**Irrigated Alfalfa Management**
for Mediterranean and Desert Zones

# Alfalfa Utilization by Livestock

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Alfalfa may be fed safely to a wide range of livestock, primarily ruminants (cows, sheep, and goats), but also non-ruminants (principally horses). Alfalfa is utilized as hay, silage, greenchop, as pelleted or cubed products, or grazed. In this chapter we provide an overview of the utilization patterns by the major classes of livestock and alfalfa's role for these animals. Specific feeding recommendations can be obtained from other University of California resources, and further information on forage quality is including in Chapter 16, "Forage Quality."

The major value of feeding alfalfa to livestock is its high nutritive value, especially its high-digestibility energy and protein content compared to other common forage crops. Dietary carbohydrates (both rapidly available and slowly available) provide energy, and are quantitatively the most important nutrient in the diet of livestock. Protein in the diet of livestock is necessary for growth, maintenance, lactation, and reproduction. Forage legumes are also rich in mineral content compared to grasses, and are good sources of calcium, phosphorus, and magnesium, which are critical for the formation and maintenance of

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the skeleton and teeth, for muscle contraction, and are a major component in milk.

## Livestock Digestive Systems

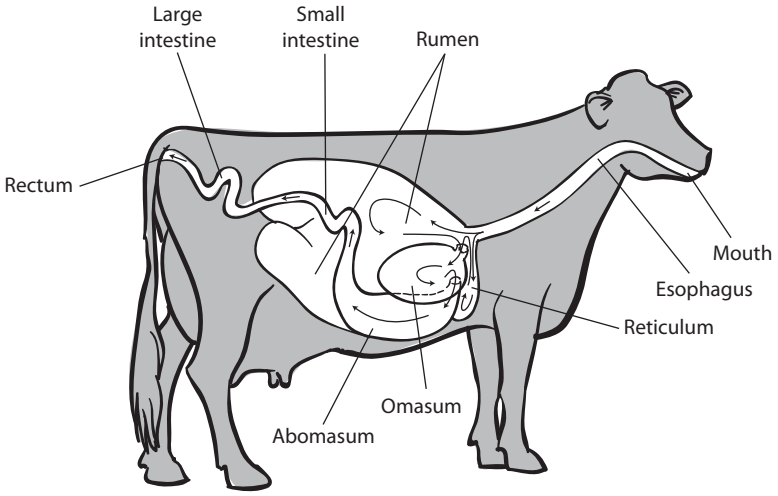
The digestive systems of various types of livestock differ significantly. Humans, swine, horses, and other animals have a simple, single compartment or "true" stomach and are referred to as monogastric animals. In comparison, cattle (dairy and beef), sheep, and goats have a complex four-compartment stomach and are known as ruminants.

### Ruminants

The digestive system of the ruminant is shown in Figure 17.1. The ruminant has four compartments of the digestive system: the rumen, reticulum, omasum, and abomasum. Compared to non-ruminants, ruminants have the ability to digest fiber and to utilize forage crops. Although the ruminants themselves do not digest fiber, the microbes in the rumen ferment the cellulose, hemicellulose, and other portions of the feed to high-energy products absorbed by the cow as nutrients. The very large capacity of the rumen allows extensive digestion of the fiber in forages over hours or days.

**FIGURE 17.1**

The digestive system of the ruminant. *Adapted from:* J.G. Linn, M.F. Hutjens, R. Shaver, D.E. Otterby, W.T. Howard, and L.H. Kilmer, *Feeding the Dairy Herd.* University of Minnesota Extension. 2002.




Initially, feed enters the large rumen (80% capacity of the four compartments) and mixes with the contents of the reticulum, since it is separated by an incomplete partition. The partially digested feed passes from the rumen and reticulum to the omasum for further absorption of nutrients and water. The digesta then moves into the abomasum, or true stomach, for continued degradation of and absorption of nutrients, especially protein, by the animal's own enzymes. The continued movement of digesta from the abomasum, through the small and large intestine and into the rectum, and the digestion that takes place in these compartments is similar to that of monogastric animals. The small intestine is the location where further breakdown of digesta by enzymes and absorption of nutrients occurs, which is aided by the secretion of enzymes, pancreatic juice, and bile. The large intestine has the capacity for limited fermentation and further digests and absorbs water, minerals, and vitamins. Excreted feces are the product of undigested feed products, microbial cells, and other waste products.

### Non-ruminants

The digestive system of the non-ruminant is shown in Figure 17.2. Horses are the primary monogastric animals that utilize alfalfa.

Monogastrics (non-ruminants) have a digestive system vastly different from ruminants. Horses have diets composed largely of roughages. The stomach is relatively small, holding only 2–4 gallons (8–15 L), with minimal digestion occurring in the stomach. Liquid and dry matter ingesta pass through the stomach quickly, usually exiting within 15 minutes, and the stomach is empty 12 hours after ingestion. Thus, it is usually recommended that the horse be fed two or more times per day, rather than one large meal.

The small intestine of the horse contains the enzymes to digest non-fiber carbohydrates (sugars, starch)

and protein, and is the site of absorption for most minerals and vitamins. The small intestine is 50–70 feet (15–21 m) long, and has the capacity to hold 10–12 gallons (38–45 L) of ingesta. Since the horse does not have a gall bladder, lipid salts are constantly secreted into the small intestine to promote emulsification of lipids. At the junction of the small and large intestine is the caecum. The relatively large caecum (7–8 gallons [26–30 L]) of the horse contains the necessary bacterial population for fiber digestion, along with some digestion of carbohydrates and bacterial protein. The active bacterial and protozoal populations in the equine caecum and bovine rumen are generally similar. The colon provides the greatest capacity of the gastrointestinal tract, with 40–50 percent of the digesta, and the slowest rate of passage, usually occurring over a period of 36–72 hours. The dry matter (DM) content of the digesta increases as it travels from the caecum to the rectum. Approximately 95 percent of the feed passes through the entire digestive tract in 65–75 hours after ingestion.

