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Understanding Forage Intake in Range Animals

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Forage quality influences the performance of range livestock and wildlife, and it is often assumed that, if forage quality meets animal nutrient requirements, animal performance will meet expectations. However, forage intake can be at least as important as forage quality, especially when quality is marginal. Forage intake in a rangeland environment is influenced by a number of important factors, including:

- Herbivore species and size.
- Foraging behavior.
- Physiological status.
- Animal production potential.
- Forage quality.
- Supplemental feed.
- Forage availability.
- Environmental factors.

Considering these factors can help you better understand the relationship between rangeland resources and herbivore production.

Herbivore Species and Size

Both the size and the species of the herbivores on your land affect the amount of forage they eat. For example, using an intake rate of 2.5 percent of body weight at body condition score 5, you would expect a 1,200-pound cow to eat 30 pounds of forage dry matter per day, compared to 25 pounds for a 1,000-pound cow. On the other hand, as a percentage of body weight, small herbivore species have higher intake rates (Table 1). Using appropriate intake rates and body weights can provide closer estimates of forage intake than traditional animal unit equivalents (like 5 ewes equals 1 cow), which tend not to adjust for animal size.

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Table 1. Ruminant wildlife and livestock intake factors for estimating daily forage demand (Adapted from Stuth and Sheffield 1986).

Live Weights and Intake Factor	
Live weight (lb.)	**Intake factor (% of live weight)**
1,000-1,500	2.5
500-1,000	3.0
100-500	3.5
less than 100	4.0

Estimated Average Live Weights and Intake Factors for Selected Range Ruminants		
Animal species	**Average live weight (lb.)**	**Intake factor (% of live weight)**
Exotics		
Aoudad	200	3.5
Axis deer	160	3.5
Blackbuck antelope	75	4.0
Fallow deer	130	3.5
Nilgai antelope	450	3.0
Native		
White-tailed deer	100	3.5
Mule deer	200	3.5
Domestic Livestock		
Beef cattle	1000	2.5
Sheep	125	3.5
Angora goats	70	4.0
Spanish goats	65	4.0

Most economically important Texas range herbivores (livestock and native or exotic wildlife) are ruminants. Small ruminants have greater nutrient requirements per pound of body weight than large ruminants. These small ruminants select particular kinds of forage to cope with their higher nutrient requirements. Regardless of their feeding type (grazers, intermediate feeders, or browsers, shown in Table 2), small ruminants tend to utilize plants and plant parts that are rapidly digestible. The rapidly digestible forages they consume pass quickly through the digestive tract, resulting in higher intake rates. Small herbivores must select higher-quality diets because of their greater relative nutrient requirements. Furthermore, small ruminants classified as browsers (such as white-tailed deer) and intermediate feeders (like sheep and goats) have mouth parts that allow them to be more selective in their browsing and grazing than ruminants classified as grazers (such as cattle). Forages selected by these smaller ruminants pass through their digestive tracts rapidly not only because they are quickly fermented and digested, but also because the browsers and intermediate feeders have an open rumen anatomy that allows materials to pass out more easily than the more compartmentalized rumen of grazers.

Table 2. Feeding types for ruminants on Texas rangeland.

Grazers[1]	Intermediate Feeders[2]	Browsers[3]
Cattle	Goats	White-tailed deer
Bison	Sheep	Blackbuck
	Aoudad	
	Axis deer	
	Fallow deer	
	Sika deer	

[1]Grazers tend to consume mostly grasses, which are high in fiber (plant cell wall material) and low in readily digestible materials (plant cell contents).

[2]Intermediate feeders tend to consume diets with more equal portions of grass, forbs, and browse than the grazers or browsers.

[3]Browsers tend to consume diets mostly of browse and forbs, which are high in readily digestible materials (plant cell contents) and low in fiber (plant cell wall material).

