

Management-intensive Grazing (MiG) and Soil Health

Fact Sheet 0.507

Crop Series | Soils

By Casey Shawver, Joe Brummer, Jim Ippolito, Jason Ahola, and Ryan Rhoades* (7/20)

Management-intensive Grazing (MiG) in Beef Systems

Over the past decade, interest in MiG has increased steadily due to prospects of reduced production costs, increased animal output, land use efficiency, and environmental benefits. Management-intensive Grazing is a flexible approach to rotational grazing where paddock size, stocking density, and length of grazing period are adjusted to balance forage supply with animal nutrient demand through the grazing season. As in all grazing systems, functioning soil is a primary driver behind forage yield and quality, which ultimately affects profitability. Positive and negative impacts of grazing in a perennial pasture system can make or break the viability of a livestock enterprise. Understanding soil processes is important for effective integration of MiG into beef systems in Colorado and throughout the West.

Practicing MiG within an irrigated, perennial pasture system has the potential to produce productive, quality forage while maintaining or improving soil health factors such as soil organic matter levels, nutrient cycling, and carbon sequestration. The caveat to successful implementation of this system is managing bulk density and compaction at a level that does not

impact water infiltration, root growth, forage productivity, and ultimately the overall system.

Positive Effects on Soil Health

Biological Factors

The goal of MiG is to improve forage production by maintaining enough of a plant's leaf area to foster healthy above and belowground growth. Management-intensive Grazing accomplishes this using time-controlled grazing (i.e., short grazing periods of 1 to 3 days) coupled with moderate degrees of defoliation (50% or less) and periods of rest ranging from approximately 21 to 40 days. By removing 50% or less of aboveground forage during a grazing period and maintaining at least a 4-inch stubble on most species, plants retain enough leaf area to support quick foliage regrowth and continued root growth (5). In addition, moderately defoliated plants tend to increase root exudates which stimulate soil microbial activity (6). This increase in microbial activity leads to more rapid decomposition of roots that have died during normal growth which improves nutrient cycling and will eventually lead to an increase in soil organic matter. Building soil organic matter is important as it is a reservoir for nutrients, improves the water holding capacity of a soil, and increases soil aggregate stability.



Quick Facts

- Soil properties that are impacted in Management-intensive Grazing Systems include biological, chemical, and physical factors.
- Positive impacts to soils from properly managed cattle grazing include increased microbial activity and improved pasture fertility.
- Negative impacts to soils from improperly managed cattle grazing include increased bulk density which is an indicator of compaction.

**Casey Shawver, Former Graduate Student, Joe Brummer, Associate Professor-Forage Extension Specialist, and Jim Ippolito, Associate Professor-Soil Fertility and Environmental Soil Quality, Department of Soil and Crop Sciences; Jason Ahola, Professor-Beef Production Systems, and Ryan Rhoades, Associate Professor-Beef Extension Specialist, Department of Animal Sciences. 7/20.*

Stable aggregates improve soil structure which leads to increased water infiltration and root penetration. Implementing an improved grazing management system, such as MiG, should increase soil microbial activity which will result in greater total forage productivity and carrying capacity of pastures. These changes can happen quickly under proper management as illustrated by an increase in soil microbes averaging 125% (as measured by soil microbial carbon) in the first year of a study at Colorado State University where tilled cropland was transitioned to a perennial MiG system (14).

Chemical Factors

Unlike cropping systems where large amounts of nutrients are removed from a field in grain or hay, the majority of nutrients are recycled in grazing systems through manure and urine deposition. For most nutrients, over 90% of what is ingested ends up being excreted. Through this deposition, overall soil fertility is maintained and reliance on inorganic fertilizer inputs is significantly reduced. Although most nutrients are returned to the soil, they are not evenly distributed. Continuous, unmanaged grazing can cause N, P, K, and other nutrients deposited in manure and urine to accumulate near water and shade sources, reaching concentrations up to five times greater than other areas (15). One of the big advantages of MiG is that it improves distribution of nutrients deposited in manure and urine by encouraging cattle to more uniformly use the area provided. Space is controlled by adjusting stocking density, which is defined as the number of animals per unit area at a point in time. As stocking density increases, cattle graze less selectively, which increases uniformity of forage utilization. However, this means cattle need to be moved more frequently because available forage will deplete faster. Once forage resources begin to diminish, cattle typically pace fence lines or lounge at watering locations causing nutrients to buildup in those areas. However, if cattle are moved prior to this point, animals will have access to fresh forage and spread out across the new paddock. In the MiG study at Colorado State University mentioned above, cattle were generally moved daily which resulted in manure and urine being relatively evenly distributed (14).

Short-term changes in phosphorus and potassium levels measured in the study at Colorado State University, where cropland was converted to a MiG system, indicated that potassium levels doubled in the top 2 inches of soil and increased by 30% in the 2 to 6-inch zone after one year (14). Phosphorus levels decreased slightly in the top 2 inches (-17.5%) with no change measured at the 2 to 6-inch depth during the same time period (14). Because phosphorus is mainly excreted in manure rather than urine, it often takes 5 plus years before a significant percentage of the total pasture area has received a manure deposit that would result in increased levels of phosphorus in soil samples. The key is to soil sample regularly (every year if deficiencies exist, every 3 years if adequate) at the same time of year to monitor changes in nutrient levels over time. As with most changes in management (e.g., tilled to no-till cropland, cropland to perennial pasture, etc.), it often takes a minimum of 4 to 5 years before significant benefits are realized. Given time, inputs of inorganic fertilizers can be significantly reduced or eliminated in properly managed MiG systems.

