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SOIL MANAGEMENT FOR INTENSIVE GRAZING

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Recycling of plant nutrients is of major concern in managing paddocks in pasturefields for intensive grazing. Redistribution of nutrients present in fecal and urine deposits is an important issue for efficient conversion of herbage into animal products while adding to the sustainability of the system. Some of the questions that arise in managing soils for intensive grazing are discussed below.

How Soil Affects Other Factors in the System

Variability of soil characteristics and microclimate results in several distinctive sites within and among fields that may require somewhat different management on the same tract of farmland. The importance of a good working knowledge of soil-plant-climatic factors acting on a specific land tract cannot be overemphasized, because these factors exert monumental control over total forage production, and thereby, animal carrying capacity.

Potential forage production and seasonal yield distribution within the pasture basically controls livestock production per unit area, which in turn, exerts much control over economic returns per unit area. This further adds to management complexities and results in a system of four major components ... soil, climate, plants, and animals. For further purposes of this discussion, only the effect of cattle on soil management will be considered. Their major diet consists of living plants, which they must harvest from the landscape, retaining some 65% of total ingested dry matter for their metabolism, while recycling the remainder. The major management concepts involved are:

(1) Manage to maximize forage production relative to soil capabilities.

(2) Manage cattle to achieve desired consumption of the forages produced in each field. This requires following a management rationale that treats grazing cattle herds as biologic mowing machines, and that utilizes sound grazing management to maximize utilization of the forages produced.

(3) Evaluation of the economic success in terms of units of animal output (pounds of beef or milk) per unit of land area (acre).

The Effect of Grazing Cattle on Soil Management

Cattle can simultaneously exert both beneficial and detrimental effects on a grazed field. The greatest detrimental effect, perhaps, is compaction, which can be caused by concentrated animal traffic on wet fields. The interaction of several factors will determine the amount of potential damage that may result. Soil moisture content, soil physical properties, type of forage, stocking rate, and number of days grazed all interact greatly in managing paddocks to minimize compaction damage. The most basic concept to keep in mind is that application of weight (cattle) to wet soil may cause compaction, thereby increasing bulk density of soil (weight per unit volume). The most severe compaction occurs just after a saturated soil has drained enough that the large pore space is filled with air instead of water (soil is wet, but water will not freely drip from it). The effect of compaction is to diminish the pore space of soil. This limits the total amount of water and air holding capacity, thereby limiting rooting volume of the plants. The pore space that remains will likely have a smaller proportion of large pores (those which store air) and a greater proportion of small pores (those which hold water). Because the effect on compaction is greatest at the soil surface, soil permeability of both air and water is decreased. Lowered rates of water infiltration may lead to higher rates of surface runoff during heavy rains and to greater soil erosion, a problem often related to overgrazing. Soil compaction by animals also reduces forage production and limits the success of no-tilled legumes seeded in a pasture renovation process.

Nature of the forage can also affect the rate at which compaction damage occurs. Established stands that have a prolific rooting system in the top 6 to 10 inches of soil (form a good sod), can absorb more compaction energy than those forages that do not form a dense rooting mass, thereby slowing the rate at which soil damage can occur. However, the forage plant itself may be physically affected by animal traffic, and the nature of the species (how it recovers) may also have an effect. Non-rhizomatous, non-stoloniferous species (e.g. orchardgrass) can more easily be damaged than rhizomatous/stoloniferous species (e.g. bermudagrass). And, of course, the stocking rate and how long the animals are kept there will influence the degree of damage.

Management to minimize potential compaction damage should be aimed at keeping cattle off fields when the soil is too wet, or if that is not possible, putting them onto well-sodded fields at a lowered stocking rate (more acres). Alternatively, at such times, cattle could be moved to "sacrifice" fields (stubble fields/run-down pastures/drylots, etc.) which will then receive the damage instead of the pasture paddocks.

From the positive standpoint, large

quantities of dung and urine are deposited within paddocks as a result of intensive grazing management. In addition to nutrient recycling, organic matter in the dung will increase the rate of organic matter buildup in the soil, which also leads to improved soil physical properties.

The Effect of Grazing Cattle on Plant Nutrient Recycling

One of the obvious consequences of using cattle to harvest forages, so as to give them added value, is that nutrient content of ingested forages may be transported from some parts of a field to other parts and re-deposited in urine and feces. In addressing the issue of how nutrient recycling by grazing cattle affects sustainability (also utilization) of forages growing in that field, a few behavorial aspects of grazing by cattle should be kept in mind.

The Proportion of Nutrients Ingested by Grazing Cattle Excreted in Urine and Feces. Most estimates indicate that about 25%, 20%, and 15%, respectively, of nitrogen (N), phosphorus (P), and potassium (K) contained in forages consumed by grazing cattle is retained in their bodies for support of their various metabolic processes. This means that about 75%, 80%, and 85%, respectively, of N, P, and K pass through the animal and are excreted in urine and feces. Most of the nutrients ingested are, thereby, recycled by the animals, perhaps many times. On grazed fields, these recycled nutrients are, or can become, available to plants. One point of concern, though, is that urination and defecation patterns of grazing cattle do not result in recycling of nutrients uniformly over the field. Grazing practices affect the distribution of recycled nutrients.

