance levels of nutrition during the first month of pregnancy.

Another aspect of conditioning ewes for breeding is referred to as static effects or ewe size embracing metabolic mass and condition. Exceptionally poor body condition or severe undernutrition during the immediate premating period, irrespective of condition, may delay onset of seasonal estrus, lengthen the estrous cycle, cause ovulation failure, or result in ovulation unaccompanied by estrus (Doney and Gunn, 1981). Foote and Mathews (1983) reported a very high correlation between body weight and body size (0.999), prolificacy (0.992), and weight of lambs born per ewe lambing (0.998). Correlations between ewe body weight and weaning rate and weight of lambs weaned were 0.336 and 0.672, respectively.

The response to flushing is affected by the age of the ewe (mature ewes show a greater response than yearlings), its breed, and the stage of the breeding season. Flushing during the seasonal peak in ovulation rate is less effective than during early or late in the breeding season. Ewes in fleshy condition during breeding have a significantly higher ovulation rate and greater follicle size but a lower embryonic survival rate (El-Sheikh et al., 1955). The lower embryonic survival rate is likely affected by and related to ovulation rate; that is, a higher ovulation rate would result in more ova subject to loss (Edey, 1969). Foote et al. (1959), however, found that maternal cotyledon weight increased when ewes were changed from full to limited feeding, probably to obtain a greater nutrient supply for the fetus from the mother, thereby protecting the fetus from a nutrient shortage imposed by the limited feeding. Ova loss is complicated by nutrition effects after mating and by interaction between pre- and postmating (Edey, 1976). Both severe undernourishment or overnourishment postmating may be associated with ova loss and may have more severe effects than a static intermediate level (Doney and Gunn, 1981).

The placenta generally attains 95 percent of its final weight during the first 90 days of gestation, whereas the fetus attains about 15 percent of its weight in 90 days (Russell, 1979). Thus, nutrition level during early gestation may have its greatest effect on maintenance of the integrity of fetal membranes, which in turn affect the retention of the fetus. Grain feeding and increased ewe weight also resulted in higher plasma glucose levels and greater adrenal and pituitary weight (Bellows et al., 1963; Howland et al., 1966; Memon et al., 1969) and consequently greater total follicle stimulating hormone and luteinizing hormone potency. Larger ewes, irrespective of fatness, had larger pituitaries and greater follicular fluid weight. Virtually all prenatal deaths occur within the first 25 days after breeding (Foote et al., 1959), and the integrity of the cotyledons and placental membranes are logically a contributing factor.

Doney (1979) suggests that the efficiency of reproduction depends on the average nutrient intake level over the year as well as on the actual level at different stages in the annual cycle. Ovulation rate is affected by factors operating up to the time of mating or during the recovery period between lactation and breeding, whereas ova loss or prenatal mortality is affected by nutrition during recovery and also during pregnancy. Thus, both the static (during the recovery period) and dynamic (flushing) aspects of nutrition influence lambing rate (Coop, 1966).

Changing nutrient intake from a high prebreeding level to a low postbreeding level appears to contribute more

to prenatal mortality than if the ewes are maintained at a low level throughout the whole period. This suggests that extremes are to be avoided and that body condition throughout the year is as critical as during a short flushing period.

Flushing is usually accomplished by providing ewes with fresh pasture, supplemental harvested forage, or up to 0.50 kg of grain per ewe daily, depending on environmental stress, availability of forage, and body condition. This level of nutrient intake should approach the energy and protein levels normally provided during late gestation. Special feeding usually begins around 2 weeks prior to mating and continues 2 to 4 weeks into the breeding season. The practice is especially beneficial for thin ewes that have not recovered from previous lactation stress. It should not continue too long, because an extended period of high feeding is unnecessarily costly, and overconditioning during pregnancy should be avoided. Drastic or severe decreases in the plane of nutrition should be avoided.

## CREEP FEEDING

The practice of providing supplemental feed to nursing lambs in an area that cannot be entered by their dams is called creep feeding. Lambs usually commence creep feeding around 10 to 14 days of age, and the amount consumed is inversely proportional to the amount of milk consumed.

Inadequate energy intake by suckling lambs is the major cause of slow weight gains. Greater efficiency and lamb weight gains occur if lambs are creep fed than if only the ewes are grain fed. Jordan and Gates (1961) fed hay to ewes but did not creep feed lambs, for a lamb ADG of 0.15 kg; fed hay plus grain to ewes but did not creep feed lambs, for a lamb ADG of 0.20 kg; gave hay to ewes and did creep feed lambs, for a lamb ADG of 0.30 kg; and gave hay plus grain to ewes and did creep feed lambs, for a lamb ADG of 0.33 kg. Creep feed consumption by the lambs approximated the amount of corn fed the ewes.

The amount of creep feed consumed by lambs 2 to 6 weeks of age is affected by the palatability of the ration (ration composition and ration form) and the location and environment of the creep area. A well-bedded, well-lighted area located close to where ewes congregate is preferred. Low milk yield tends to encourage creep consumption, but lamb size as affected by birth weight and milk consumption has a significant effect on daily creep feed consumption. Initially, lambs prefer ground creep rations to pelleted rations. After 4 or 5 weeks of age, lambs show a preference for pelleted rations, and after 5 to 6 weeks, lambs should be fed unground grains.

Ørskov (1983) reported that ground, pelleted barley, corn, wheat, or oats versus whole grains did not affect weight gains or feed-conversion efficiency but did lower rumen pH approximately 1 point and increased the proportion of propionic acid to acetic acid to a level that exceeds the metabolic capacity of the liver, giving rise to odd- and branched-chain fatty acids resulting in soft fat and reduced carcass quality. Unprocessed grain alleviates these problems.

The deterrent to feeding whole grains is the separating out of various supplements that are usually finely ground. Pelleting only the supplement alleviates this problem.

Soybean meal is an important ingredient in creep diets because of its high protein content and palatability. Bran is well liked by lambs, as are most sweet feeds. Oats, while consumed readily, are less well liked than corn as the lambs get older. Acceptability of ground feed may be increased slightly by adding 2 to 5 percent molasses.

Typical creep diets are suggested in Table 12, but other formulations may perform equally well. For rapid weight gains, creep diets must be palatable and high in energy and must contain adequate protein (12 to 14 percent), minerals (especially calcium, since grains are low in calcium), and vitamins.

The most important physiological factor determining successful early weaning and ability to utilize solid food is the state of rumen development (Ørskov, 1983). Rumen development is stimulated by the intake of solid feed, which, on fermentation, yields volatile fatty acids. Lambs suckling heavy-milking dams are less inclined to eat solid feed. Restricting protein intake of the ewe reduces milk flow and thus encourages creep feed intake (Robinson et al., 1974).

To achieve satisfactory performance and encourage rumen growth, lambs should receive a diet that ferments rapidly and does not lead to an accumulation of indigestible fibrous material within the rumen. Corn satisfies both requirements, whereas oats are high in indigestible hulls and result in pot-bellied lambs (Ørskov, 1975). High-quality legumes degrade rapidly in the rumen and also stimulate rumen growth. Unless the transition from a stage of high milk-low creep feed intake to low milk-high creep feed intake is completed prior to weaning at 4 to 6 weeks, a check in growth will occur and lambs will not gain for 7 to 10 days (Ørskov, 1982; Frederiksen et al., 1980). Thus, the level of solid food intake is a better guide to weaning than lamb weight, since lambs suckling heavy-milking dams may meet the weight criteria but, because they have consumed little solid feed, may have less-developed rumens (Ørskov, 1983).

## EARLY WEANING

Lactating ewes normally reach their peak in milk production around 3 to 4 weeks postpartum and produce 75

percent of their total milk yield during the first 8 weeks of lactation. While milk production during early lactation can be stimulated through proper selection of feeds, after 6 to 8 weeks milk production declines markedly and high nutrient intake fails to stimulate production (Jordan and Hanke, 1977).

Early weaning as used in this report refers to the practice of weaning lambs at 6 to 8 weeks of age. There is considerable interest in early weaning because of possible early marketing of lambs, out-of-season lambing, multiple lamb crops per year, and use of prolific breeds. Early weaning can be cost-effective because it enables higher and more-efficient gains while the lambs are young and also reduces ewe cost because the ewes can be maintained on a limited feed allowance for longer periods of time between parturitions.

Lambs to be early weaned should receive creep feed from the time they are old enough to eat solid feed (7 to 14 days of age). At weaning, stress on the lambs should be minimized by removing the ewes and leaving the lambs in familiar surroundings. The postweaning ration should be a high-concentrate ration with a minimum of 16 percent crude protein, 0.6 percent calcium, and 0.30 percent phosphorus.

Since their source of protein from milk has been removed, the level of protein in the dry diet of a 6- to 8-week-old weaned lamb should actually be higher than that for a 3- to 5-week-old suckling lamb (Jordan and Hanke, 1970) and certainly higher than for older lambs.

## ARTIFICIAL REARING

The practice of removing lambs from their dams when they are 8 to 24 hours old and rearing them on milk replacer for 3 to 4 weeks is referred to as artificial rearing. Although milk replacers are expensive, artificial rearing is feasible in such cases as orphan lambs and ewes with insufficient milk supply because of mastitis and in cases of more prolific breeds that give birth to litters larger than can be adequately suckled (Frederiksen et al., 1980; Gorrill et al., 1982).

Lambs intended for artificial rearing should be allowed to obtain their mother's colostrum for a minimum of 8 hours after birth before being weaned. Frozen colostrum, warmed to body temperature and bottle fed, is an adequate alternative. At least 50 ml of colostrum per kilogram of lamb weight is necessary to provide an effective level of disease resistance (Frederiksen et al., 1980; Gorrill et al., 1982). Although frozen ewe colostrum is preferred, research has shown that frozen cow colostrum also provides adequate antibodies for rearing lambs (Larsen et al., 1974; Logan et al., 1978; Franken and Elving, 1982).

Maximum performance during artificial rearing is ob-

tained by feeding specially formulated lamb milk replacers containing at least 24 percent fat and 24 percent protein, with all of the protein provided by spray-dried milk products (Heaney et al., 1982a; Gorrill et al., 1982). Similar milk replacers in which part of the skim milk powder is replaced by casein and whey or cerelose are also being used successfully, but with this type of milk replacer it is recommended that lactose content be limited to 30 to 35 percent (Glimp, 1972; Frederiksen et al., 1980).

Lambs can also be successfully reared with a high-quality milk replacer designed for calves that contains at least 20 percent fat and 20 percent protein. It is very important that only a high-quality calf milk replacer with all the protein provided by skim milk powder be used. It is unlikely that lambs could adequately utilize lower-quality ingredients at the reduced protein level. Gains on calf milk replacer are around 90 percent of gains reported with lamb milk replacer. Nevertheless, such a system could be economical because the lower cost of calf milk replacer could offset the marginal reduction in performance (Heaney et al., 1982b).

During a 3- to 4-week artificial rearing program, a lamb will consume an average of 400 to 500 g of dry milk replacer per day when 1 part milk replacer is mixed with 4 to 5 parts water. Lambs should be fed the milk replacer ad libitum at 2° to 4°C to minimize digestive disturbances, particularly abomasal bloat (Large and Penning, 1967; Peters and Heaney, 1974; Frederiksen et al., 1980; Gorrill et al., 1982).

Lambs should be provided constant access to fresh water and high-quality, palatable solid feed to accustom them to eating dry feed and to minimize weight losses during the transition from a liquid to a solid feed diet at around 3 to 4 weeks. Weight gains should approximate 0.25 to 0.30 kg (0.55 to 0.66 lb) per lamb daily during the period that milk replacer is fed.

Because milk replacer is expensive, the liquid-feeding period should be as short as possible. Lambs can be successfully weaned from milk replacer at 3 weeks of age, although a growth check will occur in which the lambs lose some weight the first week before resuming normal gains (Heaney et al., 1982a,b, 1984). The growth check is primarily a reflection of reduced nutrient intake (Frederiksen et al., 1980). Delaying weaning to 4 weeks of age reduces the growth check and results in lamb weights approximately 1 kg (2.2 lb) heavier at 70 days of age. The extra weight is not sufficient, however, to offset the extra costs of the 3.0 to 3.5 kg of milk replacer required for the extra week of feeding (Heaney et al., 1984).

The postweaning diet should be high energy and should contain 18 to 20 percent protein (as-fed basis) for the first 3 weeks and then 14 to 17 percent protein thereafter. It is doubtful whether higher levels of protein will result

in sufficiently better lamb performance to justify the cost (Meat and Livestock Commission, 1976; Frederiksen et al., 1980; Gorrill et al., 1982; Heaney et al., 1983).

## FEED ADDITIVES

Antibiotics may improve performance when added to creep diets and growing-finishing diets for lambs (Ott, 1968). Responses to antibiotics seem to be markedly affected by differences in management and in the amount of stress to which animals are subjected (Hays, 1969). At present only chlortetracycline and oxytetracycline are approved by the Food and Drug Administration for nutritional uses in sheep diets (Anonymous, 1984a). Chlortetracycline can be used at levels varying from 22 to 55 mg/kg of feed to promote growth and improve feed efficiency. Oxytetracycline is approved for use at levels of 11 to 22 mg/kg of feed for the same purpose. The polyether antibiotic, lasalocid, which was recently approved for prevention of coccidiosis in sheep held in confinement (Anonymous, 1984b), has also been shown to improve rate of gain and feed efficiency in lambs (Foreyt et al., 1979; Horton and Stockdale, 1981). Lasalocid is approved for use at levels of 22 to 33 mg/kg of the total diet.

There is some evidence that antibiotics help reduce the incidence of enterotoxemia (Ott, 1968). Chlortetracycline can be used at a level of 22 mg/kg of feed for this purpose, and oxytetracycline can be used at a level of 25 mg per lamb per day. In addition to the above, a number of feed additives are approved for treatment of specific sheep diseases. Information for the approved usage of these antibiotics can be obtained by consulting the Feed Additive Compendium (Anonymous, 1984a).

## POISONOUS PLANTS

Many poisonous plants grow on pastures and range areas in the United States (Kingsbury, 1964; Sperry et al., 1964; James et al., 1980). In some areas, such as the western states, poisonous plants are a major cause of economic loss to the sheep industry (Dwyer, 1978; Schuster, 1978). Most losses occur when desirable forage is scarce and poisonous plants are abundant (Binns, 1974). Losses result from death, abortions, photosensitization, decreased production, emaciation, and birth defects (James et al., 1980). Since there are no known specific treatments for animals poisoned by most poisonous plants, proper management of pastures and animals is the best approach to preventing losses (Merrill and Schuster, 1978). The best protection against poisonous plant problems is to become familiar with the poisonous plants that grow in pastures and learn under what conditions these plants

are dangerous to sheep. Sheep that have been under stress or that are overly hungry or thirsty should not be permitted to graze in areas infested with poisonous plants. Sheep introduced into a new area that contains poisonous plants with which they may not be familiar should be watched closely. Salt and supplemental feed should be provided to grazing animals as needed. Control of poisonous plants (spraying, grazing management, hand pulling) or of animal access to areas containing poisonous plants (fencing, pasture rotation) should be practiced where feasible. Effective treatment of poisoned sheep requires identification of the specific plant causing the problem, removal of sheep to a feed source free of the poisonous plant, and administration of an antidote if one is available. In cases where a specific treatment is unknown, the only course of action is to treat the signs.

## RATION ALTERNATIVES

Although the daily nutrient requirements for ewes presented in Table 1 are specific, the sources of nutrients available to meet these requirements are many. Confinement feeding of diets low in energy to ewes on slotted floors at high density levels and often with inadequate feed bunk space makes it difficult to provide adequate nutrient intake to all sheep and to deal with the accumulation of refused feed under the slotted floor. Alternatives to the typical high-forage diets and various management approaches are available to circumvent these problems and to minimize labor and facility costs.

For example, feeding several groups of ewes at different times with one common feed bunk eliminates the problems of inadequate bunk space. Feeding gestating ewes on alternate days or 3 times weekly accommodates feeding groups of ewes at different times. Ewes fed three times weekly the same amount of feed per week were equal in weight gains and in lamb and wool production to ewes fed daily (Jordan and Hanke, 1963; Jordan, 1966).

Another ration alternative is to feed ewes higher-than-normal grain rations. The digestible energy (DE) values used for forages are overvalued in relation to the DE in grain, and since grains are often a lower-cost source of energy than hay, high-grain rations may offer advantages for intensively managed sheep. Gestating ewes fed rations consisting of equal parts of hay and corn (69 percent total digestible nutrients) in amounts equal to one-half the weight of an all-hay ration showed weight gains and lamb and wool production equal to ewes fed the all-hay diet (Jordan, 1966). However, dry matter or bulk is lacking, which results in wool picking. A more reasonable approach is to feed 3 parts of hay and 1 part of corn at 75 percent of an all-hay ration. This is more apt to provide

adequate bulk, protein, and minerals and still reduce feeding costs.

It normally takes ewes 3 to 4 hours to eat enough long hay to meet their nutrient requirements, but when fed a 40 percent corn-60 percent hay ration, they can consume enough feed to meet their requirements in 20 to 30 minutes. The reduced time for feeding is particularly advantageous when feeding three or four different groups of ewes per day with one common feed bunk. To prevent esophageal choke, the corn should be mixed with the hay (or spread on top of long hay) to prevent too-rapid consumption. Also, hay must be of good quality with 15 to 18 percent protein so that protein and calcium deficiencies do not develop.

The composition of two important sheep feedstuffs, corn silage and haylage, are on a DM basis, but these feedstuffs contain 40 to 70 percent moisture on an as-fed basis. To compare the "as-fed" nutrient content of silage or haylage with the values presented in Table 13, multiply those values by the DM content in the silage or haylage being fed. Corn silage with 70 percent TDN, on a DM basis, × 35 percent DM contains 24.5 percent TDN on an as-fed basis. Haylage with 56 percent TDN, on a DM basis, × 50 percent DM contains 28 percent TDN on an as-fed basis.

There are numerous feedstuffs that can be used as ration alternatives to the conventional legume hay-grain feedstuffs generally used by producers. These include many grain, vegetable, fruit, and food industry by-products as well as damaged grains and roughages. The major consideration in using alternative feedstuffs is their cost relative to more conventional feeds. Frequent use of alternative feedstuffs requires careful attention to correcting whatever nutrient deficiencies may exist.

# 6 Formulating Diets for Sheep

Sheep should be fed an economical, nutritionally adequate diet. This is accomplished by combining the information given in Tables 1 and 2 on the nutritional requirements of sheep with the information in Tables 13 and 14 on the nutrients provided by various feedstuffs. The weight category is based on normal weight. If a ewe normally weighs 60 kg and gains 10 kg during early gestation, the weight category to use for late gestation in determining nutritional requirements is 60 kg, not 70 kg.

Rations can be formulated on the basis of (1) providing a complete diet containing the recommended composition shown in Table 2, which, when fed at recommended levels, will provide the daily requirements recommended in Table 1 or (2) providing the specific amount of nutrients per sheep daily as presented in Table 1.

Sheep rations usually are formulated by first selecting a major feed energy source, such as hay or silage. Next, determine what nutrients the source provides and compare these values with the requirements in Table 1 or 2. Finally, determine the composition and amount of supplement that must be fed with the hay or silage to compensate for nutrient shortages.

In the following examples rations will be formulated for a 60-kg ewe suckling twin lambs during the first 8 weeks lactation. Oat hay, barley, and soybean meal are the available feeds.

## Complete diet formulation

Write down the recommended nutrient composition of the diet (from Table 2) and the nutrient content of the feeds (from Table A). In this example, feeds used were analyzed by a commercial laboratory; if analyzed values are not available, use average values from Table 13.

TABLE A  Recommended Nutrient Concentration in Diets for 60-kg Ewes, First 6 to 8 Weeks Lactation Suckling Twins, and Nutrient Content of Feeds, Both on DM Basis

| Item | DE (Mcal/kg) | Crude protein (%) | Ca (%) | P (%) | Carotene (mg/kg) | Vitamin A (IU/kg) |
|---|---|---|---|---|---|---|
| **Diet** | | | | | | |
| concentration | 2.9 | 15.0 | 0.39 | 0.29 | — | 2,500 |
| Oat hay | 2.38 | 9.2 | 0.26 | 0.24 | 101.0 | |
| Barley | 3.79 | 13.0 | 0.09 | 0.47 | — | |
| Soybean meal | 3.53 | 51.5 | 0.36 | 0.75 | — | |

## Procedure

1. Compare the composition of oat hay with the ewe's requirements. The oat hay is inadequate in all nutrients except carotene (5 mg of carotene would supply the vitamin A requirement; see the section on Vitamin A on pp. 22).

2. Determine the substitution value of barley for oat hay: 3.79 Mcal DE (barley) − 2.38 Mcal DE (hay) = 1.41 Mcal DE/kg. The DE deficiency in an oat hay diet is 2.90 Mcal (required) − 2.38 Mcal (hay) = 0.52 Mcal DE. Determine the percent barley to substitute for part of the hay to provide the 0.52 Mcal DE/kg deficiency (0.52 Mcal ÷ 1.41 Mcal = 0.37). The diet at this stage becomes 37 percent barley and 63 percent oat hay.

3. Compare this combination of oat hay and barley with the dietary requirements for DM, DE, and protein (Table B).

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**TABLE B** Comparison of Dietary Requirements with Amount of Nutrients Provided in Hay-Barley Diet

| Item | DM (% of diet) | DE (Mcal) | Protein (%) |
|---|---|---|---|
| Dietary requirement | 100.0 | 2.9 | 15.0 |
| Oat hay | 63.0 | 1.5[a] | 5.8[a] |
| Barley | 37.0 | 1.4 | 4.8 |
| Total | 100.0 | 2.9 | 10.6 |
| Difference | — | — | −4.4 |

[a]Values obtained by multiplying energy or protein content in feeds by percent of feeds in diet.

The diet is now adequate in digestible energy but is 4.4 percent deficient in protein.

4. Substitute soybean meal for barley to provide for the protein deficiency. Determine the difference in crude protein content of the two feeds: 51.5 percent (soybean meal) − 13.0 percent (barley) = 38.5 percent protein. Divide the amount of protein that is deficient (4.4 percent) by the amount provided when soybean meal is substituted for a unit of barley: 4.4 percent divided by 38.5 percent = 0.114, or 11.4 percent of the entire ration will be soybean meal. The diet becomes (Table C):

**TABLE C** Comparison of Dietary Requirements with Energy and Protein Provided by the Oat Hay-Barley-Soybean Meal Diet

| Item | DM (%) | DE (Mcal) | Protein (%) |
|---|---|---|---|
| Requirement | 100.0 | 2.9 | 15.0 |
| Oat hay | 63.0 | 1.5 | 5.8 |
| Barley | 25.6 | 1.0 | 3.3 |
| Soybean meal | 11.4 | 0.4 | 5.9 |
| Total | 100.0 | 2.9 | 15.0 |

The diet is now adequate in both digestible energy and protein.

The Pearson square method may also be used for determining the amount of soybean meal to add to the barley. The hay contains 9.2 percent protein (see Table A) but constitutes only 63.0 percent of the ration (see Table C). Thus, the hay provides 5.8 percent (9.2 percent × 0.63) protein to the total ration. The dietary requirement of 15.0 percent protein (see Table C) − 5.8 percent protein from hay = 9.2 percent protein that must be provided in the 37.0 percent barley-soybean meal part of the ration. Thus, 9.2 percent ÷ 37.0 percent of the ration = 24.9 percent protein required in the barley-soybean meal mixture. The next step is to determine the parts of barley and soybean meal needed in the ration to provide the 24.9 percent protein requirement.
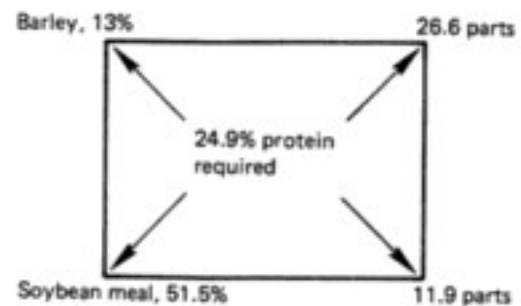


The parts of barley needed in the barley-soybean mixture can be calculated by subtracting diagonally the percent protein required (24.9) from the percent protein in the soybean meal (51.5), which equals 26.6 parts barley. The same method gives 11.9 parts soybean meal required. Then, 26.6 parts barley ÷ 38.5 total parts equals 69.1 percent barley required in the mixture; 11.9 parts soybean meal ÷ 38.5 total parts equals 30.9 percent soybean meal:

| | Parts | Percent |
|---|---|---|
| Barley | 26.6 | 69.1 |
| Soybean meal | 11.9 | 30.9 |
| Total | 38.5 | 100.0 |

If there is 30.9 percent soybean meal in the 37 percent portion of the ration that is provided by the barley-soybean meal mix, then in the entire hay-barley-soybean meal diet there is 0.37 × 30.9 = 0.114 = 11.4 percent soybean meal.

5. Write down the calcium and phosphorus requirements and compare these with the amounts provided by the hay-barley-soybean meal diet (Table D).

**TABLE D** Comparison of Dietary Requirements with Calcium and Phosphorus Provided by the Oat Hay-Barley-Soybean Meal Diet

| Item | DM (%) | Calcium (%) | Phosphorus (%) |
|---|---|---|---|
| Requirement | 100.0 | 0.39 | 0.29 |
| Oat hay | 63.0 | 0.16 | 0.15 |
| Barley | 25.6 | 0.02 | 0.12 |
| Soybean meal | 11.4 | 0.04 | 0.08 |
| Total | 100.0 | 0.22 | 0.35 |
| Difference | — | −0.17 | +0.06 |

The diet is adequate in phosphorus but is 0.17 percent deficient in calcium. Limestone is a rich (34 percent) and inexpensive source of calcium (Table 14). Dividing the 0.17 percent deficiency by the 34 percent calcium in limestone gives 0.5 parts limestone that should be added to the diet.

The final diet now becomes as shown in Table E (parts, DM basis). When fed at the levels recommended in Table 1, it will satisfy the daily requirements for this category of sheep.

TABLE E   Complete Diet for 60-kg Ewes, First 6 to 8 Weeks Lactation Suckling Twins

| Ingredient | DM (%) | Parts in Diet DM[a] | Air Dry or As-Fed Basis Parts[b] | Percent[c] |
|---|---|---|---|---|
| Oat hay | 88.2 | 63.0 | 71.4 | 62.9 |
| Barley | 89.0 | 25.6 | 28.8 | 25.4 |
| Soybean meal | 89.0 | 11.4 | 12.8 | 11.3 |
| Limestone | 100.0 | 0.5 | 0.5 | 0.4 |
| Total | | | 113.5 | 100.0 |

[a]As determined in above steps.
[b]Calculated as 63.0/0.882 = 71.4.
[c]Calculated as 71.4/1.135 = 62.9.

Up to this point, all calculations have been made on a DM basis; however, few feeds are 100 percent dry matter. To convert the portions of feeds on a DM basis to an as-fed basis (Table E), divide the contribution of the feed in question by the percent of dry matter it contains (oat hay: 63 parts of the diet DM ÷ 88.2 percent dry matter = 71.4 parts, air dry). To convert the various component parts of the diet back to percentage values, divide the number of parts for each of the ration components by the total number of parts (oat hay: 71.4 parts air dry ÷ 113.5 total parts = 62.9 percent on an as-fed basis). Dry matter intake is converted to an as-fed basis by dividing the daily feed intake given in Table 1 (2.6 kg) by 0.89 (approximate DM in the total ration) = 2.92 kg (6.4 lb) of the complete diet per day. If the feeds were hand fed separately to the ewes, 62.9 percent or 1.84 kg (0.629 × 2.92) of the as-fed diet would be oat hay and 1.08 kg (2.92 − 1.84 kg) of the diet would consist of barley, soybean meal, and limestone.

The total air dry part of the barley-soybean meal-limestone portion of the diet is 42.1. Each feed part is divided by this value and multiplied by 100 to obtain the percent it contributes. The composition of this mixture becomes 68.4 percent barley, 30.4 percent soybean meal, and 1.2 percent limestone on an air dry basis.

Formulation to provide specific amounts of nutrients (same category of ewe and same feeds)

1. Write down the ewe's daily requirement (from Table 1) and the nutrient composition of the three feed ingredients (Table F). (Dry matter per se is not a nutrient, but it is an important indication of the amount of feed the ewe can and should consume.)

2. Determine the amount of energy that the designated DM intake of the major feed ingredient (oat hay) provides (2.6 kg DM × 2.38 Mcal DE/kg of hay = 6.19 Mcal DE). The ewe requires 7.4 Mcal DE and the oat hay provides 6.19 Mcal; thus, the diet is deficient by 1.21 Mcal DE.

TABLE F   Daily Nutrient Requirements and Feed Composition for 60-kg Ewes, First 6 to 8 Weeks Lactation Suckling Twins

| Item | DM (kg) | DE (Mcal) | Crude protein (kg) | Ca (g) | P (g) | Carotene (mg/kg feed) | Vitamin A (IU) |
|---|---|---|---|---|---|---|---|
| | | | *Daily Requirements* | | | | |
| | 2.6 | 7.4 | 0.405 | 10.7 | 7.7 | | 6,000 |
| | | | *Feed composition, dry matter basis* | | | | |
| Oat hay | 88.2% | 2.38 | 9.2% | 0.26% | 0.24% | 101.0 | |
| Barley | 89.0% | 3.79 | 13.0% | 0.09% | 0.47% | — | |
| Soybean meal | 89.0% | 3.53 | 51.5% | 0.36% | 0.75% | — | |

3. Assume that 2.6 kg of dry matter is the maximum amount a 60-kg ewe can consume in a day. The shortage of digestible energy in the oat hay is provided by substituting barley for oat hay: 3.79 Mcal DE/kg (barley) − 2.38 Mcal DE/kg (hay) = 1.41 Mcal DE. Divide the 1.21 Mcal DE in which the hay is deficient (step 2) by the 1.41 Mcal of additional DE that one unit of barley provides to determine the amount of barley required in addition to hay (1.21 ÷ 1.41 = 0.86 kg of barley). Thus, the 2.6-kg ration of dry matter should comprise 0.86 kg of barley DM + 1.74 kg (i.e., 2.6 − 0.86 kg) of hay.

4. Determine whether the hay-barley ration provides sufficient protein (1.74 kg of hay DM × 9.2 percent protein [from Table A] = 0.160 kg of protein from hay; 0.86 kg barley DM × 13.0 percent = 0.112 kg protein from barley; total protein from the hay − barley ration is 0.272 kg). Thus, 0.405 kg required − 0.272 kg provided by the hay-barley ration gives a 0.133-kg protein deficiency in the hay-barley ration.

5. To determine the amount of soybean meal to substitute for barley to provide the required amount of protein, calculate the difference in the protein content of soybean meal and that of barley from Table F (0.515 − 0.13 = 0.385 percent). To compensate for the 0.133 kg protein lacking in the hay-barley ration, divide 0.133 by 0.385 = 0.345 kg DM from soybean meal. The ewe's ration becomes 1.74 kg DM from hay, 0.51 kg DM from barley, and 0.35 kg DM from soybean meal. The amount of soybean meal needed to substitute for part of the barley may also be determined by the Pearson square method.

6. The calcium provided by the hay (1.74 kg × 0.26 percent = 4.5 g), barley (0.51 kg × 0.09 percent = 0.5 g), and soybean meal (0.35 kg × 0.36 percent = 1.3 g) adds up to 6.3 g, leaving a deficiency of 4.4 g (10.7 − 6.3). To determine the amount of limestone to add to compensate for the calcium deficiency, divide 4.4 by 0.34 (calcium content of limestone) = 13 g or 0.013 kg. A similar comparison for phosphorus shows the diet to be adequate in this mineral. Therefore, the daily diet per ewe on a DM basis becomes 1.74 kg oat hay, 0.51 kg barley, 0.35 kg soybean meal, and 0.01 kg limestone.

To convert to an as-fed basis, divide each amount of dry matter by the percent dry matter in that feed. On an as-fed basis the daily diet per ewe is 1.97 kg oat hay, 0.57 kg barley, 0.39 kg soybean meal, and 0.01 kg lime-stone.

These are only two methods of formulating diets. Other methods include the use of simultaneous equations to algebraically arrive at a solution and the use of computers to solve more complex sets of equations. The procedures discussed in this section do not include all nutrients or effects of feed palatability, economics, and other factors that nutritionists and feed producers should consider.

# 7 Composition of Feeds

Tables 13 and 14 present the composition of certain sheep feeds and the composition of mineral supplements, respectively. In both tables, data are expressed on an as-fed and dry basis.

## INTERNATIONAL NOMENCLATURE

In Tables 13 and 14 and in the *United States-Canadian Tables of Feed Composition* (NRC, 1982), which lists approximately 400 feeds, names of the feeds are based on a scheme proposed by Harris et al. (1980, 1981). The names are designed to give a qualitative description of each product where such information is available and pertinent. A complete name consists of as many as six facets, separated by commas and written in linear form. The facets are

    1. Origin, consisting of scientific name (genus, species, variety) and common name (generic name, breed or kind, strain or chemical formula)
    2. Part fed to animals as affected by process(es)
    3. Process(es) and treatment(s) to which the part has been subjected
    4. Stage of maturity or development of feed
    5. Cutting (applicable to forages)
    6. Grade (official grades with guarantees)

## INTERNATIONAL FEED CLASSES

Feeds are grouped into eight classes:

    1. Dry forages and roughages
    2. Pasture, range plants, and forages fed fresh
    3. Silages
    4. Energy feeds
    5. Protein supplements
    6. Mineral supplements
    7. Vitamin supplements
    8. Additives

Feeds with more than 18 percent crude fiber or 35 percent cell wall (DM basis) are classified as forages or roughages; feeds with less than 20 percent protein and less than 18 percent crude fiber or less than 35 percent cell wall are classified as energy feeds; and those with 20 percent or more protein are considered protein supplements.

The feed class number precedes the international feed number in Tables 13 and 14.

## INTERNATIONAL FEED NUMBER

Each international feed name is assigned a 5-digit international feed number (IFN) for identification and computer manipulation. The IFN is particularly useful as a tag to recall nutrient data for calculation of diets (Harris, 1963; Harris et al., 1968).

The following table shows how three feeds are described.

Descriptions of Three Feeds, Including Classification and IFN

| Components of Name | Feed No. 1 | Feed No. 2 | Feed No. 3 |
|---|---|---|---|
| Origin (or parent material) | Clover | Cotton | Wheat |
| Species, variety or kind | Red | — | — |
| Part eaten | Hay (foliage) | Seeds | Flour by-product |
| Process(es) and treatment(s) to which product has been subjected | Sun-cured | Meal mechanical extraced | — |
| Stage of maturity[a] | Early bloom | — | — |

Descriptions of Three Feeds, Including Classification and IFN—
*Continued*

| Components of Name | Feed No. 1 | Feed No. 2 | Feed No. 3 |
|---|---|---|---|
| Grade or quality designation | — | 41% Protein | < 4% Fiber (wheat) (red dog) |
| Classification (first digit in IFN) | Dry Forages and roughages | Protein supplements | Energy feeds |
| IFN | 1-01-400 | 5-01-617 | 4-05-203 |

*See Table 15 for definitions of stages of maturity.

Thus, the names of the three feeds are written as follows:

Feed No. 1: Clover, red, hay, sun-cured, early bloom.

Feed No. 2: Cotton, seeds, meal mechanical extracted, 41 percent protein.

Feed No. 3: Wheat, flour by-product, less than 4 percent fiber (wheat, red dog).

## DATA

The analytical data in Tables 13 and 14 are expressed in the metric system and are shown on an as-fed and dry basis. See Tables 16 and 17 for weight unit conversion factors and weight equivalents, respectively.

Analytical data may differ in the various NRC reports because the data are updated for each report. The feed names may also differ as feeds are more precisely described or as official definitions change. If the feed is the same, however, the International Feed Number will remain the same.

## ENERGY VALUES OF FEEDS

*Total digestible nutrients.* Total digestible nutrients (TDN) were calculated from

(1) Average TDN *or*

(2) From digestion coefficients such as

| | |
|---|---|
| digestible protein (%) | × 1 |
| digestible crude fiber (%) | × 1 |
| digestible nitrogen free extract (%) | × 1 |
| digestible ether extract (%) | × 2.25 |
| TDN (%) | Total *or* |

(3) From regression equations of Harris et al. (1972).

*Digestible energy.* Digestible energy was calculated with the formula of Crampton et al. (1957) and Swift (1957):

DE (Mcal/kg DM) = % TDN for sheep × 0.04409

*Metabolizable energy.* ME was calculated from DE by the following formula:

ME (Mcal/kg DM) = 0.82 × DE (Mcal/kg DM)

*Digestible protein.* Digestible protein was calculated as follows:

(1) $$\text{Digestible protein} = \frac{\% \text{ protein} \times \text{protein digestion coefficient}}{100} \text{ or}$$

(2) By equations of Knight and Harris (1966).