Negative Effects on Soil Health

Soil Physical Factors

Perennial pasture systems can enhance soil health by reducing erosion, building soil organic matter, sequestering carbon, increasing macro and micropore space, and retaining more plant available water (11). Several specific examples are detailed in the above discussion. However, adverse effects can also occur, especially to soil physical properties due to hoof action by livestock. Some level of increased bulk density is an unavoidable consequence associated with grazing. As the surface of the soil becomes compacted from grazing, pore space in the upper horizons of the profile decreases which increases bulk density, particularly when soils are grazed wet (16, 17, 18). Root growth is impeded at bulk densities exceeding 1.7 g cm⁻³ (2). Increases in bulk density can also lead to reduced water infiltration (17, 18) and pasture yields (2, 9). In the study at Colorado State University mentioned above, mean bulk density levels increased to about 1.5 g cm⁻³ at both the 0 to 2 and 2 to 6-inch depths after only 2 months of grazing

in 2017 (Fig. 1). This was expected as the pasture transitioned from cropland in which the soil was tilled annually, subsequently decreasing bulk density, to grazed perennial forages in which cattle hoof action compressed the top layers of soil. As the system comes into balance over time, bulk density is expected to level out. Plants should become larger with deep, extensive root systems that will add organic matter to the soil and aid in development of soil aggregates that create pore space which will maintain or reduce bulk density.

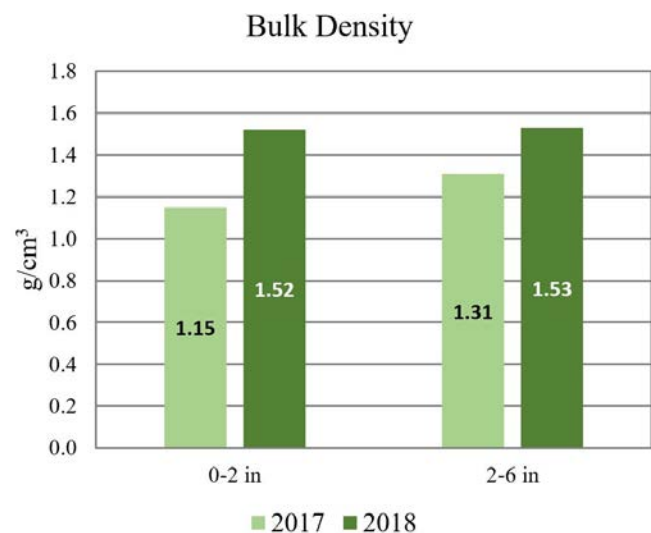


Figure 1: Soil bulk density prior to grazing and after 2 months of grazing in 2017 within an irrigated, MiG system at Colorado State University (14).

Managing Soil Physical Factors

Moving cattle more frequently, maintaining soil surface residue, avoiding grazing when soils are wet, and allowing time for plant and soil recovery after substantial grazing impact are ways to mitigate long-term, negative impacts of MiG on soil physical factors (8, 9, 14).

Soil moisture and texture are two of the most important factors affecting a system's vulnerability to physical soil impacts. As soil moisture and clay content increase, the ability of the soil to compact also increases. Having a contingency plan for precipitation events is imperative to minimize soil compaction. Options for management include removing cattle from a pasture entirely, moving to an area of sandy textured soil (i.e., greater drainage capacity), giving cattle a larger area (paddock) to spread out hoof impact, or utilizing a sacrifice area until soil is dry enough to graze. More detailed information on management options

for grazing when soils are wet can be found in the factsheet '[Managing Cattle Impacts When Grazing on Wet Soils](#)'.

Stocking density (i.e., number of animals per unit area) also plays a large role. As stocking density increases, regardless of grazing system, animals will walk over an area multiple times which can lead to a breakdown in soil structure (1, 3), especially when soils are wet (Fig. 2). Impacts on soil structure (i.e., aggregates) can be mitigated by more frequent moves which can reduce effects on bulk density by animals simply spending less time in a given area (4). More frequent cattle movements can also lead to greater amounts of live and dead (i.e., litter) plant material on the soil surface. Having denser plant cover and more residue on the soil surface has the potential to mitigate increases in bulk density as it tends to provide structure on the soil surface which keeps cattle hooves from penetrating as deeply (10, 12).



Figure 2. Surface impact of cattle grazing wet soils in a MiG system. (Photo by Casey Shawver).

Soils that have been negatively impacted by heavy grazing, grazing during wet conditions, or other scenarios should be given a period of rest. Increases in bulk density in intensive grazing systems are reversible given adequate time for recovery (17, 18). Recovery begins within a few weeks once animals are removed from a paddock but is a slow process that can take 1 to 4 years of grazing exclusion to recover to levels approaching pre-trampling conditions (7). Even though complete recovery is a long-term process, significant improvement has been noted to occur within 6 months of grazing exclusion, especially

in the top 2 to 4 inches of soil (7). Rest allows the soil to be free of impact for a period of time and for root growth and other biological activity to aid in remediation. Freeze-thaw cycles over the winter also have a regenerative impact on soils affected by increased bulk density (13). The goal is to manage bulk density at a level that does not impact root growth, water infiltration, or microbial activity which ultimately will affect forage productivity and carrying capacity of the pasture.

Conclusion

Positive soil impacts from properly implemented MiG systems include increased microbial activity and improved pasture fertility. Conversely, negative impacts can be incurred from improper management leading to compaction issues. With frequent livestock movements, maintaining moderate forage utilization of about 50% or less, avoiding grazing when soils are wet, and being flexible in cattle management, there is great potential to improve soil health over the long-term when using MiG leading to more resilient, productive systems.

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