Although horses are herbivores, they are not ruminants and have a different digestive strategy which influences their level of forage intake. In the horse's digestive tract, fermentation (the breakdown of plant material by microorganisms) occurs in the hindgut (cecum and large intestine), which is past the small intestines, where most nutrients are absorbed. Because there are no physical barriers to food passage through the horse hindgut, as in the rumen, food passes rapidly through the digestive tract. This rapid passage rate results in a high intake rate for horses. In fact, the horse may consume up to 70 percent more forage than a cow of similar size.

Physiological Status, Production Potential, and Forage Intake Control

The amount of food eaten by herbivores is controlled by body maintenance demands and production needs. For example, lactating animals have a higher nutrient demand and greater intake rate than animals of the same size that are dry, open, or pregnant (Figure 1).

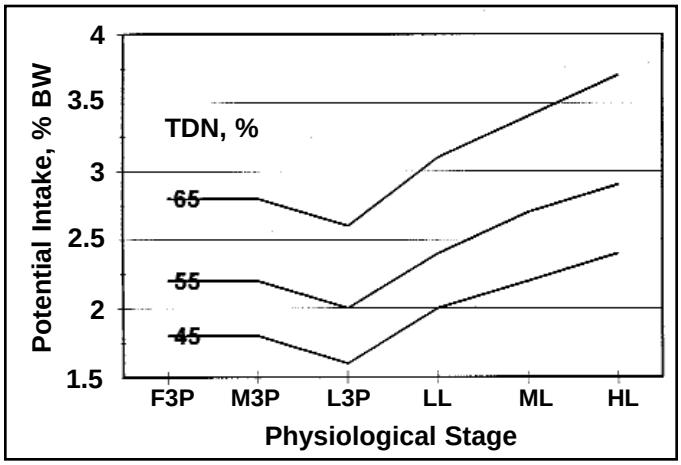

Figure 1. Relationship between forage digestibility, physiological stage, and potential intake (percent body weight, BW) for beef cattle during first (F3P), middle (M3P), and last third of pregnancy (L3P) and low (LL), medium (LM), and high (LH) lactation levels.

The same animal can eat 35 to 50 percent more when lactating than when dry, open, or pregnant. It is not clear how this increased intake happens in ruminants, where the rumen physically limits the animal's intake. One explanation is that hormonal changes may reduce the rumen's sensitivity to pressure, so the animal can eat more. Although food intake increases dramatically after parturition, peak intake lags behind peak milk production by an average of about 16 weeks in cattle, 8 weeks in goats, and 6 weeks in sheep.

Pregnancy does not appear to affect intake until the last trimester, when intake in cattle generally declines. Two theories have been offered to explain this decline: first, the increasing size of the fetus may displace rumen contents and decrease its capacity and, second, increasing estrogen levels occurring during this period may decrease intake. However, some studies have shown that increased rates of passage during the last third of pregnancy maintain forage intake in spite of the decreased rumen capacity caused by the growing fetus.

It seems logical that some sort of chemical feedback from the digestive tract to the brain, similar to what people experience when eating a rich food, may help to regulate forage intake in ruminants. Evidence exists that chemical feedback may influence the quantity of an individual forage eaten. However, research has failed to clearly show that such a feedback mechanism is involved in regulating the total quantity of forage intake for grazing and browsing ruminants. Therefore, the primary determinants of total quantity of forage consumed (all-forage diets) by ruminants appear to be rumen capacity and the rate that digested material exits the rumen.

Forage Quality

As forage quality increases, the amount of forage necessary to meet nutrient requirements decreases (Figure 2). Although nutrient requirements are useful guidelines, animals do not stop eating once requirements for a certain performance level are met. Therefore, in general, as forage quality increases, intake also increases. Studies involving all-forage diets have consistently shown that intake increases as forage digestibility increases from 40 to 80 percent. Higher-quality forages are digested rapidly, thus allowing room for more forage. As forage quality decreases, the forage quantity needed to meet requirements increases. However, because low-quality forages are digested more slowly and remain in the rumen longer, forage intake is reduced. Because these low-quality forages exit slowly, animals may not eat enough of them to meet nutrient demand.