# Tables

TABLE 1 Daily Nutrient Requirements of Sheep

| Body Weight (kg) | (lb) | Weight Change/Day (g) | (lb) | Dry Matter per Animal[b] (kg) | (lb) | (% body weight) | Energy[b] TDN (kg) | (lb) | DE (Mcal) | ME (Mcal) | Crude protein (g) | (lb) | Ca (g) | P (g) | Vitamin A Activity (IU) | Vitamin E Activity (IU) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ewes[c]** | | | | | | | | | | | | | | | | |
| **Maintenance** | | | | | | | | | | | | | | | | |
| 50 | 110 | 10 | 0.02 | 1.0 | 2.2 | 2.0 | 0.55 | 1.2 | 2.4 | 2.0 | 95 | 0.21 | 2.0 | 1.8 | 2,350 | 15 |
| 60 | 132 | 10 | 0.02 | 1.1 | 2.4 | 1.8 | 0.61 | 1.3 | 2.7 | 2.2 | 104 | 0.23 | 2.3 | 2.1 | 2,820 | 16 |
| 70 | 154 | 10 | 0.02 | 1.2 | 2.6 | 1.7 | 0.66 | 1.5 | 2.9 | 2.4 | 113 | 0.25 | 2.5 | 2.4 | 3,290 | 18 |
| 80 | 176 | 10 | 0.02 | 1.3 | 2.9 | 1.6 | 0.72 | 1.6 | 3.2 | 2.6 | 122 | 0.27 | 2.7 | 2.8 | 3,760 | 20 |
| 90 | 198 | 10 | 0.02 | 1.4 | 3.1 | 1.5 | 0.78 | 1.7 | 3.4 | 2.8 | 131 | 0.29 | 2.9 | 3.1 | 4,230 | 21 |
| **Flushing—2 Weeks prebreeding and first 3 weeks of breeding** | | | | | | | | | | | | | | | | |
| 50 | 110 | 100 | 0.22 | 1.6 | 3.5 | 3.2 | 0.94 | 2.1 | 4.1 | 3.4 | 150 | 0.33 | 5.3 | 2.6 | 2,350 | 24 |
| 60 | 132 | 100 | 0.22 | 1.7 | 3.7 | 2.8 | 1.00 | 2.2 | 4.4 | 3.6 | 157 | 0.34 | 5.5 | 2.9 | 2,820 | 26 |
| 70 | 154 | 100 | 0.22 | 1.8 | 4.0 | 2.6 | 1.06 | 2.3 | 4.7 | 3.8 | 164 | 0.36 | 5.7 | 3.2 | 3,290 | 27 |
| 80 | 176 | 100 | 0.22 | 1.9 | 4.2 | 2.4 | 1.12 | 2.5 | 4.9 | 4.0 | 171 | 0.38 | 5.9 | 3.6 | 3,760 | 28 |
| 90 | 198 | 100 | 0.22 | 2.0 | 4.4 | 2.2 | 1.18 | 2.6 | 5.1 | 4.2 | 177 | 0.39 | 6.1 | 3.9 | 4,230 | 30 |
| **Nonlactating—First 15 weeks gestation** | | | | | | | | | | | | | | | | |
| 50 | 110 | 30 | 0.07 | 1.2 | 2.6 | 2.4 | 0.67 | 1.5 | 3.0 | 2.4 | 112 | 0.25 | 2.9 | 2.1 | 2,350 | 18 |
| 60 | 132 | 30 | 0.07 | 1.3 | 2.9 | 2.2 | 0.72 | 1.6 | 3.2 | 2.6 | 121 | 0.27 | 3.2 | 2.5 | 2,820 | 20 |
| 70 | 154 | 30 | 0.07 | 1.4 | 3.1 | 2.0 | 0.77 | 1.7 | 3.4 | 2.8 | 130 | 0.29 | 3.5 | 2.9 | 3,290 | 21 |
| 80 | 176 | 30 | 0.07 | 1.5 | 3.3 | 1.9 | 0.82 | 1.8 | 3.6 | 3.0 | 139 | 0.31 | 3.8 | 3.3 | 3,760 | 22 |
| 90 | 198 | 30 | 0.07 | 1.6 | 3.5 | 1.8 | 0.87 | 1.9 | 3.8 | 3.2 | 148 | 0.33 | 4.1 | 3.6 | 4,230 | 24 |
| **Last 4 weeks gestation (130-150% lambing rate expected) or last 4-6 weeks lactation suckling singles[d]** | | | | | | | | | | | | | | | | |
| 50 | 110 | 180 (45) | 0.40 (0.10) | 1.6 | 3.5 | 3.2 | 0.94 | 2.1 | 4.1 | 3.4 | 175 | 0.38 | 5.9 | 4.8 | 4,250 | 24 |
| 60 | 132 | 180 (45) | 0.40 (0.10) | 1.7 | 3.7 | 2.8 | 1.00 | 2.2 | 4.4 | 3.6 | 184 | 0.40 | 6.0 | 5.2 | 5,100 | 26 |
| 70 | 154 | 180 (45) | 0.40 (0.10) | 1.8 | 4.0 | 2.6 | 1.06 | 2.3 | 4.7 | 3.8 | 193 | 0.42 | 6.2 | 5.6 | 5,950 | 27 |
| 80 | 176 | 180 (45) | 0.40 (0.10) | 1.9 | 4.2 | 2.4 | 1.12 | 2.4 | 4.9 | 4.0 | 202 | 0.44 | 6.3 | 6.1 | 6,800 | 28 |
| 90 | 198 | 180 (45) | 0.40 (0.10) | 2.0 | 4.4 | 2.2 | 1.18 | 2.5 | 5.1 | 4.2 | 212 | 0.47 | 6.4 | 6.5 | 7,650 | 30 |
| **Last 4 weeks gestation (180-225% lambing rate expected)** | | | | | | | | | | | | | | | | |
| 50 | 110 | 225 | 0.50 | 1.7 | 3.7 | 3.4 | 1.10 | 2.4 | 4.8 | 4.0 | 196 | 0.43 | 6.2 | 3.4 | 4,250 | 26 |
| 60 | 132 | 225 | 0.50 | 1.8 | 4.0 | 3.0 | 1.17 | 2.6 | 5.1 | 4.2 | 205 | 0.45 | 6.9 | 4.0 | 5,100 | 27 |
| 70 | 154 | 225 | 0.50 | 1.9 | 4.2 | 2.7 | 1.24 | 2.8 | 5.4 | 4.4 | 214 | 0.47 | 7.6 | 4.5 | 5,950 | 28 |
| 80 | 176 | 225 | 0.50 | 2.0 | 4.4 | 2.5 | 1.30 | 2.9 | 5.7 | 4.7 | 223 | 0.49 | 8.3 | 5.1 | 6,800 | 30 |
| 90 | 198 | 225 | 0.50 | 2.1 | 4.6 | 2.3 | 1.37 | 3.0 | 6.0 | 5.0 | 232 | 0.51 | 8.9 | 5.7 | 7,650 | 32 |
| **First 6-8 weeks lactation suckling singles or last 4-6 weeks lactation suckling twins[d]** | | | | | | | | | | | | | | | | |
| 50 | 110 | -25 (90) | -0.06 (0.20) | 2.1 | 4.6 | 4.2 | 1.36 | 3.0 | 6.0 | 4.9 | 304 | 0.67 | 8.9 | 6.1 | 4,250 | 32 |
| 60 | 132 | -25 (90) | -0.06 (0.20) | 2.3 | 5.1 | 3.8 | 1.50 | 3.3 | 6.6 | 5.4 | 319 | 0.70 | 9.1 | 6.6 | 5,100 | 34 |
| 70 | 154 | -25 (90) | -0.06 (0.20) | 2.5 | 5.5 | 3.6 | 1.63 | 3.6 | 7.2 | 5.9 | 334 | 0.73 | 9.3 | 7.0 | 5,950 | 38 |
| 80 | 176 | -25 (90) | -0.06 (0.20) | 2.6 | 5.7 | 3.2 | 1.69 | 3.7 | 7.4 | 6.1 | 344 | 0.76 | 9.5 | 7.4 | 6,800 | 39 |
| 90 | 198 | -25 (90) | -0.06 (0.20) | 2.7 | 5.9 | 3.0 | 1.75 | 3.8 | 7.6 | 6.3 | 353 | 0.78 | 9.6 | 7.8 | 7,650 | 40 |

TABLE 1   Daily Nutrient Requirements of Sheep—*Continued*

| Body Weight (kg) | (lb) | Weight Change/Day (g) | (lb) | Dry Matter per Animal (kg) | (lb) | (% body weight) | TDN (kg) | (lb) | DE (Mcal) | ME (Mcal) | Crude protein (g) | (lb) | Ca (g) | P (g) | Vitamin A Activity (IU) | Vitamin E Activity (IU) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **First 6-8 weeks lactation suckling twins** | | | | | | | | | | | | | | | | |
| 50 | 110 | −60 | −0.13 | 2.4 | 5.3 | 4.8 | 1.56 | 3.4 | 6.9 | 5.6 | 389 | 0.86 | 10.5 | 7.3 | 5,000 | 36 |
| 60 | 132 | −60 | −0.13 | 2.6 | 5.7 | 4.3 | 1.69 | 3.7 | 7.4 | 6.1 | 405 | 0.89 | 10.7 | 7.7 | 6,000 | 39 |
| 70 | 154 | −60 | −0.13 | 2.8 | 6.2 | 4.0 | 1.82 | 4.0 | 8.0 | 6.6 | 420 | 0.92 | 11.0 | 8.1 | 7,000 | 42 |
| 80 | 176 | −60 | −0.13 | 3.0 | 6.6 | 3.8 | 1.95 | 4.3 | 8.6 | 7.0 | 435 | 0.96 | 11.2 | 8.6 | 8,000 | 45 |
| 90 | 198 | −60 | −0.13 | 3.2 | 7.0 | 3.6 | 2.08 | 4.6 | 9.2 | 7.5 | 450 | 0.99 | 11.4 | 9.0 | 9,000 | 48 |
| **Ewe lambs** | | | | | | | | | | | | | | | | |
| **Nonlactating—First 15 weeks gestation** | | | | | | | | | | | | | | | | |
| 40 | 88 | 160 | 0.35 | 1.4 | 3.1 | 3.5 | 0.83 | 1.8 | 3.6 | 3.0 | 156 | 0.34 | 5.5 | 3.0 | 1,880 | 21 |
| 50 | 110 | 135 | 0.30 | 1.5 | 3.3 | 3.0 | 0.88 | 1.9 | 3.9 | 3.2 | 159 | 0.35 | 5.2 | 3.1 | 2,350 | 22 |
| 60 | 132 | 135 | 0.30 | 1.6 | 3.5 | 2.7 | 0.94 | 2.0 | 4.1 | 3.4 | 161 | 0.35 | 5.5 | 3.4 | 2,820 | 24 |
| 70 | 154 | 125 | 0.28 | 1.7 | 3.7 | 2.4 | 1.00 | 2.2 | 4.4 | 3.6 | 164 | 0.36 | 5.5 | 3.7 | 3,290 | 26 |
| **Last 4 weeks gestation (100-120% lambing rate expected)** | | | | | | | | | | | | | | | | |
| 40 | 88 | 180 | 0.40 | 1.5 | 3.3 | 3.8 | 0.94 | 2.1 | 4.1 | 3.4 | 187 | 0.41 | 6.4 | 3.1 | 3,400 | 22 |
| 50 | 110 | 160 | 0.35 | 1.6 | 3.5 | 3.2 | 1.00 | 2.2 | 4.4 | 3.6 | 189 | 0.42 | 6.3 | 3.4 | 4,250 | 24 |
| 60 | 132 | 160 | 0.35 | 1.7 | 3.7 | 2.8 | 1.07 | 2.4 | 4.7 | 3.9 | 192 | 0.42 | 6.6 | 3.8 | 5,100 | 26 |
| 70 | 154 | 150 | 0.33 | 1.8 | 4.0 | 2.6 | 1.14 | 2.5 | 5.0 | 4.1 | 194 | 0.43 | 6.8 | 4.2 | 5,950 | 27 |
| **Last 4 weeks gestation (130-175% lambing rate expected)** | | | | | | | | | | | | | | | | |
| 40 | 88 | 225 | 0.50 | 1.5 | 3.3 | 3.8 | 0.99 | 2.2 | 4.4 | 3.6 | 202 | 0.44 | 7.4 | 3.5 | 3,400 | 22 |
| 50 | 110 | 225 | 0.50 | 1.6 | 3.5 | 3.2 | 1.06 | 2.3 | 4.7 | 3.8 | 204 | 0.45 | 7.8 | 3.9 | 4,250 | 24 |
| 60 | 132 | 225 | 0.50 | 1.7 | 3.7 | 2.8 | 1.12 | 2.5 | 4.9 | 4.0 | 207 | 0.46 | 8.1 | 4.3 | 5,100 | 26 |
| 70 | 154 | 215 | 0.47 | 1.8 | 4.0 | 2.6 | 1.14 | 2.5 | 5.0 | 4.1 | 210 | 0.46 | 8.2 | 4.7 | 5,950 | 27 |
| **First 6-8 weeks lactation suckling singles (wean by 8 weeks)** | | | | | | | | | | | | | | | | |
| 40 | 88 | −50 | −0.11 | 1.7 | 3.7 | 4.2 | 1.12 | 2.5 | 4.9 | 4.0 | 257 | 0.56 | 6.0 | 4.3 | 3,400 | 26 |
| 50 | 110 | −50 | −0.11 | 2.1 | 4.6 | 4.2 | 1.39 | 3.1 | 6.1 | 5.0 | 282 | 0.62 | 6.5 | 4.7 | 4,250 | 32 |
| 60 | 132 | −50 | −0.11 | 2.3 | 5.1 | 3.8 | 1.52 | 3.4 | 6.7 | 5.5 | 295 | 0.65 | 6.8 | 5.1 | 5,100 | 34 |
| 70 | 154 | −50 | −0.11 | 2.5 | 5.5 | 3.6 | 1.65 | 3.6 | 7.3 | 6.0 | 301 | 0.68 | 7.1 | 5.6 | 5,450 | 38 |
| **First 6-8 weeks lactation suckling twins (wean by 8 weeks)** | | | | | | | | | | | | | | | | |
| 40 | 88 | −100 | −0.22 | 2.1 | 4.6 | 5.2 | 1.45 | 3.2 | 6.4 | 5.2 | 306 | 0.67 | 8.4 | 5.6 | 4,000 | 32 |
| 50 | 110 | −100 | −0.22 | 2.3 | 5.1 | 4.6 | 1.59 | 3.5 | 7.0 | 5.7 | 321 | 0.71 | 8.7 | 6.0 | 5,000 | 34 |
| 60 | 132 | −100 | −0.22 | 2.5 | 5.5 | 4.2 | 1.72 | 3.8 | 7.6 | 6.2 | 336 | 0.74 | 9.0 | 6.4 | 6,000 | 38 |
| 70 | 154 | −100 | −0.22 | 2.7 | 6.0 | 3.9 | 1.85 | 4.1 | 8.1 | 6.6 | 351 | 0.77 | 9.3 | 6.9 | 7,000 | 40 |

*Replacement ewe lambs[c]*

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 66 | 227 | 0.50 | 1.2 | 2.6 | 4.0 | 0.78 | 1.7 | 3.4 | 2.8 | 185 | 0.41 | 6.4 | 2.6 | 1,410 | 18 |
| 40 | 88 | 182 | 0.40 | 1.4 | 3.1 | 3.5 | 0.91 | 2.0 | 4.0 | 3.3 | 176 | 0.39 | 5.9 | 2.6 | 1,880 | 21 |
| 50 | 110 | 120 | 0.26 | 1.5 | 3.3 | 3.0 | 0.88 | 1.9 | 3.9 | 3.2 | 136 | 0.30 | 4.8 | 2.4 | 2,350 | 22 |
| 60 | 132 | 100 | 0.22 | 1.5 | 3.3 | 2.5 | 0.88 | 1.9 | 3.9 | 3.2 | 134 | 0.30 | 4.5 | 2.5 | 2,820 | 22 |
| 70 | 154 | 100 | 0.22 | 1.5 | 3.3 | 2.1 | 0.88 | 1.9 | 3.9 | 3.2 | 132 | 0.29 | 4.6 | 2.8 | 3,290 | 22 |

*Replacement ram lambs[c]*

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | 88 | 330 | 0.73 | 1.8 | 4.0 | 4.5 | 1.1 | 2.5 | 5.0 | 4.1 | 243 | 0.54 | 7.8 | 3.7 | 1,880 | 24 |
| 60 | 132 | 320 | 0.70 | 2.4 | 5.3 | 4.0 | 1.5 | 3.4 | 6.7 | 5.5 | 263 | 0.58 | 8.4 | 4.2 | 2,820 | 26 |
| 80 | 176 | 290 | 0.64 | 2.8 | 6.2 | 3.5 | 1.8 | 3.9 | 7.8 | 6.4 | 268 | 0.59 | 8.5 | 4.6 | 3,760 | 28 |
| 100 | 220 | 250 | 0.55 | 3.0 | 6.6 | 3.0 | 1.9 | 4.2 | 8.4 | 6.9 | 264 | 0.58 | 8.2 | 4.8 | 4,700 | 30 |

*Lambs finishing—4 to 7 months old[f]*

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 66 | 295 | 0.65 | 1.3 | 2.9 | 4.3 | 0.94 | 2.1 | 4.1 | 3.4 | 191 | 0.42 | 6.6 | 3.2 | 1,410 | 20 |
| 40 | 88 | 275 | 0.60 | 1.6 | 3.5 | 4.0 | 1.22 | 2.7 | 5.4 | 4.4 | 185 | 0.41 | 6.6 | 3.3 | 1,880 | 24 |
| 50 | 110 | 205 | 0.45 | 1.6 | 3.5 | 3.2 | 1.23 | 2.7 | 5.4 | 4.4 | 160 | 0.35 | 5.6 | 3.0 | 2,350 | 24 |

*Early weaned lambs—Moderate growth potential[f]*

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 22 | 200 | 0.44 | 0.5 | 1.1 | 5.0 | 0.40 | 0.9 | 1.8 | 1.4 | 127 | 0.38 | 4.0 | 1.9 | 470 | 10 |
| 20 | 44 | 250 | 0.55 | 1.0 | 2.2 | 5.0 | 0.80 | 1.8 | 3.5 | 2.9 | 167 | 0.37 | 5.4 | 2.5 | 940 | 20 |
| 30 | 66 | 300 | 0.66 | 1.3 | 2.9 | 4.3 | 1.00 | 2.2 | 4.4 | 3.6 | 191 | 0.42 | 6.7 | 3.2 | 1,410 | 20 |
| 40 | 88 | 345 | 0.76 | 1.5 | 3.3 | 3.8 | 1.16 | 2.6 | 5.1 | 4.2 | 202 | 0.44 | 7.7 | 3.9 | 1,880 | 22 |
| 50 | 110 | 300 | 0.66 | 1.5 | 3.3 | 3.0 | 1.16 | 2.6 | 5.1 | 4.2 | 181 | 0.40 | 7.0 | 3.8 | 2,350 | 22 |

*Early weaned lambs—Rapid growth potential[f]*

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10 | 22 | 250 | 0.55 | 0.6 | 1.3 | 6.0 | 0.48 | 1.1 | 2.1 | 1.7 | 157 | 0.35 | 4.9 | 2.2 | 470 | 12 |
| 20 | 44 | 300 | 0.66 | 1.2 | 2.6 | 6.0 | 0.92 | 2.0 | 4.0 | 3.3 | 205 | 0.45 | 6.5 | 2.9 | 940 | 24 |
| 30 | 66 | 325 | 0.72 | 1.4 | 3.1 | 4.7 | 1.10 | 2.4 | 4.8 | 4.0 | 216 | 0.48 | 7.2 | 3.4 | 1,410 | 21 |
| 40 | 88 | 400 | 0.88 | 1.5 | 3.3 | 3.8 | 1.14 | 2.5 | 5.0 | 4.1 | 234 | 0.51 | 8.6 | 4.3 | 1,880 | 22 |
| 50 | 110 | 435 | 0.94 | 1.7 | 3.7 | 3.4 | 1.29 | 2.8 | 5.7 | 4.7 | 240 | 0.53 | 9.4 | 4.8 | 2,350 | 25 |
| 60 | 132 | 350 | 0.77 | 1.7 | 3.7 | 2.8 | 1.29 | 2.8 | 5.7 | 4.7 | 240 | 0.53 | 8.2 | 4.5 | 2,820 | 25 |

[a] To convert dry matter to an as-fed basis, divide dry matter values by the percentage of dry matter in the particular feed.

[b] One kilogram TDN (total digestible nutrients) = 4.4 Mcal DE (digestible energy). ME (metabolizable energy) = 82% of DE. Because of rounding errors, values in Table 1 and Table 2 may differ.

[c] Values are applicable for ewes in moderate condition. Fat ewes should be fed according to the next lower weight category and thin ewes at the next higher weight category. Once desired or moderate weight condition is attained, use that weight category through all production stages.

[d] Values in parentheses are for ewes suckling lambs the last 4-6 weeks of lactation.

[e] Lambs intended for breeding; thus, maximum weight gains and finish are of secondary importance.

[f] Maximum weight gains expected.

TABLE 2   Nutrient Concentration in Diets for Sheep (expressed on 100 Percent Dry Matter Basis[a])

| Body Weight | | Weight Change/Day | | Energy[b] | | | Example Diet Proportions | | Crude | Cal- | Phos- | Vitamin A | Vitamin E |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | TDN[c] | DE | ME | Concentrate | Forage | Protein | cium | phorus | Activity | Activity |
| (kg) | (lb) | (g) | (lb) | (%) | (Mcal/kg) | (Mcal/kg) | % | % | (%) | (%) | (%) | (IU/kg) | (IU/kg) |
| *Ewes[d]* | | | | | | | | | | | | | |
| Maintenance | | | | | | | | | | | | | |
| 70 | 154 | 10 | 0.02 | 55 | 2.4 | 2.0 | 0 | 100 | 9.4 | 0.20 | 0.20 | 2,742 | 15 |
| Flushing—2 weeks prebreeding and first 3 weeks of breeding | | | | | | | | | | | | | |
| 70 | 154 | 100 | 0.22 | 59 | 2.6 | 2.1 | 15 | 85 | 9.1 | 0.32 | 0.18 | 1,828 | 15 |
| Nonlactating—First 15 weeks gestation | | | | | | | | | | | | | |
| 70 | 154 | 30 | 0.07 | 55 | 2.4 | 2.0 | 0 | 100 | 9.3 | 0.25 | 0.20 | 2,350 | 15 |
| Last 4 weeks gestation (130-150% lambing rate expected) or last 4-6 weeks lactation suckling singles[e] | | | | | | | | | | | | | |
| 70 | 154 | 180 (0.45) | 0.40 (0.10) | 59 | 2.6 | 2.1 | 15 | 85 | 10.7 | 0.35 | 0.23 | 3,306 | 15 |
| Last 4 weeks gestation (180-225% lambing rate expected) | | | | | | | | | | | | | |
| 70 | 154 | 225 | 0.50 | 65 | 2.9 | 2.3 | 35 | 65 | 11.3 | 0.40 | 0.24 | 3,132 | 15 |
| First 6-8 weeks lactation suckling singles or last 4-6 weeks lactation suckling twins[e] | | | | | | | | | | | | | |
| 70 | 154 | −25(90) | −0.06 (0.20) | 65 | 2.9 | 2.4 | 35 | 65 | 13.4 | 0.32 | 0.26 | 2,380 | 15 |
| First 6-8 weeks lactation suckling twins | | | | | | | | | | | | | |
| 70 | 154 | −60 | −0.13 | 65 | 2.9 | 2.4 | 35 | 65 | 15.0 | 0.39 | 0.29 | 2,500 | 15 |
| *Ewe Lambs* | | | | | | | | | | | | | |
| Nonlactating—First 15 weeks gestation | | | | | | | | | | | | | |
| 55 | 121 | 135 | 0.30 | 59 | 2.6 | 2.1 | 15 | 85 | 10.6 | 0.35 | 0.22 | 1,668 | 15 |
| Last 4 weeks gestation (100-120% lambing rate expected) | | | | | | | | | | | | | |
| 55 | 121 | 160 | 0.35 | 63 | 2.8 | 2.3 | 30 | 70 | 11.8 | 0.39 | 0.22 | 2,833 | 15 |
| Last 4 weeks gestation (130-175% lambing rate expected) | | | | | | | | | | | | | |
| 55 | 121 | 225 | 0.50 | 66 | 2.9 | 2.4 | 40 | 60 | 12.8 | 0.48 | 0.25 | 2,833 | 15 |
| First 6-8 weeks lactation suckling singles (wean by 8 weeks) | | | | | | | | | | | | | |
| 55 | 121 | −50 | 0.22 | 66 | 2.9 | 2.4 | 40 | 60 | 13.1 | 0.30 | 0.22 | 2,125 | 15 |
| First 6-8 weeks lactation suckling twins (wean by 8 weeks) | | | | | | | | | | | | | |
| 55 | 121 | −100 | −0.22 | 69 | 3.0 | 2.5 | 50 | 50 | 13.7 | 0.37 | 0.26 | 2,292 | 15 |
| *Replacement Ewe Lambs[f]* | | | | | | | | | | | | | |
| 30 | 66 | 227 | 0.50 | 65 | 2.9 | 2.4 | 35 | 65 | 12.8 | 0.53 | 0.22 | 1,175 | 15 |
| 40 | 88 | 182 | 0.40 | 65 | 2.9 | 2.4 | 35 | 65 | 10.2 | 0.42 | 0.18 | 1,343 | 15 |
| 50-70 | 110-154 | 115 | 0.25 | 59 | 2.6 | 2.1 | 15 | 85 | 9.1 | 0.31 | 0.17 | 1,567 | 15 |
| *Replacement Ram Lambs[f]* | | | | | | | | | | | | | |
| 40 | 88 | 330 | 0.73 | 63 | 2.8 | 2.3 | 30 | 70 | 13.5 | 0.43 | 0.21 | 1,175 | 15 |
| 60 | 132 | 320 | 0.70 | 63 | 2.8 | 2.3 | 30 | 70 | 11.0 | 0.35 | 0.18 | 1,659 | 15 |
| 80-100 | 176-220 | 270 | 0.60 | 63 | 2.8 | 2.3 | 30 | 70 | 9.6 | 0.30 | 0.16 | 1,979 | 15 |
| *Lambs Finishing—4 to 7 months old[g]* | | | | | | | | | | | | | |
| 30 | 66 | 295 | 0.65 | 72 | 3.2 | 2.5 | 60 | 40 | 14.7 | 0.51 | 0.24 | 1,085 | 15 |
| 40 | 88 | 275 | 0.60 | 76 | 3.3 | 2.7 | 75 | 25 | 11.6 | 0.42 | 0.21 | 1,175 | 15 |
| 50 | 110 | 205 | 0.45 | 77 | 3.4 | 2.8 | 80 | 20 | 10.0 | 0.35 | 0.19 | 1,469 | 15 |
| *Early Weaned Lambs—Moderate and rapid growth potential[g]* | | | | | | | | | | | | | |
| 10 | 22 | 250 | 0.55 | 80 | 3.5 | 2.9 | 90 | 10 | 26.2 | 0.82 | 0.38 | 940 | 20 |
| 20 | 44 | 300 | 0.66 | 78 | 3.4 | 2.8 | 85 | 15 | 16.9 | 0.54 | 0.24 | 940 | 20 |
| 30 | 66 | 325 | 0.72 | 78 | 3.3 | 2.7 | 85 | 15 | 15.1 | 0.51 | 0.24 | 1,085 | 15 |
| 40-60 | 88-132 | 400 | 0.88 | 78 | 3.3 | 2.7 | 85 | 15 | 14.5 | 0.55 | 0.28 | 1,253 | 15 |

[a]Values in Table 2 are calculated from daily requirements in Table 1 divided by DM intake. The exception, vitamin E daily requirements /head, are calculated from vitamin E/kg diet × DM intake.

[b]One kilogram TDN = 4.4 Mcal DE (digestible energy); ME (metabolizable energy) = 82% of DE. Because of rounding errors, values in Table 1 and Table 2 may differ.

[c]TDN calculated on following basis: hay DM, 55% TDN and on as-fed basis 50% TDN; grain DM, 83% TDN and on as-fed basis 75% TDN.

[d]Values are for ewes in moderate condition. Fat ewes should be fed according to the next lower weight category and thin ewes at the next higher weight category. Once desired or moderate weight condition is attained, use that weight category through all production stages.

[e]Values in parentheses are for ewes suckling lambs the last 4-6 weeks of lactation.

[f]Lambs intended for breeding; thus, maximum weight gains and finish are of secondary importance.

[g]Maximum weight gains expected.

TABLE 3 Net Energy Requirements for Lambs of Small, Medium, and Large Mature Weight Genotypes[a] (kcal/d)

| Body Weight (kg)[b]: | 10 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
|---|---|---|---|---|---|---|---|---|
| NE$_m$ Requirements[c]: | 315 | 530 | 626 | 718 | 806 | 891 | 973 | 1053 |
| Daily Gain (g)[b] | | | | | | | | |
| NE$_g$ Requirements | | | | | | | | |
| *Small mature weight lambs[d]* | | | | | | | | |
| 100 | 178 | 300 | 354 | 406 | 456 | 504 | 551 | 596 |
| 150 | 267 | 450 | 532 | 610 | 684 | 756 | 826 | 894 |
| 200 | 357 | 600 | 708 | 812 | 912 | 1,008 | 1,102 | 1,192 |
| 250 | 446 | 750 | 886 | 1,016 | 1,140 | 1,261 | 1,377 | 1,490 |
| 300 | 535 | 900 | 1,064 | 1,219 | 1,368 | 1,513 | 1,652 | 1,788 |
| *Medium mature weight lambs[e]* | | | | | | | | |
| 100 | 155 | 261 | 309 | 354 | 397 | 439 | 480 | 519 |
| 150 | 233 | 392 | 463 | 531 | 596 | 658 | 719 | 778 |
| 200 | 310 | 522 | 618 | 708 | 794 | 878 | 960 | 1,038 |
| 250 | 388 | 653 | 771 | 884 | 993 | 1,097 | 1,199 | 1,297 |
| 300 | 466 | 784 | 926 | 1,062 | 1,191 | 1,316 | 1,438 | 1,557 |
| 350 | 543 | 914 | 1,080 | 1,238 | 1,390 | 1,536 | 1,678 | 1,816 |
| 400 | 621 | 1,044 | 1,234 | 1,415 | 1,589 | 1,756 | 1,918 | 2,076 |
| *Large mature weight lambs[f]* | | | | | | | | |
| 100 | 132 | 221 | 262 | 300 | 337 | 372 | 407 | 439 |
| 150 | 197 | 332 | 392 | 450 | 505 | 558 | 610 | 660 |
| 200 | 263 | 442 | 524 | 600 | 674 | 744 | 813 | 880 |
| 250 | 329 | 553 | 654 | 750 | 842 | 930 | 1,016 | 1,099 |
| 300 | 394 | 663 | 785 | 900 | 1,010 | 1,116 | 1,220 | 1,320 |
| 350 | 461 | 775 | 916 | 1,050 | 1,179 | 1,303 | 1,423 | 1,540 |
| 400 | 526 | 885 | 1,046 | 1,200 | 1,347 | 1,489 | 1,626 | 1,760 |
| 450 | 592 | 996 | 1,177 | 1,350 | 1,515 | 1,675 | 1,830 | 1,980 |

[a] Approximate mature ram weights of 95 kg, 115 kg, and 135 kg, respectively.
[b] Weights and gains include fill.
[c] NE$_m$ = 56 kcal · W$^{0.75}$ · d$^{-1}$.
[d] NE$_g$ = 317 kcal · W$^{0.75}$ · LWG, kg · d$^{-1}$.
[e] NE$_g$ = 276 kcal · W$^{0.75}$ · LWG, kg · d$^{-1}$.
[f] NE$_g$ = 234 kcal · W$^{0.75}$ · LWG, kg · d$^{-1}$.

TABLE 4 NE$_{preg}$ (NE$_y$) Requirements of Ewes Carrying Different Numbers of Fetuses at Various Stages of Gestation

| Number of Fetuses Being Carried | Stage of Gestation (days)[a] | | | | | |
|---|---|---|---|---|---|---|
| | 100 | %[b] | 120 | %[b] | 140 | %[b] |
| | NE$_{preg}$ Required (kcal/day) | | | | | |
| 1 | 70 | 100 | 145 | 100 | 260 | 100 |
| 2 | 125 | 178 | 265 | 183 | 440 | 169 |
| 3 | 170 | 243 | 345 | 238 | 570 | 219 |

[a] For gravid uterus (plus contents) and mammary gland development only.
[b] As a percentage of a single fetus's requirement.

TABLE 5   Crude Protein Requirements for Lambs of Small, Medium, and Large Mature Weight Genotypes[a] (g/d)

| Body Weight (kg)[b]: | 10 | 20 | 25 | 30 | 35 | 40 | 45 | 50 |
|---|---|---|---|---|---|---|---|---|
| Daily Gain (g)[b] | | | | | | | | |
| *Small mature weight lambs* | | | | | | | | |
| 100 | 84 | 112 | 122 | 127 | 131 | 136 | 135 | 134 |
| 150 | 103 | 121 | 137 | 140 | 144 | 147 | 145 | 143 |
| 200 | 123 | 145 | 152 | 154 | 156 | 158 | 154 | 151 |
| 250 | 142 | 162 | 167 | 168 | 168 | 169 | 164 | 159 |
| 300 | 162 | 178 | 182 | 181 | 180 | 180 | 174 | 168 |
| *Medium mature weight lambs* | | | | | | | | |
| 100 | 85 | 114 | 125 | 130 | 135 | 140 | 139 | 139 |
| 150 | 106 | 132 | 141 | 145 | 149 | 153 | 151 | 149 |
| 200 | 127 | 150 | 158 | 160 | 163 | 166 | 163 | 160 |
| 250 | 147 | 167 | 174 | 175 | 177 | 179 | 175 | 171 |
| 300 | 168 | 185 | 191 | 191 | 191 | 191 | 186 | 181 |
| 350 | 188 | 203 | 207 | 206 | 205 | 204 | 198 | 192 |
| 400 | 209 | 221 | 224 | 221 | 219 | 217 | 210 | 202 |
| *Large mature weight lambs* | | | | | | | | |
| 100 | 94 | 128 | 134 | 139 | 145 | 144 | 150 | 156 |
| 150 | 115 | 147 | 152 | 156 | 160 | 159 | 164 | 169 |
| 200 | 136 | 166 | 170 | 173 | 176 | 174 | 178 | 182 |
| 250 | 157 | 186 | 188 | 190 | 192 | 189 | 192 | 195 |
| 300 | 179 | 205 | 206 | 207 | 208 | 204 | 206 | 208 |
| 350 | 200 | 224 | 224 | 224 | 224 | 219 | 220 | 221 |
| 400 | 221 | 243 | 242 | 241 | 240 | 234 | 234 | 234 |
| 450 | 242 | 262 | 260 | 256 | 256 | 249 | 248 | 248 |

[a]Approximate mature ram weights of 95 kg, 115 kg, and 135 kg, respectively.
[b]Weights and gains include fill.

TABLE 6   Macromineral Requirements of Sheep (percentage of diet dry matter)[a]

| Nutrient | Requirement |
|---|---|
| Sodium | 0.09-0.18 |
| Chlorine | — |
| Calcium | 0.20-0.82 |
| Phosphorus | 0.16-0.38 |
| Magnesium | 0.12-0.18 |
| Potassium | 0.50-0.80 |
| Sulfur | 0.14-0.26 |

[a]Values are estimates based on experimental data.

TABLE 7   Micromineral Requirements of Sheep and Maximum Tolerable Levels (ppm, mg/kg of diet dry matter)[a]

| Nutrient | Requirement | Maximum Tolerable Level[b] |
|---|---|---|
| Iodine | 0.10-0.80[c] | 50 |
| Iron | 30-50 | 500 |
| Copper | 7-11[d] | 25[e] |
| Molybdenum | 0.5 | 10[e] |
| Cobalt | 0.1-0.2 | 10 |
| Manganese | 20-40 | 1,000 |
| Zinc | 20-33 | 750 |
| Selenium | 0.1-0.2 | 2 |
| Fluorine | — | 60-150 |

[a]Values are estimates based on experimental data.
[b]NRC (1980).
[c]High level for pregnancy and lactation in diets not containing goitrogens; should be increased if diets contain goitrogens.
[d]Requirement when dietary Mo concentrations are <1 mg/kg DM. See text for requirements under other circumstances.
[e]Lower levels may be toxic under some circumstances. See text.