## Alfalfa Utilization by Dairy Cattle

By far the most important hay crop fed to dairy cattle in the United States is alfalfa (Fig. 17.3). Alfalfa combines the virtues of high dry matter yield, high protein and mineral content, and excellent palatability. Dairy cattle nutritionists favor alfalfa hay for its high energy content, its ability to digest rapidly in the rumen, and its high protein level, which supports the protein needs of the dairy cow. Dairy utilization may account for 75–80 percent of the utilization of alfalfa in the major dairy states, such as California, Wisconsin, New York, Idaho, and New Mexico.

### Nutrient Requirements

The nutrient requirements of dairy animals depend on rate of growth, body size, reproductive status, and level of milk production. Certain qualities of alfalfa forage are best suited for the different classes of dairy animals. The most efficient use of alfalfa is to be included at the appropriate amounts in balanced rations to meet animal nutritional requirements. A summary of the minimum quality of alfalfa needed

**FIGURE 17.2**

The digestive system of the non-ruminant (horse). *Adapted from:* M.E. Ensminger and C.G. Olentine, *Feeds & Nutrition,* 1st Edition. 2002.

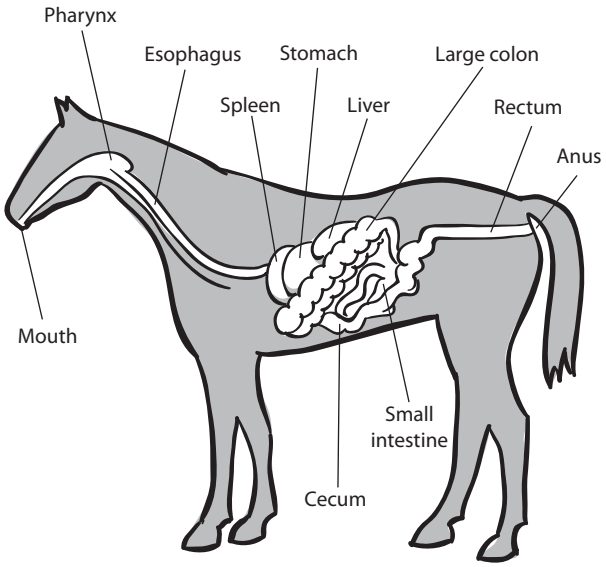



**FIGURE 17.3**

Total mixed rations, which include alfalfa hay, are typically fed to dairy cows.

by various classes of dairy cows is shown in Table 17.1.

Calves from 2 weeks to 3 months old benefit from high-quality forage. Calves can begin to consume small quantities of alfalfa within 2 weeks of birth. Alfalfa consumption will increase until it comprises a significant amount of the calves' diet at over 8 weeks of age. Calves 8 to 12 weeks old do not have a fully developed rumen; because of this limited rumen capacity, fiber should be limited. However, alfalfa is a particularly good source of protein, minerals, and carbohydrates, as well as sugars and easily fermented fiber. It is recommended that alfalfa provided to these animals be greater than 18 percent crude protein and less than 42 percent neutral detergent fiber (NDF). Alfalfa for dairy calves can be preserved either as hay or low-moisture silage (less than 55% moisture). High-moisture silage should be avoided because the high moisture content may limit intake and protein quality.

Heifers 3–12 months old have sufficient rumen function and capacity to utilize fiber to meet some of their requirements. Protein requirements decline and alfalfa higher in NDF and lower in protein content can be utilized, compared with younger animals. Feeding alfalfa that contains 16–18 percent crude protein and 41–46 percent NDF (33–38% acid detergent fiber [ADF]) will provide optimal growth with minimum concentrate supplementation. Heifers 12–18 months old have larger digestive tract capacities than younger heifers and can utilize more forage in their diet. Heifers at 500–1,000 pounds (227–454 kg) should be able to meet all of their nutritional needs from good-quality alfalfa containing 14–16 percent crude protein and 45–48 percent NDF. Heifers 18–24 months of age and dry cows are able to utilize alfalfa of lower quality than other classes of dairy animals. Forage that is 12–14 percent crude protein and 48–52 percent NDF is adequate. Feeding large quantities of very-high-quality alfalfa near the end of gestation may lead to milk fever in adult cows at calving because of the high potassium content. Calcium, phosphorus, magnesium, and potassium levels in dry cow diets can affect animal health post-calving. The alfalfa and other feeds should be analyzed so that the entire diet stays within mineral feeding recommendations.

Lactating cows during the first 100 days after calving have rapidly increasing nutrient requirements. The high protein and mineral content combined with low fiber concentrations make alfalfa ideal forage for early lactation cows. Alfalfa containing 19–24 percent crude protein and 38–42 percent NDF is well suited for these animals. Alfalfa lower in crude protein (CP) and higher in NDF will require the feeding of additional amounts of concentrates or high-quality forages to achieve a given level of milk production. Alfalfa with lower NDF concentrations may not provide enough fiber to maintain proper rumen function. Lactating cows during the last 200 days of lactation have reduced energy and protein demands as milk production declines. Therefore, lower quality forage can be fed at that time than during the first 100 days of lac-

**TABLE 17.1**

Minimum quality of alfalfa required for various classes of dairy cows

| Class of dairy animal | Nutrient Parameter (DM basis) TDN | NDF % | CP |
|---|---|---|---|
| Calf | 59.0[1] | 42.0 | 20.0 |
| Heifer | 59.0 | 42.0 | 20.0 |
| Bull | 55.0 | 50.0 | 17.0 |
| Dry Cow | 55.0 | 50.0 | 17.0 |
| Milking Cow | | | |
| Transition: 0–21 days in milk | 62.0 | 36.0 | 23.0 |
| 90 lb (41 kg) milk/day | 62.0 | 36.0 | 23.0 |
| 75 lb (34 kg) milk/day | 59.0 | 42.0 | 20.0 |
| 50 lb (23 kg) milk/day | 59.0 | 42.0 | 20.0 |

*Source:* National Research Council. Nutrient Requirements of Dairy Cattle, 7th rev. ed. 2001. National Academy Press, Washington, DC.

