Integrating Grazing into Cropping Systems: Grazing Cover Crops for Soil Health

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About Grazing Cover Crops for Soil Health

For a long time, the tendency in modern farming has been to specialize, resulting in grazing animals being excluded from cropland. However, there is a new appreciation for the potential benefits of grazing animals for soil, crops, and farmers. By bringing the grazing animal back on the land we are in a way mimicking nature. Cover crops have been promoted to help improve soil health and reduce soil erosion and nutrient losses from cropland. They cover the land that would otherwise be sitting idle, again mimicking nature. Those cover crops can also be eaten by grazing animals, improving the financial bottom line of the farm. If done right, grazing cover crops can also help improve soil while maintaining the environmental benefits of the cover crops. If done wrong, however, grazing cover crops can become an environmental liability that can degrade soil. The key is proper cover crop and grazing management. In this fact sheet we will discuss management strategies to optimize the soil health benefits of grazing cover crops, while avoiding soil erosion, detrimental soil compaction, and nutrient runoff.

Maximize soil health by grazing cover crops

Soil health is "the capacity of a living soil to function, within natural or managed ecosystem boundaries, to sustain plant and animal productivity, maintain or enhance water and air quality, and promote plant and animal health" (Doran, 2002). The importance of the living component of soil cannot be overstated. What is done above-ground has effects on the below-ground food web (Figure 1), and this affects soil chemical and physical properties. In this fact sheet we will focus on management of cover crop grazing to maximize soil health.

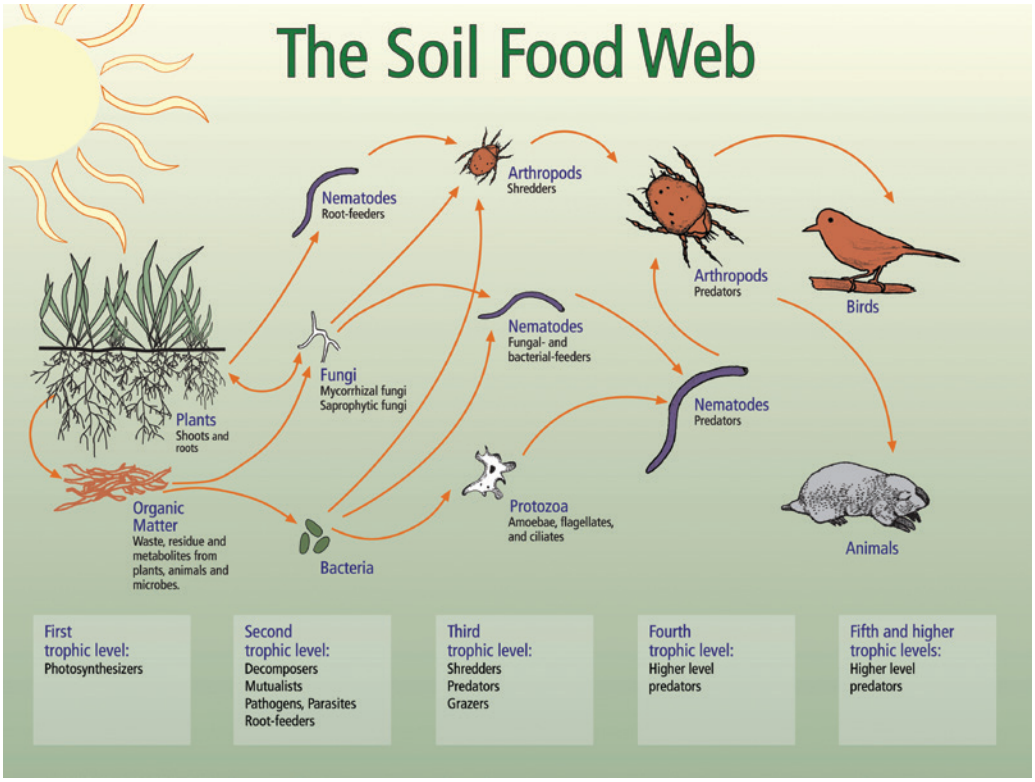

FIGURE 1. Soil health depends on an active and diverse soil food web at the basis of which stand plants that convert solar energy into chemical energy that can be used by other organisms.