TABLE 8   Composition of Ewe's Milk (2.5 weeks postpartum)[a]

| | |
|---|---|
| Dry matter | 18.2% |
| Fat (5-10%) | 7.1 g/100 g milk |
| Protein (true) | 4.5 × 5.49 = 24.7% DM basis |
| Lactose | 4.8 × 5.49 = 26.4% DM basis |
| Ash | 0.85 g/100 g milk |
| Fiber | 0.0 g/100 g milk |
| Caloric value (GE) | 110 kcal/100 g × 5.49 = 6.04 Mcal/kg milk DM basis |
| Principal salts (g/100 g) | |
| Na | 0.040 |
| K | 0.150 |
| Ca | 0.200 |
| Mg | 0.016 |
| P | 0.150 |
| Cl | 0.075 |
| Citrate | 0.170 |
| Trace minerals (mg/liter) | |
| Fe | 0.60-0.70 |
| Cu | 0.05-0.15 |
| Mn | 0.06 |
| Al | 1.70 |
| Zn | 2.00-3.00 |
| Vitamins (mg/liter, except where noted) | |
| A | 1,450 IU/liter |
| E ($\alpha$-tocopherol) | 15 |
| Thiamin | 1.0 |
| Riboflavin | 4.0 |
| Niacin | 5.0 |
| $B_6$ | 0.7 |
| Pantothenic acid | 4.0 |
| Biotin | 0.05-0.09 |
| Folacin | 0.05 |
| $B_{12}$ | 0.006-0.010 |
| Ascorbic acid | 40-50 |

[a]Courtesy of Dr. Robert Jenness, Biochemistry Department, University of Minnesota.

TABLE 9   Vitamin E Requirements of Growing-Finishing Lambs and Suggested Levels of Feed Fortification to Provide 100 Percent of Requirements

| Body Weight | | $\alpha$-Tocopheryl Acetate | | Feed Intake per Lamb | | Amount of Vitamin E Added to Concentrate | | | Amount of Vitamin E Added to Protein Supplement[b] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (kg) | (lb) | (mg/lamb/day)[a] | (mg/kg diet) | (kg) | (lb) | (mg/kg) | (mg/lb) | (mg/ton) | (mg/kg) | (mg/lb) | (mg/ton) |
| 10 | 22 | 5.0 | 20 | 0.23 | 0.50 | 20 | 9.1 | 18,200 | 133 | 60 | 120,000 |
| 20 | 44 | 10.0 | 20 | 0.45 | 1.00 | 20 | 9.1 | 18,200 | 133 | 60 | 120,000 |
| 30 | 66 | 15.0 | 15 | 0.96 | 2.10 | 15 | 6.8 | 13,600 | 100 | 45 | 90,000 |
| 40 | 88 | 20.0 | 15 | 1.30 | 2.86 | 15 | 6.8 | 13,600 | 100 | 45 | 90,000 |
| 50 | 110 | 25.0 | 15 | 1.60 | 3.50 | 15 | 6.8 | 13,600 | 100 | 45 | 90,000 |

[a]Rounded values based on approximate diet intake containing recommended vitamin E levels.
[b]Assumes the concentrate diet contains 15 percent protein supplement.

TABLE 10   Relative Ranking of Pasture Forages for Sheep

| Species | Carrying Capacity | Lamb Performance | Lamb Production/ Acre | Sheep and Pasture Management Required |
|---|---|---|---|---|
| Alfalfa | High | High | High | Medium |
| Ladino clover | Low | High | Medium | Medium |
| Bird's-foot trefoil | Low | High | High | Medium |
| Blue grass | Low | Low | Low | Low |
| Brome grass | Medium | Medium | Medium | Low |
| Fescue | High | Low | Low | Low |
| Orchard grass | High | Medium | Medium | Low |
| Canarygrass | High | Low | Medium | Low |
| Timothy | Low | Low | Low | Low |
| Oats | Medium | Medium | Medium | Low |
| Barley | Medium | Medium | Medium | Low |
| Sudan | High | Low | Medium | High |
| Rape | High | High | High | Low |
| Turnips | High | Low | Medium | Low |

TABLE 11   Range Supplements for Sheep (DM basis)[a]

| Feeds[b] | Relative Protein Level (%) | | | |
|---|---|---|---|---|
| | High | Medium-High | Medium-Low | Low |
| Barley, grain or corn, dent yellow, grain, grade 2 US, min 54 lb/bu | 5 | 40 | 75 | 65 |
| Beet, sugar, molasses, or sugar cane molasses, 48% invert sugar, min 79.5° Brix | 5 | 5 | 5 | 5 |
| Cottonseed with some hulls, solvent extracted, ground, min 41% protein, max 14% fiber, min 0.5% fat (cottonseed meal) | 66 | 36 | — | 16 |
| Soybean, seeds, solvent extracted, ground, max 7% fiber, 44% protein (soybean meal) | 10 | 10 | 10 | 10 |
| Urea, technical, 282% protein equivalent | — | — | 5 | — |
| Alfalfa, aerial parts, dehydrated, ground, min 17% protein or alfalfa, hay, sun-cured, early bloom | 10 | 5 | — | — |
| Vitamin A (IU/kg) | — | 4,000 | 8,000 | 8,000 |
| Calcium phosphate, monobasic, commercial | 1 | 1 | 2 | 1 |
| Sodium phosphate, monobasic, technical | 2 | 2 | 2 | 2 |
| Salt or trace mineralized salt | 1 | 1 | 1 | 1 |
| Total | 100 | 100 | 100 | 100 |
| Composition[c] | | | | |
| Protein (N × 6.25) (%) | 33.8 | 24.3 | 26.2 | 17.7 |
| Digestible energy (Mcal/kg) | 3.3 | 3.3 | 3.3 | 3.1 |
| Phosphorus (%) | 2.0 | 1.5 | 0.9 | 1.2 |
| Carotene (mg/kg) | 22.0 | 10.0 | — | — |
| Vitamin A (IU/kg) | — | 4,000.0 | 8,000.0 | 8,000.0 |
| Rate of feeding[d] (kg/day) | 0.1-0.2 | 0.1-0.2 | 0.1-0.2[e] | 0.1-0.2[e] |

[a]Feeds mixed and fed in meal or pellet form.
[b]See Table 16.
[c]Molasses and alfalfa hay, sun-cured, early bloom not included.
[d]Calculated on as-fed basis for mixing and feeding.
[e]In emergency situations, up to 0.5 kg may be fed.

TABLE 12   Suggested Creep Diets

| Ingredient | Amount (as-fed basis, %) | | |
|---|---|---|---|
| | Diet A | Diet B | Diet C |
| *Simple Diets (grind for lambs under 6 weeks of age; feed whole thereafter; hand- or self-feed)*[a] | | | |
| Barley, grain | 38.5 | — | — |
| Corn, dent yellow, grain, ground, grade 2 US, min 54 lb/bu | 40.0 | 60.0 | 88.5 |
| Oats, grain | — | 28.5 | — |
| Wheat, bran, dry milled | 10.0 | — | — |
| Linseed meal, soybean meal, or sunflower meal | 10.0 | 10.0 | 10.0 |
| Limestone, ground, min 33% calcium | 1.0 | 1.0 | 1.0 |
| Trace mineralized salt with selenium | 0.5 | 0.5 | 0.5 |
|     Total | 100.0 | 100.0 | 100.0 |

Alfalfa hay, sun-cured, early bloom should be fed free choice in conjunction with any of the above diets.

| | | | |
|---|---|---|---|
| *Commercially Mixed Diets (hand- or self-fed as meal, but usually as pellets)*[b] | | | |
| Alfalfa, sun-cured, early bloom or dehydrated alfalfa | — | 10.0 | 20.0 |
| Barley, grain | 20.0 | — | — |
| Corn, dent yellow, grain, grade 2 US, min 54 lb/bu | 54.5 | 34.5 | 44.5 |
| Oats, grain | — | 30.0 | 10.0 |
| Linseed, soybean, or sunflower meal | 10.0 | 10.0 | 10.0 |
| Bran, wheat | 10.0 | 10.0 | 10.0 |
| Beet or cane molasses | 4.0 | 4.0 | 4.0 |
| Limestone, ground, min 33% calcium | 1.0 | 1.0 | 1.0 |
| Trace mineralized salt with selenium | 0.5 | 0.5 | 0.5 |
|     Total | 100.0 | 100.0 | 100.0 |
| Chlortetracycline or oxytetracycline | 15.0-25.0 mg/kg | 15.0-25.0 mg/kg | 15.0-25.0 mg/kg |
| Vitamin A, IU/kg | 500.0 | 500.0 | 500.0 |
| Vitamin D, IU/kg | 50.0 | 50.0 | 50.0 |
| Vitamin E, IU/kg | 20.0 | 20.0 | 20.0 |

[a]Limestone will separate from whole grain, so a combination of protein supplement with 10% limestone may be top dressed on the whole grain. Equal parts of trace mineralized salt and limestone is an additional way to maintain adequate calcium intake and prevent urinary calculi.

[b]The addition of 0.25 to 0.50% ammonium chloride will minimize urinary calculi. Corn may be substituted for all the barley and oats. Weight gains are depressed when barley or oats exceed 40% of the ration.

TABLE 13  Composition of Some Sheep Feeds; Data Expressed on an As-Fed and Dry Basis (100% Dry Matter)

| Entry Number | Feed Name Description[a] | International Feed Number | Dry Matter (%) | DE Sheep (Mcal/kg) | ME Sheep (Mcal/kg) | NEm (Mcal/kg) | NEg (Mcal/kg) | TDN Sheep (%) | Crude Protein (%) | Dig. Protein (%) | Cellulose (%) | Crude Fiber (%) | Lignin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ALFALFA *Medicago sativa* | | | | | | | | | | | | |
| 001 | fresh | 2-00-196 | 24 | 0.62 | 0.51 | 0.30 | 0.16 | 14 | 4.8 | 3.5 | — | 6.4 | — |
| 002 | | | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 19.7 | 14.6 | — | 26.2 | — |
| 003 | hay, sun-cured, late vegetative | 1-00-054 | 90 | 2.29 | 1.88 | 1.12 | 0.61 | 52 | 17.9 | 14.3 | 21 | 19.7 | 6 |
| 004 | | | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 20.0 | 15.9 | 23 | 22.0 | 7 |
| 005 | hay, sun-cured, early bloom | 1-00-059 | 90 | 2.22 | 1.82 | 1.06 | 0.55 | 51 | 16.2 | 12.7 | 22 | 20.7 | 7 |
| 006 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 18.0 | 14.1 | 24 | 23.0 | 8 |
| 007 | hay, sun-cured, midbloom | 1-00-063 | 90 | 2.22 | 1.82 | 1.06 | 0.55 | 51 | 15.3 | 11.6 | 23 | 23.4 | 8 |
| 008 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 17.0 | 12.9 | 26 | 26.0 | 9 |
| 009 | hay, sun-cured, full bloom | 1-00-068 | 90 | 2.10 | 1.72 | 0.96 | 0.47 | 47 | 13.5 | 9.4 | 25 | 26.1 | 9 |
| 010 | | | 100 | 2.34 | 1.92 | 1.07 | 0.52 | 53 | 15.0 | 10.5 | 28 | 29.0 | 10 |
| 011 | hay, sun-cured, mature | 1-00-071 | 91 | 2.17 | 1.78 | 1.01 | 0.50 | 49 | 11.7 | 7.7 | 26 | 34.4 | 13 |
| 012 | | | 100 | 2.38 | 1.95 | 1.11 | 0.55 | 54 | 12.9 | 8.5 | 29 | 37.7 | 14 |
| 013 | meal dehydrated, 15% protein | 1-00-022 | 90 | 2.27 | 1.86 | 1.09 | 0.58 | 52 | 15.6 | 10.9 | 26 | 26.6 | 11 |
| 014 | | | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 17.3 | 12.1 | 29 | 29.4 | 12 |
| 015 | meal dehydrated, 17% protein | 1-00-023 | 92 | 2.43 | 1.99 | 1.23 | 0.71 | 55 | 17.3 | 11.6 | 22 | 24.0 | 10 |
| 016 | | | 100 | 2.65 | 2.17 | 1.34 | 0.77 | 60 | 18.9 | 12.7 | 24 | 26.2 | 11 |
| 017 | silage | 3-00-212 | 41 | 1.08 | 0.88 | 0.52 | 0.29 | 24 | 7.4 | 5.4 | — | 13.6 | — |
| 018 | | | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 17.8 | 13.0 | — | 33.0 | — |
| 019 | silage, < 30% dry matter | 3-08-149 | 26 | 0.73 | 0.60 | 0.37 | 0.22 | 17 | 4.9 | 3.3 | — | 7.4 | — |
| 020 | | | 100 | 2.78 | 2.28 | 1.41 | 0.83 | 63 | 18.7 | 12.4 | — | 28.2 | — |
| 021 | silage, 30-50% dry matter | 3-08-150 | 43 | 1.11 | 0.91 | 0.53 | 0.29 | 25 | 7.8 | 5.5 | — | 15.0 | — |
| 022 | | | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 17.9 | 12.7 | — | 34.6 | — |
| 023 | silage, > 50% dry matter | 3-08-151 | 57 | 1.42 | 1.17 | 0.69 | 0.36 | 32 | 9.8 | 6.7 | — | 19.3 | — |
| 024 | | | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 17.3 | 11.9 | — | 34.0 | — |
| | BARLEY *Hordeum vulgare* | | | | | | | | | | | | |
| 025 | grain | 4-00-549 | 88 | 3.35 | 2.74 | 1.87 | 1.28 | 76 | 11.9 | 9.8 | 4 | 5.0 | 2 |
| 026 | | | 100 | 3.79 | 3.11 | 2.12 | 1.45 | 86 | 13.5 | 11.1 | 5 | 5.7 | 2 |
| 027 | grain, Pacific coast | 4-07-939 | 89 | 3.46 | 2.84 | 1.94 | 1.36 | 79 | 9.6 | 6.3 | — | 6.3 | — |
| 028 | | | 100 | 3.88 | 3.18 | 2.18 | 1.50 | 88 | 10.8 | 7.1 | — | 7.1 | — |
| 029 | hay, sun-cured | 1-00-495 | 87 | 2.16 | 1.77 | 1.03 | 0.53 | 49 | 7.6 | 4.1 | — | 24.1 | — |
| 030 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 8.7 | 4.7 | — | 27.5 | — |
| 031 | straw | 1-00-498 | 91 | 1.93 | 1.58 | 0.82 | 0.32 | 43 | 4.0 | 0.7 | 34 | 38.3 | 10 |
| 032 | | | 100 | 2.12 | 1.74 | 0.90 | 0.35 | 48 | 4.3 | 0.8 | 37 | 42.0 | 11 |
| | BEAN, NAVY *Phaseolus vulgaris* | | | | | | | | | | | | |
| 033 | seeds | 5-00-623 | 89 | 3.43 | 2.82 | 1.91 | 1.32 | 78 | 22.6 | 19.9 | — | 4.5 | — |
| 034 | | | 100 | 3.84 | 3.15 | 2.15 | 1.48 | 87 | 25.3 | 22.3 | — | 5.0 | — |
| | BEET, MANGEL *Beta vulgaris macrorrhiza* | | | | | | | | | | | | |
| 035 | roots, fresh | 4-00-637 | 11 | 0.39 | 0.32 | 0.22 | 0.15 | 9 | 1.3 | 0.9 | — | 0.8 | — |
| 036 | | | 100 | 3.57 | 2.93 | 1.97 | 1.32 | 81 | 11.8 | 8.0 | — | 7.4 | — |
| | BEET, SUGAR *Beta vulgaris altissima* | | | | | | | | | | | | |
| 037 | pulp, dehydrated | 4-00-669 | 91 | 2.96 | 2.43 | 1.60 | 1.04 | 67 | 8.8 | 4.5 | — | 18.0 | 2 |
| 038 | | | 100 | 3.26 | 2.68 | 1.76 | 1.14 | 74 | 9.7 | 5.0 | — | 19.8 | 2 |
| 039 | pulp, wet | 4-00-671 | 11 | 0.37 | 0.30 | 0.20 | 0.13 | 8 | 1.2 | 0.7 | — | 3.1 | — |
| 040 | | | 100 | 3.35 | 2.75 | 1.82 | 1.19 | 76 | 11.2 | 6.1 | — | 28.1 | — |
| 041 | pulp with molasses, dehydrated | 4-00-672 | 92 | 3.11 | 2.55 | 1.70 | 1.12 | 71 | 9.3 | 6.1 | — | 15.1 | 3 |
| 042 | | | 100 | 3.40 | 2.78 | 1.85 | 1.22 | 77 | 10.1 | 6.7 | — | 16.5 | 3 |
| | BERMUDAGRASS *Cynodon dactylon* | | | | | | | | | | | | |
| 043 | hay, sun-cured | 1-00-703 | 91 | 1.97 | 1.62 | 0.85 | 0.35 | 45 | 8.9 | 4.6 | — | 27.8 | — |
| 044 | | | 100 | 2.16 | 1.77 | 0.93 | 0.39 | 49 | 9.8 | 5.0 | — | 30.4 | — |
| 045 | hay, sun-cured, midbloom | 1-00-700 | 93 | 2.21 | 1.81 | 1.03 | 0.51 | 50 | 8.8 | 4.7 | — | 25.9 | — |
| 046 | | | 100 | 2.38 | 1.95 | 1.11 | 0.55 | 54 | 9.5 | 5.1 | — | 27.9 | — |
| 047 | hay, sun-cured, full bloom | 1-00-701 | 92 | 2.11 | 1.73 | 0.96 | 0.45 | 48 | 7.5 | 3.5 | — | 26.3 | — |
| 048 | | | 100 | 2.29 | 1.88 | 1.04 | 0.49 | 52 | 8.1 | 3.8 | — | 28.5 | — |
| | BERMUDAGRASS, COASTAL *Cynodon dactylon* | | | | | | | | | | | | |
| 049 | hay, sun-cured | 1-00-716 | 90 | 2.15 | 1.77 | 0.99 | 0.50 | 49 | 5.4 | 3.4 | — | 27.7 | 5 |
| 050 | | | 100 | 2.38 | 1.95 | 1.11 | 0.55 | 54 | 6.0 | 3.8 | — | 30.7 | 6 |
| 051 | hay, sun-cured, early vegetative | 1-00-713 | 94 | 2.49 | 2.04 | 1.23 | 0.70 | 57 | 15.0 | 10.3 | — | 25.2 | 4 |
| 052 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 16.0 | 10.9 | — | 26.8 | 4 |
| 053 | hay, sun-cured, late vegetative | 1-20-900 | 91 | 2.17 | 1.78 | 1.01 | 0.50 | 50 | 15.0 | 10.3 | — | 24.8 | — |
| 054 | | | 100 | 2.38 | 1.95 | 1.11 | 0.55 | 54 | 16.5 | 11.4 | — | 27.3 | — |
| 055 | hay, sun-cured, early bloom | 1-20-793 | 93 | 2.17 | 1.78 | 1.00 | 0.48 | 49 | — | — | — | 29.8 | 5 |
| 056 | | | 100 | 2.34 | 1.92 | 1.07 | 0.52 | 53 | — | — | — | 32.1 | 5 |
| 057 | hay, sun-cured, full bloom | 1-20-812 | 94 | 2.16 | 1.77 | 0.96 | 0.46 | 49 | — | — | — | 28.1 | 6 |
| 058 | | | 100 | 2.29 | 1.88 | 1.04 | 0.49 | 52 | — | — | — | 29.9 | 6 |
| | BLOOD | | | | | | | | | | | | |
| 059 | meal | 5-00-380 | 92 | 2.70 | 2.22 | 1.42 | 0.86 | 61 | 79.8 | 65.0 | — | 1.0 | — |
| 060 | | | 100 | 2.95 | 2.42 | 1.54 | 0.94 | 67 | 87.2 | 71.0 | — | 1.1 | — |

| Entry Number | Calcium (%) | Chlorine (%) | Cobalt (mg/kg) | Copper (mg/kg) | Fluorine (mg/kg) | Iodine (mg/kg) | Iron (mg/kg) | Magnesium (%) | Manganese (mg/kg) | Molybdenum (mg/kg) | Phosphorus (%) | Potassium (%) | Selenium (mg/kg) | Sodium (%) | Sulfur (%) | Zinc (mg/kg) | Provitamin A (Carotene) (mg/kg) | Vitamin E (mg/kg) | Vitamin D₂ (IU/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 001 | 0.45 | 0.11 | 0.03 | 2 | — | — | 70 | 0.07 | 10 | — | 0.07 | 0.51 | — | 0.05 | 0.09 | 4 | 45 | — | 46 |
| 002 | 1.96 | 0.47 | 0.13 | 10 | — | — | 286 | 0.27 | 43 | — | 0.30 | 2.09 | — | 0.19 | 0.37 | 18 | 185 | — | 191 |
| 003 | 1.38 | 0.31 | 0.08 | 8 | — | — | 204 | 0.22 | 30 | — | 0.26 | 2.29 | — | 0.13 | 0.28 | 25 | 181 | — | — |
| 004 | 1.54 | 0.34 | 0.09 | 9 | — | — | 227 | 0.24 | 34 | — | 0.29 | 2.56 | — | 0.15 | 0.31 | 27 | 202 | — | — |
| 005 | 1.27 | 0.34 | 0.15 | 10 | — | — | 173 | 0.29 | 27 | — | 0.20 | 2.27 | 0.49 | 0.13 | 0.25 | 22 | 126 | 23 | 1,796 |
| 006 | 1.41 | 0.38 | 0.16 | 11 | — | — | 192 | 0.33 | 31 | — | 0.22 | 2.52 | 0.54 | 0.14 | 0.28 | 25 | 140 | 26 | 1,996 |
| 007 | 1.27 | 0.34 | 0.32 | 13 | — | — | 121 | 0.28 | 25 | — | 0.22 | 1.54 | — | 0.11 | 0.26 | 21 | 30 | — | 1,389 |
| 008 | 1.41 | 0.38 | 0.36 | 14 | — | — | 134 | 0.31 | 28 | — | 0.24 | 1.71 | — | 0.12 | 0.28 | 23 | 33 | — | 1,544 |
| 009 | 1.13 | — | 0.29 | 13 | — | — | 135 | 0.28 | 34 | — | 0.20 | 1.38 | — | 0.10 | 0.25 | 22 | 59 | — | — |
| 010 | 1.25 | — | 0.33 | 14 | — | — | 150 | 0.31 | 37 | — | 0.22 | 1.53 | — | 0.11 | 0.27 | 25 | 65 | — | — |
| 011 | 1.03 | — | 0.08 | 13 | — | — | 139 | 0.24 | 40 | — | 0.17 | 1.62 | — | 0.08 | 0.23 | 22 | 11 | — | 1,287 |
| 012 | 1.13 | — | 0.09 | 14 | — | — | 153 | 0.27 | 44 | — | 0.18 | 1.76 | — | 0.08 | 0.25 | 24 | 12 | — | 1,411 |
| 013 | 1.24 | 0.44 | 0.17 | 9 | — | 0.12 | 280 | 0.28 | 28 | — | 0.22 | 2.34 | 0.28 | 0.07 | 0.22 | 19 | 74 | 82 | — |
| 014 | 1.37 | 0.48 | 0.19 | 10 | — | 0.13 | 309 | 0.31 | 31 | — | 0.24 | 2.48 | 0.31 | 0.08 | 0.24 | 21 | 82 | 91 | — |
| 015 | 1.40 | 0.47 | 0.30 | 10 | — | 0.15 | 405 | 0.29 | 31 | — | 0.23 | 2.39 | 0.33 | 0.10 | 0.22 | 19 | 120 | 111 | — |
| 016 | 1.52 | 0.52 | 0.33 | 11 | — | 0.16 | 441 | 0.32 | 34 | — | 0.25 | 2.60 | 0.37 | 0.11 | 0.24 | 21 | 131 | 121 | — |
| 017 | 0.62 | 0.17 | 0.04 | 5 | — | — | 104 | 0.14 | 18 | — | 0.12 | 0.89 | — | 0.05 | 0.14 | 8 | 41 | — | 120 |
| 018 | 1.50 | 0.41 | 0.09 | 11 | — | — | 252 | 0.34 | 42 | — | 0.28 | 2.15 | — | 0.11 | 0.33 | 19 | 99 | — | 289 |
| 019 | 0.37 | — | — | — | — | — | 79 | 0.10 | — | — | 0.08 | 0.62 | — | 0.04 | 0.10 | — | — | — | — |
| 020 | 1.40 | — | — | — | — | — | 300 | 0.36 | — | — | 0.32 | 2.36 | — | 0.16 | 0.36 | — | — | — | — |
| 021 | 0.60 | — | — | 3 | — | — | 121 | 0.15 | 17 | — | 0.12 | 0.89 | — | 0.05 | 0.16 | 8 | 62 | — | — |
| 022 | 1.39 | — | — | 6 | — | — | 279 | 0.34 | 39 | — | 0.27 | 2.05 | — | 0.11 | 0.36 | 18 | 144 | — | — |
| 023 | 0.54 | — | — | 6 | — | — | 133 | 0.19 | 23 | — | 0.17 | 1.13 | — | 0.04 | 0.22 | 9 | 61 | — | — |
| 024 | 0.95 | — | — | 11 | — | — | 234 | 0.34 | 41 | — | 0.30 | 2.00 | — | 0.07 | 0.38 | 17 | 107 | — | — |
| 025 | 0.04 | 0.16 | 0.09 | 8 | — | 0.04 | 75 | 0.14 | 16 | — | 0.34 | 0.41 | 0.19 | 0.03 | 0.15 | 17 | 2 | 22 | — |
| 026 | 0.05 | 0.18 | 0.10 | 9 | — | 0.05 | 85 | 0.15 | 18 | — | 0.38 | 0.47 | 0.22 | 0.03 | 0.17 | 19 | 2 | 25 | — |
| 027 | 0.05 | 0.15 | 0.09 | 8 | — | — | 87 | 0.12 | 16 | — | 0.34 | 0.51 | 0.10 | 0.02 | 0.14 | 15 | — | 26 | — |
| 028 | 0.06 | 0.17 | 0.10 | 9 | — | — | 97 | 0.14 | 18 | — | 0.39 | 0.58 | 0.11 | 0.02 | 0.16 | 17 | — | 30 | — |
| 029 | 0.20 | — | 0.06 | 21 | — | — | 89 | 0.16 | 24 | — | 0.23 | 1.03 | 0.14 | 0.12 | 0.15 | 42 | 46 | — | 963 |
| 030 | 0.23 | — | 0.07 | 24 | — | — | 101 | 0.18 | 27 | — | 0.26 | 1.18 | 0.16 | 0.14 | 0.17 | 48 | 53 | — | 1,103 |
| 031 | 0.27 | 0.61 | 0.06 | 5 | — | — | 183 | 0.21 | 15 | — | 0.07 | 2.16 | — | 0.13 | 0.16 | 7 | 2 | — | 603 |
| 032 | 0.30 | 0.67 | 0.07 | 5 | — | — | 201 | 0.23 | 17 | — | 0.07 | 2.37 | — | 0.14 | 0.17 | 7 | 2 | — | 662 |
| 033 | 0.16 | 0.06 | — | 10 | — | — | 99 | 0.13 | 21 | — | 0.52 | 1.31 | — | 0.04 | 0.23 | — | — | 1 | — |
| 034 | 0.18 | 0.06 | — | 11 | — | — | 110 | 0.15 | 24 | — | 0.59 | 1.47 | — | 0.05 | 0.26 | — | — | 1 | — |
| 035 | 0.02 | 0.16 | — | 1 | — | — | 17 | 0.02 | — | — | 0.02 | 0.25 | — | 0.07 | 0.02 | — | 0 | — | — |
| 036 | 0.18 | 1.41 | — | 6 | — | — | 154 | 0.20 | — | — | 0.22 | 2.30 | — | 0.63 | 0.20 | — | 1 | — | — |
| 037 | 0.63 | 0.04 | 0.07 | 12 | — | — | 299 | 0.24 | 35 | — | 0.09 | 0.18 | — | 0.19 | 0.20 | 1 | 0 | — | 577 |
| 038 | 0.69 | 0.04 | 0.08 | 14 | — | — | 329 | 0.27 | 38 | — | 0.10 | 0.20 | — | 0.21 | 0.22 | 1 | 0 | — | 637 |
| 039 | 0.10 | — | — | — | — | — | 36 | 0.02 | — | — | 0.01 | 0.02 | — | 0.02 | 0.02 | 0 | — | — | — |
| 040 | 0.87 | — | — | — | — | — | 330 | 0.22 | — | — | 0.10 | 0.19 | — | 0.19 | 0.22 | 1 | — | — | — |
| 041 | 0.56 | — | 0.21 | 15 | — | — | 190 | 0.14 | 24 | — | 0.09 | 1.63 | — | 0.48 | 0.39 | 1 | 0 | — | — |
| 042 | 0.61 | — | 0.23 | 16 | — | — | 207 | 0.16 | 27 | — | 0.10 | 1.78 | — | 0.53 | 0.42 | 2 | 0 | — | — |
| 043 | 0.43 | — | 0.11 | — | — | 0.11 | 265 | 0.16 | — | — | 0.16 | 1.40 | — | 0.07 | 0.19 | — | 53 | — | — |
| 044 | 0.47 | — | 0.12 | — | — | 0.12 | 290 | 0.17 | — | — | 0.17 | 1.53 | — | 0.08 | 0.21 | — | 58 | — | — |
| 045 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 046 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 047 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 048 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 049 | 0.39 | — | — | — | — | — | 271 | 0.16 | — | — | 0.15 | 1.45 | — | 0.40 | 0.19 | 9 | 95 | — | — |
| 050 | 0.43 | — | — | — | — | — | 300 | 0.17 | — | — | 0.20 | 1.61 | — | 0.44 | 0.21 | 11 | 105 | — | — |
| 051 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 052 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 053 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 116 | — | — |
| 054 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 125 | — | — |
| 055 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 056 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 057 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — |
| 058 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 1 | — | — | — |
| 059 | 0.29 | 0.28 | 0.09 | 10 | — | — | 3719 | 0.22 | 5 | — | 0.24 | 0.09 | 0.73 | 0.32 | 0.34 | 4 | — | — | — |
| 060 | 0.32 | 0.30 | 0.10 | 11 | — | — | 4064 | 0.24 | 6 | — | 0.26 | 0.10 | 0.50 | 0.35 | 0.37 | 5 | — | — | — |

TABLE 13    Composition of Some Sheep Feeds; Data Expressed on an As-Fed and Dry Basis (100% Dry Matter)—*Continued*

| Entry Number | Feed Name Description[a] | International Feed Number | Dry Matter (%) | DE Sheep (Mcal/kg) | ME Sheep (Mcal/kg) | NEm (Mcal/kg) | NEg (Mcal/kg) | TDN Sheep (%) | Crude Protein (%) | Dig Protein (%) | Cellulose (%) | Crude Fiber (%) | Lignin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BLUEGRASS, CANADA *Poa compressa* | | | | | | | | | | | | |
| 061 | fresh, early vegetative | 2-00-763 | 26 | 0.76 | 0.62 | 0.39 | 0.24 | 17 | 4.9 | 3.7 | — | 6.6 | — |
| 062 | | | 100 | 2.91 | 2.39 | 1.51 | 0.91 | 66 | 18.7 | 14.4 | — | 25.5 | — |
| 063 | hay, sun-cured | 1-00-762 | 92 | 2.44 | 2.00 | 1.21 | 0.68 | 55 | 9.6 | 4.1 | — | 27.8 | — |
| 064 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 10.3 | 4.5 | — • | 30.1 | — |
| 065 | hay, sun-cured, early vegetative | 1-00-760 | 91 | 2.41 | 1.97 | 1.19 | 0.67 | 54 | 15.7 | 11.0 | — | 23.5 | — |
| 066 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 17.3 | 12.1 | — | 25.8 | — |
| | BLUEGRASS, KENTUCKY *Poa pratensis* | | | | | | | | | | | | |
| 067 | fresh, early vegetative | 2-00-777 | 31 | 0.88 | 0.72 | 0.46 | 0.27 | 20 | 5.4 | 4.1 | 8 | 7.8 | 1 |
| 068 | | | 100 | 2.87 | 2.35 | 1.47 | 0.88 | 65 | 17.4 | 13.2 | 26 | 25.3 | 3 |
| 069 | fresh, early bloom | 2-00-779 | 35 | 1.07 | 0.87 | 0.56 | 0.35 | 24 | 5.8 | 4.2 | 10 | 9.6 | 1 |
| 070 | | | 100 | 3.04 | 2.50 | 1.60 | 1.00 | 69 | 16.6 | 12.0 | 28 | 27.4 | 4 |
| | BREWERS | | | | | | | | | | | | |
| 071 | grains, dehydrated | 5-02-141 | 92 | 2.84 | 2.33 | 1.50 | 0.95 | 65 | 27.1 | 19.8 | — | 13.2 | 6 |
| 072 | | | 100 | 3.09 | 2.53 | 1.63 | 1.03 | 70 | 29.4 | 21.5 | — | 14.4 | 6 |
| | BROME *Bromus spp* | | | | | | | | | | | | |
| 073 | fresh, early vegetative | 2-00-892 | 34 | 1.20 | 0.98 | 0.66 | 0.44 | 27 | 6.1 | 5.0 | 9 | 8.1 | 1 |
| 074 | | | 100 | 3.53 | 2.89 | 1.94 | 1.30 | 80 | 18.0 | 14.8 | 27 | 24.0 | 3 |
| 075 | fresh, mature | 2-00-898 | 57 | — | — | — | — | — | 3.6 | 1.7 | 20 | 21.5 | 5 |
| 076 | | | 100 | — | — | — | — | — | 6.4 | 3.0 | 35 | 38.0 | 9 |
| 077 | hay, sun-cured | 1-00-890 | 91 | 2.20 | 1.80 | 1.04 | 0.53 | 49 | 8.8 | 4.8 | — | 30.1 | 4 |
| 078 | | | 100 | 2.43 | 1.99 | 1.14 | 0.58 | 55 | 9.7 | 5.3 | — | 33.3 | 5 |
| | BUFFALOGRASS *Buchloe dactyloides* | | | | | | | | | | | | |
| 079 | fresh | 2-01-010 | 46 | 1.13 | 0.93 | 0.54 | 0.28 | 26 | 4.7 | 2.5 | — | 12.2 | 3 |
| 080 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 10.3 | 5.6 | — | 26.7 | 6 |
| | CANARYGRASS, REED *Phalaris arundinacca* | | | | | | | | | | | | |
| 081 | fresh | 2-01-113 | 27 | 0.66 | 0.54 | 0.32 | 0.16 | 15 | 3.1 | 0.4 | 6 | 7.8 | 1 |
| 082 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 11.6 | 1.7 | 22 | 29.5 | 4 |
| 083 | hay, sun-cured | 1-01-104 | 91 | 1.97 | 1.61 | 0.85 | 0.35 | 45 | 9.4 | 5.8 | 24 | 30.1 | 3 |
| 084 | | | 100 | 2.16 | 1.77 | 0.93 | 0.39 | 49 | 10.3 | 6.4 | 26 | 33.0 | 4 |
| | CANE MOLASSES—SEE MOLASSES CATTLE MILK—SEE MILK CITRUS *Citrus spp* | | | | | | | | | | | | |
| 085 | pomace, silage (pulp) | 4-01-234 | 21 | 0.81 | 0.67 | 0.46 | 0.32 | 18 | 1.5 | 0.8 | — | 3.3 | — |
| 086 | | | 100 | 3.88 | 3.18 | 2.18 | 1.50 | 88 | 7.3 | 3.7 | — | 15.6 | — |
| 087 | pomace without fines, dehydrated | 4-01-237 | 91 | 3.38 | 2.77 | 1.87 | 1.27 | 76 | 6.1 | 3.1 | — | 11.6 | 3 |
| 088 | (pulp) | | 100 | 3.70 | 3.04 | 2.06 | 1.40 | 84 | 6.7 | 3.4 | — | 12.7 | 3 |
| | CLOVER, ALSIKE *Trifolium hybridum* | | | | | | | | | | | | |
| 089 | hay, sun-cured | 1-01-313 | 88 | 2.25 | 1.84 | 1.09 | 0.60 | 51 | 13.1 | 8.7 | — | 26.5 | — |
| 090 | | | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 14.9 | 9.9 | — | 30.1 | — |
| | CLOVER, CRIMSON *Trifolium incarnatum* | | | | | | | | | | | | |
| 091 | hay, sun-cured | 1-01-328 | 87 | 2.12 | 1.73 | 0.99 | 0.50 | 48 | 16.1 | 11.0 | — | 26.3 | — |
| 092 | | | 100 | 2.43 | 1.99 | 1.14 | 0.58 | 55 | 18.4 | 12.7 | — | 30.1 | — |
| | CLOVER, LADINO *Trifolium repens* | | | | | | | | | | | | |
| 093 | hay, sun-cured | 1-01-378 | 90 | 2.61 | 2.14 | 1.36 | 0.82 | 59 | 19.7 | 15.0 | — | 19.1 | 6 |
| 094 | | | 100 | 2.91 | 2.39 | 1.51 | 0.91 | 66 | 22.0 | 16.7 | — | 21.2 | 7 |
| | CLOVER, RED *Trifolium pratense* | | | | | | | | | | | | |
| 095 | fresh, early bloom | 2-01-428 | 20 | 0.59 | 0.49 | 0.31 | 0.09 | 13 | 3.8 | 3.0 | — | 4.6 | — |
| 096 | | | 100 | 3.00 | 2.46 | 1.57 | 0.47 | 68 | 19.4 | 15.0 | — | 23.3 | — |
| 097 | fresh, midbloom | 2-07-725 | 26 | 0.80 | 0.66 | 0.42 | 0.27 | 18 | 4.0 | 2.9 | — | 6.6 | — |
| 098 | | | 100 | 3.09 | 2.53 | 1.63 | 1.03 | 70 | 15.3 | 11.0 | — | 25.4 | — |
| 099 | fresh, full bloom | 2-01-429 | 26 | 0.74 | 0.61 | 0.37 | 0.22 | 17 | 3.8 | 2.8 | — | 6.8 | — |
| 100 | | | 100 | 2.82 | 2.31 | 1.44 | 0.86 | 64 | 14.6 | 10.6 | — | 26.1 | — |
| 101 | fresh, late bloom | 2-07-724 | 23 | 0.67 | 0.55 | 0.34 | 0.20 | 15 | 3.6 | 2.6 | — | 5.5 | — |
| 102 | | | 100 | 2.87 | 2.35 | 1.47 | 0.88 | 65 | 15.2 | 11.2 | — | 23.4 | — |
| 103 | hay, sun-cured | 1-01-415 | 89 | 2.34 | 1.92 | 1.17 | 0.66 | 53 | 14.2 | 9.0 | 23 | 25.5 | 9 |
| 104 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 16.0 | 10.1 | 26 | 28.8 | 10 |
| 105 | hay, sun-cured, early vegetative | 1-01-394 | 87 | 2.50 | 2.05 | 1.28 | 0.77 | 57 | 18.7 | 13.8 | — | 17.8 | — |
| 106 | | | 100 | 2.87 | 2.35 | 1.47 | 0.88 | 65 | 21.4 | 15.8 | — | 20.4 | — |
| 107 | hay, sun-cured, late vegetative | 1-01-397 | 87 | 2.56 | 2.10 | 1.34 | 0.82 | 58 | 17.0 | 10.5 | — | 17.3 | — |
| 108 | | | 100 | 2.95 | 2.42 | 1.54 | 0.94 | 67 | 19.6 | 12.1 | — | 20.0 | — |
| 109 | hay, sun-cured, early bloom | 1-01-400 | 86 | 2.44 | 2.00 | 1.24 | 0.74 | 55 | 16.0 | 11.4 | — | 23.5 | — |
| 110 | | | 100 | 2.82 | 2.31 | 1.44 | 0.86 | 64 | 18.5 | 13.2 | — | 27.2 | — |
| 111 | hay, sun-cured, midbloom | 1-01-401 | 88 | 2.41 | 1.98 | 1.21 | 0.70 | 55 | 16.0 | 10.1 | — | 25.3 | — |
| 112 | | | 100 | 2.73 | 2.24 | 1.38 | 0.80 | 62 | 18.1 | 11.4 | — | 28.6 | — |
| 113 | hay, sun-cured, full bloom | 1-01-403 | 86 | 2.38 | 1.96 | 1.21 | 0.71 | 54 | 13.1 | 8.5 | — | 25.6 | — |
| 114 | | | 100 | 2.78 | 2.28 | 1.41 | 0.83 | 63 | 15.3 | 9.9 | — | 29.8 | — |