[1]TDN as expressed on a 100% DM basis, calculated from ADF or NDF. TDN is often expressed on a 90% DM basis by multiplying this number by 0.9.

Abbreviations: ADF = acid detergent fiber

CP = crude protein

DM = dry matter

NDF = neutral detergent fiber

TDN = total digestible nutrients

tation. As a general guideline, lactating dairy cows will typically consume 14–16 pounds of alfalfa hay per day. When feeding greenchop, 20–25 pounds is usually fed to lactating cows per day. Haylage is usually fed at a rate of 15–25 pounds per day. All of these amounts are on an as-fed basis.

## Alfalfa for Beef Cattle

Although dairy production is the most important market for western-grown alfalfa, beef producers fulfill some component of their forage needs from alfalfa, depending upon price and availability. The grazing of alfalfa by beef cattle in California is not a common occurrence, and most of the utilization of alfalfa hay is the consumption of low- or medium-quality alfalfa hay.

### Beef Grazing

Stocker steers, from 400–600 pounds (181–272 kg) may experience from 1.75–2 pounds (0.8–0.9 kg) per day of live weight gain, and even as high as 3 pounds per day (1.4 kg/d) on alfalfa pasture. Rotational grazing is the key to successfully grazing alfalfa by beef cattle (Fig. 17.4). The need for mineral supplementation for livestock will be necessary, depending on local soil conditions, particularly trace elements. It is recommended that forage samples be tested for mineral (macro and micro) levels. Contact you local livestock advisor regarding specific mineral supplementation recommendations for your local area. Ionophores, which improve animal nutrient utilization, are often incorporated into the salt mixtures of grazing cattle and can reduce the incidence of bloat and increase animal health.

A complete discussion of grazing for dairy or beef purposes can be found in Chapter 18 of this series, "Alfalfa Grazing Management."

Not all alfalfa fields are appropriate for rotational grazing. Rectangular, square, or round shaped fields are conducive to rotational grazing because the electric fence required for rotational grazing is easily adapted to these shaped fields. On square or rectangular shaped fields, temporary electric fences often coincide with irrigation borders. On fields that are irrigated with a center pivot, it is convenient to place the drinker (water supply) at the center and separate the grazing subsections in a bicycle spoke fashion.

Great care must be taken not to graze wet fields. Soil compaction caused by cattle will diminish future hay yields. Cattle should be removed from alfalfa fields during rainfall events. After irrigation, cattle should not be moved onto the field as long as the field is wet. To reduce soil compaction after a rainfall or irrigation event, the top 1 inch (2.5 cm) of soil (for loams or heavier soils) should be dry before moving cattle onto the field. Grazing cattle tend to naturally congregate around water. If possible, every cattle move onto new field subsections should be accompanied by a corresponding move of the cattle's water supply, to prevent soil compaction around the drinker.

Bloat is a risk that must be carefully considered by practitioners when grazing alfalfa. A thorough discussion of bloat can be found in Chapter 18, "Alfalfa Grazing Management."

**FIGURE 17.4**

Rotational grazing enables large numbers of animals to graze on small areas for a short period of time.

## Alfalfa Hay for Beef Animals

Under most situations, beef cattle will not compete with dairy cattle for Supreme, Premium, or even Good alfalfa hay. Good-quality grass hays typically provide sufficient energy and protein sources for overwintering beef cows, although grass hay standards are not generally fully defined. It is a common practice to incorporate low-quality, grassy summer hay into feedlot diets in Southern California. Because of the hot summer growing conditions in Southern California deserts, summer hay is often harvested at the full-bloom stage of growth and is low in crude protein and high in fiber. Desert, summer alfalfa hays, low in quality and price, are commonly used in beef feedlot diets. These low-quality alfalfa hays are used in feedlot diets for their fiber contribution to the diet, and constitute only 10–20 percent of the diet.

*Under most situations, beef cattle will not compete with dairy cattle for Supreme, Premium, or even Good quality alfalfa hay.*

Under certain circumstances, beef cattle grazing of alfalfa might be advantageous. The grazing of alfalfa by beef cattle requires specific management techniques to protect the alfalfa stand. The use of alfalfa hay for beef cattle is not common in California; beef cattle cannot compete with dairy cattle for premium alfalfa hays. Feedlot cattle or beef cows are good ways to market poor-quality or year-old alfalfa hay.

# Alfalfa Utilization by Sheep

The United States had sheep populations exceeding 11 million in 1990; today 6.7 million sheep remain in the United States—Texas and California having the largest U.S. sheep populations (almost one-half the total). Per capita consumption of beef, although it has declined in the recent past, is still 65 pounds (29.5 kg,) in the United States, while lamb consumption is 1 pound (0.45 kg). Despite a reduced sheep population, sheep remain significant users of forage resources in the western United States.

## Sheep Grazing

Although cattle and sheep may have similar digestive systems, it is incorrect to think of sheep as merely small cattle. Sheep have different nutritional requirements and different grazing characteristics than cattle. Cattle graze coarser and taller forage species because they graze to fill their much larger rumens, whereas sheep focus on more nutritious forbs, grass regrowth, and on browse.