These five principles can guide us in our quest to improve soil health:

1. **Use soil armor**. Keep soil covered with dead or living plant matter at all times. Soil armor is needed to maintain an optimal habitat for underground life – it protects the soil from the impact of raindrops, conserves soil moisture, moderates temperature fluctuations, and provides food for important soil engineers such as nightcrawlers. In our annual cropping systems, 30 percent residue cover immediately after planting is desired for erosion control, while at least 70 percent residue cover is desired to optimize water infiltration and limit soil water evaporation. A farmer can apply this principle by leaving cover crop residue after grazing. In many cases, the rule "take half, leave half" is applicable. If the cover crop is massive, however (for example, 8,000 lbs./A of dry matter), a larger portion (for example, 75 percent) of the above-ground biomass can be harvested while still leaving enough cover for soil function. When calculating the size of the area offered to the grazing animals, the farmer should use only the portion of the cover crop that will actually be consumed instead of all the standing cover crop biomass. Once the farmer gets experience with grazing of cover crops it is amazing to see that what seemed difficult in theory proves relatively straightforward in practice. Once the proper stocking density and period of occupation has been determined, animals often consume the low-fiber, easily digestible part of the cover crop first and leave the stemmy material. This is usually the desired amount of cover crop residue needed for soil function (Figure 2).

FIGURE 2. Image showing the take-half-leave-half principle of grazing. The stems are typically left and trampled on the ground for soil protection, to feed the soil food web, and to generate new growth for future grazing.

2. **Minimize soil disturbance**. Soil tillage disrupts soil organisms and their habitat, just like when a tornado hits your house! Tillage has been shown to disrupt activity of large soil organisms such as earthworms, as well as microorganisms. Deep burrowing earthworms such as nightcrawlers help keep soil porous, alleviating soil compaction and improving water infiltration. Mycorrhizae and other soil fungi that are important for soil aggregation and plant nutrient and water uptake are reduced when soil is tilled. One advantage of permanent no-tillage is that the soil is

firm while there are plenty of macropores for aeration and water infiltration and percolation. This helps improve drainage and reduces pugging of the animals, usually eliminating the need for tillage after grazing cover crops to level the soil for planting of the next crop. A tilled soil is much softer, and this leads to more severe pugging, leading to greater likelihood to need tillage again to level the soil for planting of the next crop! Another benefit of permanent no-till is that the high concentration of organic matter that builds up in the surface of long-term no-till soil makes it more resistant to compaction by reducing bulk density and improving aggregate stability. Soil compaction needs to be managed by moving animals more frequently when soil conditions are wet. For example, moving animals once or twice a day instead of leaving them in one area for two or three days will dramatically reduce soil damage. Nonetheless, it is highly recommended to have an emergency area where the grazing animals can be brought when the soil is very wet to avoid excessive soil compaction. Again, in practice these periods tend to be few and far between except in poorly drained soil.

FIGURE 3. Excellent soil structure of long-term no-till field has a stable aggregate and plenty of permanent macropores.

3. **Ensure plant diversity**. Use a diversity of crops in rotation and try to use cover crop mixtures. Plant diversity stimulates below-ground biological diversity. In a monoculture, certain undesired organisms become problems (for example, in continuous corn, the insect pest corn rootworm, the disease grey leafspot, or the weed marestail), while nutrients are used inefficiently. A diversity of plant species in rotation or in mixtures helps soil organisms keep each other in check. A diversity of root types, such as taproots and fibrous roots, deep roots and shallow roots, improves soil profile exploration for water and nutrients, while the roots also improve porosity and add carbon. Growing winter and summer crops and warm- and cool-season species, either in succession or in mixtures, improves utilization of precipitation and solar radiation. Benefits of grazing cover crops are that the generated economic return motivates the farmer to (1) plant the cover crop immediately after harvest of the main crop instead of considering the cover crop an afterthought; (2) use higher seeding rates so a heavy stand is guaranteed when grazing starts; and (3) use greater diversity in the cover crop species selected instead of going for the lowest-cost option.

