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Understanding Soil Mechanics to Improve Beef Cattle Winter-Feeding Areas and Production

Steve Higgins and Morgan Hayes, Biosystems and Agricultural Engineering

Soils directly affect beef and forage production, yet active soil management is limited. Understanding soil mechanics and management in winter-feeding areas could improve beef cattle production, with less effort on the part of the producer and the cattle. This guide will help producers evaluate soil strength for winter-feeding areas and the pollution potential of winter-feeding areas, as well as solutions for correcting structural deficiencies and reducing mud on both the ground and on the cattle.

Addressing these challenges is important because of the cyclical and repetitive nature of beef and forage production problems. Every winter and spring, beef cattle producers complain that too much hay is wasted, which requires more hay production and storage. Other common complaints include poor gains, weak calves, loss of body condition, and mortalities. In spring, technical assistance requests are often related to reducing or eliminating mud, weeds, erosion, and compaction (if the producer knows about it) due to winter hay feeding. If pasture renovation is conducted, winter-feeding areas might incur additional costs and labor for equipment, seed, fertilizer, chemicals, and fuel.

Geotechnical engineers or others who study soil mechanics usually refer to soil as the soil material from the subsoil to bedrock. To them, "soil" is the building material on which the foundations of structures and buildings such as farm roads, barns, buildings, and houses, are situated. To an engineer, topsoil has an agricultural value, but it has no structural value because it essentially has no load bearing strength. That is why contractors and builders scrape off topsoil to a depth of 4 to 12 inches to get to a compactible clay layer or remove all material to bedrock.

Water-soil interactions affect how soil responds to winter feeding. When water in the soil is frozen, it increases the force of loads that can be handled by the soil, such as the weight of tractor tires. The frost depth represents the depth in which water in the soil is expected to freeze. In northern climates, there are expected frost depths of greater than three feet that can be maintained for months. Kentucky's climate typically does not freeze topsoil for prolonged periods. For example, January is the coldest month; however, average daily temperatures in Lexington remain around 32° Fahrenheit (NOAA/NESDIS/NCEI). During winter, Kentucky does not have the intensity of sunlight and warm temperatures for evaporation or plant transpiration to dry out soils.

When topsoil becomes saturated with liquid water, the soil particles become slick. The soil moves around easily, which explains why winter feeding creates so much mud and large ruts as the tires mold, compact, and push water and soil particles away to try an achieve traction. This is one reason winter-feeding in areas with above average moisture or poorly draining soils should be avoided. Winter-feeding areas should not be located in ditches, draws, or bottoms that receive runoff and moisture from upland areas.

To choose a good winter-feeding area, a producer needs to consider all aspects of animal, soil, and land husbandry standards. Producers can determine their farms' soil properties by using tools such as the NRCS Web Soil Survey, county soil survey manuals, databases accessed using ARCMAP, and maps supplied by the conservation district. Similarly, topographic maps can be used to identify higher and lower areas. This information is extremely useful to a beef producer because it determines best and worst locations for practices such as winter-feeding and infrastructure improvements. Water content, soil texture, drainage, and landscape position, such as summits and slopes, are very important factors to consider for siting conservation practices such as sustainable winter-feeding areas for cattle.

The main criteria for selecting a winter-feeding area has more to do with the content and potential of soil water than anything else. The amount of water that falls on, flows over, or runs through the soil profile, and that is contained in a column of soil, affects many soil mechanical properties. These mechanical properties relate to the slipperiness, stickiness, plasticity, strength, trafficability, and compressibility of a soil.

Using winter feeding as an example, a producer should look up the soil hydrologic grouping (A, B, C, or D) to quickly and easily determine the suitability for winter feeding. Select soil hydrologic groups A and B for this kind of use because these are well-drained soils. Selection standards for winter-feeding areas require that soils have a moderately low runoff potential when thoroughly wet (hydrologic soil group B). Choose soil with a good infiltration rate, but not so great that the infiltrated water passes immediately through the soil profile. Sandy soils often demonstrate these very high infiltration rates. The goal is to filter the water as it passes through the soil profile. Inadequate infiltration is also not good, because it increases runoff potential without any filtering. Be aware when using hydrologic classifications that existing soil properties will change with time because of animal treading, tractor traffic, compaction, erosion, organic matter content, and soil phosphorus levels, etc. Long-term use may require periodic relocation.

Once the producer has identified possible locations for winter feeding the next step is to rule out any low-lying areas, particularly those along floodplains. Even though sites may provide well-drained conditions, these areas should be avoided if flooding periodically occurs or if they are in close proximity to a water body. Also exclude areas where streams of stormwater flow through the winter-feeding area or where ephemeral ponding occurs. These areas will often collect additional water originating from upland watershed areas. Moisture levels from a rising water table and drainage can easily shift a soil from a friable (workable) to plastic (moldable) to liquid state. Plasticity in soil refers to soil that can be formed and reformed into shapes similar to clay used in pottery. Plasticity requires moderate water content; dry soils will crumble, and moderately wet soil particles will adhere to other particles. The liquid state for soils occurs when the moisture content is greater than the plastic state can handle. A liquid consistency can cause soil to shift, flow, or move offsite. The soil particles become suspended in the liquid water. This liquid state causes erosion.

Solar radiation should be used during winter feeding to dry and stiffen soil. Shade from buildings, structures, and trees can interfere with solar energy and lower wind speeds across the area. High humidity tends to be concentrated in low-lying areas and is most common overnight and in the morning as the sun rises. During a typical day, humidity will be lowest when high temperatures are reached in midafternoon. To leverage these trends, orienting your winter-feeding area on slopes with a southern exposure is best. If southern exposures are not easily accessible, western, then eastern aspects should be chosen over northern aspects.

The slope for a winter-feeding area should be less than 4 percent. A vegetative buffer or area that maintains good vegetative cover should be provided downhill from the winter-feeding area prior to entering a water body. The vegetation can filter solids/organic matter and trap potential pathogens in the manure while allowing nutrients to infiltrate into the soil profile and boost yields for the vegetation being grown. A standard setback minimum distance from a water body located downhill from a winter-feeding area is 100 feet. A steeper slope requires a significantly greater setback. The number of cattle being fed as a group is a criterion that also affects the setback distance.

Selecting an ideal site is the first step. But even with good siting, well-drained soils, with time (and depending on stocking rates) can erode, compact, and modify inherent soil properties. These conditions are predictable based on measured values applied to soil engineering concepts. To keep a winter-feeding area in the same site for a longer term might mean using an adaptive strategy such as installing an all-weather surface, which should be designed to increase the load-bearing capacity of the surface while reducing mud creation. Gravel and geotextile fabric, concrete, or appropriate similar structural materials are examples of all-weather surfaces.

The benefits of understanding a soil's physical properties can be invaluable to a beef producer. Engineering properties are used to determine a soil's suitability for septic systems, manure application, burial sites, roads, the ability to corrode steel and concrete materials, and as a structural material. Engineering concepts are no less important as a critical part of the planning process for the beef producer designing infrastructure improvements like winter-feeding areas. These plans can prevent structural failure and limit future management difficulties on a farm, which means improved feeding situations, compliance with environmental regulations, and sustainability for the operation.

Resources

Web Soil Survey Available at: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm.

Topographic Map Available at: https://viewer.nationalmap.gov/basic/?basemap=b1&category=histtopo%2Custopo&title=Map%20View#startUp.

Typical Weather Available at: https://www.ncdc.noaa.gov/cdo-web/datatools/normals.

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