Although there are many factors that affect forage consumption, in general grass consumption for sheep, cattle, and goats is 50, 70, and 30 percent; forb consumption is 30, 15, and 10 percent; and browse consumption is 20, 15, and 60 percent, respectively. Sheep have cleft upper lips, permitting them to graze much closer to the soil surface than cattle, which have to grab forage with their tongues, lower teeth, and upper dental pad. Sheep are selective grazers, not necessarily consuming plants in the same proportion as available plants. For example, in a field of weedy seedling alfalfa, we have recorded that grazing lambs first consumed broadleaf weeds and winter annual grasses before they consumed the seedling alfalfa. On seedling alfalfa in the irrigated Sonoran Desert, we have documented that broadleaf weeds often had higher dietary CP levels and lower NDF levels did than the alfalfa forage.

Due to the protein structure of wool and the higher propensity for multiple births, sheep have a higher crude protein requirement than cattle. Mature ewes require about 9.5 percent dietary CP, lactating ewes require about

15 percent dietary CP, and feeder lambs require 14.5 percent dietary CP. Excluding immature grasses, grasses rarely have these levels of crude protein, partially explaining the reason why sheep have such a high preference for forbs and browse.

Cattle and sheep complement each other in grazing situations since they have only moderate dietary overlaps. Much research has been published regarding the grazing of these two species, either alone or grazing together. When sheep graze with cattle, sheep have about 30 percent higher weight gains than with sheep-only grazing. At moderate stocking rates, total pounds of live weight gain per acre was greater when sheep and cattle grazed together than when each species grazed alone. Because of the dietary differences of cattle and sheep, when both species graze together the carrying capacity of a particular paddock may be increased by 10–20 percent than by single-species grazing. Cattle prefer flat, mesic sites, whereas sheep can graze on steeper or drier rangelands. On hilly or mountainous rangelands, cattle with relatively large hooves often create visible trails on flatter ground, whereas sheep with smaller hooves may graze the steeper slopes.

## Sheep in Sustainable Agriculture

In many situations, sheep grazing is used to "clean up" pastures of possibly toxic plants that cattle cannot use. In the irrigated Sonoran Desert of southeastern California and southwestern Arizona, we compared the use of grazing lambs with herbicides for weed control in seedling alfalfa and concluded that grazing lambs were just as effective, or in some cases more effective, than herbicides for weed control in seedling alfalfa (Fig. 17.5).

Grazing lambs may also be used as a biological insect control measure. In one study, grazing lambs were more efficient than insecticides for control of Egyptian alfalfa weevil (*Hypera brunneipennis* Boh.) in established winter alfalfa. Plots grazed during the winter grazing season produced more hay at the first spring alfalfa harvest than insecticide-treated plots.

## Sheep Grazing Methods

Every winter (December through March), from 300,000 to 400,000 lambs graze nondormant alfalfa in the irrigated Sonoran Desert along the lower Colorado River. During this period, there is sufficient high-quality forage production, yet conditions are not conducive to hay making. Lamb gains on winter-grown alfalfa are from 10–12 pounds (4.5–5.4 kg) per month. The most common grazing method is to confine about 1,600 lambs on 40-acre (16.2-ha) fields for about 10–12 days or until the alfalfa resource is totally exhausted. Grazing lambs gain equally well on weedy fields as on weed-free alfalfa. Portable water troughs should be placed at the perimeters of alfalfa fields and should be moved at least every 5 days to avoid excessive hoof traffic in any one area of the field. In California, copper (Cu) and selenium (Se) supplementation may be necessary for grazing sheep, depending on local soil deficiencies (<7 ppm of dietary DM for Cu and <0.1 ppm of dietary DM for Se).

**FIGURE 17.5**

Sheep grazing has been shown to control weeds and insects in alfalfa and result in excellent gains.

## Utilization by Goats

Goats differ from other domestic livestock in that they are primarily browsers and will feed on shrubs, trees, and forbs in preference to grazing other forages. As browsers, goats are highly selective in their feeding habits and have agile lips. However, goats are also quite adaptive, and in confinement they will eat diets similar in composition to those of other ruminants, such as cattle and sheep. If goats are offered coarse, stemmy hay, nothing but a pile of stems will be left in the feed bunk when they are finished. The incorporation of good-quality alfalfa into the goat diet is an excellent forage choice and can be quite cost effective.

Goats can consume approximately 3–4 percent of their body weight daily, depending on age, stage of lactation, and other production demands (e.g., pregnancy, lactation). As a general rule, approximately 50 percent or more of the diet should be composed of forages. This is essential for maintaining proper functioning of the rumen and preventing acidosis.

The hay chosen for lactating feeding goats should be Extra Premium Supreme or Premium quality as described in Chapter 16, "Forage Quality and Testing." Extra Premium or Supreme hay contains less than 27 percent ADF or <34 percent NDF (100% DM basis) and is high in crude protein. This hay is completely free of grasses and weeds, is soft textured and highly palatable, and is typically harvested in the vegetative to early bud stages of maturity. Premium-quality hay is slightly higher in fiber content than Extra Premium hay, but this hay is still of excellent feeding value. The ADF content ranges from 27–29 percent and NDF from 34–36 percent (100% DM basis). Since some grasses and weeds can be of excellent feeding value, some weeds may be acceptable, provided they are low in fiber and high in crude protein concentration. However, noxious weeds and weeds with anti-nutritional factors or poor palatability should be avoided. Most hays in these categories are prebud, bud, or early-bloom hays.

**FIGURE 17.6**

Roughages such as alfalfa hay furnish most of the energy required by goats.

### Ration Formulation for Goats

Goats should be offered a balanced ration that meets the nutrient requirements outlined by the National Research Council's "Nutrient Requirements for Small Ruminants." These nutrients include energy, protein, fiber, vitamins, and minerals. Diets should be formulated to meet the metabolic demands such as growth, pregnancy, fiber production, or lactation.