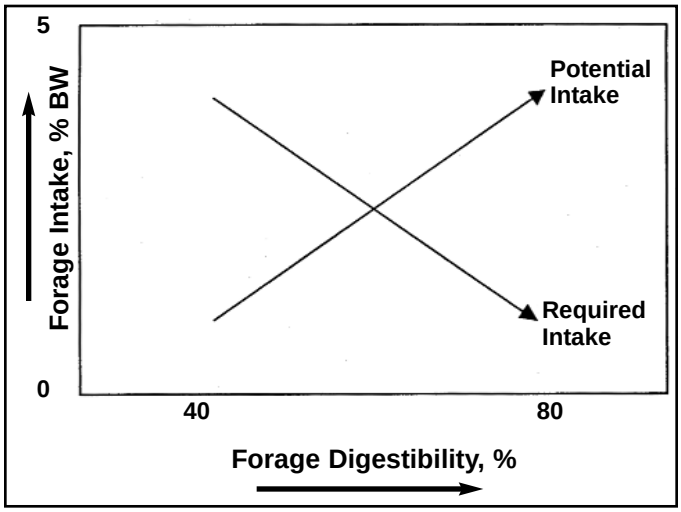

Figure 2. Relationship between forage digestibility, the amount of forage ruminants can eat, and the amount of forage needed to meet nutrient requirements as a percent of body weight (BW).

Forage Water Content

It is often suggested that an animal's intake of succulent forages is depressed by their high water content. Most studies indicate no difference in dry-matter intake until forages become very lush (more than 85 percent water). Water in plant material appears to be absorbed rapidly from the rumen, reducing interference with intake. Normal

moisture levels for range forages are 5 to 60 percent for grasses and 0 to 80 percent for forbs. Poor performances observed on new spring growth are most probably caused by decreased forage intake resulting from increased time spent by animals searching for green leaf material which is in short supply.

Forage Characteristics and Foraging Behavior

Range herbivores generally select leaf in preference to stem, and green material in preference to dry or dead material. Leaf availability is particularly important in maintaining forage intake as indicated by the decreased intake associated with declining leaf material.

Bite size also has a great influence on forage intake. While bite size declines as leaf material becomes less available, animals temporarily compensate by increasing bite rate and grazing time. However, as available leaf material continues to decline, both bite size and grazing time decline, resulting in reduced forage intake. Plant characteristics regulating bite size (leaf size and shape, spines, etc.) frequently control rates of forage intake by grazing animals. For example, plant spines restrict bite size and reduce intake, although animals extend feeding periods in an attempt to compensate for smaller bite size.

Chemical feedback, from forages being digested in the rumen, appears to influence the quantity of some individual forages consumed by ruminants. Intake of nutritious foods containing toxins often runs in cycles, with sharp declines followed by gradual increases in intake. This feedback can occur quickly, because blood flow in the rumen increases soon after feeding begins and peaks in about 15 minutes. When ruminants eat poisonous plants, plant toxins may cause animals to become sick, which in turn may cause them to eat small amounts of a variety of plants. By sampling new foods in small quantities, ruminants may be able to associate toxic effects with particular plants and avoid them in the future.

Supplemental Feeding

Forage crude protein levels below 6 to 8 percent generally result in decreased forage intake. This decrease appears to be related to decreased ruminal microbial activity, which reduces digestibility and thus the rate at which forage exits the rumen. With low-protein forages, a protein supplement usually increases forage intake until the amount of supplement begins to substitute for forage intake (Figure 3). When high-energy, especially high-starch, supplements are fed above 0.25 to 0.5 percent of body weight with low-protein forages, intake is usually depressed (Figure 3). High-energy supplements break down rapidly, releasing large quantities of volatile fatty acids which lower rumen pH. Rumen microbes that digest the fiber in forages function best at a pH of 6.7 to 7.1. When rumen pH is lowered, fiber fermentation and passage from the rumen are reduced, thus depressing forage intake. Fermentation of cellulose, the major structural fiber material in forages, can be depressed from 20 to 55 percent when rumen pH falls below 6.3.