| Entry Number | Calcium (%) | Chlorine (%) | Cobalt (mg/kg) | Copper (mg/kg) | Fluorine (mg/kg) | Iodine (mg/kg) | Iron (mg/kg) | Magnesium (%) | Manganese (mg/kg) | Molybdenum (mg/kg) | Phosphorus (%) | Potassium (%) | Selenium (mg/kg) | Sodium (%) | Sulfur (%) | Zinc (mg/kg) | Provitamin A (Carotene) (mg/kg) | Vitamin E (mg/kg) | Vitamin D₃ (IU/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 061 | 0.10 | — | — | — | — | — | 78 | 0.04 | — | — | 0.10 | 0.53 | — | 0.04 | 0.04 | — | 104 | — | — |
| 062 | 0.39 | — | — | — | — | — | 300 | 0.16 | — | — | 0.39 | 2.04 | — | 0.14 | 0.17 | — | 400 | — | — |
| 063 | 0.28 | — | — | — | — | — | 277 | 0.31 | 85 | — | 0.25 | 1.65 | — | 0.10 | 0.12 | — | 270 | — | — |
| 064 | 0.30 | — | — | — | — | — | 300 | 0.33 | 93 | — | 0.27 | 1.78 | — | 0.11 | 0.13 | — | 293 | — | — |
| 065 | 0.27 | — | — | — | — | — | 273 | 0.30 | — | — | 0.26 | 1.45 | — | 0.10 | 0.12 | — | — | — | — |
| 066 | 0.30 | — | — | — | — | — | 300 | 0.33 | — | — | 0.29 | 1.59 | — | 0.11 | 0.13 | — | — | — | — |
| 067 | 0.15 | — | — | — | — | — | 92 | 0.05 | — | — | 0.14 | 0.70 | — | 0.04 | 0.05 | — | 149 | 45 | — |
| 068 | 0.50 | — | — | — | — | — | 300 | 0.18 | — | — | 0.44 | 2.27 | — | 0.14 | 0.17 | — | 482 | 156 | — |
| 069 | 0.16 | — | — | — | — | — | 105 | 0.04 | — | — | 0.14 | 0.70 | — | 0.05 | 0.06 | — | 98 | — | — |
| 070 | 0.46 | — | — | — | — | — | 300 | 0.11 | — | — | 0.39 | 2.01 | — | 0.14 | 0.17 | — | 280 | — | — |
| 071 | 0.30 | 0.15 | 0.06 | 21 | — | 0.07 | 245 | 0.15 | 37 | — | 0.51 | 0.08 | 0.70 | 0.21 | 0.30 | 27 | 0 | 26 | — |
| 072 | 0.33 | 0.17 | 0.06 | 23 | — | 0.07 | 266 | 0.16 | 40 | — | 0.55 | 0.09 | 0.76 | 0.23 | 0.32 | 30 | 1 | 29 | — |
| 073 | 0.17 | — | — | — | — | — | 68 | 0.06 | — | — | 0.10 | 0.78 | — | 0.01 | 0.07 | — | 156 | — | — |
| 074 | 0.50 | — | — | — | — | — | 200 | 0.18 | — | — | 0.30 | 2.30 | — | 0.02 | 0.20 | — | 459 | — | — |
| 075 | 0.11 | — | — | — | — | — | 113 | 0.10 | — | — | 0.15 | 0.71 | — | 0.01 | 0.11 | — | 47 | — | — |
| 076 | 0.20 | — | — | — | — | — | 200 | 0.18 | — | — | 0.26 | 1.25 | — | 0.02 | 0.20 | — | 83 | — | — |
| 077 | 0.31 | — | — | — | — | — | 181 | 0.09 | — | — | 0.17 | 1.74 | — | 0.02 | 0.18 | — | 31 | — | 948 |
| 078 | 0.35 | — | — | — | — | — | 200 | 0.09 | — | — | 0.19 | 1.93 | — | 0.02 | 0.20 | — | 34 | — | 1,407 |
| 079 | 0.26 | — | — | — | — | — | — | 0.06 | — | — | 0.09 | 0.33 | — | — | — | — | 43 | — | — |
| 080 | 0.57 | — | — | — | — | — | — | 0.14 | — | — | 0.21 | 0.71 | — | — | — | — | 94 | — | — |
| 081 | 0.11 | — | — | — | — | — | — | — | — | — | 0.09 | 0.97 | — | — | — | — | — | — | — |
| 082 | 0.41 | — | — | — | — | — | — | — | — | — | 0.35 | 3.64 | — | — | — | — | — | — | — |
| 083 | 0.35 | — | 0.02 | 11 | — | — | 137 | 0.27 | 108 | — | 0.23 | 2.51 | — | 0.13 | — | — | 23 | — | — |
| 084 | 0.38 | — | 0.02 | 12 | — | — | 150 | 0.29 | 118 | — | 0.25 | 2.76 | — | 0.14 | — | — | 26 | — | — |
| 085 | 0.43 | — | — | — | — | — | 33 | 0.03 | — | — | 0.63 | 0.13 | — | 0.02 | 0.00 | 3 | — | — | — |
| 086 | 2.04 | — | — | — | — | — | 160 | 0.16 | — | — | 0.15 | 0.62 | — | 0.09 | 0.02 | 16 | — | — | — |
| 087 | 1.67 | — | 0.14 | 5 | — | — | 345 | 0.16 | 7 | — | 0.11 | 0.72 | — | 0.08 | 0.08 | 14 | 0 | — | — |
| 088 | 1.84 | — | 0.16 | 6 | — | — | 378 | 0.17 | 7 | — | 0.12 | 0.79 | — | 0.09 | 0.08 | 15 | 0 | — | — |
| 089 | 1.13 | 0.69 | — | 5 | — | — | 225 | 0.36 | 61 | — | 0.23 | 2.17 | — | 0.40 | 0.17 | — | 164 | — | — |
| 090 | 1.29 | 0.78 | — | 6 | — | — | 260 | 0.41 | 69 | — | 0.26 | 2.46 | — | 0.46 | 0.19 | — | 187 | — | — |
| 091 | 1.22 | 0.55 | — | — | — | 0.06 | 610 | 0.24 | 149 | — | 0.19 | 2.09 | — | 0.34 | 0.24 | — | 20 | — | — |
| 092 | 1.40 | 0.63 | — | — | — | 0.07 | 700 | 0.28 | 171 | — | 0.22 | 2.40 | — | 0.39 | 0.28 | — | 23 | — | — |
| 093 | 1.21 | 0.27 | 0.15 | 9 | — | 0.27 | 370 | 0.43 | 85 | — | 0.28 | 2.35 | — | 0.12 | 0.19 | 15 | 75 | — | — |
| 094 | 1.35 | 0.30 | 0.16 | 10 | — | 0.30 | 413 | 0.48 | 95 | — | 0.31 | 2.62 | — | 0.13 | 0.21 | 17 | 83 | — | — |
| 095 | 0.45 | — | — | — | — | — | 59 | 0.10 | — | — | 0.08 | 0.49 | — | 0.04 | 0.03 | — | 49 | — | — |
| 096 | 2.26 | — | — | — | — | — | 300 | 0.51 | — | — | 0.38 | 2.49 | — | 0.20 | 0.17 | — | 248 | — | — |
| 097 | 0.46 | — | — | — | — | — | — | 0.13 | — | — | 0.09 | 0.52 | — | — | 0.05 | — | — | — | — |
| 098 | 1.76 | — | — | — | — | — | — | 0.51 | — | — | 0.33 | 1.96 | — | — | 0.18 | — | — | — | — |
| 099 | 0.27 | — | — | — | — | — | 79 | 0.13 | — | — | 0.07 | 0.51 | — | 0.05 | 0.05 | — | 54 | — | — |
| 100 | 1.01 | — | — | — | — | — | 300 | 0.51 | — | — | 0.27 | 1.96 | — | 0.20 | 0.17 | — | 208 | — | — |
| 101 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 102 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 103 | 1.35 | 0.28 | 0.14 | 10 | — | 0.22 | 163 | 0.35 | 65 | — | 0.22 | 1.44 | — | 0.16 | 0.15 | 15 | 18 | — | 1,694 |
| 104 | 1.53 | 0.32 | 0.16 | 11 | — | 0.25 | 184 | 0.43 | 73 | — | 0.25 | 1.62 | — | 0.19 | 0.17 | 17 | 20 | — | 1,914 |
| 105 | 1.35 | — | 0.20 | 18 | — | — | 629 | 0.34 | 76 | — | 0.32 | 2.82 | — | — | — | 45 | — | — | — |
| 106 | 1.55 | — | 0.23 | 21 | — | — | 721 | 0.39 | 87 | — | 0.37 | 3.24 | — | — | — | 52 | — | — | — |
| 107 | 1.29 | — | 0.15 | 18 | — | — | 315 | 0.33 | 72 | — | 0.29 | 2.54 | — | — | — | 37 | — | — | — |
| 108 | 1.49 | — | 0.17 | 20 | — | — | 363 | 0.38 | 83 | — | 0.33 | 2.93 | — | — | — | 43 | — | — | — |
| 109 | 1.24 | — | 0.14 | 15 | — | — | 213 | 0.19 | 69 | — | 0.30 | 2.59 | — | — | — | 35 | — | — | — |
| 110 | 1.44 | — | 0.16 | 18 | — | — | 246 | 0.22 | 80 | — | 0.35 | 3.00 | — | — | — | 40 | — | — | — |
| 111 | 1.48 | — | — | — | — | — | — | — | — | — | 0.26 | 1.28 | — | — | — | — | — | — | — |
| 112 | 1.67 | — | — | — | — | — | — | — | — | — | 0.29 | 1.45 | — | — | — | — | — | — | — |
| 113 | 1.25 | — | 0.11 | 13 | — | — | 137 | 0.33 | 66 | — | 0.23 | 2.00 | — | 0.17 | 0.15 | 35 | — | — | 1,643 |
| 114 | 1.46 | — | 0.13 | 15 | — | — | 159 | 0.39 | 77 | — | 0.27 | 2.33 | — | 0.20 | 0.18 | 41 | — | — | 1,914 |

TABLE 13  Composition of Some Sheep Feeds; Data Expressed on an As-Fed and Dry Basis (100% Dry Matter)—*Continued*

| Entry Number | Feed Name Description[a] | International Feed Number | Dry Matter (%) | DE Sheep (Mcal/kg) | ME Sheep (Mcal/kg) | NE$_m$ (Mcal/kg) | NE$_g$ (Mcal/kg) | TDN Sheep (%) | Crude Protein (%) | Dig Protein (%) | Cellulose (%) | Crude Fiber (%) | Lignin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CORN, DENT YELLOW** *Zea mays indentata* | | | | | | | | | | | | |
| 115 | aerial part with ears, sun-cured (fodder) | 1-28-231 | 81 | 2.26 | 1.85 | 1.14 | 0.67 | 51 | 7.2 | 3.8 | 23 | 20.5 | 2 |
| 116 | | | 100 | 2.76 | 2.28 | 1.41 | 0.83 | 63 | 8.9 | 4.7 | 28 | 25.2 | 3 |
| 117 | aerial part without ears without husks, sun-cured (stover) (straw) | 1-28-233 | 85 | 2.21 | 1.82 | 1.09 | 0.60 | 50 | 5.6 | 2.5 | 21 | 29.3 | 9 |
| 118 | | | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 6.6 | 2.9 | 25 | 34.4 | 11 |
| 119 | cobs, ground | 1-28-234 | 90 | 2.03 | 1.66 | 0.96 | 0.41 | 46 | 2.8 | -0.5 | 25 | 32.7 | 6 |
| 120 | | | 100 | 2.25 | 1.84 | 1.07 | 0.45 | 51 | 3.2 | -0.5 | 28 | 36.2 | 7 |
| 121 | distillers grains, dehydrated | 5-28-235 | 94 | 3.59 | 2.94 | 2.02 | 1.39 | 82 | 21.5 | 15.6 | — | 11.3 | — |
| 122 | | | 100 | 3.84 | 3.15 | 2.12 | 1.48 | 87 | 23.0 | 16.7 | — | 12.1 | — |
| 123 | distillers grains with solubles, dehydrated | 5-28-236 | 92 | 3.52 | 2.89 | 1.98 | 1.36 | 80 | 23.0 | 11.2 | 13 | 9.1 | 4 |
| 124 | | | 100 | 3.84 | 3.15 | 2.15 | 1.48 | 87 | 25.0 | 12.3 | 14 | 9.9 | 4 |
| 125 | distillers solubles, dehydrated | 5-28-237 | 93 | 3.48 | 2.85 | 1.94 | 1.33 | 79 | 27.6 | 21.8 | 6 | 4.6 | 1 |
| 126 | | | 100 | 3.75 | 3.07 | 2.09 | 1.43 | 85 | 29.7 | 23.5 | 6 | 5.0 | 1 |
| 127 | ears, ground (corn and cob meal) | 4-28-238 | 87 | 3.17 | 2.60 | 1.77 | 1.19 | 71 | 7.8 | 4.8 | — | 8.2 | — |
| 128 | | | 100 | 3.66 | 3.00 | 2.03 | 1.37 | 83 | 9.0 | 5.5 | — | 9.4 | — |
| 129 | ears with husks, silage | 4-28-239 | 44 | 1.43 | 1.17 | 0.77 | 0.50 | 32 | 3.9 | 2.1 | — | 5.1 | — |
| 130 | | | 100 | 3.26 | 2.68 | 1.76 | 1.14 | 74 | 8.9 | 4.8 | — | 11.6 | — |
| 131 | gluten, meal | 5-28-241 | 91 | 3.54 | 2.90 | 1.98 | 1.37 | 80 | 42.7 | 36.3 | 7 | 4.4 | 1 |
| 132 | | | 100 | 3.88 | 3.18 | 2.18 | 1.50 | 88 | 46.8 | 39.8 | 8 | 4.8 | 1 |
| 133 | gluten with bran (corn gluten feed) | 5-28-243 | 90 | 3.29 | 2.70 | 1.83 | 1.23 | 75 | 23.0 | — | — | 8.7 | — |
| 134 | | | 100 | 3.66 | 3.00 | 2.03 | 1.37 | 83 | 25.6 | — | — | 9.7 | — |
| 135 | grain, grade 2 69.5 kg/hl (54 lb/bushel) | 4-02-931 | 88 | 3.39 | 2.78 | 1.89 | 1.30 | 77 | 8.9 | 5.7 | — | 2.0 | — |
| 136 | | | 100 | 3.84 | 3.15 | 2.15 | 1.48 | 87 | 10.1 | 6.5 | — | 2.2 | — |
| 137 | grain, grade 3 66.9 kg/hl (52 lb/bushel) | 4-02-932 | 86 | 3.30 | 2.71 | 1.85 | 1.27 | 75 | 8.7 | 5.6 | — | 2.0 | — |
| 138 | | | 100 | 3.84 | 3.15 | 2.15 | 1.48 | 87 | 10.1 | 6.5 | — | 2.4 | — |
| 139 | silage, aerial part without ears without husks (stalklage) (stover) | 3-28-251 | 31 | 0.72 | 0.59 | 0.33 | 0.16 | 16 | 1.9 | 0.5 | 8 | 9.6 | 2 |
| 140 | | | 100 | 2.34 | 1.92 | 1.07 | 0.52 | 53 | 6.3 | 1.7 | 25 | 31.3 | 7 |
| 141 | silage, well eared | 3-28-250 | 33 | 1.03 | 0.85 | 0.54 | 0.34 | 23 | 2.7 | 1.2 | — | 7.9 | — |
| 142 | | | 100 | 3.09 | 2.53 | 1.63 | 1.03 | 70 | 8.1 | 3.6 | — | 23.7 | — |
| | **CORN SWEET** *Zea mays saccharata* | | | | | | | | | | | | |
| 143 | process residue, silage (cannery residue) | 3-07-955 | 32 | 0.88 | 0.72 | 0.45 | 0.27 | 20 | 2.4 | 1.0 | — | 11.2 | — |
| 144 | | | 100 | 2.75 | 2.28 | 1.41 | 0.83 | 63 | 7.7 | 3.2 | — | 35.5 | — |
| | **COTTON** *Gossypium* spp | | | | | | | | | | | | |
| 145 | gin by-product | 1-08-413 | 90 | 1.83 | 1.50 | 0.75 | 0.26 | 42 | 6.6 | 2.9 | — | 30.7 | — |
| 146 | | | 100 | 2.03 | 1.66 | 0.83 | 0.29 | 46 | 7.4 | 3.2 | — | 34.1 | — |
| 147 | hulls | 1-01-599 | 91 | 1.96 | 1.60 | 0.85 | 0.35 | 44 | 3.7 | -0.5 | 53 | 43.3 | 22 |
| 148 | | | 100 | 2.16 | 1.77 | 0.93 | 0.39 | 49 | 4.1 | -0.5 | 59 | 47.8 | 24 |
| 149 | seeds, ground | 5-01-608 | 92 | 3.96 | 3.27 | 2.27 | 1.60 | 90 | 21.8 | 16.1 | — | 18.2 | — |
| 150 | | | 100 | 4.32 | 3.54 | 2.47 | 1.74 | 98 | 23.6 | 17.5 | — | 19.8 | — |
| 151 | seeds, meal mechanical extracted | 5-01-609 | 93 | 2.58 | 2.12 | 1.31 | 0.77 | 59 | 37.9 | 27.3 | — | 13.3 | — |
| 152 | | | 100 | 2.75 | 2.28 | 1.41 | 0.83 | 63 | 40.8 | 29.3 | — | 14.3 | — |
| 153 | seeds, meal mechanical extracted, 41% protein | 5-01-617 | 93 | 3.06 | 2.51 | 1.66 | 1.08 | 70 | 41.0 | — | 12 | 11.9 | 6 |
| 154 | | | 100 | 3.31 | 2.71 | 1.79 | 1.16 | 75 | 44.3 | — | 13 | 12.8 | 6 |
| 155 | seeds, meal solvent extracted, 41% protein | 5-01-621 | 91 | 2.86 | 2.34 | 1.52 | 0.96 | 65 | 41.2 | — | 11 | 12.1 | — |
| 156 | | | 100 | 3.13 | 2.57 | 1.67 | 1.06 | 71 | 45.2 | — | 12 | 13.3 | — |
| | **DISTILLERS GRAINS—SEE CORN; SEE RYE; SEE SORGHUM** | | | | | | | | | | | | |
| | **FESCUE, KENTUCKY 31** *Festuca arundinacea* | | | | | | | | | | | | |
| 157 | fresh | 2-01-902 | 29 | 0.85 | 0.69 | 0.44 | 0.26 | 19 | 4.2 | 2.8 | — | 7.1 | — |
| 158 | | | 100 | 2.91 | 2.39 | 1.51 | 0.91 | 66 | 14.5 | 9.6 | — | 24.6 | — |
| 159 | fresh, early vegetative | 2-01-900 | 28 | 0.89 | 0.73 | 0.48 | 0.31 | 20 | 6.1 | 4.9 | — | 5.9 | — |
| 160 | | | 100 | 3.22 | 2.64 | 1.73 | 1.11 | 73 | 22.1 | 17.6 | — | 21.4 | — |
| 161 | fresh, early bloom | 2-01-901 | 29 | 0.85 | 0.69 | 0.45 | 0.27 | 19 | 4.8 | 3.6 | — | 7.1 | — |
| 162 | | | 100 | 2.95 | 2.42 | 1.54 | 0.94 | 67 | 16.7 | 12.6 | — | 24.7 | — |
| 163 | hay, sun-cured | 1-20-800 | 92 | 2.43 | 1.99 | 1.20 | 0.68 | 55 | 16.7 | 12.0 | — | 22.9 | 4 |
| 164 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 18.2 | 13.1 | — | 24.9 | 4 |
| 165 | hay, sun-cured, early vegetative | 1-09-184 | 92 | 3.09 | 2.53 | 1.67 | 1.09 | 70 | 18.9 | 14.1 | — | 21.2 | 3 |
| 166 | | | 100 | 3.35 | 2.75 | 1.82 | 1.19 | 76 | 20.6 | 15.3 | — | 23.0 | 3 |
| 167 | hay, sun-cured, late vegetative | 1-09-185 | 91 | 3.05 | 2.50 | 1.66 | 1.08 | 70 | 19.4 | 14.9 | — | 22.4 | — |
| 168 | | | 100 | 3.35 | 2.75 | 1.82 | 1.19 | 76 | 21.3 | 16.3 | — | 24.6 | — |
| 169 | hay, sun-cured, early bloom | 1-09-186 | 91 | 2.49 | 2.04 | 1.26 | 0.73 | 56 | 15.4 | 13.9 | 26 | 22.8 | 3 |
| 170 | | | 100 | 2.73 | 2.24 | 1.38 | 0.80 | 62 | 20.2 | 15.3 | 29 | 25.0 | 3 |
| 171 | hay, sun-cured, midbloom | 1-09-187 | 92 | 2.44 | 2.00 | 1.21 | 0.68 | 55 | 15.2 | 10.3 | 28 | 24.4 | 3 |
| 172 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 16.4 | 11.2 | 30 | 26.5 | 4 |
| 173 | hay, sun-cured, full bloom | 1-09-188 | 92 | 2.34 | 1.92 | 1.14 | 0.63 | 53 | 11.1 | 7.1 | 29 | 25.1 | 5 |
| 174 | | | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 12.1 | 7.7 | 32 | 27.4 | 5 |

| Entry Number | Calcium (%) | Chlorine (%) | Cobalt (mg/kg) | Copper (mg/kg) | Fluorine (mg/kg) | Iodine (mg/kg) | Iron (mg/kg) | Magnesium (%) | Manganese (mg/kg) | Molybdenum (mg/kg) | Phosphorus (%) | Potassium (%) | Selenium (mg/kg) | Sodium (%) | Sulfur (%) | Zinc (mg/kg) | Provitamin A (Carotene) (mg/kg) | Vitamin E (mg/kg) | Vitamin D2 (IU/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 115 | 0.41 | 0.15 | — | 6 | — | — | 81 | 0.24 | 55 | — | 0.20 | 0.76 | — | 0.02 | 0.11 | — | 4 | — | 1,074 |
| 116 | 0.50 | 0.19 | — | 8 | — | — | 100 | 0.29 | 68 | — | 0.25 | 0.93 | — | 0.03 | 0.14 | — | 4 | — | 1,323 |
| 117 | 0.49 | — | — | 4 | — | — | 179 | 0.34 | 116 | — | 0.08 | 1.24 | — | 0.06 | 0.15 | — | 4 | — | 938 |
| 118 | 0.57 | — | — | 5 | — | — | 210 | 0.40 | 136 | — | 0.10 | 1.45 | — | 0.07 | 0.17 | — | 4 | — | 1,103 |
| 119 | 0.11 | — | 0.12 | 7 | — | — | 206 | 0.06 | 6 | — | 0.04 | 0.79 | — | 0.42 | 0.42 | — | 1 | — | — |
| 120 | 0.12 | — | 0.13 | 7 | — | — | 230 | 0.07 | 6 | — | 0.04 | 0.87 | — | 0.47 | 0.47 | — | 1 | — | — |
| 121 | 0.10 | 0.07 | 0.08 | 45 | — | 0.04 | 209 | 0.07 | 22 | — | 0.40 | 0.17 | 0.45 | 0.09 | 0.43 | 33 | 3 | — | — |
| 122 | 0.11 | 0.08 | 0.09 | 48 | — | 0.05 | 223 | 0.07 | 23 | — | 0.43 | 0.18 | 0.48 | 0.10 | 0.46 | 35 | 3 | — | — |
| 123 | 0.14 | 0.17 | 0.17 | 53 | — | — | 237 | 0.16 | 23 | — | 0.65 | 0.40 | 0.39 | 0.53 | 0.31 | — | 3 | 40 | 551 |
| 124 | 0.15 | 0.18 | 0.18 | 58 | — | — | 259 | 0.18 | 25 | — | 0.71 | 0.44 | 0.42 | 0.57 | 0.33 | — | 3 | 43 | 600 |
| 125 | 0.33 | 0.26 | 0.20 | 83 | — | 0.11 | 566 | 0.60 | 74 | — | 1.27 | 1.67 | 0.33 | 0.23 | 0.37 | 85 | 1 | 46 | — |
| 126 | 0.35 | 0.28 | 0.21 | 89 | — | 0.12 | 610 | 0.65 | 80 | — | 1.37 | 1.80 | 0.36 | 0.25 | 0.40 | 92 | 1 | 49 | — |
| 127 | 0.06 | 0.04 | 0.27 | 7 | — | 0.02 | 79 | 0.12 | 12 | — | 0.24 | 0.46 | 0.07 | 0.02 | 0.14 | 12 | 3 | 18 | — |
| 128 | 0.07 | 0.05 | 0.31 | 8 | — | 0.03 | 91 | 0.14 | 14 | — | 0.27 | 0.53 | 0.09 | 0.02 | 0.16 | 14 | 4 | 20 | — |
| 129 | 0.04 | — | — | — | — | — | 35 | 0.05 | — | — | 0.13 | 0.22 | — | 0.00 | 0.06 | — | 3 | — | — |
| 130 | 0.10 | — | — | — | — | — | 80 | 0.12 | — | — | 0.29 | 0.49 | — | 0.01 | 0.13 | — | 8 | — | — |
| 131 | 0.15 | 0.06 | 0.08 | 28 | — | — | 386 | 0.06 | 8 | — | 0.45 | 0.03 | 1.01 | 0.09 | 0.35 | 174 | 16 | 31 | — |
| 132 | 0.16 | 0.07 | 0.08 | 30 | — | — | 423 | 0.06 | 8 | — | 0.50 | 0.03 | 1.11 | 0.10 | 0.39 | 190 | 18 | 34 | — |
| 133 | 0.33 | 0.22 | 0.09 | 47 | — | 0.07 | 484 | 0.33 | 23 | — | 0.74 | 0.57 | 0.27 | 0.94 | 0.21 | 65 | 6 | 12 | — |
| 134 | 0.36 | 0.25 | 0.10 | 52 | — | 0.07 | 471 | 0.36 | 26 | — | 0.82 | 0.64 | 0.30 | 1.05 | 0.23 | 72 | 7 | 14 | — |
| 135 | 0.02 | 0.04 | 0.03 | 4 | — | — | 23 | 0.12 | 5 | — | 0.31 | 0.33 | — | 0.02 | 0.12 | 14 | 2 | 22 | — |
| 136 | 0.02 | 0.05 | 0.04 | 4 | — | — | 26 | 0.13 | 6 | — | 0.35 | 0.37 | — | 0.02 | 0.14 | 16 | 2 | 25 | — |
| 137 | 0.02 | — | — | — | — | — | 22 | 0.15 | 5 | — | 0.25 | 0.33 | — | 0.01 | 0.12 | — | — | — | — |
| 138 | 0.02 | — | — | — | — | — | 25 | 0.17 | 6 | — | 0.29 | 0.38 | — | 0.01 | 0.14 | — | — | — | — |
| 139 | 0.12 | — | — | — | — | — | — | 0.10 | — | — | 0.09 | 0.47 | — | 0.01 | 0.03 | — | 5 | — | — |
| 140 | 0.38 | — | — | — | — | — | — | 0.31 | — | — | 0.31 | 1.54 | — | 0.03 | 0.11 | — | 15 | — | — |
| 141 | 0.06 | — | 0.02 | 3 | — | — | 87 | 0.06 | 10 | — | 0.07 | 0.32 | — | 0.00 | 0.05 | 7 | 15 | — | 40 |
| 142 | 0.23 | — | 0.06 | 10 | — | — | 260 | 0.19 | 30 | — | 0.22 | 0.96 | — | 0.01 | 0.15 | 21 | 45 | — | 119 |
| 143 | 0.10 | — | — | — | — | — | 63 | 0.06 | — | — | 0.29 | 0.36 | — | 0.01 | 0.04 | — | 4 | — | — |
| 144 | 0.30 | — | — | — | — | — | 200 | 0.24 | — | — | 0.90 | 1.15 | — | 0.03 | 0.11 | — | 13 | — | — |
| 145 | 0.75 | — | — | — | — | — | — | — | — | — | 0.20 | — | — | — | — | — | — | — | — |
| 146 | 0.83 | — | — | — | — | — | — | — | — | — | 0.22 | — | — | — | — | — | — | — | — |
| 147 | 0.13 | 0.02 | 0.02 | 12 | — | — | 119 | 0.13 | 108 | — | 0.09 | 0.79 | — | 0.02 | 0.06 | 20 | — | — | — |
| 148 | 0.15 | 0.02 | 0.02 | 13 | — | — | 131 | 0.14 | 119 | — | 0.09 | 0.87 | — | 0.02 | 0.09 | 22 | — | — | — |
| 149 | 0.14 | — | — | 50 | — | — | 139 | 0.32 | 9 | — | 0.67 | 1.11 | — | 0.29 | 0.24 | — | — | — | — |
| 150 | 0.15 | — | — | 53 | — | — | 151 | 0.35 | 10 | — | 0.73 | 1.20 | — | 0.31 | 0.26 | — | — | — | — |
| 151 | 0.20 | 0.02 | 0.15 | 21 | — | — | 139 | 0.53 | 22 | — | 0.90 | 1.26 | — | 0.04 | 0.24 | — | — | — | — |
| 152 | 0.21 | 0.02 | 0.16 | 23 | — | — | 150 | 0.57 | 24 | — | 0.97 | 1.35 | — | 0.04 | 0.26 | — | — | — | — |
| 153 | 0.19 | 0.04 | 0.16 | 19 | — | — | 182 | 0.54 | 22 | — | 1.08 | 1.34 | — | 0.04 | 0.40 | 64 | 0 | 32 | — |
| 154 | 0.21 | 0.05 | 0.17 | 20 | — | — | 197 | 0.58 | 24 | — | 1.16 | 1.45 | — | 0.05 | 0.43 | 69 | 0 | 35 | — |
| 155 | 0.17 | 0.05 | 0.15 | 20 | — | — | 208 | 0.54 | 21 | — | 1.10 | 1.39 | — | 0.04 | 0.26 | 62 | — | 16 | — |
| 156 | 0.18 | 0.05 | 0.17 | 22 | — | — | 225 | 0.59 | 23 | — | 1.21 | 1.52 | — | 0.05 | 0.28 | 68 | — | 17 | — |
| 157 | 0.15 | — | — | — | — | — | — | — | — | — | 0.11 | — | — | — | — | — | 64 | — | — |
| 158 | 0.51 | — | — | — | — | — | — | — | — | — | 0.37 | — | — | — | — | — | 219 | — | — |
| 159 | 0.15 | — | — | — | — | — | — | — | — | — | 0.11 | — | — | — | — | — | 64 | — | — |
| 160 | 0.53 | — | — | — | — | — | — | — | — | — | 0.39 | — | — | — | — | — | 306 | — | — |
| 161 | 0.15 | — | — | — | — | — | — | — | — | — | 0.11 | — | — | — | — | — | 63 | — | — |
| 162 | 0.52 | — | — | — | — | — | — | — | — | — | 0.37 | — | — | — | — | — | 221 | — | — |
| 163 | 0.41 | — | — | 25 | — | — | 157 | 0.19 | 114 | — | 0.37 | 2.57 | — | 0.01 | — | 35 | — | — | — |
| 164 | 0.44 | — | — | 28 | — | — | 171 | 0.21 | 124 | — | 0.40 | 2.80 | — | 0.01 | — | 38 | — | — | — |
| 165 | 0.62 | — | — | 17 | — | — | 451 | 0.22 | 153 | — | 0.47 | 2.17 | — | 0.01 | — | 53 | — | — | — |
| 166 | 0.67 | — | — | 18 | — | — | 490 | 0.24 | 166 | — | 0.51 | 2.36 | — | 0.01 | — | 57 | — | — | — |
| 167 | 0.45 | — | — | 16 | — | — | 294 | 0.18 | 139 | — | 0.38 | 2.37 | — | 0.01 | — | 38 | — | — | — |
| 168 | 0.50 | — | — | 17 | — | — | 323 | 0.19 | 153 | — | 0.42 | 2.61 | — | 0.01 | — | 42 | — | — | — |
| 169 | 0.35 | — | — | 15 | — | — | 221 | 0.11 | 74 | — | 0.24 | 1.75 | — | 0.02 | — | 32 | — | — | — |
| 170 | 0.38 | — | — | 17 | — | — | 243 | 0.12 | 81 | — | 0.26 | 1.96 | — | 0.02 | — | 35 | — | — | — |
| 171 | 0.42 | — | — | 23 | — | — | 144 | 0.16 | 96 | — | 0.27 | 1.90 | — | 0.01 | — | 33 | — | — | — |
| 172 | 0.45 | — | — | 25 | — | — | 156 | 0.17 | 104 | — | 0.29 | 2.06 | — | 0.01 | — | 36 | — | — | — |
| 173 | 0.39 | — | — | 26 | — | — | 174 | 0.16 | 94 | — | 0.29 | 2.16 | — | — | — | 35 | — | — | — |
| 174 | 0.43 | — | — | 28 | — | — | 190 | 0.17 | 103 | — | 0.32 | 2.36 | — | — | — | 38 | — | — | — |