### Kids and Growing Goats

Goat kids should be started on solid foods early, to be ready for weaning at about 8 weeks of age. A grain mix for kids (kid starter) and good-quality hay can be offered free choice when the kid is a few days old. Extra Premium or Premium alfalfa hay or high-quality pasture are the best forage choices for kids, and should meet the requirements described above. Diets should allow for body weight gains from 0.3–0.5 pounds (0.1–0.2 kg) per day, depending upon the breed. Kid starter should contain 16–18 percent crude protein. Cottonseed products should be omitted from kid starter diets. Kids may be weaned as early as 8 weeks of age, when they are consuming approximately 1.5 pounds (0.7 kg) of grain per day. After weaning, high-quality forage feeding should continue as described above, but kids may gradually (4–6 weeks following weaning) switch to a 14 percent protein grain mix (no cottonseed products), similar to the diet of

milking does. This feeding program can continue until breeding. Does are considered of breeding size and age when they weigh about 75 pounds (34 kg).

## Nonlactating and Growing Yearling Does

Between breeding and kidding, does should be on a high-forage diet. Adequate protein, energy, mineral, and other nutrient levels must be maintained for their age and growth requirements. A few weeks prior to kidding, the does may be gradually introduced to grain feeding. The amount of grain fed depends on the body condition of the doe and the quality of the forage being fed.

## Goat Pregnancy and Lactation

Rapid changes in diet during pregnancy and kidding should be avoided. If the doe is fed a total mixed ration, supplementing with long-stem alfalfa hay of premium quality or better will help stimulate feed intake. Digestive disorders can be prevented by limiting concentrates to a maximum of 60–65 percent of the diet. Although most does will lose body condition in early lactation, it is important to minimize large changes in body condition and not allow does to become overly fat or thin. Either condition will predispose them to metabolic and reproductive problems. Feeding should be adjusted throughout lactation to compensate for changes in milk production and body condition.

## Dry Does, Fiber Goats, and Bucks

At the end of lactation, does should be changed to an all-forage diet, which will provide the necessary nutrients for maintenance and fetal growth. The resulting reduction in both nutrient quality and quantity will help stop milk production. For adult dairy, meat, and fiber (wool-producing) goats, maintaining body condition and health are the primary goals of a feeding program. Again, diets provided should meet the National Research Council's nutrient requirements for goats, appropriate for metabolic demands such as growth and fiber or milk production.

If goats are grazing alfalfa, the area should be inspected first to be sure there are no toxic plants that will be a threat to the goats or humans via transmission of toxins in the milk. The alfalfa should be sampled and analyzed to determine its nutritional value. Again, diet supplements may be necessary to meet the goat's minimum nutrient requirements, depending on the quality and quantity of the pasture available.

## Urinary Stones

Bucks require a balanced diet similar to that of the nonlactating doe. However, they are at risk of urinary tract obstruction (urolithiasis) under dietary conditions that may promote the formation of urinary tract stones (calculi) or a decreased water intake. The type of stone formed varies by diet and mineral status of a region. A nutritionist should be consulted to recommend a diet balanced in calcium and phosphorous.

Bucks fed entirely alfalfa hay or excessive concentrates (grain) are at higher risk of urolithiasis. Salt intake should be maximized to prevent the formation of urinary calculi. Free-choice, loose salt should be provided at all times; salt intake will be higher when salt is offered loose as opposed to in blocks. Commercial diets may be available that provide urinary acidifiers. A nutritionist should be consulted to select the best diet for bucks in a given region and for different management conditions.

*Moldy hay may considerably reduce milk production and growth or weight gains, and may depress resistance to metabolic and infectious diseases.*

## Bloat, Mold, Insects, Weeds

Bloat, as described in detail in Chapter 18, "Alfalfa Grazing Management," can be a serious problem for ruminants, including goats. Mold can develop in baled alfalfa hay under

conditions where alfalfa is baled with higher than recommended moisture levels. Moldy hay may considerably reduce milk production and growth or weight gains, and may depress resistance to metabolic and infectious diseases. The feeding of moldy alfalfa hay to any class of animals should be avoided.

The presence of weeds in alfalfa hay detracts from the quality of the hay, lowers the potential selling price, and may be hazardous to the animal consuming the hay. The predominant poisonous weeds that may be found in alfalfa hay are fiddleneck (*Amsinckia menziesii* Lemm. Nelson & J.F. Macbr.) and common groundsel (*Senecio vulgaris* L.) Because many of these poisonous plants are principally spring plants, most problems with weeds are associated with first cutting.

Weeds in alfalfa hay may also cause off-flavors in milk. The off-flavor from some weeds such as swine cress (*Coronopus didymus*) appears principally in the milk fat, whereas that from others such as bitterweed is associated with the skim milk (non-fat) portion. The off-flavor in milk from weeds may be more pronounced with young plants such as with cocklebur (*Xanthium*) or with older plants or their seeds such as penny cress (*Noccaea fendleri ssp. californicum*). Flavors from some weeds persist for longer than 12 hours after they are eaten; therefore such weeds must be kept out of the ration. Flavors caused by some can be controlled if the weeds are withheld from the doe 5 hours before milking. These feeding recommendations are impractical for most dairy farm operations, so hay should be obtained with a very small contamination from weeds.

Blister beetles (*Epicauta* sp.) have recently been observed in the High Desert areas of California. Consumption of these beetles or alfalfa hay contaminated with blister beetles can cause death. See Chapter 9, "Managing Insects in Alfalfa," for more details. See also "Blister Beetles" in the following section on horses.

**FIGURE 17.7**

Alfalfa is an excellent source of energy, protein, and calcium for horses and is very palatable, but feeding should be moderated depending upon animal activity.