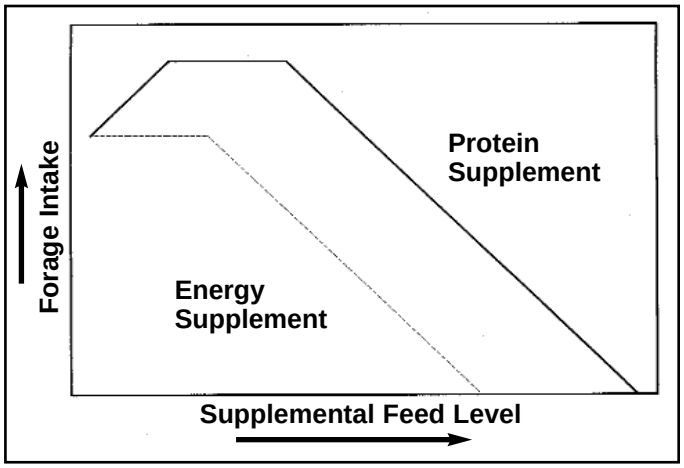

Figure 3. Effect of amount of protein or energy supplement on intake of low-quality forages. As protein supplements are added to the diet, forage intake increases, reaches a plateau, and then decreases. As energy supplements are added, forage intake is unchanged for a short period and then begins to decrease.

The time of day when supplemental feed is offered can alter forage intake. Forage intake is likely to be reduced if feeding interferes with normal grazing time and patterns. Feeding should be avoided during normal grazing times. Browsers, like deer, tend to have many (10 to 12) short grazing periods evenly distributed over a 24-hour period. On the other hand, grazers like cattle tend to feed during three major periods, with the first beginning near dawn, a second beginning in late afternoon and ending near sunset, and a third near midnight. As daytime temperatures and humidity increase, more grazing occurs at night. Grazing during the heat of the day in summer is an indicator of restricted forage intake.

Forage Standing Crop and Forage Allowance

Forage quantity also affects intake. One approach to this issue has been to relate intake to the amount of forage available. According to NRC (1987), forage standing crop levels above 2,250 to 3,000 pounds per acre do not limit intake by most livestock species. However, as standing crop levels decline from 2,250 to 1,000 pounds per acre, a 15-percent decline in forage intake can be expected. A rapid decline in intake occurs when forage supplies drop below 1,000 pounds per acre. Studies vary widely with regard to the forage standing crop level at which intake becomes restricted. For example, threshold values have been reported from about 120 to 5,000 pounds per acre. Differences between these threshold values are related to the kinds of forage and types of animals in the studies. Therefore, standing crop alone has limited value in estimating the impact of forage availability on intake.

Daily forage allowance is the amount of forage available per individual animal. It is usually expressed as pounds of forage (dry matter basis) available per pound or 100 pounds of live weight and is determined by including pasture size, animal number, and animal size.

Daily forage allowance, rather than forage standing crop alone, is a more useful indicator of how forage availability influences intake. According to NRC (1987), intake is not expected to increase above a forage allowance of about 20 pounds per 100 pounds live weight (Figure 4). From 20 pounds to 4 pounds daily forage allowance per 100 pounds live weight, a 15 percent decline in intake is expected; and, below 4 pounds, a steep decline in intake is expected. On Texas and Oklahoma wheat pastures, observed and estimated daily gains for steers reached a maximum at daily forage allowances of 25 and 20 pounds per 100 pounds live weight, respectively. The use of daily forage allowance in rangeland situations should be based on an estimate of the amount of forage material available from plant species that will be used by the herbivores being managed.