TABLE 13  Composition of Some Sheep Feeds; Data Expressed on an As-Fed and Dry Basis (100% Dry Matter)—*Continued*

| Entry Number | Feed Name Description[a] | International Feed Number | Dry Matter (%) | DE Sheep (Mcal/kg) | ME Sheep (Mcal/kg) | NE_m (Mcal/kg) | NE_g (Mcal/kg) | TDN Sheep (%) | Crude Protein (%) | Dig. Protein (%) | Cellulose (%) | Crude Fiber (%) | Lignin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | FESCUE, MEADOW *Festuca elatior* | | | | | | | | | | | | |
| 175 | hay, sun-cured | 1-01-912 | 88 | 2.29 | 1.87 | 1.13 | 0.62 | 52 | 8.0 | 4.4 | 33 | 29.1 | 6 |
| 176 | | | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 9.1 | 5.1 | 38 | 33.1 | 7 |
| | FISH, MENHADEN *Brevoortia tyrannus* | | | | | | | | | | | | |
| 177 | meal mechanical extracted | 5-02-009 | 92 | 2.83 | 2.32 | 1.50 | 0.95 | 64 | 61.1 | 49.5 | — | 0.9 | — |
| 178 | | | 100 | 3.09 | 2.53 | 1.63 | 1.03 | 70 | 66.7 | 54.0 | — | 1.0 | — |
| 179 | meal mechanical extracted, 60% | 5-20-969 | 91 | 3.11 | 2.55 | 1.68 | 1.11 | 71 | 60.9 | — | — | 0.8 | — |
| 180 | protein | | 100 | 3.40 | 2.78 | 1.85 | 1.22 | 77 | 66.6 | — | — | 0.9 | — |
| 181 | solubles, condensed | 5-02-007 | 50 | 1.87 | 1.53 | 1.03 | 0.70 | 42 | 31.6 | — | — | — | — |
| 182 | | | 100 | 3.70 | 3.04 | 2.06 | 1.40 | 84 | 62.7 | — | — | — | — |
| 183 | solubles, dehydrated | 5-02-008 | 93 | 3.39 | 2.78 | 1.89 | 1.27 | 77 | 62.0 | — | — | — | — |
| 184 | | | 100 | 3.66 | 3.00 | 2.03 | 1.37 | 83 | 66.9 | — | — | — | — |
| | FLAX, COMMON *Linum usitatissimum* | | | | | | | | | | | | |
| 185 | seeds, meal mechanical extracted | 5-02-045 | 91 | 3.32 | 2.72 | 1.85 | 1.25 | 75 | 34.3 | 28.9 | — | 8.8 | 6 |
| 186 | (linseed meal) | | 100 | 3.66 | 3.00 | 2.03 | 1.37 | 83 | 37.9 | 31.8 | — | 9.6 | 7 |
| 187 | seeds, meal solvent extracted | 5-02-048 | 90 | 3.14 | 2.58 | 1.72 | 1.14 | 72 | 34.6 | 29.5 | — | 9.1 | 5 |
| 188 | (linseed meal) | | 100 | 3.48 | 2.86 | 1.91 | 1.27 | 79 | 38.3 | 32.8 | — | 10.1 | 6 |
| | GRAMA *Bouteloua* spp | | | | | | | | | | | | |
| 189 | fresh, early vegetative | 2-02-163 | 41 | 1.09 | 0.89 | 0.54 | 0.30 | 25 | 5.4 | 3.8 | — | 11.2 | — |
| 190 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 13.1 | 9.2 | — | 27.2 | — |
| 191 | fresh, mature | 2-02-166 | 63 | 1.57 | 1.28 | 0.74 | 0.43 | 35 | 4.1 | 1.9 | — | 20.7 | — |
| 192 | | | 100 | 2.47 | 2.03 | 1.18 | 0.68 | 56 | 6.5 | 3.0 | — | 32.7 | — |
| | GRASS-LEGUME | | | | | | | | | | | | |
| 193 | aerial part molasses added, silage | 3-02-309 | 28 | 0.74 | 0.61 | 0.36 | 0.20 | 17 | 3.4 | 2.0 | — | 9.1 | — |
| 194 | | | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 11.8 | 6.9 | — | 32.0 | — |
| 195 | silage | 3-02-303 | 29 | 0.81 | 0.66 | 0.40 | 0.23 | 18 | 3.3 | 1.9 | — | 9.4 | — |
| 196 | | | 100 | 2.73 | 2.24 | 1.38 | 0.80 | 62 | 11.3 | 6.5 | — | 31.8 | — |
| | HOP, COMMON *Humulus lupulus* | | | | | | | | | | | | |
| 197 | fruit (hops), spent dehydrated | 5-02-396 | 93 | 1.40 | 1.15 | 0.34 | — | 32 | 23.1 | 6.9 | — | 22.7 | — |
| 198 | | | 100 | 1.50 | 1.23 | 0.37 | — | 34 | 24.8 | 7.4 | — | 24.3 | — |
| | KOCHIA—SEE SUMMERCYPRESS | | | | | | | | | | | | |
| | LESPEDEZA, COMMON *Lespedeza striata* | | | | | | | | | | | | |
| 199 | fresh | 2-02-568 | 28 | 0.71 | 0.58 | 0.35 | 0.19 | 16 | 4.2 | 3.1 | — | 10.0 | — |
| 200 | | | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 15.3 | 11.3 | — | 36.1 | — |
| 201 | fresh, late vegetative | 2-07-093 | 25 | 0.65 | 0.53 | 0.32 | 0.18 | 15 | 4.0 | 3.0 | — | 8.0 | — |
| 202 | | | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 16.0 | 11.9 | — | 32.0 | — |
| 203 | hay, sun-cured | 1-08-591 | 88 | 1.95 | 1.60 | 0.85 | 0.37 | 44 | 14.8 | 6.4 | — | 27.2 | — |
| 204 | | | 100 | 2.21 | 1.81 | 0.97 | 0.42 | 50 | 16.8 | 7.2 | — | 30.8 | — |
| 205 | hay, sun-cured, early vegetative | 1-20-886 | 89 | 2.40 | 1.97 | 1.19 | 0.69 | 54 | 14.3 | 9.7 | — | 22.7 | — |
| 206 | | | 100 | 2.69 | 2.21 | 1.34 | 0.77 | 61 | 16.0 | 10.9 | — | 25.5 | — |
| 207 | hay, sun-cured, late vegetative | 1-20-881 | 90 | 2.18 | 1.79 | 1.03 | 0.52 | 50 | 14.4 | 9.8 | — | 23.0 | — |
| 208 | | | 100 | 2.43 | 1.99 | 1.14 | 0.58 | 55 | 16.0 | 10.9 | — | 25.6 | — |
| 209 | hay, sun-cured, midbloom | 1-02-554 | 92 | 2.30 | 1.89 | 1.11 | 0.59 | 52 | 13.8 | 9.2 | — | 26.4 | — |
| 210 | | | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 15.1 | 10.1 | — | 28.8 | — |
| 211 | hay, sun-cured, full bloom | 1-20-887 | 89 | 2.28 | 1.87 | 1.10 | 0.61 | 52 | 12.8 | 8.4 | — | 27.4 | — |
| 212 | | | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 14.3 | 9.4 | — | 30.7 | — |
| | LINSEED—SEE FLAX | | | | | | | | | | | | |
| | MEADOW PLANTS, INTERMOUNTAIN | | | | | | | | | | | | |
| 213 | hay, sun-cured | 1-03-181 | 95 | 2.43 | 1.99 | 1.18 | 0.65 | 55 | 8.3 | 5.0 | — | 30.7 | — |
| 214 | | | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 8.7 | 5.2 | — | 32.3 | — |
| 215 | hay, sun-cured, early vegetative | 1-08-464 | 90 | 2.78 | 2.28 | — | — | 63 | — | — | — | — | — |
| 216 | | | 100 | 3.09 | 2.53 | — | — | 70 | — | — | — | — | — |
| 217 | hay, sun-cured, late bloom, cut 1 | 1-09-176 | 94 | 1.90 | 1.56 | 0.78 | 0.27 | 43 | 7.6 | 3.6 | — | — | — |
| 218 | | | 100 | 2.03 | 1.66 | 0.83 | 0.29 | 46 | 8.1 | 3.8 | — | — | — |
| 219 | hay, sun-cured, mature | 1-08-465 | 91 | 1.64 | 1.35 | 0.58 | 0.10 | 37 | 5.1 | 1.5 | — | 30.0 | — |
| 220 | | | 100 | 1.81 | 1.48 | 0.64 | 0.11 | 41 | 5.6 | 1.6 | — | 33.0 | — |
| | MILK *Bos taurus* | | | | | | | | | | | | |
| 221 | fresh (cattle) | 5-01-168 | 12 | 0.69 | 0.65 | 0.46 | 0.46 | 8 | 3.3 | 3.1 | — | — | — |
| 222 | | | 100 | 5.60 | 5.43 | 3.80 | 3.80 | 150 | 26.7 | 25.4 | — | — | — |
| 223 | skimmed, fresh (cattle) | 5-01-170 | 10 | 0.39 | 0.39 | 0.28 | 0.28 | 11 | 3.0 | — | — | — | — |
| 224 | | | 100 | 4.06 | 3.94 | 2.76 | 2.76 | 109 | 31.2 | — | — | — | — |
| | MILK *Ovis aries* | | | | | | | | | | | | |
| 225 | fresh (sheep) | 5-08-510 | 19 | 1.15 | 1.11 | 0.77 | 0.77 | 31 | 4.7 | — | — | 0 | — |
| 226 | | | 100 | 6.00 | 5.82 | 4.07 | 4.07 | 161 | 24.7 | — | — | 0 | — |
| | MOLASSES *Beta vulgaris altissima* | | | | | | | | | | | | |
| | beet, sugar, molasses, more than 48% | | | | | | | | | | | | |
| 227 | invert sugar more than 79.5 degrees | 4-00-668 | 78 | 2.64 | 2.16 | 1.44 | 0.95 | 60 | 6.6 | 3.4 | — | — | — |
| 228 | brix | | 100 | 3.40 | 2.78 | 1.85 | 1.22 | 77 | 8.5 | 4.4 | — | — | — |

| Entry Number | Calcium (%) | Chlorine (%) | Cobalt (mg/kg) | Copper (mg/kg) | Fluorine (mg/kg) | Iodine (mg/kg) | Iron (mg/kg) | Magnesium (%) | Manganese (mg/kg) | Molybdenum (mg/kg) | Phosphorus (%) | Potassium (%) | Selenium (mg/kg) | Sodium (%) | Sulfur (%) | Zinc (mg/kg) | Provitamin A (Carotene) (mg/kg) | Vitamin E (mg/kg) | Vitamin D2 (IU/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 175 | 0.35 | — | 0.12 | — | — | — | — | 0.44 | 22 | — | 0.27 | 1.61 | — | — | — | — | 64 | 119 | — |
| 176 | 0.40 | — | 0.14 | — | — | — | — | 0.50 | 25 | — | 0.31 | 1.84 | — | — | — | — | 73 | 136 | — |
| 177 | 5.18 | 0.55 | 0.15 | 11 | — | 1.09 | 480 | 0.14 | 34 | — | 2.89 | 0.70 | 2.19 | 0.39 | 0.45 | 148 | — | 12 | — |
| 178 | 5.65 | 0.60 | 0.17 | 12 | — | 1.19 | 524 | 0.16 | 37 | — | 3.16 | 0.76 | 2.40 | 0.43 | 0.49 | 162 | — | 13 | — |
| 179 | 5.21 | 0.32 | 0.14 | 11 | — | 1.20 | 423 | 0.13 | 30 | — | 3.00 | 0.60 | — | 0.32 | 0.34 | 134 | — | 9 | — |
| 180 | 5.70 | 0.35 | 0.16 | 12 | — | 1.31 | 462 | 0.14 | 33 | — | 3.28 | 0.65 | — | 0.35 | 0.38 | 146 | — | 10 | — |
| 181 | 0.06 | — | — | 2 | — | — | 839 | 0.12 | 12 | — | 0.58 | 1.79 | 2.14 | 1.80 | — | 17 | — | — | — |
| 182 | 0.11 | — | — | 4 | — | — | 1663 | 0.24 | 24 | — | 1.15 | 3.55 | 4.24 | 3.57 | — | 35 | — | — | — |
| 183 | 0.13 | — | — | 7 | — | — | 736 | 0.22 | 14 | — | 1.19 | 3.82 | 3.93 | 4.91 | — | 26 | — | — | — |
| 184 | 0.14 | — | — | 7 | — | — | 794 | 0.24 | 15 | — | 1.25 | 4.12 | 4.24 | 5.30 | — | 25 | — | — | — |
| 185 | 0.41 | 0.04 | 0.41 | 26 | — | 0.07 | 176 | 0.58 | 38 | — | 0.87 | 1.22 | 0.81 | 0.11 | 0.37 | 33 | 0 | 8 | — |
| 186 | 0.45 | 0.04 | 0.46 | 29 | — | 0.07 | 194 | 0.64 | 42 | — | 0.96 | 1.34 | 0.89 | 0.12 | 0.41 | 36 | 0 | 9 | — |
| 187 | 0.39 | 0.04 | 0.19 | 26 | — | — | 319 | 0.60 | 38 | — | 0.80 | 1.38 | 0.82 | 0.14 | 0.39 | — | — | 14 | — |
| 188 | 0.43 | 0.04 | 0.21 | 29 | — | — | 354 | 0.66 | 42 | — | 0.89 | 1.53 | 0.91 | 0.15 | 0.43 | — | — | 15 | — |
| 189 | 0.22 | — | — | 2 | — | — | — | — | 18 | — | 0.08 | — | — | — | — | — | — | — | — |
| 190 | 0.53 | — | — | 6 | — | — | — | — | 44 | — | 0.19 | — | — | — | — | — | — | — | — |
| 191 | 0.22 | — | 0.12 | 8 | — | — | 824 | — | 30 | — | 0.08 | 0.22 | — | — | — | — | 19 | — | — |
| 192 | 0.34 | — | 0.18 | 13 | — | — | 1300 | — | 47 | — | 0.12 | 0.35 | — | — | — | — | 30 | — | — |
| 193 | 0.30 | — | — | — | — | — | 148 | 0.09 | — | — | 0.10 | 0.55 | — | 0.04 | 0.07 | — | — | — | — |
| 194 | 1.07 | — | — | — | — | — | 520 | 0.32 | — | — | 0.34 | 1.92 | — | 0.13 | 0.24 | — | — | — | — |
| 195 | 0.25 | 0.31 | 0.04 | — | — | — | 153 | 0.09 | 16 | — | 0.08 | 0.53 | — | 0.04 | 0.16 | — | 68 | — | 85 |
| 196 | 0.85 | 1.06 | 0.13 | — | — | — | 520 | 0.32 | 55 | — | 0.27 | 1.80 | — | 0.13 | 0.54 | — | 230 | — | 289 |
| 197 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 198 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 199 | 0.31 | — | — | — | — | — | 88 | 0.08 | 49 | — | 0.08 | 0.32 | — | — | — | — | — | — | — |
| 200 | 1.13 | — | — | — | — | — | 320 | 0.27 | 178 | — | 0.27 | 1.16 | — | — | — | — | — | — | — |
| 201 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 202 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 203 | 0.78 | — | — | 7 | — | — | 187 | 0.20 | 99 | — | 0.25 | 1.21 | — | — | 0.21 | 21 | 44 | — | — |
| 204 | 0.88 | — | — | 8 | — | — | 211 | 0.23 | 112 | — | 0.29 | 1.37 | — | — | 0.24 | 24 | 50 | — | — |
| 205 | 1.09 | — | — | — | — | — | 285 | 0.23 | 145 | — | 0.26 | 0.95 | — | — | — | — | — | — | — |
| 206 | 1.22 | — | — | — | — | — | 320 | 0.26 | 163 | — | 0.29 | 1.07 | — | — | — | — | — | — | — |
| 207 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 208 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 209 | 1.08 | — | — | — | — | — | 284 | 0.24 | 204 | — | 0.22 | 0.92 | — | — | — | — | — | — | — |
| 210 | 1.18 | — | — | — | — | — | 310 | 0.26 | 223 | — | 0.24 | 1.01 | — | — | — | — | — | — | — |
| 211 | 1.02 | — | — | — | — | — | 268 | 0.20 | 102 | — | 0.19 | 0.93 | — | — | — | 36 | — | — | — |
| 212 | 1.14 | — | — | — | — | — | 300 | 0.23 | 114 | — | 0.21 | 1.04 | — | — | — | 41 | — | — | — |
| 213 | 0.58 | — | — | — | — | — | — | 0.16 | — | — | 0.17 | 1.50 | — | 0.11 | — | — | 32 | — | — |
| 214 | 0.61 | — | — | — | — | — | — | 0.17 | — | — | 0.18 | 1.58 | — | 0.12 | — | — | 33 | — | — |
| 215 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 216 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 217 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 218 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 219 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 220 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 221 | 0.12 | 0.11 | 0.00 | 0 | — | — | 1 | 0.01 | — | — | 0.09 | 0.14 | — | 0.05 | 0.04 | 3 | — | — | — |
| 222 | 0.95 | 0.92 | 0.01 | 1 | — | — | 10 | 0.10 | — | — | 0.76 | 1.12 | — | 0.38 | 0.32 | 23 | — | — | — |
| 223 | 0.13 | 0.09 | 0.01 | — | — | — | 1 | 0.01 | 0 | — | 0.10 | 0.18 | — | 0.04 | 0.03 | 5 | — | — | — |
| 224 | 1.31 | 0.96 | 0.11 | — | — | — | 10 | 0.12 | 2 | — | 1.04 | 1.90 | — | 0.47 | 0.32 | 51 | — | — | — |
| 225 | 0.20 | 0.04 | — | — | — | — | — | 0.02 | — | — | 0.15 | — | — | 0.04 | — | — | — | 15 | — |
| 226 | — | — | — | — | — | — | — | — | — | — | — | — | — | 0 | — | — | — | — | — |
| 227 | 0.13 | 1.28 | 0.36 | 17 | — | — | 68 | 0.23 | 4 | — | 0.03 | 4.72 | — | 1.15 | 0.46 | 14 | — | 4 | — |
| 228 | 0.17 | 1.64 | 0.46 | 22 | — | — | 87 | 0.29 | 6 | — | 0.03 | 6.07 | — | 1.45 | 0.60 | 18 | — | 5 | — |

TABLE 13   Composition of Some Sheep Feeds; Data Expressed on an As-Fed and Dry Basis (100% Dry Matter)—*Continued*

| Entry Number | Feed Name Description[a] | International Feed Number | Dry Matter (%) | DE Sheep (Mcal/kg) | ME Sheep (Mcal/kg) | NEm (Mcal/kg) | NEg (Mcal/kg) | TDN Sheep (%) | Crude Protein (%) | Dig. Protein (%) | Cellulose (%) | Crude Fiber (%) | Lignin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | MOLASSES *Saccharum officinarum* | | | | | | | | | | | | |
| 229 | sugarcane, molasses, dehydrated | 4-04-695 | 94 | 3.16 | 2.60 | 1.71 | 1.12 | 71 | 9.7 | 6.3 | — | 6.3 | — |
| 230 | | | 100 | 3.35 | 2.75 | 1.83 | 1.19 | 76 | 10.3 | 6.7 | — | 6.7 | — |
| | sugarcane, molasses > 46% | | | | | | | | | | | | |
| 231 | invert sugars > 79.5° | 4-04-696 | 75 | 2.60 | 2.13 | 1.43 | 0.95 | 59 | 4.4 | -1.3 | — | 0.4 | 0 |
| 232 | Brix (black strap) | | 100 | 3.48 | 2.86 | 1.91 | 1.27 | 79 | 5.8 | -1.7 | — | 0.5 | 0 |
| | NEEDLEANDTHREAD *Stipa comata* | | | | | | | | | | | | |
| 233 | fresh, early vegetative | 2-03-195 | 29 | 0.75 | 0.62 | 0.37 | 0.21 | 17 | 3.1 | 2.0 | 9 | 8.4 | 1 |
| 234 | | | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 10.6 | 6.9 | 30 | 29.0 | 4 |
| 235 | fresh, early bloom | 2-03-196 | 33 | 0.86 | 0.70 | 0.42 | 0.23 | 19 | 3.1 | 1.9 | 11 | 10.3 | 2 |
| 236 | | | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 9.5 | 5.8 | 33 | 31.1 | 5 |
| 237 | fresh, midbloom | 2-03-197 | 35 | 0.90 | 0.73 | 0.43 | 0.24 | 20 | 3.1 | 1.9 | — | 11.5 | — |
| 238 | | | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 8.9 | 5.3 | — | 32.9 | — |
| 239 | fresh, full bloom | 2-03-198 | 38 | 0.94 | 0.77 | 0.45 | 0.23 | 21 | 3.2 | 1.8 | — | 14.2 | — |
| 240 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 8.4 | 4.8 | — | 37.3 | — |
| 241 | fresh, mature | 2-03-199 | 57 | 1.13 | 0.93 | 0.45 | 0.14 | 26 | 3.0 | 0.9 | 19 | 20.6 | 4 |
| 242 | | | 100 | 1.98 | 1.63 | 0.79 | 0.25 | 45 | 5.2 | 1.5 | 33 | 36.2 | 7 |
| 243 | fresh, stem cured | 2-07-989 | 92 | 1.74 | 1.43 | 0.66 | 0.17 | 40 | 3.7 | 1.0 | 33 | — | 6 |
| 244 | | | 100 | 1.90 | 1.56 | 0.72 | 0.18 | 43 | 4.1 | 1.1 | 36 | — | 6 |
| | OATS *Avena sativa* | | | | | | | | | | | | |
| 245 | cereal by-product, less than 4% fiber | 4-03-303 | 91 | 3.88 | 3.18 | 2.23 | 1.57 | 88 | 14.8 | 11.9 | — | 3.5 | — |
| 246 | (feeding oat meal) (oat middlings) | | 100 | 4.25 | 3.51 | 2.45 | 1.73 | 97 | 16.4 | 13.1 | — | 3.9 | — |
| 247 | grain | 4-03-309 | 89 | 3.02 | 2.47 | 1.65 | 1.09 | 68 | 11.8 | 9.3 | 10 | 10.8 | 2 |
| 248 | | | 100 | 3.40 | 2.78 | 1.85 | 1.22 | 77 | 13.3 | 10.4 | 11 | 12.1 | 3 |
| 249 | grain, grade 1 heavy 46.3 kg/hl | 4-03-312 | 89 | 3.18 | 2.61 | 1.75 | 1.17 | 72 | 12.6 | 11.1 | — | 8.9 | — |
| 250 | | | 100 | 3.57 | 2.93 | 1.97 | 1.32 | 81 | 14.2 | 12.5 | — | 10.0 | — |
| 251 | grain, grade 2 41.2 kg/hl | 4-03-316 | 89 | 2.98 | 2.44 | 1.62 | 1.06 | 68 | 11.4 | 8.0 | — | 10.8 | — |
| 252 | | | 100 | 3.35 | 2.75 | 1.82 | 1.19 | 76 | 12.8 | 9.0 | — | 12.2 | — |
| 253 | grain, light less than 34.7 kg/hl | 4-03-318 | 91 | 2.64 | 2.16 | 1.37 | 0.83 | 59 | 11.9 | 8.2 | — | 14.4 | — |
| 254 | | | 100 | 2.91 | 2.39 | 1.51 | 0.91 | 66 | 13.1 | 9.1 | — | 15.9 | — |
| 255 | grain, Pacific coast | 4-07-999 | 91 | 3.13 | 2.56 | 1.71 | 1.13 | 71 | 9.1 | 5.8 | — | 11.2 | — |
| 256 | | | 100 | 3.44 | 2.82 | 1.88 | 1.24 | 78 | 10.0 | 6.4 | — | 12.3 | — |
| 257 | groats | 4-03-331 | 90 | 4.03 | 3.30 | 2.12 | 1.49 | 91 | 15.8 | 12.0 | — | 2.5 | — |
| 258 | | | 100 | 4.50 | 3.69 | 2.35 | 1.65 | 102 | 17.7 | 13.4 | — | 2.8 | — |
| 259 | hay, sun-cured | 1-03-280 | 91 | 2.13 | 1.75 | 1.04 | 0.53 | 49 | 8.5 | 5.2 | — | 27.8 | 5 |
| 260 | | | 100 | 2.34 | 1.92 | 1.14 | 0.58 | 53 | 9.3 | 5.7 | — | 30.4 | 6 |
| 261 | silage | 3-03-296 | 31 | 0.84 | 0.69 | 0.43 | 0.25 | 19 | 3.0 | 1.5 | — | 9.7 | — |
| 262 | | | 100 | 2.73 | 2.24 | 1.38 | 0.80 | 62 | 9.6 | 4.9 | — | 31.5 | — |
| 263 | straw | 1-03-283 | 92 | 1.91 | 1.57 | 0.73 | 0.23 | 44 | 4.1 | 0.3 | 37 | 37.3 | 13 |
| 264 | | | 100 | 2.07 | 1.70 | 0.79 | 0.25 | 47 | 4.4 | 0.3 | 40 | 40.5 | 14 |
| | ONION, GARDEN *Allium cepa* | | | | | | | | | | | | |
| 265 | aerial part, fresh | 2-03-417 | 91 | 2.66 | 2.18 | 1.37 | 0.83 | 60 | 11.5 | 8.0 | — | 20.7 | — |
| 266 | | | 100 | 2.91 | 2.39 | 1.51 | 0.91 | 66 | 12.6 | 8.7 | — | 22.6 | — |
| 267 | bulbs, fresh, mature | 4-03-418 | 10 | — | — | — | — | — | 1.0 | 0.7 | — | — | — |
| 268 | | | 100 | — | — | — | — | — | 10.1 | 6.5 | — | — | — |
| | ORCHARDGRASS *Dactylis glomerata* | | | | | | | | | | | | |
| 269 | fresh, early vegetative | 2-03-439 | 23 | 0.69 | 0.57 | 0.35 | 0.22 | 16 | 4.3 | 3.1 | 6 | 5.8 | 1 |
| 270 | | 270 | 100 | 2.95 | 2.42 | 1.54 | 0.94 | 67 | 18.4 | 13.3 | 25 | 24.7 | 3 |
| 271 | fresh, late vegetative | 2-08-476 | 24 | 0.70 | 0.57 | 0.36 | 0.22 | 16 | 4.1 | 3.1 | 4 | 6.4 | 1 |
| 272 | | 272 | 100 | 2.91 | 2.39 | 1.51 | 0.91 | 66 | 17.0 | 12.8 | 19 | 26.5 | 4 |
| 273 | fresh, early bloom | 2-03-442 | 25 | 0.67 | 0.55 | 0.34 | 0.19 | 15 | 4.0 | 2.2 | 7 | 7.4 | 1 |
| 274 | | 274 | 100 | 2.69 | 2.21 | 1.34 | 0.77 | 61 | 16.0 | 8.9 | 28 | 30.0 | 4 |
| 275 | fresh, midbloom | 2-03-443 | 31 | 0.79 | 0.65 | 0.40 | 0.22 | 18 | 3.9 | 2.7 | 10 | 10.2 | 2 |
| 276 | | 276 | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 12.8 | 8.9 | 33 | 33.5 | 6 |
| 277 | fresh, full bloom | 2-03-445 | 30 | 0.79 | 0.65 | 0.39 | 0.22 | 18 | 3.2 | 2.0 | 8 | 9.9 | 2 |
| 278 | | 278 | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 10.6 | 6.8 | 28 | 33.1 | 8 |
| 279 | hay, sun-cured | 1-03-438 | 91 | 2.33 | 1.91 | 1.13 | 0.62 | 53 | 10.2 | 6.5 | 31 | 31.9 | 4 |
| 280 | | 280 | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 11.2 | 7.1 | 35 | 35.1 | 4 |
| 281 | hay, sun-cured, early vegetative | 1-03-423 | 90 | 2.45 | 2.01 | 1.24 | 0.72 | 56 | — | — | — | — | 3 |
| 282 | | 282 | 100 | 2.73 | 2.24 | 1.38 | 0.80 | 62 | — | — | — | — | 3 |
| 283 | hay, sun-cured, late vegetative | 1-03-424 | 89 | 2.20 | 1.80 | 1.05 | 0.54 | 50 | 14.5 | 10.0 | 31 | 25.4 | 3 |
| 284 | | 284 | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 16.3 | 11.2 | 35 | 28.5 | 3 |
| 285 | hay, sun-cured, early bloom | 1-03-425 | 89 | 2.04 | 1.68 | 0.93 | 0.44 | 47 | 13.4 | 7.3 | 26 | 27.6 | 4 |
| 286 | | 286 | 100 | 2.29 | 1.88 | 1.04 | 0.49 | 52 | 15.0 | 8.2 | 29 | 31.0 | 5 |
| 287 | hay, sun-cured, full bloom | 1-03-427 | 93 | 2.00 | 1.64 | 0.86 | 0.36 | 45 | 11.5 | 6.6 | — | 30.7 | 4 |
| 288 | | 288 | 100 | 2.16 | 1.77 | 0.93 | 0.39 | 49 | 12.4 | 7.1 | — | 33.1 | 5 |

| Entry Number | Calcium (%) | Chlorine (%) | Cobalt (mg/kg) | Copper (mg/kg) | Fluorine (mg/kg) | Iodine (mg/kg) | Iron (mg/kg) | Magnesium (%) | Manganese (mg/kg) | Molybdenum (mg/kg) | Phosphorus (%) | Potassium (%) | Selenium (mg/kg) | Sodium (%) | Sulfur (%) | Zinc (mg/kg) | Provitamin A (Carotene) (mg/kg) | Vitamin E (mg/kg) | Vitamin D2 (IU/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 229 | 1.04 | — | 1.15 | 75 | — | 1.96 | 236 | 0.44 | 54 | — | 0.14 | 3.40 | — | 0.19 | 0.43 | 31 | — | 5 | — |
| 230 | 1.10 | — | 1.21 | 79 | — | 2.10 | 250 | 0.47 | 57 | — | 0.15 | 3.60 | — | 0.20 | 0.46 | 33 | — | 6 | — |
| 231 | 0.75 | 2.31 | 0.90 | 59 | — | 1.57 | 186 | 0.32 | 42 | — | 0.08 | 2.86 | — | 0.16 | 0.35 | 22 | — | 5 | — |
| 232 | 1.00 | 3.10 | 1.21 | 79 | — | 2.10 | 250 | 0.43 | 56 | — | 0.11 | 3.84 | — | 0.22 | 0.47 | 30 | — | 7 | — |
| 233 | 0.27 | — | 0.02 | — | — | — | — | — | — | — | 0.05 | — | — | — | — | — | 26 | — | — |
| 234 | 0.93 | — | 0.05 | — | — | — | — | — | — | — | 0.16 | — | — | — | — | — | 85 | — | — |
| 235 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 236 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 237 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 238 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 239 | 0.22 | — | — | 2 | — | — | — | 0.06 | 23 | — | 0.04 | 0.32 | — | 0.00 | 0.05 | 5 | — | — | — |
| 240 | 0.58 | — | — | 6 | — | — | — | 0.16 | 59 | — | 0.11 | 0.83 | — | 0.01 | 0.12 | 14 | — | — | — |
| 241 | 0.28 | — | — | — | — | — | — | — | — | — | 0.05 | — | — | — | — | — | 0 | — | — |
| 242 | 0.49 | — | — | — | — | — | — | — | — | — | 0.09 | — | — | — | — | — | 0 | — | — |
| 243 | 0.99 | — | — | — | — | — | — | — | — | — | 0.06 | — | — | — | — | — | — | — | — |
| 244 | 1.08 | — | — | — | — | — | — | — | — | — | 0.06 | — | — | — | — | — | — | — | — |
| 245 | 0.07 | 0.05 | 0.05 | 4 | — | — | 382 | 0.14 | 44 | — | 0.44 | 0.50 | — | 0.09 | 0.22 | 139 | — | 24 | — |
| 246 | 0.08 | 0.06 | 0.05 | 5 | — | — | 421 | 0.16 | 48 | — | 0.49 | 0.55 | — | 0.10 | 0.24 | 154 | — | 26 | — |
| 247 | 0.07 | 0.09 | 0.06 | 6 | — | 0.10 | 76 | 0.13 | 37 | — | 0.33 | 0.39 | 0.23 | 0.07 | 0.21 | 37 | 0 | 14 | — |
| 248 | 0.07 | 0.11 | 0.06 | 7 | — | 0.11 | 85 | 0.14 | 42 | — | 0.38 | 0.44 | 0.26 | 0.06 | 0.23 | 41 | 0 | 15 | — |
| 249 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 250 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 251 | 0.06 | — | — | — | — | — | — | — | — | — | 0.27 | — | — | — | — | — | — | — | — |
| 252 | 0.07 | — | — | — | — | — | — | — | — | — | 0.30 | — | — | — | — | — | — | — | — |
| 253 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 254 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 255 | 0.10 | 0.12 | — | — | — | — | 73 | 0.17 | 38 | — | 0.31 | 0.38 | 0.06 | 0.06 | 0.20 | — | — | 20 | — |
| 256 | 0.11 | 0.13 | — | — | — | — | 80 | 0.19 | 42 | — | 0.34 | 0.42 | 0.06 | 0.07 | 0.22 | — | — | 22 | — |
| 257 | 0.08 | 0.08 | — | 6 | — | 0.11 | 73 | 0.11 | 28 | — | 0.43 | 0.35 | — | 0.05 | 0.20 | 0 | — | 15 | — |
| 258 | 0.08 | 0.09 | — | 7 | — | 0.12 | 82 | 0.13 | 31 | — | 0.48 | 0.39 | — | 0.06 | 0.22 | 0 | — | 16 | — |
| 259 | 0.22 | 0.48 | 0.07 | 14 | — | — | 142 | 0.24 | 59 | — | 0.20 | 1.38 | 0.16 | 0.17 | 0.22 | 36 | 25 | — | 1,410 |
| 260 | 0.24 | 0.52 | 0.07 | 15 | — | — | 155 | 0.26 | 64 | — | 0.22 | 1.51 | 0.17 | 0.18 | 0.25 | 39 | 28 | — | 1,544 |
| 261 | 0.10 | — | 0.02 | 2 | — | — | 65 | 0.09 | 13 | — | 0.07 | 0.54 | 0.03 | 0.07 | 0.09 | 11 | 14 | — | — |
| 262 | 0.34 | — | 0.06 | 6 | — | — | 211 | 0.30 | 43 | — | 0.24 | 2.74 | 0.06 | 0.23 | 0.29 | 35 | 45 | — | — |
| 263 | 0.22 | 0.71 | — | 9 | — | — | 161 | 0.17 | 34 | — | 0.06 | 2.37 | — | 0.39 | 0.21 | 6 | 4 | — | 609 |
| 264 | 0.24 | 0.78 | — | 10 | — | — | 175 | 0.18 | 37 | — | 0.06 | 2.57 | — | 0.42 | 0.23 | 6 | 4 | — | 662 |
| 265 | 1.65 | — | — | — | — | — | — | 0.15 | — | — | 0.19 | 1.61 | — | — | — | — | — | — | — |
| 266 | 1.80 | — | — | — | — | — | — | 0.16 | — | — | 0.21 | 1.76 | — | — | — | — | — | — | — |
| 267 | — | — | — | — | — | — | — | — | — | — | 0.04 | — | — | — | — | — | — | — | — |
| 268 | — | — | — | — | — | — | — | — | — | — | 0.40 | — | — | — | — | — | — | — | — |
| 269 | 0.13 | 0.02 | — | 2 | — | — | 39 | 0.07 | 22 | — | 0.13 | 0.54 | — | 0.01 | 0.05 | — | 112 | — | — |
| 270 | 0.58 | 0.08 | — | 7 | — | — | 169 | 0.31 | 96 | — | 0.54 | 3.55 | — | 0.04 | 0.21 | — | 482 | — | — |
| 271 | 0.10 | — | — | — | — | — | 45 | 0.07 | — | — | 0.10 | 0.81 | — | 0.01 | 0.06 | — | — | — | — |
| 272 | 0.42 | — | — | — | — | — | 200 | 0.31 | — | — | 0.42 | 3.38 | — | 0.04 | 0.26 | — | — | — | — |
| 273 | 0.06 | — | — | 8 | — | — | 194 | 0.08 | 26 | — | 0.10 | 0.54 | — | 0.01 | 0.06 | — | — | — | — |
| 274 | 0.15 | — | — | 33 | — | — | 785 | 0.31 | 104 | — | 0.39 | 3.38 | — | 0.04 | 0.26 | — | — | — | — |
| 275 | 0.07 | — | — | — | — | — | — | — | — | — | 0.07 | — | — | — | — | — | — | — | — |
| 276 | 0.23 | — | — | — | — | — | — | — | — | — | 0.23 | — | — | — | — | — | — | — | — |
| 277 | 0.07 | — | — | — | — | — | — | — | — | — | 0.07 | — | — | — | — | — | 73 | — | — |
| 278 | 0.23 | — | — | — | — | — | — | — | — | — | 0.22 | — | — | — | — | — | 245 | — | — |
| 279 | 0.35 | 0.37 | 0.42 | 12 | — | — | 90 | 0.15 | 109 | — | 0.32 | 3.06 | — | 0.05 | 0.24 | 23 | 20 | 174 | — |
| 280 | 0.39 | 0.41 | 0.46 | 13 | — | — | 99 | 0.17 | 120 | — | 0.35 | 3.36 | — | 0.05 | 0.26 | 26 | 22 | 191 | — |
| 281 | 0.34 | — | 0.49 | 16 | — | — | 276 | 0.11 | 141 | — | 0.39 | 3.41 | — | 0.02 | — | 42 | — | — | — |
| 282 | 0.38 | — | 0.55 | 18 | — | — | 306 | 0.12 | 157 | — | 0.43 | 3.80 | — | 0.02 | — | 47 | — | — | — |
| 283 | 0.31 | — | 0.52 | 15 | — | — | 191 | 0.12 | 122 | — | 0.45 | 3.45 | — | 0.02 | — | 36 | — | — | — |
| 284 | 0.35 | — | 0.58 | 17 | — | — | 214 | 0.14 | 137 | — | 0.50 | 3.91 | — | 0.03 | — | 40 | — | — | — |
| 285 | 0.24 | — | 0.38 | 17 | — | — | 83 | 0.10 | 141 | — | 0.30 | 2.59 | — | 0.01 | — | 36 | 33 | — | — |
| 286 | 0.27 | — | 0.43 | 19 | — | — | 93 | 0.11 | 158 | — | 0.34 | 2.91 | — | 0.01 | — | 40 | 38 | — | — |
| 287 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 288 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