Quantification of Urine and Fecal Deposits in Pasture Fields. In order to determine recycling patterns, it is useful to know the frequencies of defecation and urination per day, and the area covered per elimination. A rule-of-thumb value would be 10 defecations per bovine animal per day, each covering about 1 square foot, for a daily total of 10 square feet per head. Urination events are harder to quantify because they leave no visible short-term deposit on the surface. Some researchers estimate that the daily number of urinations are about the same as defecation, and are deposited very similarly over the field. There is a key difference in the nutrient content of feces and urine. About half the N eliminated from the animal's body is in urine and the remainder in feces. This proportion can increase to nearly two-thirds in urine if cattle are grazing on a high N-containing forage (grass, well-fertilized with N, or legumes), which greatly exceeds their N requirements. Nearly all the N in urine is present as urea, which when deposited onto the field, behaves just as commercial urea fertilizer (some surface volatilization occurs). The N content of feces exists in various organic structures (including microbial and plant protein), some of which break down fairly quickly to ammonium N (NH_4+), and others which are very resistant to decomposition, and may remain in the soil for weeks, months, or even years.

In contrast to N, most of the P is contained in feces, largely bound in organic compounds, which, even though they are not immediately available for plant uptake, contribute very effectively to increasing soil test levels of P. Consequently, all the P in feces is credited to soil buildup of available P within a year after deposition. And, in contrast to P, most of the K passing through the animal is in the urine. It is as effective as fertilizer K and is immediately available for plant uptake after deposition.

Factors Affecting Patterns of Fecal and Urine Deposits. Several factors have been shown to affect the pattern of nutrient recycling by grazing cattle. Perhaps the most notable of these are landscape features, such as shade, field shape, and topography of the landscape. Shade tends to promote loafing areas for cattle, so that more defecations and urinations occur in shaded than unshaded areas. Similarly, the presence of depressions on the landscape, such as swales, hollows, draws, etc., results in more animal use of such areas, with resulting increased urination and defecation patterns there. It has been reported that soil test K levels in these special areas increased 4 to 10 fold over that from the remainder of the field.

Cattle also tend to defecate more during the night, in areas where they rest, than during the day while they move about and graze. However, they tend to urinate more frequently during the daytime. These differing patterns are related to the rapid rate of absorption and excretion of water, compared with the slow rate of passage of undigested plant herbage through the digestive tract, and may also contribute to uneven distribution of recycled plant nutrients.

Source of water is another factor having major impact on elimination patterns by cattle. Concentrations of feces and urine are greater around water sources. Supplemental feeding sites (hay, mineral, and concentrate feeders) within the field have a similar effect. One study of intensive rotational grazing practices showed that if animals have to travel through a lane at distances greater than 450 feet to get to water, nearly one fourth (22%) of the total manure deposits were made in the water lane.

Another factor impacting patterns of dung and urine deposition is stocking density. The more animals per acre, the more uniform will be the distribution. Duration of grazing must also be considered. If the field size is large enough to provide several days, or weeks, of grazing by the number of animals present, manure deposits will not be as uniform as if field size is restricted to provide only a few days grazing. Missouri studies suggest that if paddock size or animal numbers are restricted to provide less than 6 days feed to the number of cattle present, and if water is available in the paddock, manure distribution will be fairly uniform over the paddock. This would represent the optimum situation for managing grazing cattle to recycle nutrients uniformly over the grazed area. Otherwise, and to varying degrees, as influenced by the factors discussed above, recycling will result in a net movement of nutrients from within the field to areas where cattle congregate, thereby non-uniformly re-distributing them and increasing the potential for increased nutrient, fecal material, and fecal bacteria runoff into surface water sources, following rainfall.

Are Commercial Fertilizers Required on Fields Grazed by Cattle? If fertility levels of fields are low, it should be obvious that grazing will not raise overall fertility levels. It is quite likely, though, at low fertility and at low stocking rates, that grazing cattle will concentrate nutrients in some areas of the field, with the result that soil fertility in some areas of the field may be depleted while other areas are enriched. On the other hand, if soil fertility is or has been built to desirable levels (medium to high) and if management is designed to concentrate animals onto areas with no more than a few days (less than 6) of grazing (intensive grazing), and are provided water within the area being grazed, recycling of nutrients will be fairly uniform, and existing fertility levels may be maintained for several years before additional commercial fertilizer is needed. Above and beyond the uniformity of defecation and urination which can be obtained by confined, mob grazing of a few days duration, additional benefits in uniformity can be attained rather economically by use of a chain drag harrow, perhaps following clipping of ungrazed stubble, within a few days after removing cattle from the paddock. A soil testing program of sampling each paddock to a depth of 4 inches every 3 to 4 years should be sufficient to monitor soil fertility levels so as to maintain sustainability of the paddock.

For larger fields with low grazing pressure and in areas where cattle congregate, avoid sampling (or at least sample separately) within and around such areas (shade, water sources, gates, depressions, etc.) because they will test higher in P and K than the remainder of the field. Also, avoid spreading P and K fertilizers in such areas. Confine P and K applications to the lower testing areas of the field. For legume-grass mixtures, manage fertilizer applications to favor legumes, rather than grasses. This means development of medium to high soil test levels of P and periodic liming to maintain soil pH around 6.5. Urination and defecation by grazing livestock has little effect on soil acidification.

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