Structure, Quality and Skills Interact to Influence Forage Intake

In general, the more livestock eat, the more weight they gain or milk they produce. Thus, forage intake is key to animal performance. Agronomists tend to focus on plant density and height to ensure that herbivores maximize intake. While plant structure is important, intake is not dictated by structure alone. Forage quality, current nutritional state, and experience also affect forage intake by herbivores.

Calculating Intake. Daily intake can be calculated using the following equation: Intake = BS x BR x GT where BS = bite size or the amount of forage per bite; BR = bite rate or the amount of forage eaten over time; and GT = grazing time or the amount of time herbivores spend grazing during in a 24 hour period.

Structure Matters. According to a number of research studies bite size has the greatest effect on intake. Managers can maximize bite size by maintaining pastures in a vegetative state - immature and leafy- and by keeping plant height between 6 to 8 and 2 to 2.5 inches. When forage grows above 6 to 8 inches, nutritional quality declines as the proportion of stems relative to leaves increases, and bite size also decreases as animals attempt to select leaves over stems. When forage height drops below 2.5 inches, bite size declines due to a decrease in forage availability. Herbivores must spend more time grazing and/or increase their bite rate to ingest the same amount of food. If forage is too short, herbivores cannot graze fast enough or long enough to maintain intake.

Differences in the size and physical characteristics of different plant species cause differences in rates of intake by large herbivores. Intake rates in deer and elk increase as their diet changes from grasses to mixed forages and browse because increasing leaf size allows for bigger bite size. For example, the arrangement and larger size of oak leaves compared with blackbrush leaves enables goats to ingest more oak brush than blackbrush.

Nutritional Quality Matters. Studies of plant structure rarely consider how nutritional quality affects intake because forages used in these studies are typically kept in a high quality state - immature and leafy. In studies where quality and structure both vary, the effects of structure and quality cannot be separated because forages high in nutrients are typically leafy with few stems and easy to eat, while foods low in nutrients are stemmy or woody and difficult to eat.

In cases where structure and quality have been separated, researchers found that diet selection is influenced by the nutrient content of the food as well as by intake rates. Animals may prefer foods with lower rates of intake if those foods contain needed nutrients or are higher in nutrients than alternative foods. For example, in one study lambs on a high-protein diet were offered a choice between ground barley and alfalfa pellets. Even though intake rates were lower for ground barley than alfalfa pellets, they preferred ground barley because barley is higher in energy relative to protein than alfalfa. Likewise, some sheep grazing a grass pasture, took smaller bites of forage because they preferred to eat only leaves. They could have maintained higher rates of intake by taking larger bites and eating both leaves and stem. Sheep that took larger bites consumed a lower quality diet than sheep that ate only leaves. These findings indicate that managers of high producing livestock, such as dairy cows, can influence what

animals select on pasture by feeding supplements in the barn that complement their pastures.

The rate of food intake is generally thought to be fixed, and determined by bite size and rates of chewing and swallowing as influenced by plant density, height, and toughness. Food quality is rarely considered a factor influencing intake rates. However, research indicates that when nutrients compliment an animal's nutritional state, intake increases. For example, when sheep were given a solution of starch and water with a stomach tube every time they ate long wheat straw, bite size, bite rate and intake all increased. (Does this mean that they ate more of the long wheat straw because of the feedback they were getting in spite of the fact that it was tough and stemmy?)Likewise, lambs fed a high energy diet ate high energy barley more slowly than lambs maintained on a high protein diet and lacked foods with energy.

Experience Matters. Small amounts of experience browsing or grazing a food can mean big changes in rates of intake. Lambs fed chopped serviceberry in boxes (inexperienced) were compared with lambs with 30 hours experience browsing serviceberry (experienced). Experienced lambs had faster bite rates and intake rates were 27% higher compared with inexperienced lambs. Inexperienced lambs took larger bites than experienced lambs but could not make up for their slower bite rate. In addition, inexperienced lambs had a higher failure rate when foraging. (What is a failure? Do they die or do they just not know how to bite off the serviceberry?)

Young animals learn foraging skills more quickly than older animals. Six-month-old goats browsing blackbrush had faster bite rates than 18-month-old goats even though both groups of goats had browsed the shrub for 30 days. In addition, after 30 days, bite rates for 6-month-old goats were still increasing whereas biting rates for 18-month-old goats had leveled off.

To some degree skills acquired by lambs on one type of plant form (grass or shrub) are specific to that plant form. Lambs experienced browsing shrubs are more efficient at harvesting shrubs than lambs experienced grazing grass. Lambs with experience grazing grass were more efficient at harvesting grasses than shrubs. Nevertheless, skills transfer from one shrub to another. Goats with experience browsing blackbrush were more efficient at harvesting oak leaves than goats without browsing experience.

Implications. Intake rate is thought to be solely dependent on plant structure. However, plant structure, current nutritional state of the animal, prior feedback from nutrients, and the acquisition of foraging skills interact to influence rates of intake. Managers can improve intake rates in their animals by keeping pastures at the correct height, feeding foods in the barn that complement the nutritional composition of forages in pastures and exposing young animals to the forages they will be required to eat later in life.