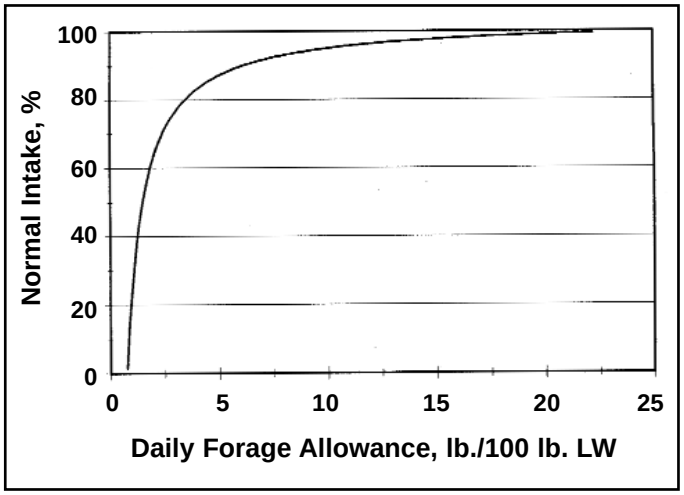

Figure 4. Effect of pounds of daily forage allowance per 100 pounds of live weight (LW) on percentage of normal intake (Adapted from NRC 1987).

Environmental Influences

Climatic conditions in which range herbivores graze and browse can have a profound effect on forage intake (NRC 1987). Each herbivore species appears to have its own comfort zone with upper and lower temperature limits. This comfort zone is usually called the thermoneutral zone (TNZ). Intake is not affected when temperatures are within this zone.

When temperatures exceed the upper limit of the TNZ, intake decreases. The degree of intake depression at high temperatures is also affected by night cooling. For example, in cattle breeds lacking heat tolerance, intake may be depressed by as much as 35 percent at maximum daily temperatures of 95° F and no night cooling (Figure 5). At the same daily maximum temperature with night cooling, this depression may be only 20 percent. Night cooling allows animals to shift grazing to night to compensate for lost grazing time during the day. Heat-tolerant animals may not be affected as much by lack of night cooling.

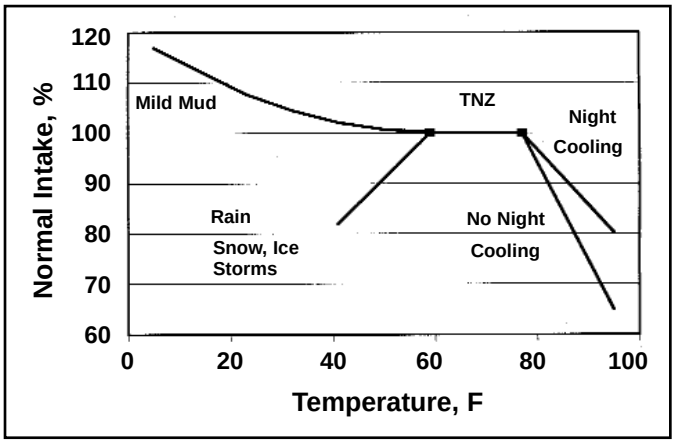

Figure 5. Effect of environmental conditions on cattle dry matter intake in relation to the thermoneutral zone (TNZ) (Adapted from NRC 1987).

With temperatures below the thermoneutral zone, intake may be either stimulated or depressed, depending on precipitation. If rain, snow, or mud are present, depressions in intake can be expected, because of decreased grazing time and increased searching and travel time. If conditions are dry, cooler temperatures generally stimulate intake.

Conclusions

Forage intake is influenced by a number of factors. Understanding how these factors affect forage intake is important, because forage intake affects nutrient intake and, as a result, animal nutrient status. Both nutrient requirements and forage intake increase with increased physiological demands such as lactation. However, forage digestibility, forage availability, supplemental feed type, quantity and provision, and environmental conditions may restrict forage intake, preventing adequate nutrient intake. Understanding forage intake is also important from the standpoint of managing the rangeland resource. Forage intake estimates, adjusted for body size and production level of the animals being managed, are an essential consideration in determining an appropriate stocking rate.

For More Information

Some information in this publication is taken from these sources:

NRC. 1987. Predicting feed intake of food-producing animals. National Academy Press. Washington, D.C.

Stuth, J.W. and W.J. Sheffield. 1986. Determining carrying capacity for combinations of livestock, white-tailed deer, and exotic ungulates. In: Proceedings of the 1986 International Ranchers Roundup. Texas Agricultural Extension Service.

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