4. **Maintain living plant roots in soil year-round**. Biological activity in soils is concentrated in the rhizosphere—a very thin layer of soil surrounding root hairs. Plants exude easily degraded organic compounds such as citric, malic, and oxalic acids that are food for soil microbes and help make plant nutrients available from soil minerals. Mycorrhizae are fungi that live in symbiosis with living roots of most crops—and if living roots are continuously available, they will be able to thrive. Mycorrhizae produce glomalin, a mycoprotein that stimulates soil aggregation. Further, plant roots create pores while they grow, and this improves soil porosity. Also, plant roots recycle nutrients from the subsoil and make them available for the next crop when their residues decompose. Root systems help protect the soil from compaction by the grazing animals, like geotextile fabric used by engineers. To guarantee maximum root occupation and root growth, the cover crops should be planted as quickly as possible after the main crop harvest. Ideally, the farmer should have a drill with cover crop seed hooked up to the tractor in the field at harvest time. A cover crop can also be established in the standing main crop so that it will already be present at harvest. One fool-proof and inexpensive method that takes minimal equipment is frost-seeding of red clover in late winter into standing winter wheat, barley, or rye. Another method is interseeding shade-tolerant cover crops such as annual ryegrass and red clover into corn between the V-4 and V-6 leaf stages. Further, the cover crop should be allowed to grow as much as possible until the planting of the next crop to maximize the living root period.

5. **Integrate livestock**. Grazing livestock have many potential benefits for soil – they help process fibrous plant material in their rumen, and their urine and manure provide a mix of readily available and slow-release nutrients for plants and the living soil. There are many insects living in manure pies that help with recycling of the manure and adding diversity to the ecosystem. There is even some evidence of "plant-animal talk"—the saliva of grazing livestock has been shown to improve regrowth of some grass species, especially on poor soils. Finally, farmers grazing ruminant livestock often use more diverse plant types in their cropping system to maximize the number of grazing days per year.

Avoiding Problems when Grazing Cover Crops

Avoiding excessive soil compaction

Alleviation of compaction in healthy soil

Grazing animals exert pressure on the soil surface that equals that of common farm equipment. Therefore, compaction caused by grazing animals is a concern. Fortunately, research has shown that soil compaction by grazing cattle rarely penetrates deeper than four to six inches beneath the soil surface. This zone of the soil is where biological activity is highest and freeze-thaw and wetting-drying cycles are the most frequent. Biological organisms such as earthworms and other burrowing organisms, as well as crop and cover crop roots, help restore soil porosity, especially in the surface of the soil. The importance of soil health improvement practices that stimulate biological activity can therefore not be overstated when talking about grazing. Further, when the soil goes through freeze-thaw cycles, the expansion of ice crystals creates small pores. Research has shown that the soil needs to go through several freeze-thaw cycles for it to be effective for compaction alleviation. Since only the surface soil goes through several freeze-thaw cycles, it does not help alleviate subsoil compaction (which is fortunately a minor concern with grazing). Drying-wetting cycles can also help restore porosity in soils containing clay minerals that swell when they are moistened and shrink when they dry. Both freeze-thaw and wetting-drying cycles are not effective in sandy soils because they do not hold enough water or contain too little clay.

FIGURE 4. Soil compaction can become excessive during wet periods, especially around water and in shady areas. More frequent movement can help avoid excessive soil compaction.

Differences between soil types and times of year

The threat of soil compaction is greater in spring than in fall because soil moisture content is typically higher in the spring. Soils on north-facing slopes typically dry out more slowly than south-facing slopes and pose a greater compaction threat. Further, the threat of soil compaction is greater on poorly drained soils than on well-drained soils. Finally, soils with high clay content tend to compact more easily than those with low clay content because the clay platelets slide and pack easily when wet. Farmers must be cognizant of their soils and monitor soil moisture conditions when grazing.