## Utilization of Alfalfa by Horses

Tradition has played a large role in the selection of feeds for horses. Timothy hay and oat hay have been the favorite feed of horses for many years, but alfalfa is also widely used. Controversy exists over the use of alfalfa in horse rations (Fig. 17.7). Alfalfa hay may not be the best feed for all horses in all situations, but it contains important nutrients for many classes of horses.

Alfalfa hay is an excellent source of energy, protein, calcium, and some other nutrients for horses. Its concentration of protein and calcium often meets the nutrient needs of horses in high levels of production, such as growth and lactation, but exceeds the nutrient requirements of horses in other life stages. Grass hays are popular for horses because of the lower energy, protein, and calcium concentrations that most closely meet the nutrient requirements of the largest percentage of horses: the idle horse. The incorporation of alfalfa hay into equine diets as the sole roughage or in combination with other grass or cereal hays has been increasing over

the last 30 years. The palatability of alfalfa is generally better than most grass hays.

## Nutritional Requirements for Horses

Some basic feeding management concepts apply to horses in all stages of production, growth, and work levels. The average horse will eat about 2 percent of its body weight daily. Diets are forage based, with at least 1 percent of the body weight being consumed as forage each day. However, it is desirable that forage make up more than 50 percent of the diet. Thus, a 1,100 pound horse will consume from 11 to 22 pounds of hay per day. Adequate forage intake is important for proper gastrointestinal fill, which is essential in maintaining the proper pH of the digestive tract and the health of the microbes in the large intestine, along with acting as a reservoir of water in the body.

Horses cannot tolerate large amounts of soluble carbohydrates, for example, from grains in their diets. The majority of soluble carbohydrates are digested and absorbed in the small intestine. When horses are fed large, infrequent meals of carbohydrates, some of the soluble carbohydrates may not be absorbed in the small intestine but pass into the large intestine. If significant amounts of soluble carbohydrate reach the large intestine, rapid fermentation by microbes produces excessive lactic acid production, causing a decrease in pH, microbial death, toxin production, and possible endotoxemia, colic, and laminitis. Many of the nutrient requirements of working, lactating, and growing horses may be met by feeding good-quality forage, such as alfalfa, and less supplementation will be necessary.

## Ration Formulation for Horses

The National Research Council's "Nutrient Requirements of Horses" provides estimates of nutrient requirements of horses at different physiologic stages (Table 17.2) and also the nutrient content of various feeds commonly fed to horses. Feeding management of horses may be grouped into several categories, including diets for maintenance, pregnancy,

### TABLE 17.2

Recommended nutrient intake in total diets for the horses of different production stages or work levels (dry matter [DM] basis)

| | Digestible Energy Mcal/lb | Crude Protein % | Calcium % | Phosphorous % |
|---|---|---|---|---|
| **Maintenance** | 0.90 | 8.0 | 0.24 | 0.17 |
| **Pregnancy** (9–11 months) | 1.00–1.10 | 10.0–10.6 | 0.43–0.45 | 0.32–0.34 |
| **Lactation** | 1.15 to 1.20 | 11–13.2 | 0.36–0.52 | 0.22–0.34 |
| **Growing** | | | | |
| Weanling | 1.4 | 14.5 | 0.56–0.68 | 0.31–0.38 |
| Yearling | 1.3 | 11.3–12.6 | 0.34–0.45 | 0.19–0.25 |
| 2-year-old | 1.2 | 10.4–11.3 | 0.31–0.34 | 0.17–0.20 |
| **Work** | 1.15 –1.30 | 9.8–11.4 | 0.30–0.35 | 0.22–0.25 |

*Source*: National Research Council. 1989. Nutrient Requirements of Horses, 5th rev. edn. National Academy Press, Washington, DC.

### TABLE 17.3

Nutrient content of alfalfa and grass hays (dry matter [DM] basis)

| | Digestible Energy Mcal/lb | Crude Protein % | Calcium % | Phosphorous % |
|---|---|---|---|---|
| **Alfalfa** | | | | |
| Early bloom | 1.05 | 19.3 | 1.41 | 0.21 |
| Mid bloom | 1.03 | 18.7 | 1.37 | 0.24 |
| Full bloom | 0.98 | 17.0 | 1.19 | 0.24 |
| **Grass Hay** | | | | |
| Timothy | 0.82–0.94 | 7.8–10.8 | 0.38–0.51 | 0.15–0.29 |
| Oat hay | 0.87 | 9.5 | 0.32 | 0.25 |
| Orchardgrass | 0.87–0.99 | 8.4–12.8 | 0.26–0.27 | 0.30–0.34 |

*Source*: National Research Council. 1989. Nutrient Requirements of Horses, 5th rev. edn. National Academy Press, Washington, DC.

lactation, growth, and work. Only alfalfa that is free of dust, weeds, toxins, and mold should be fed to horses. The protein content in quality alfalfa hay available to horse owners may range from 15 to over 20 percent crude protein, but acceptable-quality alfalfa for horses contains approximately 17 to 19 percent crude protein and 0.95–1.1 Mcal/lb (2.1–2.4 Mcal/kg) of digestible energy (Table 17.3). These feeds normally consist of weed-free alfalfa hay or alfalfa–grass mixtures in the Fair-to-Good categories in the California marketplace. Exceeding the recommended crude protein level for horses of different physiologic states may not be beneficial to their dietary needs. Choice of alfalfa protein and energy characteristics depends highly upon the stage of growth of the animal.