TABLE 13   Composition of Some Sheep Feeds; Data Expressed on an As-Fed and Dry Basis (100% Dry Matter)—*Continued*

| Entry Number | Feed Name Description[a] | International Feed Number | Dry Matter (%) | DE Sheep (Mcal/kg) | ME Sheep (Mcal/kg) | $NE_m$ (Mcal/kg) | $NE_g$ (Mcal/kg) | TDN Sheep (%) | Crude Protein (%) | Dig Protein (%) | Cellulose (%) | Crude Fiber (%) | Lignin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **PEANUT** *Arachis hypogaea* | | | | | | | | | | | | |
| 289 | kernels, meal mechanical extracted | 5-03-649 | 93 | 3.84 | 3.15 | 2.19 | 1.53 | 87 | 48.1 | 43.8 | 4 | 6.9 | — |
| 290 | (peanut meal) | | 100 | 4.14 | 3.40 | 2.35 | 1.65 | 94 | 52.0 | 47.3 | 5 | 7.5 | — |
| 291 | kernels, meal solvent extracted | 5-03-650 | 92 | 3.12 | 2.56 | 1.70 | 1.12 | 71 | 48.1 | — | — | 9.9 | — |
| 292 | (peanut meal) | | 100 | 3.40 | 2.78 | 1.85 | 1.22 | 77 | 52.3 | — | — | 10.8 | — |
| 293 | pods (hulls) | 1-08-028 | 91 | 0.80 | 0.66 | — | — | 19 | 7.1 | 1.7 | 36 | 57.3 | 21 |
| 294 | | 294 | 100 | 0.88 | 0.72 | — | — | 20 | 7.8 | 1.9 | 40 | 62.9 | 23 |
| | **PRAIRIE PLANTS, MIDWEST** | | | | | | | | | | | | |
| 295 | hay, sun-cured, early vegetative | 1-03-183 | 90 | 2.50 | 2.05 | 1.27 | 0.75 | 57 | 7.8 | 3.9 | — | 28.3 | — |
| 296 | | 296 | 100 | 2.78 | 2.28 | 1.41 | 0.83 | 63 | 8.7 | 4.4 | — | 31.4 | — |
| 297 | hay, sun-cured, midbloom | 1-07-956 | 95 | 2.26 | 1.86 | 1.05 | 0.52 | 51 | 6.7 | 2.7 | — | 30.5 | — |
| 298 | | 298 | 100 | 2.38 | 1.95 | 1.11 | 0.55 | 54 | 7.0 | 2.8 | — | 32.1 | — |
| 299 | hay, sun-cured, full bloom | 1-03-184 | 89 | 2.03 | 1.67 | 0.93 | 0.40 | 46 | 5.4 | 1.8 | — | 29.9 | — |
| 300 | | 300 | 100 | 2.29 | 1.88 | 1.04 | 0.45 | 52 | 6.1 | 2.0 | — | 33.7 | — |
| 301 | hay, sun-cured, mature | 1-03-187 | 91 | 1.92 | 1.58 | 0.82 | 0.32 | 44 | 4.6 | 2.2 | — | 32.2 | — |
| 302 | | 302 | 100 | 2.12 | 1.74 | 0.90 | 0.35 | 48 | 5.1 | 2.4 | — | 35.4 | — |
| | **PRICKLYPEAR** *Opuntia* spp | | | | | | | | | | | | |
| 303 | fresh | 2-01-061 | 17 | 0.42 | 0.35 | 0.21 | 0.11 | 9 | 0.8 | 0.4 | — | 2.3 | 1 |
| 304 | | 304 | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 4.8 | 2.1 | — | 13.5 | 8 |
| | **RAPE** *Brassica napus* | | | | | | | | | | | | |
| 305 | fresh | 2-03-867 | 17 | 0.58 | 0.48 | 0.32 | 0.22 | 13 | 2.9 | 2.4 | — | 2.4 | — |
| 306 | | 306 | 100 | 3.48 | 2.86 | 1.91 | 1.27 | 79 | 17.6 | 14.5 | — | 14.7 | — |
| 307 | fresh, early vegetative | 2-03-865 | 18 | 0.65 | 0.53 | 0.35 | 0.24 | 15 | 4.6 | 3.7 | — | 2.4 | — |
| 308 | | 308 | 100 | 3.57 | 2.93 | 1.97 | 1.32 | 81 | 25.0 | 20.3 | — | 13.0 | — |
| 309 | fresh, early bloom | 2-03-866 | 11 | 0.37 | 0.31 | 0.20 | 0.13 | 8 | 2.7 | 2.3 | — | 1.8 | — |
| 310 | | 310 | 100 | 3.31 | 2.71 | 1.79 | 1.16 | 75 | 23.5 | 20.2 | — | 15.8 | — |
| 311 | seeds, meal mechanical extracted | 5-03-870 | 92 | 3.04 | 2.49 | 1.65 | 1.07 | 69 | 35.6 | 30.1 | — | 12.0 | — |
| 312 | | 312 | 100 | 3.31 | 2.71 | 1.79 | 1.16 | 75 | 38.7 | 32.8 | — | 13.1 | — |
| 313 | seeds, meal solvent extracted | 5-03-871 | 91 | 2.97 | 2.44 | 1.60 | 1.04 | 67 | 37.0 | — | — | 12.0 | — |
| 314 | | 314 | 100 | 3.26 | 2.68 | 1.76 | 1.14 | 74 | 40.6 | — | — | 13.2 | — |
| | **REDTOP** *Agrostis alba* | | | | | | | | | | | | |
| 315 | fresh, midbloom | 2-03-890 | 39 | 1.02 | 0.83 | 0.50 | 0.28 | 23 | 2.9 | 1.8 | — | 11.3 | — |
| 316 | | 316 | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 7.4 | 4.5 | — | 29.0 | — |
| 317 | fresh, full bloom | 2-03-891 | 26 | 0.67 | 0.55 | 0.32 | 0.18 | 15 | 2.1 | 1.2 | — | 7.9 | — |
| 318 | | 318 | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 8.1 | 4.5 | — | 30.0 | — |
| 319 | hay, sun-cured | 1-03-885 | 92 | 2.19 | 1.80 | 1.02 | 0.51 | 50 | 7.4 | 3.5 | — | 28.4 | — |
| 320 | | 320 | 100 | 2.38 | 1.95 | 1.11 | 0.55 | 54 | 8.1 | 3.8 | — | 30.9 | — |
| 321 | hay, sun-cured, early vegetative | 1-03-880 | 92 | 2.31 | 1.90 | 1.11 | 0.59 | 52 | 12.7 | 8.2 | — | 29.3 | — |
| 322 | | 322 | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 13.8 | 8.9 | — | 31.9 | — |
| 323 | hay, sun-cured, early bloom | 1-03-883 | 91 | 2.29 | 1.88 | 1.10 | 0.58 | 52 | 11.4 | 7.1 | — | 25.0 | — |
| 324 | | 324 | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 12.5 | 7.8 | — | 27.5 | — |
| 325 | hay, sun-cured, midbloom | 1-03-886 | 94 | 2.33 | 1.91 | 1.11 | 0.57 | 53 | 11.0 | 6.9 | — | 29.0 | — |
| 326 | | 326 | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 11.7 | 7.3 | — | 30.7 | — |
| 327 | hay, sun-cured, full bloom | 1-03-882 | 91 | 2.16 | 1.77 | 1.01 | 0.50 | 49 | 8.5 | 5.3 | — | 28.2 | — |
| 328 | | 328 | 100 | 2.38 | 1.95 | 1.11 | 0.55 | 54 | 9.4 | 5.8 | — | 31.1 | — |
| | **RICE** *Oryza sativa* | | | | | | | | | | | | |
| 329 | bran with germs (rice, bran) | 4-03-928 | 91 | 2.96 | 2.43 | 1.60 | 1.04 | 67 | 12.7 | 8.7 | 10 | 11.6 | 4 |
| 330 | | 330 | 100 | 3.26 | 2.68 | 1.76 | 1.14 | 74 | 14.1 | 9.6 | 11 | 12.8 | 4 |
| 331 | groats, polished (rice, polished) | 4-03-942 | 89 | 3.56 | 2.92 | 2.03 | 1.41 | 81 | 7.2 | 3.9 | — | 0.4 | — |
| 332 | | 332 | 100 | 4.01 | 3.29 | 2.28 | 1.58 | 91 | 8.2 | 4.5 | — | 0.4 | — |
| | **RYE** *Secale cereale* | | | | | | | | | | | | |
| 333 | distillers grains, dehydrated | 5-04-023 | 92 | 2.59 | 2.13 | 1.32 | 0.79 | 59 | 21.6 | 12.9 | — | 12.3 | — |
| 334 | | 334 | 100 | 2.82 | 2.31 | 1.44 | 0.86 | 64 | 23.5 | 14.1 | — | 13.4 | — |
| 335 | grain | 4-04-047 | 88 | 3.28 | 2.69 | 1.84 | 1.26 | 75 | 12.1 | 9.5 | — | 2.2 | — |
| 336 | | 336 | 100 | 3.75 | 3.07 | 2.09 | 1.43 | 85 | 13.8 | 10.9 | — | 2.5 | — |
| 337 | straw | 1-04-007 | 90 | 1.78 | 1.46 | 0.71 | 0.23 | 41 | 2.7 | -0.6 | — | 38.7 | — |
| 338 | | 338 | 100 | 1.98 | 1.63 | 0.79 | 0.25 | 45 | 3.0 | -0.7 | — | 43.1 | — |
| | **RYEGRASS, ITALIAN** *Lolium multiflorum* | | | | | | | | | | | | |
| 339 | fresh | 2-04-073 | 25 | 0.64 | 0.52 | 0.45 | 0.18 | 14 | 3.5 | 1.5 | — | 5.8 | — |
| 340 | | 340 | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 14.5 | 6.2 | — | 23.8 | — |
| 341 | fresh, early bloom | 2-04-071 | 35 | 0.93 | 0.77 | 0.46 | 0.26 | 21 | 5.3 | 3.9 | — | 10.6 | — |
| 342 | | 342 | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 15.0 | 11.0 | — | 30.1 | — |
| 343 | fresh, mature | 2-04-072 | 35 | 0.90 | 0.74 | 0.43 | 0.24 | 21 | 2.0 | 0.8 | — | 10.6 | — |
| 344 | | 344 | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 5.8 | 2.4 | — | 30.1 | — |
| 345 | hay, sun-cured | 1-04-069 | 86 | 2.24 | 1.84 | 1.00 | 0.61 | 51 | 6.5 | 2.7 | — | 26.6 | — |
| 346 | | 346 | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 7.6 | 3.1 | — | 30.9 | — |
| 347 | hay, sun-cured, early vegetative | 1-04-064 | 89 | 2.36 | 1.94 | 1.17 | 0.66 | 54 | 13.6 | 9.1 | — | 17.6 | — |
| 348 | | 348 | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 15.2 | 10.2 | — | 19.7 | — |
| 349 | hay, sun-cured, early bloom | 1-04-066 | 88 | 2.21 | 1.81 | 1.06 | 0.56 | 50 | 11.4 | 7.1 | — | 25.4 | — |
| 350 | | 350 | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 12.9 | 8.1 | — | 28.9 | — |
| 351 | hay, sun-cured, full bloom | 1-04-067 | 86 | 2.08 | 1.71 | 0.98 | 0.50 | 48 | 5.7 | 1.5 | — | 26.5 | — |
| 352 | | 352 | 100 | 2.43 | 1.99 | 1.14 | 0.58 | 55 | 6.6 | 1.7 | — | 30.9 | — |

| Entry Number | Calcium (%) | Chlorine (%) | Cobalt (mg/kg) | Copper (mg/kg) | Fluorine (mg/kg) | Iodine (mg/kg) | Iron (mg/kg) | Magnesium (%) | Manganese (mg/kg) | Molybdenum (mg/kg) | Phosphorus (%) | Potassium (%) | Selenium (mg/kg) | Sodium (%) | Sulfur (%) | Zinc (mg/kg) | Provitamin A (Carotene) (mg/kg) | Vitamin E (mg/kg) | Vitamin D3 (IU/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 289 | 0.19 | 0.03 | 0.11 | 15 | — | 0.07 | 156 | 0.29 | 26 | — | 0.57 | 1.16 | 0.29 | 0.21 | 0.27 | 21 | 0 | 2 | — |
| 290 | 0.20 | 0.03 | 0.12 | 16 | — | 0.07 | 169 | 0.31 | 28 | — | 0.61 | 1.25 | 0.31 | 0.23 | 0.29 | 22 | 0 | 3 | — |
| 291 | 0.27 | 0.03 | 0.11 | 15 | — | 0.07 | 142 | 0.15 | 27 | — | 0.62 | 1.13 | — | 0.07 | 0.30 | 20 | — | 3 | — |
| 292 | 0.29 | 0.03 | 0.12 | 17 | — | 0.07 | 154 | 0.17 | 29 | — | 0.68 | 1.23 | — | 0.08 | 0.33 | 22 | — | 3 | — |
| 293 | 0.24 | — | 0.11 | 16 | — | — | 255 | 0.15 | 63 | — | 0.06 | 0.87 | — | 0.12 | 0.09 | 22 | 1 | — | — |
| 294 | 0.26 | — | 0.12 | 18 | — | — | 312 | 0.17 | 69 | — | 0.07 | 0.95 | — | 0.13 | 0.10 | 24 | 1 | — | — |
| 295 | 0.44 | — | — | — | — | — | 81 | 0.22 | — | — | 0.21 | 0.97 | — | — | — | — | — | — | — |
| 296 | 0.49 | — | — | — | — | — | 90 | 0.24 | — | — | 0.23 | 1.06 | — | — | — | — | — | — | — |
| 297 | — | — | 0.07 | — | — | — | 95 | — | — | — | — | — | — | — | — | 28 | — | — | — |
| 298 | — | — | 0.07 | — | — | — | 100 | — | — | — | — | — | — | — | — | 29 | — | — | — |
| 299 | 0.34 | — | — | 9 | — | — | 80 | 0.21 | 109 | — | 0.12 | 0.96 | — | — | — | 30 | — | — | 879 |
| 300 | 0.38 | — | — | 10 | — | — | 90 | 0.24 | 123 | — | 0.14 | 1.08 | — | — | — | 34 | — | — | 992 |
| 301 | 0.34 | — | — | 21 | — | — | 101 | 0.26 | 45 | — | 0.14 | — | — | — | — | — | 9 | — | — |
| 302 | 0.38 | — | — | 23 | — | — | 111 | 0.29 | 49 | — | 0.16 | — | — | — | — | — | 10 | — | — |
| 303 | 1.61 | 0.04 | — | — | — | — | — | 0.23 | — | — | 0.02 | 0.37 | — | 0.05 | 0.04 | — | — | — | — |
| 304 | 9.61 | 0.21 | — | — | — | — | — | 1.38 | — | — | 0.12 | 2.21 | — | 0.30 | 0.23 | — | — | — | — |
| 305 | 0.22 | 0.08 | — | 1 | — | — | 30 | 0.01 | 8 | — | 0.07 | 0.50 | — | 0.01 | 0.10 | — | — | — | — |
| 306 | 1.33 | 0.45 | — | 8 | — | — | 182 | 0.07 | 46 | — | 0.39 | 2.96 | — | 0.05 | 0.58 | — | — | — | — |
| 307 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 28 | — | — |
| 308 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 155 | — | — |
| 309 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 310 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 311 | 0.66 | — | — | 7 | — | — | 175 | 0.50 | 55 | — | 1.04 | 0.83 | 0.96 | 0.46 | — | 43 | — | 19 | — |
| 312 | 0.72 | — | — | 7 | — | — | 190 | 0.54 | 60 | — | 1.14 | 0.90 | 1.04 | 0.50 | — | 47 | — | 20 | — |
| 313 | 0.61 | 0.10 | — | — | — | — | — | 0.55 | — | — | 0.95 | 1.24 | 0.97 | 0.09 | 1.14 | — | — | — | — |
| 314 | 0.67 | 0.11 | — | — | — | — | — | 0.60 | — | — | 1.04 | 1.36 | 1.07 | 0.10 | 1.25 | — | — | — | — |
| 315 | 0.13 | — | — | — | — | — | — | 0.07 | — | — | 0.09 | 0.53 | — | — | 0.10 | — | — | — | — |
| 316 | 0.33 | — | — | — | — | — | — | 0.18 | — | — | 0.23 | 2.13 | — | — | 0.26 | — | — | — | — |
| 317 | 0.16 | — | — | — | — | — | 53 | 0.07 | — | — | 0.10 | 0.62 | — | 0.01 | 0.04 | — | 40 | — | — |
| 318 | 0.62 | — | — | — | — | — | 800 | 0.25 | — | — | 0.37 | 2.35 | — | 0.05 | 0.16 | — | 153 | — | — |
| 319 | 0.39 | 0.06 | 0.13 | 4 | — | 0.09 | 141 | 0.20 | 208 | — | 0.20 | 1.74 | — | 0.06 | 0.23 | — | 4 | — | — |
| 320 | 0.43 | 0.07 | 0.15 | 4 | — | 0.10 | 154 | 0.22 | 226 | — | 0.22 | 1.89 | — | 0.07 | 0.25 | — | 4 | — | — |
| 321 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 322 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 323 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 324 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 325 | 0.60 | — | — | — | — | — | — | — | — | — | 0.33 | 1.60 | — | — | — | — | 5 | — | — |
| 326 | 0.63 | — | — | — | — | — | — | — | — | — | 0.35 | 1.69 | — | — | — | — | 5 | — | — |
| 327 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 328 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 329 | 0.07 | 0.07 | — | 13 | — | — | 190 | 0.94 | 376 | — | 1.54 | 1.74 | 0.40 | 0.03 | 0.15 | 29 | — | 60 | — |
| 330 | 0.08 | 0.08 | — | 15 | — | — | 210 | 1.04 | 415 | — | 1.70 | 1.92 | 0.44 | 0.04 | 0.20 | 32 | — | 66 | — |
| 331 | 0.02 | 0.04 | — | 3 | — | — | 14 | 0.02 | 11 | — | 0.11 | 0.11 | — | 0.02 | 0.08 | 2 | — | 4 | — |
| 332 | 0.03 | 0.04 | — | 3 | — | — | 16 | 0.02 | 12 | — | 0.13 | 0.12 | — | 0.02 | 0.09 | 2 | — | 4 | — |
| 333 | 0.05 | 0.15 | — | — | — | — | — | 0.17 | 18 | — | 0.48 | 0.07 | — | 0.17 | 0.44 | — | — | — | — |
| 334 | 0.16 | 0.05 | — | — | — | — | — | 0.18 | 20 | — | 0.52 | 0.08 | — | 0.18 | 0.48 | — | — | 15 | — |
| 335 | 0.06 | 0.03 | — | 7 | — | — | 60 | 0.12 | 58 | — | 0.32 | 0.46 | 0.38 | 0.02 | 0.15 | 31 | 0 | 15 | — |
| 336 | 0.07 | 0.03 | — | 8 | — | — | 69 | 0.14 | 66 | — | 0.37 | 0.52 | 0.44 | 0.03 | 0.17 | 36 | 0 | 17 | — |
| 337 | 0.22 | 0.21 | — | 4 | — | — | — | 0.07 | 6 | — | 0.08 | 0.87 | — | 0.12 | 0.10 | — | — | — | — |
| 338 | 0.24 | 0.24 | — | 4 | — | — | — | 0.08 | 7 | — | 0.09 | 0.97 | — | 0.13 | 0.11 | — | — | — | — |
| 339 | 0.16 | — | — | — | — | — | 160 | 0.09 | — | — | 0.10 | 0.49 | — | 0.00 | 0.03 | — | 96 | — | — |
| 340 | 0.65 | — | — | — | — | — | 650 | 0.35 | — | — | 0.41 | 2.00 | — | 0.01 | 0.10 | — | 401 | — | — |
| 341 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 342 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 343 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 344 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 345 | 0.53 | — | — | — | — | — | 275 | 0.25 | — | — | 0.29 | 1.34 | — | — | — | — | 250 | — | — |
| 346 | 0.62 | — | — | — | — | — | 380 | 0.32 | — | — | 0.34 | 1.56 | — | — | — | — | 290 | — | — |
| 347 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 348 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 349 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 350 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 351 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 352 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

TABLE 13  Composition of Some Sheep Feeds; Data Expressed on an As-Fed and Dry Basis (100% Dry Matter)—*Continued*

| Entry Number | Feed Name Description[a] | International Feed Number | Dry Matter (%) | DE Sheep (Mcal/kg) | ME Sheep (Mcal/kg) | $NE_m$ (Mcal/kg) | $NE_g$ (Mcal/kg) | TDN Sheep (%) | Crude Protein (%) | Dig Protein (%) | Cellulose (%) | Crude Fiber (%) | Lignin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SAFFLOWER *Carthamus tinctorius* | | | | | | | | | | | | |
| 353 | seeds, meal mechanical extracted | 5-04-109 | 91 | 2.50 | 2.05 | 1.26 | 0.73 | 57 | 20.2 | 17.0 | — | 32.4 | — |
| 354 | | | 100 | 2.73 | 2.24 | 1.38 | 0.80 | 62 | 22.1 | 18.6 | — | 35.4 | — |
| 355 | seeds, meal solvent extracted | 5-04-110 | 92 | 2.28 | 1.87 | 1.09 | 0.56 | 52 | 23.4 | — | — | 30.0 | 13 |
| 356 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 25.4 | — | — | 32.5 | 14 |
| | SAGE, BLACK *Salvia mellifera* | | | | | | | | | | | | |
| 357 | browse, fresh, stem cured | 2-05-564 | 65 | 1.40 | 1.15 | 0.60 | 0.25 | 32 | 5.5 | 2.9 | — | — | — |
| 358 | | | 100 | 2.16 | 1.77 | 0.93 | 0.39 | 49 | 8.5 | 4.5 | — | — | — |
| | SAGEBRUSH, BIG *Artemisia tridentata* | | | | | | | | | | | | |
| 359 | browse, fresh, stem cured | 2-07-992 | 65 | 1.43 | 1.18 | 0.63 | 0.27 | 33 | 6.1 | 3.2 | — | — | 8 |
| 360 | | | 100 | 2.21 | 1.81 | 0.97 | 0.42 | 50 | 9.3 | 4.9 | — | — | 12 |
| | SAGEBRUSH, BUD *Artemisia spinescens* | | | | | | | | | | | | |
| 361 | browse, fresh, early vegetative | 2-07-991 | 23 | 0.52 | 0.42 | 0.23 | 0.10 | 12 | 4.0 | 3.1 | — | — | — |
| 362 | | | 100 | 2.25 | 1.84 | 1.00 | 0.45 | 51 | 17.3 | 13.7 | — | — | — |
| 363 | browse, fresh, late vegetative | 2-04-124 | 32 | 0.79 | 0.65 | 0.38 | 0.20 | 18 | 5.6 | 4.3 | — | 7.3 | — |
| 364 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 17.5 | 13.3 | — | 22.7 | — |
| | SAGEBRUSH, FRINGED *Artemisia frigida* | | | | | | | | | | | | |
| 365 | browse, fresh, midbloom | 2-04-129 | 43 | 1.12 | 0.92 | 0.55 | 0.31 | 26 | 4.0 | 2.5 | — | 14.3 | — |
| 366 | | | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 9.4 | 5.8 | — | 33.2 | — |
| 367 | browse, fresh, mature | 2-04-130 | 60 | 1.43 | 1.17 | 0.67 | 0.33 | 33 | 4.3 | 2.2 | — | 19.1 | 6 |
| 368 | | | 100 | 2.38 | 1.95 | 1.11 | 0.55 | 54 | 7.1 | 3.6 | — | 31.8 | 10 |
| | SALTBUSH, NUTTALL *Atriplex nuttallis* | | | | | | | | | | | | |
| 369 | browse, fresh, stem cured | 2-07-993 | 55 | 0.87 | 0.72 | 0.25 | — | 20 | 4.0 | 1.8 | — | — | — |
| 370 | | | 100 | 1.59 | 1.30 | 0.45 | — | 36 | 7.2 | 3.4 | — | — | — |
| | SALTBUSH, SHADSCALE *Atriplex confertifolia* | | | | | | | | | | | | |
| 371 | browse, fresh, stem cured | 2-05-565 | 80 | 1.09 | 0.90 | 0.21 | — | 25 | 6.1 | 3.5 | — | — | — |
| 372 | | | 100 | 1.37 | 1.12 | 0.26 | — | 31 | 7.7 | 4.4 | — | — | — |
| | SALTGRASS *Distichlis spp* | | | | | | | | | | | | |
| 373 | fresh | 2-04-170 | 74 | 1.87 | 1.53 | 0.90 | 0.47 | 42 | 4.8 | 0.7 | — | 22.5 | — |
| 374 | | | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 6.5 | 0.9 | — | 30.3 | — |
| 375 | fresh, post ripe | 2-04-169 | 74 | 1.87 | 1.53 | 0.90 | 0.47 | 42 | 3.1 | 0.7 | — | 26.0 | — |
| 376 | | | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 4.2 | 0.9 | — | 34.9 | — |
| 377 | hay, sun-cured | 1-04-168 | 89 | 2.01 | 1.65 | 0.89 | 0.41 | 45 | 8.0 | 4.1 | — | 28.3 | — |
| 378 | | | 100 | 2.25 | 1.84 | 1.00 | 0.45 | 51 | 8.9 | 4.6 | — | 31.6 | — |
| | SALTGRASS, DESERT *Distichlis stricta* | | | | | | | | | | | | |
| 379 | fresh | 2-04-171 | 29 | 0.77 | 0.63 | 0.38 | 0.21 | 17 | 1.7 | 0.7 | — | 8.6 | — |
| 380 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 5.9 | 2.5 | — | 29.7 | — |
| | SHEEP MILK—SEE MILK | | | | | | | | | | | | |
| | SORGHUM *Sorghum bicolor* | | | | | | | | | | | | |
| 381 | aerial part, sun-cured, early vegetative | 1-04-299 | 92 | — | — | — | — | — | 14.7 | 10.0 | 25 | 25.8 | 4 |
| 382 | | | 100 | — | — | — | — | — | 16.0 | 10.9 | 27 | 28.0 | 4 |
| 383 | aerial part, sun-cured, full bloom | 1-04-371 | 90 | 2.21 | 1.51 | 1.06 | 0.35 | 50 | 5.7 | 2.1 | — | 21.3 | — |
| 384 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 6.4 | 2.3 | — | 23.8 | — |
| 385 | aerial part, sun-cured, mature | 1-04-301 | 90 | 2.11 | 1.73 | 0.96 | 0.47 | 48 | 6.1 | 2.3 | — | 25.2 | — |
| 386 | | | 100 | 2.34 | 1.92 | 1.07 | 0.52 | 53 | 6.7 | 2.6 | — | 28.0 | — |
| 387 | aerial part, sun-cured | 1-07-960 | 89 | 2.28 | 1.87 | 1.10 | 0.61 | 52 | 6.7 | 2.8 | — | 23.9 | — |
| 388 | | | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 7.5 | 3.1 | — | 26.9 | — |
| 389 | aerial part without heads, sun-cured, mature | 1-07-961 | 88 | — | — | — | — | — | 3.9 | 0.5 | — | 28.4 | — |
| 390 | | | 100 | — | — | — | — | — | 4.4 | 0.5 | — | 32.3 | — |
| 391 | distillers grains, dehydrated | 5-04-374 | 94 | 3.51 | 2.88 | 1.96 | 1.34 | 79 | 32.2 | — | — | 11.9 | — |
| 392 | | | 100 | 3.75 | 3.07 | 2.09 | 1.43 | 85 | 34.4 | — | — | 12.7 | — |
| 393 | grain | 4-04-383 | 90 | 3.48 | 2.85 | 1.96 | 1.35 | 79 | 11.1 | 8.2 | 3 | 2.4 | — |
| 394 | | | 100 | 3.88 | 3.18 | 2.18 | 1.50 | 88 | 12.4 | 9.1 | 3 | 2.6 | — |
| 395 | grain, less than 9% protein | 4-08-138 | 89 | 3.36 | 2.75 | 1.89 | 1.29 | 76 | 8.9 | 5.7 | — | 2.2 | — |
| 396 | | | 100 | 3.79 | 3.11 | 2.12 | 1.45 | 86 | 10.1 | 6.5 | — | 2.5 | — |
| 397 | grain, 9-12% protein | 4-08-139 | 89 | 3.36 | 2.76 | 1.89 | 1.29 | 76 | 10.2 | 6.9 | — | 2.2 | — |
| 398 | | | 100 | 3.79 | 3.11 | 2.12 | 1.45 | 86 | 11.5 | 7.7 | — | 2.4 | — |
| 399 | grain, > 12% protein | 4-08-140 | 89 | — | — | — | — | — | 11.6 | 8.1 | — | 1.8 | — |
| 400 | | | 100 | — | — | — | — | — | 13.0 | 9.1 | — | 2.0 | — |
| 401 | silage | 3-04-323 | 30 | 0.74 | 0.61 | 0.36 | 0.12 | 17 | 2.2 | 0.6 | — | 8.2 | 2 |
| 402 | | | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 7.5 | 2.2 | — | 27.9 | 6 |
| 403 | silage, milk stage | 3-09-092 | 25 | 0.64 | 0.52 | 0.30 | 0.16 | 14 | 2.4 | 1.0 | 8 | 7.5 | 2 |
| 404 | | | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 9.6 | 3.8 | 31 | 29.5 | 7 |
| 405 | silage, dough stage | 3-04-321 | 28 | 0.64 | 0.52 | 0.28 | 0.13 | 14 | 1.7 | 0.3 | 9 | 8.1 | 2 |
| 406 | | | 100 | 2.25 | 1.84 | 1.00 | 0.45 | 51 | 6.0 | 0.9 | 31 | 28.5 | 7 |
| 407 | silage, mature | 3-04-322 | 32 | 0.71 | 0.58 | 0.31 | 0.13 | 16 | 2.4 | 0.7 | 9 | 8.0 | 2 |
| 408 | | | 100 | 2.21 | 1.81 | 0.97 | 0.42 | 50 | 7.5 | 2.3 | 28 | 24.9 | 7 |

| Entry Number | Calcium (%) | Chlorine (%) | Cobalt (mg/kg) | Copper (mg/kg) | Fluorine (mg/kg) | Iodine (mg/kg) | Iron (mg/kg) | Magnesium (%) | Manganese (mg/kg) | Molybdenum (mg/kg) | Phosphorus (%) | Potassium (%) | Selenium (mg/kg) | Sodium (%) | Sulfur (%) | Zinc (mg/kg) | Provitamin A (Carotene) (mg/kg) | Vitamin E (mg/kg) | Vitamin D2 (IU/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 353 | 0.25 | — | — | 10 | — | — | 471 | 0.33 | 18 | — | 0.71 | 0.72 | — | 0.05 | — | 40 | — | 1 | — |
| 354 | 0.27 | — | — | 11 | — | — | 515 | 0.36 | 20 | — | 0.78 | 0.79 | — | 0.05 | — | 44 | — | 1 | — |
| 355 | 0.34 | — | — | 10 | — | — | 495 | 0.35 | 18 | — | 0.75 | 0.76 | — | 0.05 | 0.13 | 41 | — | 1 | — |
| 356 | 0.37 | — | — | 11 | — | — | 537 | 0.37 | 20 | — | 0.81 | 0.82 | — | 0.05 | 0.14 | 44 | — | 1 | — |
| 357 | 0.53 | — | — | — | — | — | — | — | — | — | 0.11 | — | — | — | — | — | — | — | — |
| 358 | 0.51 | — | — | — | — | — | — | — | — | — | 0.17 | — | — | — | — | — | — | — | — |
| 359 | 0.46 | — | — | — | — | — | — | — | — | — | 0.12 | — | — | — | — | — | 10 | — | — |
| 360 | 0.71 | — | — | — | — | — | — | — | — | — | 0.18 | — | — | — | — | — | 16 | — | — |
| 361 | 0.22 | — | — | — | — | — | — | — | — | — | 0.08 | — | — | — | — | — | 5 | — | — |
| 362 | 0.97 | — | — | — | — | — | — | — | — | — | 0.33 | — | — | — | — | — | 24 | — | — |
| 363 | 0.19 | — | — | — | — | — | — | 0.16 | — | — | 0.13 | — | — | — | — | — | — | — | — |
| 364 | 0.60 | — | — | — | — | — | — | 0.49 | — | — | 0.42 | — | — | — | — | — | — | — | — |
| 365 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 366 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 367 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 368 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 369 | 1.22 | — | — | — | — | — | — | — | — | — | 0.06 | — | — | — | — | — | 10 | — | — |
| 370 | 2.21 | — | — | — | — | — | — | — | — | — | 0.12 | — | — | — | — | — | 19 | — | — |
| 371 | 1.78 | — | — | — | — | — | — | — | — | — | 0.07 | — | — | — | — | — | 14 | — | — |
| 372 | 2.23 | — | — | — | — | — | — | — | — | — | 0.08 | — | — | — | — | — | 18 | — | — |
| 373 | 0.16 | — | — | — | — | — | 141 | 0.22 | 115 | — | 0.06 | 0.18 | — | — | — | — | — | — | — |
| 374 | 0.22 | — | — | — | — | — | 190 | 0.30 | 155 | — | 0.06 | 0.24 | — | — | — | — | — | — | — |
| 375 | 0.17 | — | — | — | — | — | — | 0.22 | — | — | 0.05 | — | — | — | — | — | — | — | — |
| 376 | 0.23 | — | — | — | — | — | — | 0.30 | — | — | 0.07 | — | — | — | — | — | — | — | — |
| 377 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 378 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 379 | 0.05 | — | — | — | — | — | — | — | — | — | 0.03 | — | — | — | — | — | — | — | — |
| 380 | 0.16 | — | — | — | — | — | — | — | — | — | 0.09 | — | — | — | — | — | — | — | — |
| 381 | 0.46 | — | — | — | — | — | — | 0.46 | — | — | 0.17 | 2.39 | — | — | — | — | — | — | — |
| 382 | 0.50 | — | — | — | — | — | — | 0.50 | — | — | 0.18 | 2.60 | — | — | — | — | — | — | — |
| 383 | 0.56 | — | — | — | — | — | — | 0.27 | — | — | 0.17 | 1.11 | — | 0.02 | — | — | — | — | — |
| 384 | 0.62 | — | — | — | — | — | — | 0.30 | — | — | 0.19 | 1.24 | — | 0.02 | — | — | — | — | — |
| 385 | 0.56 | — | — | — | — | — | 181 | 0.27 | — | — | 0.17 | 1.12 | — | 0.02 | — | — | — | — | — |
| 386 | 0.62 | — | — | — | — | — | 200 | 0.30 | — | — | 0.19 | 1.24 | — | 0.02 | — | — | — | — | — |
| 387 | 0.35 | — | — | — | — | — | — | 0.26 | — | — | 0.18 | 1.31 | — | 0.02 | — | — | 46 | — | — |
| 388 | 0.40 | — | — | — | — | — | — | 0.29 | — | — | 0.21 | 1.47 | — | 0.02 | — | — | 52 | — | — |
| 389 | 0.46 | — | — | — | — | — | 1,761 | 0.24 | — | — | 0.10 | 0.72 | — | 0.06 | — | — | — | — | — |
| 390 | 0.52 | — | — | — | — | — | 2,000 | 0.28 | — | — | 0.12 | 0.82 | — | 0.07 | — | — | — | — | — |
| 391 | 0.15 | — | — | — | — | — | 47 | 0.18 | — | — | 0.69 | 0.36 | — | 0.05 | 0.17 | — | — | — | — |
| 392 | 0.16 | — | — | — | — | — | 50 | 0.19 | — | — | 0.74 | 0.38 | — | 0.05 | 0.18 | — | — | — | — |
| 393 | 0.03 | 0.09 | 0.16 | 10 | — | 0.04 | 45 | 0.16 | 16 | — | 0.29 | 0.35 | 0.44 | 0.03 | 0.13 | 17 | 1 | 10 | 26 |
| 394 | 0.04 | 0.10 | 0.18 | 11 | — | 0.04 | 51 | 0.18 | 18 | — | 0.33 | 0.39 | 0.50 | 0.03 | 0.15 | 19 | 1 | 12 | 29 |
| 395 | 0.03 | — | 0.07 | 10 | — | 0.02 | 18 | — | 15 | — | 0.27 | 0.35 | — | 0.04 | — | 14 | — | 2 | — |
| 396 | 0.03 | — | 0.08 | 11 | — | 0.03 | 20 | — | 17 | — | 0.31 | 0.40 | — | 0.05 | — | 15 | — | 2 | — |
| 397 | 0.03 | — | 0.07 | 10 | — | 0.02 | 31 | 0.17 | 15 | — | 0.28 | 0.34 | — | 0.03 | 0.16 | 14 | — | 1 | — |
| 398 | 0.03 | — | 0.07 | 11 | — | 0.03 | 35 | 0.19 | 17 | — | 0.31 | 0.39 | — | 0.03 | 0.18 | 15 | — | 1 | — |
| 399 | 0.03 | — | — | — | — | — | 45 | 0.17 | — | — | 0.29 | 0.34 | — | 0.05 | 0.16 | — | — | — | — |
| 400 | 0.03 | — | — | — | — | — | 50 | 0.19 | — | — | 0.32 | 0.38 | — | 0.05 | 0.18 | — | — | — | — |
| 401 | 0.10 | 0.04 | 0.09 | 10 | — | — | 54 | 0.09 | 22 | — | 0.06 | 0.40 | 0.06 | 0.01 | 0.03 | 9 | 5 | — | 195 |
| 402 | 0.35 | 0.13 | 0.30 | 35 | — | — | 285 | 0.29 | 73 | — | 0.21 | 1.37 | 0.22 | 0.02 | 0.11 | 32 | 15 | — | 662 |
| 403 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 404 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 405 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 406 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 407 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 408 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |

TABLE 13　Composition of Some Sheep Feeds; Data Expressed on an As-Fed and Dry Basis (100% Dry Matter)—*Continued*

| Entry Number | Feed Name Description[a] | International Feed Number | Dry Matter (%) | DE Sheep (Mcal/kg) | ME Sheep (Mcal/kg) | $NE_m$ (Mcal/kg) | $NE_g$ (Mcal/kg) | TDN Sheep (%) | Crude Protein (%) | Dig. Protein (%) | Cellulose (%) | Crude Fiber (%) | Lignin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SORGHUM, JOHNSONGRASS *Sorghum halepense* | | | | | | | | | | | | |
| 409 | fresh | 2-04-412 | 24 | 0.66 | 0.54 | 0.33 | 0.19 | 15 | 3.7 | 2.7 | — | 7.0 | — |
| 410 | | | 100 | 2.73 | 2.24 | 1.38 | 0.80 | 62 | 15.4 | 11.3 | — | 29.0 | — |
| 411 | fresh, early vegetative | 2-04-409 | 20 | 0.54 | 0.44 | 0.28 | 0.16 | 12 | 3.1 | 2.3 | — | 5.6 | — |
| 412 | | | 100 | 2.73 | 2.24 | 1.38 | 0.80 | 62 | 15.5 | 11.4 | — | 28.5 | — |
| 413 | fresh, midbloom | 2-08-516 | 35 | 0.91 | 0.75 | 0.45 | 0.25 | 21 | 3.1 | 1.9 | — | 10.9 | — |
| 414 | | | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 8.9 | 5.3 | — | 31.0 | — |
| 415 | fresh, full bloom | 2-04-410 | 35 | 0.90 | 0.73 | 0.43 | 0.24 | 20 | 2.8 | 1.6 | — | 11.4 | — |
| 416 | | | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 8.1 | 4.5 | — | 32.7 | — |
| 417 | hay, sun-cured | 1-04-407 | 89 | 2.21 | 1.81 | 1.05 | 0.54 | 50 | 8.5 | 3.7 | — | 29.9 | — |
| 418 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 9.5 | 4.2 | — | 33.5 | — |
| 419 | hay, sun-cured, early vegetative | 1-04-401 | 92 | 2.23 | 1.83 | 1.05 | 0.53 | 51 | 13.8 | 9.2 | — | 26.6 | — |
| 420 | | | 100 | 2.43 | 1.99 | 1.14 | 0.58 | 55 | 15.0 | 10.0 | — | 29.0 | — |
| 421 | hay, sun-cured, late vegetative | 1-09-257 | 88 | 2.02 | 1.65 | 0.92 | 0.43 | 46 | 10.6 | 6.4 | — | 27.5 | — |
| 422 | | | 100 | 2.29 | 1.88 | 1.04 | 0.49 | 52 | 12.0 | 7.3 | — | 31.3 | — |
| 423 | hay, sun-cured, midbloom | 1-04-403 | 92 | 2.06 | 1.69 | 0.92 | 0.41 | 47 | 7.9 | 3.9 | — | 29.9 | — |
| 424 | | | 100 | 2.25 | 1.84 | 1.00 | 0.45 | 51 | 8.6 | 4.3 | — | 32.6 | — |
| 425 | hay, sun-cured, post ripe | 1-04-405 | 93 | 2.05 | 1.68 | 0.90 | 0.39 | 46 | 5.3 | 1.6 | — | 31.8 | — |
| 426 | | | 100 | 2.21 | 1.81 | 0.97 | 0.42 | 50 | 5.7 | 1.7 | — | 34.2 | — |
| | SORGHUM, KAFIR *Sorghum bicolor caffrorum* | | | | | | | | | | | | |
| 427 | grain | 4-04-428 | 89 | 3.34 | 2.74 | 1.86 | 1.27 | 75 | 10.9 | 8.8 | — | 2.0 | — |
| 428 | | | 100 | 3.75 | 3.07 | 2.09 | 1.43 | 85 | 12.3 | 9.9 | — | 2.3 | — |
| | SORGHUM, MILO *Sorghum bicolor subglabrescens* | | | | | | | | | | | | |
| 429 | grain | 4-04-444 | 89 | 3.44 | 2.82 | 1.94 | 1.34 | 78 | 10.0 | 7.8 | 3 | 2.2 | — |
| 430 | | | 100 | 3.88 | 3.18 | 2.18 | 1.50 | 88 | 11.3 | 8.8 | 3 | 2.5 | — |
| 431 | heads | 4-04-446 | 90 | 3.33 | 2.73 | 1.85 | 1.26 | 76 | 9.0 | 6.9 | — | 8.0 | — |
| 432 | | | 100 | 3.70 | 3.04 | 2.06 | 1.40 | 84 | 10.0 | 7.6 | — | 8.9 | — |
| | SORGHUM, SORGO *Sorghum bicolor saccharatum* | | | | | | | | | | | | |
| 433 | silage | 3-04-468 | 27 | 0.73 | 0.60 | 0.30 | 0.20 | 16 | 1.7 | 0.4 | — | 7.8 | — |
| 434 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 6.2 | 1.4 | — | 28.3 | — |
| | SORGHUM, SUDANGRASS *Sorghum bicolor sudanense* | | | | | | | | | | | | |
| 435 | fresh, early vegetative | 2-04-484 | 18 | 0.49 | 0.41 | 0.25 | 0.15 | 11 | 3.0 | 2.3 | 5 | 4.1 | 1 |
| 436 | | | 100 | 2.78 | 2.28 | 1.41 | 0.83 | 63 | 16.8 | 12.6 | 26 | 23.0 | 3 |
| 437 | fresh, midbloom | 2-04-485 | 23 | 0.56 | 0.46 | 0.27 | 0.14 | 13 | 2.0 | 1.2 | 8 | 6.8 | 1 |
| 438 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 8.8 | 5.2 | 34 | 30.0 | 5 |
| 439 | hay, sun-cured | 1-04-480 | 91 | 2.21 | 1.81 | 1.04 | 0.53 | 50 | 7.3 | 4.0 | 32 | 32.8 | 5 |
| 440 | | | 100 | 2.43 | 1.99 | 1.14 | 0.58 | 55 | 8.0 | 4.3 | 35 | 36.0 | 6 |
| 441 | silage | 3-04-499 | 28 | 0.67 | 0.55 | 0.30 | 0.15 | 15 | 3.1 | 1.9 | 11 | 9.4 | 1 |
| 442 | | | 100 | 2.34 | 1.92 | 1.07 | 0.52 | 53 | 10.8 | 6.6 | 38 | 33.1 | 5 |
| | SOYBEAN *Glycine max* | | | | | | | | | | | | |
| 443 | hay, sun-cured | 1-04-558 | 89 | 2.25 | 1.84 | 1.06 | 0.57 | 51 | 14.3 | 10.1 | — | 30.1 | — |
| 444 | | | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 16.0 | 11.3 | — | 33.7 | — |
| 445 | seed coats (hulls) | 1-04-560 | 91 | 2.17 | 1.78 | 1.01 | 0.50 | 49 | 11.0 | 6.7 | 42 | 36.4 | 2 |
| 446 | | | 100 | 2.38 | 1.95 | 1.11 | 0.55 | 54 | 12.1 | 7.3 | 46 | 40.1 | 2 |
| 447 | seeds | 5-04-610 | 92 | 3.79 | 3.11 | 2.16 | 1.52 | 86 | 39.2 | 35.1 | — | 5.3 | — |
| 448 | | | 100 | 4.14 | 3.40 | 2.35 | 1.65 | 94 | 42.8 | 38.3 | — | 5.8 | — |
| 449 | seeds, meal mechanical extracted | 5-04-600 | 90 | 3.37 | 2.77 | 1.88 | 1.29 | 77 | 42.9 | 36.8 | — | 5.9 | — |
| 450 | | | 100 | 3.75 | 3.07 | 2.09 | 1.43 | 85 | 47.7 | 40.9 | — | 6.6 | — |
| 451 | seeds, meal solvent extracted | 5-04-604 | 90 | 3.48 | 2.85 | 1.96 | 1.35 | 79 | 44.8 | 41.6 | — | 5.8 | — |
| 452 | | | 100 | 3.88 | 3.18 | 2.18 | 1.50 | 88 | 49.9 | 46.4 | — | 6.5 | — |
| 453 | straw | 1-04-567 | 88 | 1.66 | 1.36 | 0.63 | 0.16 | 38 | 4.6 | 1.3 | 33 | 38.9 | 14 |
| 454 | | | 100 | 1.90 | 1.56 | 0.72 | 0.18 | 43 | 5.2 | 1.5 | 38 | 44.3 | 16 |
| | SUGARCANE MOLASSES—SEE MOLASSES | | | | | | | | | | | | |
| | SUMMERCYPRESS, GRAY *Kochia vestita* | | | | | | | | | | | | |
| 455 | fresh, stem-cured | 2-08-543 | 85 | 1.87 | 1.54 | 0.82 | 0.36 | 42 | 7.7 | 5.3 | — | 18.7 | — |
| 456 | | | 100 | 2.21 | 1.81 | 0.97 | 0.42 | 50 | 9.0 | 6.2 | — | 22.0 | — |
| | SUNFLOWER, COMMON *Helianthus annuus* | | | | | | | | | | | | |
| 457 | fresh | 2-10-697 | 15 | 0.40 | 0.33 | 0.20 | 0.11 | 9 | 1.4 | 0.8 | — | 4.4 | — |
| 458 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 9.2 | 5.6 | — | 29.3 | — |
| 459 | seeds, meal solvent extracted | 5-09-340 | 90 | 1.79 | 1.46 | 0.68 | 0.23 | 41 | 23.3 | 18.9 | — | 31.6 | 11 |
| 460 | | | 100 | 1.98 | 1.63 | 0.75 | 0.25 | 45 | 25.9 | 21.0 | — | 35.1 | 12 |
| 461 | seeds without hulls, meal solvent extracted | 5-04-739 | 93 | 3.12 | 2.56 | 1.69 | 1.11 | 70 | 46.3 | — | — | 11.4 | — |
| 462 | | | 100 | 3.35 | 2.75 | 1.82 | 1.19 | 76 | 49.8 | — | — | 12.2 | — |

| Entry Number | Calcium (%) | Chlorine (%) | Cobalt (mg/kg) | Copper (mg/kg) | Fluorine (mg/kg) | Iodine (mg/kg) | Iron (mg/kg) | Magnesium (%) | Manganese (mg/kg) | Molybdenum (mg/kg) | Phosphorus (%) | Potassium (%) | Selenium (mg/kg) | Sodium (%) | Sulfur (%) | Zinc (mg/kg) | Provitamin A (Carotene) (mg/kg) | Vitamin E (mg/kg) | Vitamin D3 (IU/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 409 | 0.22 | — | — | — | — | — | — | 0.06 | — | — | 0.06 | 0.75 | — | — | — | — | 48 | — | — |
| 410 | 0.91 | — | — | — | — | — | — | 0.25 | — | — | 0.26 | 3.12 | — | — | — | — | 198 | — | — |
| 411 | 0.18 | — | — | — | — | — | — | — | — | — | 0.06 | — | — | — | — | — | — | — | — |
| 412 | 0.93 | — | — | — | — | — | — | — | — | — | 0.31 | — | — | — | — | — | — | — | — |
| 413 | 0.29 | — | — | — | — | — | — | — | — | — | 0.06 | — | — | — | — | — | — | — | — |
| 414 | 0.83 | — | — | — | — | — | — | — | — | — | 0.17 | — | — | — | — | — | — | — | — |
| 415 | 0.29 | — | — | — | — | — | — | — | — | — | 0.06 | — | — | — | — | — | — | — | — |
| 416 | 0.53 | — | — | — | — | — | — | — | — | — | 0.17 | — | — | — | — | — | — | — | — |
| 417 | 0.75 | — | — | — | — | — | 527 | 0.31 | — | — | 0.25 | 1.21 | — | 0.01 | 0.09 | — | 35 | — | — |
| 418 | 0.84 | — | — | — | — | — | 590 | 0.35 | — | — | 0.28 | 1.35 | — | 0.01 | 0.10 | — | 39 | — | — |
| 419 | 0.63 | — | — | — | — | — | — | — | — | — | 0.45 | — | — | — | — | — | — | — | — |
| 420 | 0.69 | — | — | — | — | — | — | — | — | — | 0.49 | — | — | — | — | — | — | — | — |
| 421 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 422 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 423 | 0.58 | — | — | — | — | — | — | — | — | — | 0.21 | — | — | — | — | — | — | — | — |
| 424 | 0.63 | — | — | — | — | — | — | — | — | — | 0.23 | — | — | — | — | — | — | — | — |
| 425 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 426 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 427 | 0.03 | 0.10 | 0.39 | 7 | — | — | 63 | 0.15 | 16 | — | 0.31 | 0.34 | 0.80 | 0.05 | 0.16 | 14 | 0 | — | — |
| 428 | 0.04 | 0.11 | 0.43 | 8 | — | — | 71 | 0.17 | 18 | — | 0.35 | 0.38 | 0.89 | 0.06 | 0.18 | 15 | 0 | — | — |
| 429 | 0.04 | 0.08 | 0.47 | 4 | — | 0.05 | 49 | 0.13 | 16 | — | 0.30 | 0.31 | 0.20 | 0.04 | 0.11 | 17 | 0 | 12 | 25 |
| 430 | 0.05 | 0.09 | 0.53 | 5 | — | 0.07 | 55 | 0.14 | 18 | — | 0.34 | 0.35 | 0.23 | 0.04 | 0.12 | 20 | 0 | 13 | 29 |
| 431 | 0.12 | — | — | — | — | — | — | 0.15 | — | — | 0.22 | 0.50 | — | — | 0.12 | — | 1 | — | — |
| 432 | 0.13 | — | — | — | — | — | — | 0.17 | — | — | 0.25 | 0.56 | — | — | 0.13 | — | 1 | — | — |
| 433 | 0.09 | 0.02 | — | 9 | — | — | 54 | 0.08 | 17 | — | 0.05 | 0.31 | — | 0.04 | 0.03 | — | 10 | — | — |
| 434 | 0.34 | 0.06 | — | 31 | — | — | 198 | 0.27 | 61 | — | 0.17 | 1.12 | — | 0.15 | 0.10 | — | 36 | — | — |
| 435 | 0.06 | — | — | — | — | — | 36 | 0.06 | — | — | 0.07 | 0.38 | — | 0.00 | 0.02 | — | 35 | — | — |
| 436 | 0.43 | — | — | — | — | — | 200 | 0.35 | — | — | 0.41 | 2.14 | — | 0.01 | 0.11 | — | 198 | — | — |
| 437 | 0.10 | — | — | — | — | — | 46 | 0.08 | — | — | 0.08 | 0.49 | — | 0.00 | 0.03 | — | 42 | — | — |
| 438 | 0.43 | — | — | — | — | — | 200 | 0.35 | — | — | 0.38 | 2.14 | — | 0.01 | 0.11 | — | 183 | — | — |
| 439 | 0.50 | — | 0.12 | 34 | — | — | 176 | 0.47 | 83 | — | 0.28 | 1.70 | — | 0.02 | 0.06 | 35 | 54 | — | — |
| 440 | 0.55 | — | 0.13 | 37 | — | — | 193 | 0.51 | 91 | — | 0.30 | 1.87 | — | 0.02 | 0.06 | 38 | 59 | — | — |
| 441 | 0.13 | — | 0.09 | 11 | — | — | 36 | 0.13 | 28 | — | 0.06 | 0.64 | — | 0.01 | 0.02 | — | 30 | — | — |
| 442 | 0.46 | — | 0.31 | 37 | — | — | 127 | 0.44 | 99 | — | 0.21 | 2.25 | — | 0.02 | 0.06 | — | 105 | — | — |
| 443 | 0.15 | 1.13 | 0.08 | 8 | — | 0.22 | 261 | 0.71 | 95 | — | 0.25 | 0.96 | — | 0.08 | 0.21 | 22 | 41 | 26 | 947 |
| 444 | 1.29 | 0.15 | 0.09 | 9 | — | 0.24 | 292 | 0.79 | 106 | — | 0.28 | 1.07 | — | 0.09 | 0.24 | 24 | 45 | 30 | 1059 |
| 445 | 0.45 | — | 0.11 | 16 | — | — | 295 | — | 10 | — | 0.19 | 1.16 | — | 0.01 | 0.08 | 22 | — | 6 | — |
| 446 | 0.49 | — | 0.12 | 18 | — | — | 324 | — | 11 | — | 0.21 | 1.27 | — | 0.01 | 0.09 | 24 | — | 7 | — |
| 447 | 0.25 | 0.03 | — | 18 | — | — | 84 | 0.26 | 36 | — | 0.60 | 1.66 | 0.11 | 0.02 | 0.22 | 57 | 1 | 33 | — |
| 448 | 0.27 | 0.03 | — | 20 | — | — | 91 | 0.29 | 39 | — | 0.65 | 1.82 | 0.12 | 0.02 | 0.24 | 62 | 1 | 37 | — |
| 449 | 0.26 | 0.07 | 0.18 | 22 | — | — | 157 | 0.25 | 31 | — | 0.61 | 1.79 | 0.10 | 0.03 | 0.33 | 60 | 0 | 7 | — |
| 450 | 0.29 | 0.08 | 0.20 | 24 | — | — | 175 | 0.28 | 35 | — | 0.68 | 1.98 | 0.11 | 0.03 | 0.37 | 66 | 0 | 7 | — |
| 451 | 0.30 | 0.04 | 0.09 | 23 | — | 0.13 | 119 | 0.27 | 29 | — | 0.63 | 1.97 | 0.30 | 0.04 | 0.43 | 43 | 0 | 3 | — |
| 452 | 0.34 | 0.04 | 0.10 | 25 | — | 0.15 | 133 | 0.30 | 32 | — | 0.70 | 2.20 | 0.34 | 0.04 | 0.47 | 48 | 0 | 3 | — |
| 453 | 1.40 | — | — | — | — | — | 263 | 0.81 | 45 | — | 0.05 | 0.49 | — | 0.11 | 0.23 | — | — | — | — |
| 454 | 1.59 | — | — | — | — | — | 300 | 0.92 | 51 | — | 0.06 | 0.56 | — | 0.12 | 0.26 | — | — | — | — |
| 455 | 2.01 | — | — | — | — | — | — | — | — | — | 0.10 | — | — | — | — | — | 15 | — | — |
| 456 | 2.36 | — | — | — | — | — | — | — | — | — | 0.12 | — | — | — | — | — | 16 | — | — |
| 457 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 458 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 459 | — | — | — | — | — | — | — | 0.68 | — | — | 0.93 | 0.96 | — | — | 0.30 | — | — | — | — |
| 460 | 0.23 | — | — | — | — | — | — | 0.75 | — | — | 1.03 | 1.06 | — | — | 0.33 | — | — | — | — |
| 461 | 0.41 | 0.10 | — | 4 | — | — | 31 | 0.71 | 19 | — | 0.91 | 1.05 | — | 0.22 | — | — | — | 11 | — |
| 462 | 0.44 | 0.11 | — | 4 | — | — | 33 | 0.77 | 20 | — | 0.98 | 1.14 | — | 0.24 | — | — | — | 12 | — |

TABLE 13  Composition of Some Sheep Feeds; Data Expressed on an As-Fed and Dry Basis (100% Dry Matter)—*Continued*

| Entry Number | Feed Name Description[a] | International Feed Number | Dry Matter (%) | DE Sheep (Mcal/kg) | ME Sheep (Mcal/kg) | NEm (Mcal/kg) | NEg (Mcal/kg) | TDN Sheep (%) | Crude Protein (%) | Dig Protein (%) | Cellulose (%) | Crude Fiber (%) | Lignin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SWEETCLOVER, YELLOW *Melilotus officinalis* | | | | | | | | | | | | |
| 463 | hay, sun-cured | 1-04-754 | 87 | 2.04 | 1.67 | 0.93 | 0.45 | 46 | 13.7 | 10.0 | — | 29.2 | — |
| 464 | | | 100 | 2.34 | 1.92 | 1.07 | 0.52 | 53 | 15.7 | 11.5 | — | 33.4 | — |
| | TIMOTHY *Phleum pratense* | | | | | | | | | | | | |
| 465 | fresh, late vegetative | 2-04-903 | 26 | 0.71 | 0.58 | 0.35 | 0.20 | 16 | 4.8 | 2.6 | — | 8.5 | — |
| 466 | | | 100 | 2.69 | 2.21 | 1.34 | 0.77 | 61 | 18.0 | 10.0 | — | 32.1 | — |
| 467 | fresh, midbloom | 2-04-905 | 29 | 0.80 | 0.66 | 0.40 | 0.23 | 18 | 2.7 | 1.4 | 9 | 9.8 | 1 |
| 468 | | | 100 | 2.73 | 2.24 | 1.35 | 0.80 | 62 | 9.1 | 4.9 | 31 | 33.5 | 4 |
| 469 | hay, sun-cured, late vegetative | 1-04-881 | 89 | 2.56 | 2.10 | 1.31 | 0.78 | 58 | 15.2 | 10.2 | 25 | 24.1 | 3 |
| 470 | | | 100 | 2.87 | 2.35 | 1.47 | 0.88 | 65 | 17.0 | 11.4 | 28 | 27.0 | 3 |
| 471 | hay, sun-cured, early bloom | 1-04-882 | 90 | 2.21 | 1.81 | 1.06 | 0.55 | 51 | 13.4 | 7.3 | 28 | 25.1 | 4 |
| 472 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 15.0 | 8.2 | 31 | 28.0 | 4 |
| 473 | hay, sun-cured, midbloom | 1-04-883 | 89 | 2.35 | 1.93 | 1.17 | 0.66 | 53 | 8.1 | 4.9 | 29 | 27.6 | 4 |
| 474 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 9.1 | 5.6 | 33 | 31.0 | 5 |
| 475 | hay, sun-cured, late bloom | 1-04-885 | 88 | 2.14 | 1.76 | 1.00 | 0.51 | 49 | 6.9 | 3.1 | 30 | 28.7 | 6 |
| 476 | | | 100 | 2.43 | 1.99 | 1.14 | 0.58 | 55 | 7.8 | 3.5 | 34 | 32.5 | 7 |
| 477 | silage | 3-04-922 | 34 | 0.90 | 0.74 | 0.44 | 0.25 | 20 | 3.5 | 1.9 | — | 12.1 | — |
| 478 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 10.1 | 5.6 | — | 35.6 | — |
| | TREFOIL, BIRDSFOOT *Lotus corniculatus* | | | | | | | | | | | | |
| 479 | fresh | 2-20-786 | 24 | 0.67 | 0.55 | 0.34 | 0.07 | 15 | 5.1 | 4.0 | — | 6.0 | — |
| 480 | | | 100 | 2.78 | 2.28 | 1.41 | 0.83 | 63 | 21.0 | 16.3 | — | 24.7 | — |
| 481 | hay, sun-cured | 1-05-044 | 92 | 2.36 | 1.93 | 1.14 | 0.63 | 53 | 15.0 | 10.3 | 22 | 28.3 | 8 |
| 482 | | | 100 | 2.56 | 2.10 | 1.24 | 0.68 | 58 | 16.3 | 11.2 | 24 | 30.7 | 9 |
| | TURNIP *Brassica rapa rapa* | | | | | | | | | | | | |
| 483 | aerial part, fresh | 2-05-063 | 14 | 0.42 | 0.35 | 0.23 | 0.15 | 10 | 2.9 | 1.1 | — | 1.4 | — |
| 484 | | | 100 | 3.13 | 2.57 | 1.67 | 1.06 | 71 | 21.2 | 8.1 | — | 10.3 | — |
| 485 | aerial part, silage | 3-05-066 | 14 | 0.45 | 0.37 | 0.23 | 0.15 | 10 | 2.1 | 1.5 | — | 2.4 | — |
| 486 | | | 100 | 3.13 | 2.57 | 1.67 | 1.06 | 71 | 14.8 | 10.7 | — | 17.0 | — |
| 487 | roots, fresh | 4-05-067 | 9 | 0.35 | 0.29 | 0.19 | 0.13 | 8 | 1.1 | 0.8 | — | 1.1 | 1 |
| 488 | | | 100 | 3.79 | 3.11 | 2.12 | 1.45 | 86 | 11.8 | 8.9 | — | 11.5 | 10 |
| | VETCH, *Vicia spp* | | | | | | | | | | | | |
| 489 | fresh | 2-05-111 | 22 | 0.60 | 0.49 | 0.29 | 0.16 | 13 | 4.7 | 3.5 | — | 6.2 | — |
| 490 | | | 100 | 2.65 | 2.17 | 1.31 | 0.74 | 60 | 20.9 | 15.7 | — | 27.7 | — |
| 491 | fresh, late vegetative | 2-05-108 | 22 | 0.58 | 0.48 | 0.28 | 0.16 | 13 | 4.6 | 3.5 | — | 6.2 | — |
| 492 | | | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 20.8 | 15.8 | — | 27.7 | — |
| 493 | hay, sun-cured | 1-05-106 | 89 | 2.16 | 1.77 | 1.01 | 0.52 | 49 | 18.5 | 14.0 | — | 27.3 | 7 |
| 494 | | | 100 | 2.43 | 1.99 | 1.14 | 0.58 | 55 | 20.8 | 15.7 | — | 30.6 | 8 |
| 495 | hay, sun-cured, early vegetative | 1-05-098 | 93 | 2.58 | 2.11 | 1.31 | 0.77 | 59 | 23.4 | 18.8 | — | 24.2 | 6 |
| 496 | | | 100 | 2.78 | 2.28 | 1.41 | 0.83 | 63 | 25.2 | 20.3 | — | 26.1 | 6 |
| 497 | hay, sun-cured, early bloom | 1-05-099 | 83 | 2.16 | 1.77 | 1.06 | 0.59 | 49 | 19.3 | 14.7 | — | 23.7 | — |
| 498 | | | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 23.3 | 17.7 | — | 28.6 | — |
| 499 | hay, sun-cured, midbloom | 1-05-100 | 91 | 2.29 | 1.88 | 1.10 | 0.58 | 52 | 18.9 | 15.2 | — | 26.7 | 8 |
| 500 | | | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 20.8 | 16.6 | — | 29.3 | 9 |
| | WHEAT *Triticum aestivum* | | | | | | | | | | | | |
| 501 | bran | 4-05-190 | 89 | 2.78 | 2.28 | 1.49 | 0.94 | 63 | 15.2 | 11.8 | 9 | 10.0 | 3 |
| 502 | | | 100 | 3.13 | 2.57 | 1.67 | 1.06 | 71 | 17.1 | 13.3 | 11 | 11.3 | 3 |
| 503 | flour by-product, less than 9.5% | 4-05-205 | 89 | 3.21 | 2.63 | 1.78 | 1.20 | 72 | 16.4 | 13.2 | — | 7.3 | — |
| 504 | fiber (wheat middlings) | | 100 | 3.62 | 2.97 | 2.00 | 1.35 | 82 | 18.4 | 14.8 | — | 8.2 | — |
| 505 | fresh, early vegetative | 2-05-176 | 22 | 0.73 | 0.60 | 0.39 | 0.26 | 17 | 6.3 | 5.0 | 5 | 3.9 | 1 |
| 506 | | | 100 | 3.31 | 2.71 | 1.79 | 1.16 | 75 | 28.6 | 22.6 | 24 | 17.4 | 4 |
| 507 | grain | 4-05-211 | 89 | 3.41 | 2.80 | 1.91 | 1.32 | 78 | 14.2 | 11.4 | 7 | 2.6 | — |
| 508 | | | 100 | 3.84 | 3.15 | 2.15 | 1.48 | 87 | 16.0 | 12.8 | 8 | 2.9 | — |
| 509 | grain, hard red spring | 4-05-258 | 88 | 3.48 | 2.85 | 1.97 | 1.36 | 78 | 15.1 | 11.3 | 7 | 2.5 | — |
| 510 | | | 100 | 3.97 | 3.25 | 2.24 | 1.55 | 90 | 17.2 | 13.0 | 8 | 2.9 | — |
| 511 | grain, hard red winter | 4-05-268 | 88 | 3.42 | 2.81 | 1.92 | 1.32 | 78 | 12.7 | 9.1 | — | 2.5 | — |
| 512 | | | 100 | 3.88 | 3.18 | 2.18 | 1.50 | 88 | 14.4 | 10.4 | — | 2.8 | — |
| 513 | grain, soft red winter | 4-05-294 | 88 | 3.42 | 2.81 | 1.92 | 1.32 | 78 | 11.5 | 8.6 | — | 2.2 | — |
| 514 | | | 100 | 3.88 | 3.18 | 2.18 | 1.50 | 88 | 13.0 | 9.8 | — | 2.4 | — |
| 515 | grain, soft white winter, Pacific coast | 4-08-555 | 89 | 3.50 | 2.87 | 1.97 | 1.35 | 79 | 10.0 | 6.7 | — | 2.5 | — |
| 516 | | | 100 | 3.92 | 3.22 | 2.21 | 1.52 | 89 | 11.2 | 7.5 | — | 2.8 | — |
| 517 | grain screenings | 4-05-216 | 89 | 2.95 | 2.42 | 1.59 | 1.03 | 67 | 14.1 | 10.1 | 5 | 6.9 | 7 |
| 518 | | | 100 | 3.31 | 2.71 | 1.79 | 1.16 | 75 | 15.8 | 11.3 | 6 | 7.7 | 8 |
| 519 | hay, sun-cured | 1-05-172 | 88 | 2.01 | 1.65 | 0.92 | 0.43 | 45 | 7.4 | 4.0 | — | 24.6 | 6 |
| 520 | | | 100 | 2.29 | 1.88 | 1.04 | 0.49 | 52 | 8.5 | 4.6 | — | 28.1 | 7 |
| 521 | straw | 1-05-175 | 89 | 1.60 | 1.32 | 0.57 | 0.10 | 36 | 3.2 | -3.1 | 35 | 36.9 | 12 |
| 522 | | | 100 | 1.81 | 1.48 | 0.64 | 0.11 | 41 | 3.6 | -3.5 | 39 | 41.6 | 14 |