No-till effective for grazing cover crops

Research in Nebraska on grazing corn stover in continuous no-till showed that penetration resistance due to spring grazing was higher than after fall grazing or no grazing, but it did not exceed the critical limit of 300 psi, and following corn and soybean yields were not negatively affected. In a study in Georgia, tall fescue sod was terminated by moldboard plowing or glyphosate application (no-till) and converted into annual crop production. Corn or sorghum for grain was followed by a cereal rye cover crop that was either grazed or not grazed. This was contrasted with pearl millet that was grazed in summer after wheat harvest. Grazing was continuous for at least a month and the beef animals consumed more than 90 percent of the cover crop. The authors did not see substantial negative effects of grazing on bulk density, aggregate stability, or infiltration in no-till (or tillage) and attributed that to the high surface organic matter content in no-till. If farmers use management intensive grazing practices and leave more cover crop residue, better results could be expected. Total cattle gain per grazing season tended to be higher with no-till than with conventional tillage when grazing rye or pearl millet, probably due to moisture conservation leading to higher biomass yields. Additionally, the economic return of the cropping system improved with grazing. A study of management intensive grazing of cover crops on four farms in southcentral Pennsylvania using permanent no-tillage also did not observe significant negative effects of grazing on soil health. These studies show the potential of integrating grazing in no-till systems for better soil health, improved crop yields, high-quality forages, lengthened grazing season, and overall better financial return.

Management... management… management

Management intensive grazing practices are important to avoid detrimental soil compaction. Continuous grazing where the grazing animals are left in a field for extended periods often leads to highly compacted areas near water sources or in areas where shade is available. Animals also tend to move more when forage availability is low, leading to greater likelihood that they will trample areas multiple times. To avoid this, provide enough forage for the period of occupation, move animals regularly, and back-fence the grazing area. As a general rule, do not leave the animals in one area for more than three days. However, this period should be shortened when the soil is very wet. The manager needs to monitor soil conditions closely during wet periods and move the animals before extensive pugging happens. If pugging becomes too extreme the animals

should be moved to perennial grass areas that tend to have a more robust root system than annual cover crops. In extreme situations the animals should be moved temporarily to a holding area where they are fed hay.

FIGURE 5. Mobile electric fencing is essential to facilitate frequent moves necessary for management intensive grazing.

FIGURE 6. Mobile watering systems need to be installed to facilitate back-fencing so soil exposure to animals is short.

Avoiding soil erosion

Soil should be kept covered as much as possible to prevent erosion, and soil disturbance should be kept to a minimum. A minimum level of cover crop residue should be left for erosion protection after grazing. Further, animals should be moved more frequently or moved off the field during wet soil conditions as indicated above. If cover crops are grazed multiple times, make sure to leave enough time for the vegetation to grow to the desired height. The rest period is also very important for a root system to re-develop and for soil porosity to be restored by the activity of soil-dwelling organisms.

Avoiding nutrient runoff

Animals should be moved regularly to avoid nutrient runoff. By concentrating animals in a small area for short periods of time, manure and urine distribution is improved. Water and shade are places where animals tend to congregate, defecate, and urinate. Therefore, water sources should preferably be moved with the animals and shade dispersed throughout the field or removed. Further, maintain infiltration capacity by limiting soil compaction and improving soil health. The organic matter and nutrients in manure and urine promote microbial activity as well as other beneficial organisms such as earthworms and dung beetles. These soil- and surface-dwelling organisms are essential to incorporate manure nutrients into soil. One manure pie typically contains more than 100 insects, and sometimes more than 1,000. Some insects such as dung beetles help decompose manure pies and incorporate manure nutrients in the soil. Further, most nutrients are left in the field when animals are grazed so that fertilizer needs are much less than when harvesting forages, lessening the opportunity for nutrient runoff.

FIGURE 7. Manure pies and urine spots become hotspots of biological activity. More than 1,000 insects were counted in one manure pie in a study from the Netherlands!

Conclusion

Grazing of cover crops offers promise to improve soil health and increase financial return. With careful management, problems with soil compaction, soil erosion, and nutrient runoff can be avoided.

Further Reading

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Penn State College of Agricultural Sciences research and extension programs are funded in part by Pennsylvania counties, the Commonwealth of Pennsylvania, and the U.S. Department of Agriculture.
Where trade names appear, no discrimination is intended, and no endorsement by Penn State Extension is implied.

This publication is available in alternative media on request.

Code EE0737 5C09/22MPC