## Maintenance of Horses

A mature idle horse requires a maintenance diet, which is relatively low in nutrient requirements compared to other diets but still requires a need for bulk in the diet. For these horses, acceptable quality alfalfa (17–19% crude protein and 0.95–1.1 Mcal/lb [2.1–2.4 Mcal/kg]) will meet the nutrient requirements (energy, protein, etc.) long before the gastrointestinal fill requirement is met. Grass hay (9–12% crude protein and 0.85–0.95 Mcal/lb [1.9–2.1 Mcal/kg]), alone or in combination with alfalfa, will meet their nutrient requirements and provide enough bulk in the diet for gastrointestinal fill. Digestive disturbances may occur without adequate roughage to maintain the microbial population in the large intestine. Additionally, abnormal behaviors may develop, such as cribbing, stall weaving, or chewing the manes and tails of other herd members.

*Nutrient needs of horses during pregnancy are not greater than maintenance until the last 3 months of pregnancy.*

## Pregnancy and Lactation for Mares

Nutrient needs during pregnancy are not greater than maintenance until the last 3 months of pregnancy. A diet of acceptable-quality alfalfa (17–19% crude protein and 0.95–1.1 Mcal/lb [2.1–2.4 Mcal/kg]) fed to 100 percent of the energy need in the last trimester also provides 179 percent of the protein requirement, 290 percent of the calcium requirement, but only 78 percent of the phosphorous needs. General nutrition rules hold that the calcium to phosphorous ratio (Ca:P) should be in the range of 1:1 to 2:1. The Ca:P of alfalfa hay is always greater than 2:1, sometimes as high as 6:1 or 8:1. There is no clear consensus within the horse industry on whether phosphorous supplementation should be implemented to bring this ratio closer to 2:1 or if the high Ca:P can be tolerated once the phosphorous requirement is met.

Alfalfa hay is a good source of lysine, the first limiting amino acid in horse diets. During lactation, especially early lactation, the nutrient requirements are high. Alfalfa fed up to 2.5 percent of body weight cannot alone meet the energy requirement. Thus, concentrate, usually in the form of cereal grains such as oats or corn, must be added to the diet as an energy source. Other supplements may be required to meet any deficiencies such as of trace minerals or vitamins.

## Growing Horses

Nutrients such as energy, crude protein and essential amino acids, and calcium and phosphorus are important in rations for growing horses. Alfalfa, when balanced with oats, provides or exceeds these nutrient requirements. However, protein availability and associated amino acids may be marginal in meeting the nutrient requirements. Digestion of protein in the small intestine allows amino acids to be absorbed into the bloodstream and then utilized for growth. Much of the protein in alfalfa will bypass digestion in the small intestine. Protein that reaches the large intestine can be utilized for microbial growth rather than growth of the horse. Feeds with a higher level

of small intestine digested protein, such as soybean meal, should be considered for growing horses to ensure adequacy of absorbable protein and lysine. Additional supplementation may be required to correct for deficiencies or imbalances in nutrients of the diets of growing horses to promote optimal growth and skeletal development.

## Working Horses

The primary nutrient needed for work is energy, and the energy requirements are proportional to the amount of work performed. At low levels of work, energy and other nutrient requirements may be met by simply feeding more of the maintenance diet. Diets for working horses would be similar to those fed to weanlings or mares in late gestation, but not as nutrient dense as diets for horses in early lactation or long yearlings (18 months). The higher energy content of alfalfa as compared to grass hay would be advantageous, with concentrates balancing the diet. Horses undergoing intense work (racehorses) may require additional energy in their diet, along with increases in protein, calcium, and phosphorous.

## Special Considerations

### Starved Horses

Horses neglected without feed over a long period may require a nutritional rehabilitation program to successfully reintroduce feed. Small, frequent (six times per day) meals of alfalfa have been shown to be physiologically supportive during refeeding. Large electrolyte shifts during initial refeeding may be fatal to a starved horse. The high density of nutrients provided by alfalfa, especially of magnesium and phosphorus, assists in minimizing these electrolyte deficiencies.

### Excessive Protein

Alfalfa hay may contain excessive protein over the protein requirement for a particular horse. This excess protein is converted to energy in the horse along with the by-product of nitrogen. Nitrogen is subsequently eliminated from the horse in the form of urea in the urine. Thus, feeding alfalfa hay, especially compared to grass hay, increases the amount of ammonia in the urine, and a strong odor may be present in the stable. Lung irritation from the ammonia may result in stables without adequate ventilation and/or proper stall cleaning.

### Enteroliths (Stones)

Enteroliths are intestinal stones that form in the large intestine of some horses. These may migrate in the large intestine and sometimes into the small intestine, and may become lodged or cause total blockage leading to colic and possible death. Reports have shown that a large majority of horses treated for enteroliths were fed a diet that contained at least 50 percent alfalfa. Enteroliths are formed over time, usually years, by the building of concentric rings around a foreign object, such as a small pebble or piece of baling wire. The rings are formed from a crystalline combination of magnesium, ammonia, and phosphorous that is readily available in alfalfa and some water sources. Enteroliths have been found in all breeds of horses, but Arabians and quarter horses are the most commonly affected. Enteroliths occur in horses worldwide, but the highest prevalence has been monitored in California. Over 900 horses were diagnosed with conditions involving enteroliths at the Veterinary Medical Teaching Hospital at the University of California, Davis, from 1973 through 1996.

*Reports have shown that a large majority of horses treated for enteroliths were fed a diet that contained at least 50 percent alfalfa.*

### Blister Beetles

Horses are very sensitive to blister beetle toxicosis, which usually occurs from consuming blister beetles in alfalfa hay cut after midsummer. The hay is usually cut, crimped, and swathed in one operation, which captures the crushed beetle (see Chapter 9, "Managing Insects in Alfalfa"). Clinical signs depend on the number of beetles ingested, but can range from a mild fever, colic, and even death. It is

estimated that the ingestion of 125 beetles would provide a lethal dose of the toxin cantharidin. Often more than one horse in a stable during the same period will be affected. There is no specific antidote for cantharidin, but early supportive therapy is often helpful. Recovery or death usually occurs within 1 to 3 days. The potential for blister beetle toxicosis exists throughout the United States, but most cases are located in the southwest. It has been reported that in a 26-month period in Texas, 53 cases of blister beetle toxicosis were diagnosed. Peak incidence occurs in the late summer and early fall.