| Entry Number | Calcium (%) | Chlorine (%) | Cobalt (mg/kg) | Copper (mg/kg) | Fluorine (mg/kg) | Iodine (mg/kg) | Iron (mg/kg) | Magnesium (%) | Manganese (mg/kg) | Molybdenum (mg/kg) | Phosphorus (%) | Potassium (%) | Selenium (mg/kg) | Sodium (%) | Sulfur (%) | Zinc (mg/kg) | Provitamin A (Carotene) (mg/kg) | Vitamin E (mg/kg) | Vitamin D₂ (IU/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 463 | 1.11 | 0.32 | — | 9 | — | — | 133 | 0.63 | 94 | — | 0.22 | 1.40 | — | 0.08 | 0.41 | — | 86 | — | 1636 |
| 464 | 1.27 | 0.37 | — | 10 | — | — | 152 | 0.49 | 108 | — | 0.25 | 1.60 | — | 0.09 | 0.47 | — | 99 | — | 1874 |
| 465 | 0.10 | — | — | — | — | — | 53 | 0.04 | — | — | 0.08 | 0.63 | — | 0.05 | 0.03 | — | 62 | — | — |
| 466 | 0.39 | — | — | — | — | — | 200 | 0.15 | — | — | 0.32 | 2.40 | — | 0.19 | 0.13 | — | 235 | — | — |
| 467 | 0.11 | 0.19 | — | 3 | — | — | 52 | 0.04 | 56 | — | 0.09 | 0.60 | — | 0.06 | 0.04 | — | 57 | — | — |
| 468 | 0.38 | 0.64 | — | 11 | — | — | 179 | 0.14 | 192 | — | 0.30 | 2.06 | — | 0.19 | 0.13 | — | 195 | — | — |
| 469 | 0.59 | — | — | 23 | — | — | 179 | 0.13 | 79 | — | 0.30 | 1.50 | — | 0.16 | — | 60 | 112 | — | — |
| 470 | 0.66 | — | — | 26 | — | — | 200 | 0.14 | 89 | — | 0.34 | 1.68 | — | 0.18 | — | 67 | 125 | — | — |
| 471 | 0.48 | — | — | 57 | — | — | 179 | 0.13 | 92 | — | 0.22 | — | — | 0.16 | — | 56 | 47 | 12 | — |
| 472 | 0.53 | — | — | 64 | — | — | 200 | 0.14 | 103 | — | 0.25 | — | — | 0.18 | — | 62 | 53 | 13 | — |
| 473 | 0.43 | — | — | 5 | — | — | 151 | 0.14 | — | — | 0.20 | 1.41 | — | 0.16 | — | 38 | 47 | — | 1764 |
| 474 | 0.48 | — | — | 5 | — | — | 170 | 0.16 | — | — | 0.22 | 1.59 | — | 0.18 | — | 43 | 53 | — | 1965 |
| 475 | 0.34 | — | — | — | — | — | 141 | 0.12 | — | — | 0.16 | 1.42 | — | 0.06 | — | — | 40 | — | — |
| 476 | 0.38 | — | — | — | — | — | 160 | 0.13 | — | — | 0.18 | 1.61 | — | 0.07 | — | — | 45 | — | — |
| 477 | 0.19 | — | — | 2 | — | — | 37 | 0.05 | 31 | — | 0.10 | 0.58 | — | 0.04 | 0.04 | — | 31 | — | — |
| 478 | 0.55 | — | — | 6 | — | — | 110 | 0.15 | 90 | — | 0.29 | 1.69 | — | 0.11 | 0.13 | — | 90 | — | — |
| 479 | 0.46 | — | 0.05 | — | — | — | 97 | 0.07 | — | — | 0.05 | 0.48 | — | 0.02 | 0.06 | — | — | — | — |
| 480 | 1.91 | — | 0.21 | — | — | — | 400 | 0.28 | — | — | 0.22 | 1.99 | — | 0.07 | 0.25 | — | — | — | — |
| 481 | 1.57 | — | 0.10 | 9 | — | — | 210 | 0.47 | 26 | — | 0.25 | 1.77 | — | 0.06 | 0.23 | — | 173 | — | 1421 |
| 482 | 1.70 | — | 0.11 | 9 | — | — | 228 | 0.51 | 29 | — | 0.27 | 1.92 | — | 0.07 | 0.25 | — | 188 | — | 1544 |
| 483 | 0.40 | 0.26 | — | 2 | — | — | 54 | 0.07 | 55 | — | 0.05 | 0.41 | — | 0.15 | 0.04 | 5 | — | — | — |
| 484 | 2.93 | 1.93 | — | 18 | — | — | 403 | 0.54 | 409 | — | 0.39 | 3.03 | — | 1.13 | 0.27 | 37 | — | — | — |
| 485 | 0.41 | — | — | 3 | — | — | 54 | 0.07 | 58 | — | 0.06 | 0.54 | — | — | — | — | 71 | 3 | — |
| 486 | 2.87 | — | — | 18 | — | — | 380 | 0.47 | 409 | — | 0.58 | 3.79 | — | — | — | — | 501 | 22 | — |
| 487 | 0.05 | 0.06 | — | 2 | — | — | 11 | 0.02 | 4 | — | 0.02 | 0.28 | — | 0.10 | 0.04 | 3 | — | — | — |
| 488 | 0.59 | 0.65 | — | 21 | — | — | 118 | 0.22 | 43 | — | 0.26 | 2.99 | — | 1.05 | 0.43 | 29 | — | — | — |
| 489 | — | 0.42 | 0.07 | — | — | — | — | — | — | — | — | — | — | 0.11 | 0.03 | — | — | — | — |
| 490 | — | 1.85 | 0.30 | — | — | — | — | — | — | — | — | — | — | 0.49 | 0.15 | — | — | — | — |
| 491 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 492 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 493 | 1.05 | — | 0.32 | 9 | — | 0.44 | 374 | 0.22 | 65 | — | 0.29 | 2.07 | — | 0.46 | 0.13 | — | 411 | — | — |
| 494 | 1.15 | — | 0.36 | 10 | — | 0.49 | 420 | 0.25 | 73 | — | 0.32 | 2.32 | — | 0.52 | 0.15 | — | 461 | — | — |
| 495 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 358 | — | — |
| 496 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 386 | — | — |
| 497 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 498 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 499 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 500 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 501 | 0.11 | 0.05 | 0.10 | 13 | — | 0.07 | 114 | 0.53 | 111 | — | 1.22 | 1.38 | 0.38 | 0.04 | 0.22 | 114 | 3 | 18 | — |
| 502 | 0.13 | 0.05 | 0.11 | 14 | — | 0.07 | 128 | 0.60 | 125 | — | 1.38 | 1.56 | 0.43 | 0.04 | 0.25 | 128 | 3 | 21 | — |
| 503 | 0.11 | 0.04 | 0.09 | 19 | — | 0.11 | 83 | 0.36 | 112 | — | 0.88 | 1.00 | 0.74 | 0.17 | 0.17 | 103 | 3 | 23 | — |
| 504 | 0.13 | 0.04 | 0.10 | 22 | — | 0.12 | 93 | 0.40 | 126 | — | 0.99 | 1.13 | 0.83 | 0.19 | 0.20 | 116 | 3 | 25 | — |
| 505 | 0.09 | — | — | — | — | — | 22 | 0.05 | — | — | 0.09 | 0.75 | — | 0.04 | 0.05 | — | 115 | — | — |
| 506 | 0.42 | — | — | — | — | — | 100 | 0.21 | — | — | 0.40 | 3.50 | — | 0.18 | 0.22 | — | 520 | — | — |
| 507 | 0.04 | 0.07 | 0.12 | 6 | — | 0.09 | 54 | 0.15 | 37 | — | 0.37 | 0.38 | 0.26 | 0.04 | 0.16 | 44 | 0 | 15 | — |
| 508 | 0.04 | 0.08 | 0.14 | 7 | — | 0.10 | 61 | 0.16 | 42 | — | 0.42 | 0.42 | 0.30 | 0.05 | 0.18 | 50 | 0 | 17 | — |
| 509 | 0.03 | 0.08 | 0.12 | 6 | — | — | 56 | 0.15 | 37 | — | 0.38 | 0.36 | 0.25 | 0.02 | 0.15 | 45 | 0 | 13 | — |
| 510 | 0.04 | 0.09 | 0.13 | 7 | — | — | 64 | 0.17 | 42 | — | 0.43 | 0.41 | 0.29 | 0.03 | 0.17 | 52 | 0 | 14 | — |
| 511 | 0.04 | 0.05 | 0.14 | 5 | — | — | 31 | 0.11 | 29 | — | 0.38 | 0.43 | 0.40 | 0.02 | 0.13 | 38 | — | 11 | — |
| 512 | 0.05 | 0.06 | 0.16 | 5 | — | — | 35 | 0.13 | 33 | — | 0.43 | 0.49 | 0.45 | 0.02 | 0.15 | 43 | — | 12 | — |
| 513 | 0.04 | 0.07 | 0.10 | 6 | — | — | 27 | 0.10 | 32 | — | 0.38 | 0.41 | 0.04 | 0.01 | 0.11 | 42 | — | 16 | — |
| 514 | 0.05 | 0.08 | 0.12 | 7 | — | — | 30 | 0.11 | 36 | — | 0.43 | 0.46 | 0.05 | 0.01 | 0.12 | 48 | — | 15 | — |
| 515 | 0.09 | — | — | — | — | — | 54 | 0.13 | — | — | 0.30 | 0.45 | — | 0.09 | 0.16 | — | — | — | — |
| 516 | 0.10 | — | — | — | — | — | 60 | 0.15 | — | — | 0.34 | 0.51 | — | 0.10 | 0.18 | — | — | — | — |
| 517 | 0.13 | — | — | — | — | — | 54 | 0.16 | 29 | — | 0.35 | 0.52 | 0.61 | 0.09 | 0.20 | — | — | — | — |
| 518 | 0.15 | — | — | — | — | — | 60 | 0.18 | 33 | — | 0.39 | 0.58 | 0.68 | 0.10 | 0.22 | — | — | — | — |
| 519 | 0.13 | — | — | — | — | — | 175 | 0.11 | — | — | 0.17 | 0.87 | — | 0.18 | 0.19 | — | 75 | — | 1352 |
| 520 | 0.15 | — | — | — | — | — | 200 | 0.12 | — | — | 0.20 | 1.00 | — | 0.21 | 0.22 | — | 85 | — | 1544 |
| 521 | 0.16 | 0.28 | 0.04 | 3 | — | — | 140 | 0.11 | 36 | — | 0.04 | 1.26 | — | 0.13 | 0.17 | 6 | 2 | — | 587 |
| 522 | 0.18 | 0.32 | 0.05 | 4 | — | — | 157 | 0.12 | 41 | — | 0.05 | 1.42 | — | 0.14 | 0.19 | 6 | 2 | — | 662 |

TABLE 13 Composition of Some Sheep Feeds; Data Expressed on an As-Fed and Dry Basis (100% Dry Matter)—*Continued*

| Entry Number | Feed Name Description[a] | International Feed Number | Dry Matter (%) | DE Sheep (Mcal/kg) | ME Sheep (Mcal/kg) | NE_m (Mcal/kg) | NE_g (Mcal/kg) | TDN Sheep (%) | Crude Protein (%) | Dig. Protein (%) | Cellulose (%) | Crude Fiber (%) | Lignin (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | WHEATGRASS, CRESTED *Agropyron desertorum* | | | | | | | | | | | | |
| 523 | fresh, early vegetative | 2-05-420 | 28 | 0.92 | 0.76 | 0.50 | 0.32 | 21 | 6.0 | 5.1 | — | 6.2 | — |
| 524 | | | 100 | 3.31 | 2.71 | 1.79 | 1.16 | 75 | 21.5 | 18.3 | — | 22.2 | — |
| 525 | fresh, late vegetative | 2-05-421 | 34 | 0.91 | 0.75 | 0.46 | 0.26 | 21 | 4.8 | 3.4 | — | 7.8 | — |
| 526 | | | 100 | 2.69 | 2.21 | 1.34 | 0.77 | 61 | 14.0 | 10.0 | — | 22.9 | — |
| 527 | fresh, early bloom | 2-05-422 | 37 | 0.93 | 0.76 | 0.45 | 0.24 | 21 | 4.4 | 3.0 | — | 9.9 | — |
| 528 | | | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 12.0 | 8.2 | — | 26.9 | — |
| 529 | fresh, full bloom | 2-05-424 | 45 | 1.11 | 0.91 | 0.53 | 0.27 | 25 | 4.4 | 1.8 | — | 13.6 | — |
| 530 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 9.8 | 4.0 | — | 30.3 | — |
| 531 | fresh, milk stage | 2-05-425 | 48 | 1.16 | 0.95 | 0.53 | 0.28 | 26 | 3.8 | 2.1 | — | 16.8 | — |
| 532 | | | 100 | 2.43 | 1.99 | 1.14 | 0.58 | 55 | 8.0 | 4.4 | — | 35.0 | |
| 533 | fresh, mature | 2-05-427 | 60 | 1.43 | 1.17 | 0.67 | 0.33 | 32 | 3.3 | 1.3 | — | 23.2 | — |
| 534 | | | 100 | 2.38 | 1.95 | 1.11 | 0.55 | 54 | 5.5 | 2.1 | — | 38.7 | — |
| 535 | fresh, post ripe | 2-05-428 | 80 | 1.91 | 1.56 | 0.89 | 0.44 | 43 | 2.5 | −0.1 | — | 32.2 | — |
| 536 | | | 100 | 2.38 | 1.95 | 1.11 | 0.55 | 54 | 3.1 | −0.1 | — | 40.3 | — |
| 537 | fresh, stem-cured | 2-08-558 | 81 | 1.89 | 1.55 | 0.87 | 0.42 | 43 | 2.7 | 1.2 | — | 31.7 | — |
| 538 | | | 100 | 2.34 | 1.92 | 1.07 | 0.52 | 53 | 3.3 | 1.5 | — | 39.1 | — |
| 539 | hay, sun-cured | 1-05-418 | 93 | 2.17 | 1.78 | 1.00 | 0.48 | 49 | 11.5 | 7.4 | — | 30.5 | 5 |
| 540 | | | 100 | 2.34 | 1.92 | 1.07 | 0.52 | 53 | 12.4 | 8.0 | — | 32.9 | 6 |
| 541 | hay, sun-cured, early vegetative | 1-05-411 | 94 | 3.14 | 2.57 | 1.71 | 1.12 | 71 | 18.0 | 15.3 | — | 19.6 | — |
| 542 | | | 100 | 3.35 | 2.75 | 1.82 | 1.19 | 76 | 19.2 | 16.3 | — | 20.9 | — |
| 543 | hay, sun-cured, late vegetative | 1-20-201 | 92 | 2.39 | 1.96 | 1.18 | 0.65 | 55 | 19.6 | 14.4 | — | 25.2 | 4 |
| 544 | | | 100 | 2.60 | 2.13 | 1.28 | 0.71 | 59 | 21.3 | 15.6 | — | 27.4 | 5 |
| 545 | hay, sun-cured, early bloom | 1-05-412 | 92 | 2.31 | 1.89 | 1.11 | 0.59 | 52 | 12.9 | 8.4 | — | 30.8 | — |
| 546 | | | 100 | 2.51 | 2.06 | 1.21 | 0.64 | 57 | 14.0 | 9.1 | — | 33.5 | — |
| 547 | hay, sun-cured, midbloom | 1-05-413 | 96 | 2.38 | 1.95 | 1.13 | 0.59 | 54 | 12.8 | 8.2 | — | 33.0 | 6 |
| 548 | | | 100 | 2.47 | 2.03 | 1.18 | 0.61 | 56 | 13.2 | 8.5 | — | 34.3 | 6 |
| 549 | hay, sun-cured, full bloom | 1-05-414 | 95 | 2.30 | 1.89 | 1.06 | 0.55 | 52 | 8.3 | 4.2 | — | 34.2 | — |
| 550 | | | 100 | 2.43 | 1.99 | 1.14 | 0.58 | 55 | 8.7 | 4.4 | — | 36.0 | — |
| 551 | hay, sun-cured, milk stage | 1-05-415 | 93 | 2.16 | 1.77 | 1.00 | 0.48 | 49 | 6.9 | 3.1 | — | 34.2 | — |
| 552 | | | 100 | 2.34 | 1.92 | 1.07 | 0.52 | 53 | 7.5 | 3.3 | — | 37.0 | — |
| 553 | hay, sun-cured, mature | 1-05-416 | 94 | 1.99 | 1.63 | 0.85 | 0.33 | 45 | 5.3 | 3.3 | — | 36.4 | — |
| 554 | | | 100 | 2.12 | 1.74 | 0.90 | 0.35 | 48 | 5.6 | 3.5 | — | 38.7 | — |
| | WINTERFAT, COMMON *Eurotia lanata* | | | | | | | | | | | | |
| 555 | fresh, stem cured | 2-26-142 | 80 | 1.24 | 1.01 | 0.33 | — | 28 | 8.7 | 5.4 | — | — | 8 |
| 556 | | | 100 | 1.54 | 1.27 | 0.41 | — | 35 | 10.8 | 6.7 | — | — | 10 |

[a]See Table 15 for stage-of-maturity terms.

| Entry Number | Calcium (%) | Chlorine (%) | Cobalt (mg/kg) | Copper (mg/kg) | Fluorine (mg/kg) | Iodine (mg/kg) | Iron (mg/kg) | Magnesium (%) | Manganese (mg/kg) | Molybdenum (mg/kg) | Phosphorus (%) | Potassium (%) | Selenium (mg/kg) | Sodium (%) | Sulfur (%) | Zinc (mg/kg) | Provitamin A (Carotene) (mg/kg) | Vitamin E (mg/kg) | Vitamin D₂ (IU/g) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 523 | 0.13 | — | — | — | — | — | — | 0.08 | — | — | 0.10 | — | — | — | — | — | 126 | — | — |
| 524 | 0.46 | — | — | — | — | — | — | 0.28 | — | — | 0.34 | — | — | — | — | — | 451 | — | — |
| 525 | 0.08 | — | — | — | — | — | — | — | — | — | 0.07 | — | — | — | — | — | 123 | — | — |
| 526 | 0.23 | — | — | — | — | — | — | — | — | — | 0.20 | — | — | — | — | — | 361 | — | — |
| 527 | 0.09 | — | — | — | — | — | — | — | — | — | 0.07 | — | — | — | — | — | — | — | — |
| 528 | 0.24 | — | — | — | — | — | — | — | — | — | 0.18 | — | — | — | — | — | — | — | — |
| 529 | 0.18 | — | — | 3 | — | — | — | 0.04 | 19 | — | 0.13 | 0.47 | — | 0.00 | 0.21 | 6 | 69 | — | — |
| 530 | 0.39 | — | — | 7 | — | — | — | 0.09 | 43 | — | 0.28 | 1.04 | — | 0.01 | 0.47 | 13 | 154 | — | — |
| 531 | 0.15 | — | — | — | — | — | — | — | — | — | 0.12 | — | — | — | — | — | 41 | — | — |
| 532 | 0.31 | — | — | — | — | — | — | — | — | — | 0.25 | — | — | — | — | — | 86 | — | — |
| 533 | 0.16 | — | — | — | — | — | — | — | — | — | 0.09 | — | — | — | — | — | 45 | — | — |
| 534 | 0.27 | — | — | — | — | — | — | — | — | — | 0.15 | — | — | — | — | — | 75 | — | — |
| 535 | 0.22 | — | 0.20 | 7 | — | — | — | — | 42 | — | 0.06 | — | — | — | — | — | 0 | — | — |
| 536 | 0.27 | — | 0.25 | 8 | — | — | — | — | 53 | — | 0.07 | — | — | — | — | — | 0 | — | — |
| 537 | 0.16 | — | — | — | — | — | — | — | — | — | 0.07 | — | — | — | — | — | — | — | — |
| 538 | 0.20 | — | — | — | — | — | — | — | — | — | 0.09 | — | — | — | — | — | — | — | — |
| 539 | 0.31 | — | 0.22 | 15 | — | — | 165 | 0.15 | 34 | — | 0.20 | 1.85 | 0.37 | — | — | 30 | 21 | — | — |
| 540 | 0.33 | — | 0.24 | 16 | — | — | 178 | 0.16 | 36 | — | 0.21 | 2.00 | 0.40 | — | — | 32 | 22 | — | — |
| 541 | 0.40 | — | — | — | — | — | — | — | — | — | 0.25 | — | — | — | — | — | 213 | — | — |
| 542 | 0.43 | — | — | — | — | — | — | — | — | — | 0.26 | — | — | — | — | — | 228 | — | — |
| 543 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 544 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 545 | 0.31 | — | — | 15 | — | — | 164 | 0.15 | 33 | — | 0.20 | 1.84 | 0.37 | — | — | 29 | — | — | — |
| 546 | 0.34 | — | — | 16 | — | — | 178 | 0.16 | 36 | — | 0.22 | 2.00 | 0.40 | — | — | 32 | — | — | — |
| 547 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 548 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 549 | 0.25 | — | — | — | — | — | — | — | — | — | 0.15 | — | — | — | — | — | — | — | — |
| 550 | 0.26 | — | — | — | — | — | — | — | — | — | 0.16 | — | — | — | — | — | — | — | — |
| 551 | 0.24 | — | — | — | — | — | — | — | — | — | 0.10 | — | — | — | — | — | — | — | — |
| 552 | 0.26 | — | — | — | — | — | — | — | — | — | 0.11 | — | — | — | — | — | — | — | — |
| 553 | 0.18 | — | — | — | — | — | — | 0.03 | — | — | 0.11 | 0.45 | — | — | — | — | 29 | — | — |
| 554 | 0.19 | — | — | — | — | — | — | 0.03 | — | — | 0.12 | 0.48 | — | — | — | — | 31 | — | — |
| 555 | 1.58 | — | — | — | — | — | — | — | — | — | 0.09 | — | — | — | — | — | 14 | — | — |
| 556 | 1.96 | — | — | — | — | — | — | — | — | — | 0.12 | — | — | — | — | — | 18 | — | — |

TABLE 14 Composition of Mineral Supplements; Data Expressed on an As-Fed and Dry Basis (100% Dry Matter)[a]

| Entry Number | Feed Name Description | International Feed Number | Dry Matter (%) | Protein Equivalent N × 6.25 (%) | Calcium (Ca) (%) | Chlorine (Cl) (%) | Magnesium (Mg) (%) | Phosphorus (P) (%) | Potassium (K) (%) | Sodium (Na) (%) | Sulfur (S) (%) | Cobalt (Co) (mg/kg) | Copper (Cu) (mg/kg) | Fluorine (F) (mg/kg) | Iodine (I) (mg/kg) | Iron (Fe) (mg/kg) | Manganese (Mn) (mg/kg) | Selenium (Se) (mg/kg) | Zinc (Zn) (mg/kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **AMMONIUM** | | | | | | | | | | | | | | | | | | |
| 01 | phosphate, monobasic, (NH₄)H₂PO₄ (monoammonium phosphate) | 6-09-338 | 97 | 68.8 | 0.27 | — | 0.45 | 24.00 | 0.01 | 0.06 | 1.42 | 10 | 10 | 2,400 | — | 16,900 | 388 | — | 97 |
| 02 | | | 100 | 70.9 | 0.28 | — | 0.46 | 24.74 | 0.01 | 0.06 | 1.46 | 10 | 10 | 2,500 | — | 17,400 | 400 | — | 100 |
| 03 | phosphate, dibasic, (NH₄)₂HPO₄ (diammonium phosphate) | 6-00-370 | 97 | 112.4 | 0.50 | — | 0.45 | 20.00 | 0.01 | 0.05 | 2.10 | 10 | 10 | 2,037 | — | 12,028 | 388 | — | 97 |
| 04 | | 6-09-339 | 100 | 115.9 | 0.52 | — | 0.46 | 20.60 | 0.01 | 0.05 | 2.16 | 10 | 10 | 2,100 | — | 12,400 | 400 | — | 100 |
| 05 | sulfate | | 100 | 134.1 | — | — | — | — | — | — | 24.10 | — | 1 | — | — | 10 | 1 | — | — |
| 06 | | | 100 | 134.1 | — | — | — | — | — | — | 24.10 | — | 1 | — | — | 10 | 1 | — | — |
| | **BONE** | | | | | | | | | | | | | | | | | | |
| 07 | charcoal (bone black) (bone char) | 6-00-402 | 90 | — | 27.10 | — | 0.53 | 12.73 | 0.14 | — | — | — | — | — | — | — | — | — | — |
| 08 | meal, steamed | 6-00-400 | 100 | — | 30.11 | — | 0.59 | 14.14 | 0.16 | — | — | — | — | — | — | — | — | — | — |
| 09 | | | 97 | 8.1 | 30.58 | 0.01 | 0.62 | 13.79 | 0.18 | 0.39 | 0.20 | — | 14 | — | 30 | 757 | 33 | — | 332 |
| 10 | | | 100 | 8.4 | 31.53 | 0.01 | 0.64 | 14.22 | 0.19 | 0.40 | 0.21 | — | 14 | — | 31 | 789 | 34 | — | 342 |
| | **CALCIUM** | | | | | | | | | | | | | | | | | | |
| 11 | carbonate, CaCO₃ | 6-01-069 | 100 | — | 39.39 | — | 0.05 | 0.04 | 0.06 | 0.06 | 0.09 | — | — | — | — | 300 | 300 | — | — |
| 12 | | | 100 | — | 39.39 | — | 0.05 | 0.04 | 0.06 | 0.06 | 0.09 | — | — | — | — | 300 | 300 | — | — |
| 13 | phosphate, monobasic, from defluorinated phosphoric acid (monocalcium phosphate) | 6-01-082 | 97 | — | 15.91 | — | 0.59 | 20.95 | 0.08 | 0.06 | 1.19 | 10 | 10 | 2,000 | — | 15,300 | 350 | — | 87 |
| 14 | | | 100 | — | 16.40 | — | 0.61 | 21.60 | 0.08 | 0.06 | 1.22 | 10 | 10 | 2,100 | — | 15,800 | 360 | — | 90 |
| 15 | phosphate, dibasic, from defluorinated phosphoric acid (dicalcium phosphate) | 6-01-080 | 97 | — | 21.30 | — | 0.57 | 18.70 | 0.07 | 0.05 | 1.11 | 10 | 10 | 1,746 | — | 14,000 | 291 | — | 97 |
| 16 | | | 100 | — | 22.00 | — | 0.59 | 19.30 | 0.07 | 0.05 | 1.14 | 10 | 10 | 1,800 | — | 14,400 | 300 | — | 100 |
| 17 | sulfate, anhydrous (gypsum), CaSO₄ | 6-01-087 | 85 | — | 22.02 | — | 2.21 | 0.01 | — | — | 20.01 | — | — | — | — | 1,710 | — | — | — |
| 18 | | | 100 | — | 25.90 | — | 2.61 | 0.01 | — | — | 23.54 | — | — | — | — | 2,010 | — | — | — |
| | **COBALT** | | | | | | | | | | | | | | | | | | |
| 19 | carbonate, CoCO₃ | 6-01-566 | 99[b] | — | — | — | — | — | — | — | — | 4,554 | — | — | — | — | — | — | — |
| 20 | | | 100 | — | — | — | — | — | — | — | — | 4,600 | — | — | — | — | — | — | — |
| | **COLLOIDAL** | | | | | | | | | | | | | | | | | | |
| 21 | clay (soft rock phosphate) | 6-03-947 | 99[b] | — | 17.00 | — | 0.38 | 9.00 | — | 0.10 | 0.20 | — | — | — | — | 490 | — | — | — |
| 22 | | | 100 | — | 17.17 | — | 0.38 | 9.09 | — | 0.10 | 0.20 | — | — | — | — | 500 | — | — | — |
| | **COPPER (CUPRIC)** | | | | | | | | | | | | | | | | | | |
| 23 | sulfate, pentahydrate CuSO₄·5H₂O, cp | 6-01-720 | 100 | — | — | — | — | — | — | — | 12.84 | — | 254,500 | — | — | — | — | — | — |
| 24 | | | 100 | — | — | — | — | — | — | — | 12.84 | — | 254,500 | — | — | — | — | — | — |
| | **CURACAO** | | | | | | | | | | | | | | | | | | |
| 25 | phosphate | 6-05-586 | 99[b] | — | 34.00 | — | 0.80 | 14.00 | — | 0.20 | — | — | — | 5,400 | — | 3,465 | — | — | — |
| 26 | | | 100 | — | 34.34 | — | 0.81 | 14.14 | — | 0.20 | — | — | — | 5,500 | — | 3,500 | — | — | — |
| | **IRON (FERROUS)** | | | | | | | | | | | | | | | | | | |
| 27 | sulfate, heptahydrate | 6-20-734 | 99[b] | — | — | — | — | — | — | — | 12.10 | — | — | — | — | 214,000 | — | — | — |
| 28 | | | 100 | — | — | — | — | — | — | — | 12.35 | — | — | — | — | 218,400 | — | — | — |

| No. | Item | Ref. | DM % | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LIMESTONE | | | | | | | | | | | | | | | | | | | | |
| 29 | limestone | 6-02-632 | 98 | 33.32 | 0.03 | 2.02 | 0.02 | 0.12 | 0.06 | 0.04 | — | — | — | — | — | — | — | — | — | — | 3,430 |
| 30 | | | 100 | 34.00 | 0.03 | 2.06 | 0.02 | 0.12 | 0.06 | 0.04 | — | — | — | — | — | — | — | — | — | — | 3,500 |
| 31 | magnesium (dolomitic) | 6-02-633 | 99 | 22.08 | 0.12 | 9.89 | 0.04 | 0.36 | — | — | — | — | — | — | — | — | — | — | — | — | 760 |
| 32 | | | 100 | 22.30 | 0.12 | 9.99 | 0.04 | 0.36 | — | — | — | — | — | — | — | — | — | — | — | — | 770 |
| | MAGNESIUM | | | | | | | | | | | | | | | | | | | | |
| 33 | carbonate, $MgCO_3 \cdot Mg(OH)_2$ | 6-02-754 | 98 | 0.02 | 0.00 | 30.20 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 210 |
| 34 | | | 100 | 0.02 | 0.00 | 30.81 | — | — | — | — | — | — | — | — | — | — | — | — | — | — | 220 |
| 35 | oxide, $MgO$ | 6-02-756 | 98 | 3.00 | — | 54.90 | — | — | — | — | — | — | — | — | — | — | — | — | 98 | — | — |
| 36 | | | 100 | 3.07 | — | 56.20 | — | — | — | — | — | — | — | — | — | — | — | — | 100 | — | — |
| | MANGANESE (MANGANOUS) | | | | | | | | | | | | | | | | | | | | |
| 37 | oxide, $MnO$, cp | 6-03-056 | 99 | — | — | — | — | — | — | — | — | — | — | — | — | 766,700 | — | — | — | — | — |
| 38 | | | 100 | — | — | — | — | — | — | — | — | — | — | — | — | 774,500 | — | — | — | — | — |
| | OYSTERSHELL | | | | | | | | | | | | | | | | | | | | |
| 39 | ground (flour) | 6-03-481 | 99 | 37.62 | 0.01 | 0.30 | 0.07 | 0.10 | 0.21 | — | — | — | — | — | — | — | 99 | — | — | — | 2,840 |
| 40 | | | 100 | 38.00 | 0.01 | 0.30 | 0.07 | 0.10 | 0.21 | — | — | — | — | — | — | — | 100 | — | — | — | 2,870 |
| | PHOSPHATE | | | | | | | | | | | | | | | | | | | | |
| 41 | defluorinated | 6-01-780 | 100 | 32.00 | — | 0.42 | 18.00 | 0.08 | 4.90 | — | 10 | 20 | 1,800 | — | — | 200 | — | — | — | 6,700 |
| 42 | | | 100 | 32.00 | — | 0.42 | 18.00 | 0.08 | 4.90 | — | 10 | 20 | 1,800 | — | — | 200 | — | — | — | 6,700 |
| | POTASSIUM | | | | | | | | | | | | | | | | | | | | |
| 43 | bicarbonate, $KHCO_3$, cp | 6-29-493 | 99 | — | — | — | — | 38.65 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 44 | | | 100 | — | — | — | — | 39.05 | — | — | — | — | — | — | — | — | — | — | — | — | — |
| 45 | iodide, $KI$ | 6-03-759 | 100 | — | — | — | — | 21.00 | — | — | — | — | — | 681,700 | — | — | — | — | — | — | — |
| 46 | | | 100 | — | — | — | — | 21.00 | — | — | — | — | — | 681,700 | — | — | — | — | — | — | — |
| | SODIUM | | | | | | | | | | | | | | | | | | | | |
| 47 | bicarbonate, $NaHCO_3$ | 6-04-272 | 100 | — | — | — | — | — | 27.00 | — | — | — | — | — | — | — | — | — | — | — | — |
| 48 | | | 100 | — | — | — | — | — | 27.00 | — | — | — | — | — | — | — | — | — | — | — | — |
| 49 | chloride, $NaCl$ | 6-04-152 | 100 | — | 60.66 | — | — | — | 39.34 | — | — | — | — | — | — | — | — | — | — | — | — |
| 50 | | | 100 | — | 60.66 | — | — | — | 39.34 | — | — | — | — | — | — | — | — | — | — | — | — |
| 51 | phosphate, monobasic, monohydrate, $NaH_2PO_4 \cdot H_2O$ | 6-04-288 | 97 | — | — | — | 21.80 | — | 16.18 | — | — | — | — | — | — | — | — | — | — | — | — |
| 52 | (monosodium phosphate) | | 100 | — | — | — | 22.50 | — | 16.68 | — | — | — | — | — | — | — | — | — | — | — | — |
| 53 | selenite, $Na_2SeO_3$ | 6-26-013 | 98 | — | — | — | — | — | 26.07 | — | — | — | — | — | — | — | — | — | — | 447,000 | — |
| 54 | | | 100 | — | — | — | — | — | 26.60 | — | — | — | — | — | — | — | — | — | — | 456,000 | — |
| 55 | sulfate decahydrate, $Na_2SO_4 \cdot 10H_2O$, cp | 6-04-292 | 97 | — | — | — | — | — | 13.84 | 9.65 | — | — | — | — | — | — | — | — | — | — | — |
| 56 | | | 100 | — | — | — | — | — | 14.27 | 9.95 | — | — | — | — | — | — | — | — | — | — | — |
| 57 | tripolyphosphate, $Na_5P_3O_{10}$ | 6-08-076 | 96 | — | — | — | 24.00 | — | 29.80 | — | — | — | — | — | — | — | — | — | — | — | 38 |
| 58 | | | 100 | — | — | — | 25.00 | — | 31.00 | — | — | — | — | — | — | — | — | — | — | — | 40 |
| | ZINC | | | | | | | | | | | | | | | | | | | | |
| 59 | oxide, $ZnO$ | 6-05-553 | 100 | — | — | 0.05 | — | — | — | 1.0 | — | — | — | — | — | — | — | — | — | — | 780,000 |
| 60 | | | 100 | — | — | 0.05 | — | — | — | 1.0 | — | — | — | — | — | — | — | — | — | — | 780,000 |
| 61 | sulfate, monohydrate, $ZnSO_4 \cdot H_2O$ | 6-05-555 | 99 | 0.02 | 0.015 | — | — | — | — | 17.50 | — | 10 | — | — | — | — | 10 | — | — | — | 360,000 |
| 62 | | | 100 | 0.02 | 0.015 | — | — | — | — | 17.68 | — | 10 | — | — | — | — | 10 | — | — | — | 363,600 |

[a]The composition of mineral ingredients that are hydrated (e.g., $CaSO_4 \cdot 2H_2O$) is shown, including the waters of hydration. Mineral composition of feed grade mineral supplements vary by source, mining site, and manufacturer. Use manufacturer's analysis when available.

[b]Dry matter values have been estimated for these minerals.

cp = Chemically pure.

TABLE 15   Stage-of-Maturity Terms Used in Table 13

| Preferred Term | Definition | Comparable Terms |
|---|---|---|
| *For Plants That Bloom* | | |
| Germinated | Stage in which the embryo in a seed resumes growth after a dormant period | Sprouted |
| Early vegetative | Stage at which the plant is vegetative and before the stems elongate | Fresh new growth, before heading out, before inflorescence emergence, immature prebud stage, very immature, young |
| Late vegetative | Stage at which stems are beginning to elongate to just before blooming; first bud to first flowers | Before bloom, bud stage, budding plants, heading to in bloom, heads just showing, jointing and boot (grasses), prebloom, preflowering, stems elongated |
| Early bloom | Stage between initiation of bloom and stage in which 1/10 of the plants are in bloom; some grass heads are in anthesis | Early anthesis, first flower, headed out, in head, up to 1/10 bloom |
| Midbloom | Stage in which 1/10 to 2/3 of the plants are in bloom; most grass heads are in anthesis | Bloom, flowering, flowering plants, half bloom, in bloom, mid anthesis |
| Full bloom | Stage in which 2/3 or more of the plants are in bloom | 3/4 to full bloom, late anthesis |
| Late bloom | Stage in which blossoms begin to dry and fall and seeds begin to form | 15 days after silking, before milk, in bloom to early pod, late to past anthesis |
| Milk stage | Stage in which seeds are well formed but soft and immature | After anthesis, early seed, fruiting, in tassel, late bloom to early seed, past bloom, pod stage, post anthesis, post bloom, seed developing, seed forming, soft, soft immature |
| Dough stage | Stage in which the seeds are of dough-like consistency | Dough stage, nearly mature, seeds dough, seeds well developed, soft dent |
| Mature | Stage in which plants are normally harvested for seed | Dent, dough to glazing, fruiting, fruiting plants, in seed, kernels ripe, ripe seed |
| Post ripe | Stage that follows maturity; seeds are ripe and plants have been cast and weathering has taken place (applies mostly to range plants) | Late, seed, over ripe, very mature |
| Stem cured | Stage in which plants are cured on the stem; seeds have been cast and weathering has taken place (applies mostly to range plants) | Dormant, mature and weathered, seeds cast |
| Regrowth early vegetative | Stage in which regrowth occurs without flowering activity; vegetative crop aftermath; regrowth in stubble (applies primarily to fall regrowth in temperate climates); early dry season regrowth | Vegetative recovery growth |
| Regrowth late vegetative | Stage in which stems begin to elongate to just before blooming; first bud to first flowers; regrowth in stubble with stem elongation (applies primarily to fall regrowth in temperate climates) | Recovery growth, stems elongating, jointing and boot (grasses) |
| *For Plants That Do Not Bloom[a]* | | |
| 1 to 14 days' growth | A specified length of time after plants have started to grow | 2 weeks' growth |
| 15 to 28 days' growth | A specified length of time after plants have started to grow | 4 weeks' growth |
| 29 to 42 days' growth | A specified length of time after plants have started to grow | 6 weeks' growth |
| 43 to 56 days' growth | A specified length of time after plants have started to grow | 8 weeks' growth |
| 57 to 70 days' growth | A specified length of time after plants have started to grow | 10 weeks' growth |

[a]These classes are for species that remain vegetative for long periods and apply primarily to the tropics. When the name of a feed is developed, the age classes form part of the name (e.g., Pangolagrass, 15 to 28 days' growth). Do not use terms which apply to plants that bloom and those which do not bloom in same name. For plants growing longer than 70 days, the interval is increased by increments of 14 days.

TABLE 16  Weight-Unit Conversion Factors

| Units Given | Units Wanted | For Conversion Multiply by |
|---|---|---|
| lb | g | 453.6 |
| lb | kg | 0.4536 |
| oz | g | 28.35 |
| kg | lb | 2.2046 |
| kg | mg | 1,000,000. |
| kg | g | 1,000. |
| g | mg | 1,000. |
| g | µg | 1,000,000. |
| mg | µg | 1,000. |
| mg/g | mg/lb | 453.6 |
| mg/kg | mg/lb | 0.4536 |
| µg/kg | µg/lb | 0.4536 |
| Mcal | kcal | 1,000. |
| kcal/kg | kcal/lb | 0.4536 |
| kcal/lb | kcal/kg | 2.2046 |
| ppm | µg/g | 1. |
| ppm | mg/kg | 1. |
| ppm | mg/lb | 0.4536 |
| mg/kg | % | 0.0001 |
| ppm | % | 0.0001 |
| mg/g | % | 0.1 |
| g/kg | % | 0.1 |

TABLE 17  Weight Equivalents

1 lb = 453.6 g = 0.4536 kg = 16 oz
1 oz = 28.35 g
1 kg = 1,000 g = 2.2046 lb
1 g = 1,000 mg
1 mg = 1,000 µg = 0.001 g
1 µg = 0.001 mg = 0.000001 g
1 µg per g or 1 mg per kg is the same as ppm

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OF DEFICIENCY

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