*The usual cause of botulism in hay is decaying small animal carcasses that are inadvertently baled into the hay.*

### Botulism

The bacteria causing botulism (*Clostridium botulinum*) produce several different neurotoxins that cause a progressive paralysis, often initially recognized by feed and water spilling from the mouth due to the inability of the horse to swallow. Veterinary care should be sought immediately. Horses may die suddenly. The usual cause in adult horses is from decaying small animal carcasses that are inadvertently baled into the hay. The hay also may appear moldy, usually indicated by the presence of white mold on the edges or within the bale; this is often accompanied by dust. Botulism is uncommon, but acute outbreaks may occur involving a number of horses ingesting contaminated feeds such as hay cubes or pellets.

### Developmental Orthopedic Disease in Horses

Developmental Orthopedic Disease (DOD) is a multi-factorial syndrome that involves the abnormal development of the long bones during periods of fast growth in horses. It can manifest in many ways, including angular and flexural limb deformities, cysts and ulcerations of articular cartilage, and bone malformations in both the long bones of the limbs and cervical bones of the neck. Genetics are thought to play a role, but the exact mechanism is unknown. Among nutritional contributors, excessive energy, protein, and/or a high Ca:P may predispose a horse to DOD. Thus, high nutrient feeds, such as alfalfa, fed in abundance may contribute to DOD in some horses.

## Buying Hay for Horses

Several facts about horse owners may shed light on how to meet their needs for buying alfalfa. Only 20 percent of the horses in the United States are kept for profit-motivated activities such as racing and breeding, whereas 80 percent are involved in nonprofit activities such as recreation or companionship. Ninety percent of the horse-owning public has some college education, and 80 percent are women. Since the majority of horse owners do not own horses for a business, many horse operations run on a hand-to-mouth financial cycle. Owners of only one or two horses will likely buy hay at the feed store one bale at a time, so the appearance of the bale is important. Hay must be free of mold and dust, along with being uniform from bale to bale. Many female horse owners appreciate lighter-weight bales. Hay must be palatable; if the horse isn't enthusiastic about eating its hay, the owner won't want to purchase it. It is not uncommon for a horse owner to return a partial bale of unsatisfactory hay and ask for a refund.

Alfalfa suppliers may sell their services as well as their products to horse owners. Many stables don't have enough room or shelter from weather for large purchases of hay, and the storage and care of stacked hay is problematic. Horse owners may be willing to pay for the delivery of small loads of hay in a timely manner or the stacking, crowning, and securing of tarps on larger loads of hay delivered to the stable. Additionally, large purchases of hay stored at the seller's facility with delivery of smaller amounts throughout the year may be beneficial to some stables. Horse owners generally discover hay suppliers by word of mouth. Networking with feed-store owners, veterinarians, farriers, or others in equine business may increase sales.

Many horse owners are concerned about buying a quality hay to meet their horses' nutritional needs. Traditionally, buyers of large purchases of hay for horses have not requested to review the results of an objective hay test or analysis, which scientifically determines the nutrient composition. Visual appraisal of hay does not always reflect the actual nutrient composition of the hay, but the report from a hay test will indicate the protein and energy levels of the hay, along with the concentration of some selected trace minerals and vitamins. This information may be beneficial in recommending a particular supply of hay and to develop appropriate feeding programs to balance nutrients. If a hay supplier can talk knowledgeably about the individual horses' nutrient requirements, but not necessarily in great detail, this can build a trusting relationship between the horse owner and hay supplier. The extra efforts to network with horse owners, supply quality hay in a timely manner, deliver small loads, provide other convenience services, and educate horse owners on different aspects of buying, storing, and feeding of alfalfa contribute to the profitability of marketing alfalfa hay to the horse community.

## Additional Reading

Bell, C.E., J.N. Guerrero, and E.Y. Granados. 1996. A comparison of sheep grazing with herbicides for weed control in seedling alfalfa in the irrigated Sonoran Desert. J. Prod. Agric. 9:123–129.

Collar, C., L. Foley, J. Glenn, P. Hullinger, B. Reed, J. Rowe, and C. Stull. 2000. Goat care practices, 1st ed. University of California Cooperative Extension, University of California, Davis. http://www.vetmed.ucdavis.edu/vetext/INF-GO_CarePrax2000.pdf

Guerrero, J.N., M.I. Lopez, and C.E. Bell. 1997. Lamb performance on seedling alfalfa with predetermined alfalfa/weed biomass differences in the irrigated Sonoran Desert. Sheep and Goat Res. J. 13(2): 71–77.

Guerrero, J.N., E.T. Natwick, M.I. Lopez, and A.R. dos Santos. 2002. Grazing lambs control insects in alfalfa. Proc. West. Sect. Am. Soc. Anim. Sci. 53:377–380.

Lewis, Lon D. 1995. Equine clinical nutrition: feeding and care. Williams and Wilkins, Media, PA.

Mitchell, A.R., J.N. Guerrero, and V.L. Marble. 1991. Winter sheep grazing in the irrigated Sonoran Desert: II. Soil properties and alfalfa regrowth. J. Prod. Agric. 4:422–426.

Morley, F.H.W., ed. 1981. Grazing animals. Elsevier, NY.

National Research Council. 1989. Nutrient requirements of horses, 5th ed. Washington, DC.

———. 2001. Nutrient requirements of dairy cattle, 7th ed. Washington, DC.

———. 2007. Nutrient requirements of small ruminants: Sheep, goats, cervids and New World camelids. Washington, DC.

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