Benefits of Tillage Radish and Keyline Plowing for Pasture Management

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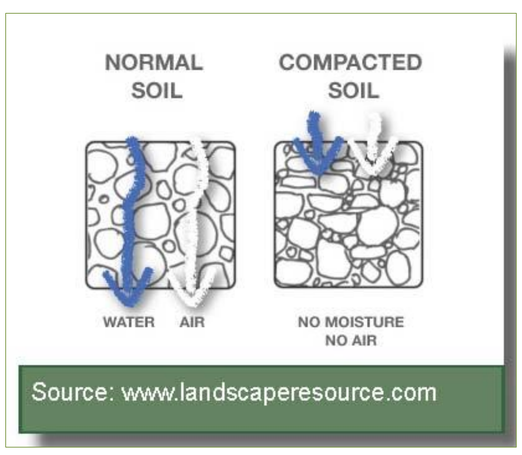
Introduction

When talking about soil quality, the first thought is fertility. This often begins with a soil test. While soil testing is an important for fertility recommendations, the standard soil test doesn't give a complete picture of soil quality. Soil quality is the ability of soil to perform many functions, and, importantly, to recover when disturbed. Soil quality comes from a range of factors, including chemical (e.g. pH, micro and macro nutrient sufficiency, cation exchange capacity), biological (e.g. organic matter and the soil food web), and physical (e.g. aggregate stability, water capacity, compaction) factors. A decline in any single factor can impact soil health and limit productivity.

Compaction is a great example of a physical limitation to soil health. In pastures, it results in soil layers that are difficult for roots to penetrate and thus interferes with pasture productivity. Soil biologists argue that compaction also disturbs the complex balance between various parts of the soil food web. To understand this, we need to look more closely at what happens during compaction. The space in a healthy soil is about half solid materials and half pores. The pores are divided into air and water-filled spaces supporting both an aquatic and a soil air-based community made up of microorganisms and soil animals. When soils are compacted, pore spaces become smaller, reducing the available habitat of microbial-feeding nematodes and protozoa. These soil animals cycle nutrients, and when they are not available, nutrient supply can be limited.



Discussion:

For both methods we expected significant effects on soil organic matter. Especially for keyline sub-soil tillage we expected increased soil organic matter. These expectations were not met. Keyline tillage did affect moisture content, draining moist pastures more readily (Figure 2). This may translate into earlier pasture accessibility for earlier use in the spring and during wetter episodes. Where soils don't readily hold water (e.g. sandy soils), keylined pastures didn't have enough water. We also expected more clearly improved penetration resistance (reduced compaction. We did not see evidence for this with the methods we used.

An unexpected result was in both radish and keyline treatments we found more earthworms than in the controls. This translates into more active soil communities and likely greater productivity. Earthworm populations may be better indicators of soil quality than the pasture quality data collected. Pasture data gives only snapshots of status; earthworm data integrates several months of activity.

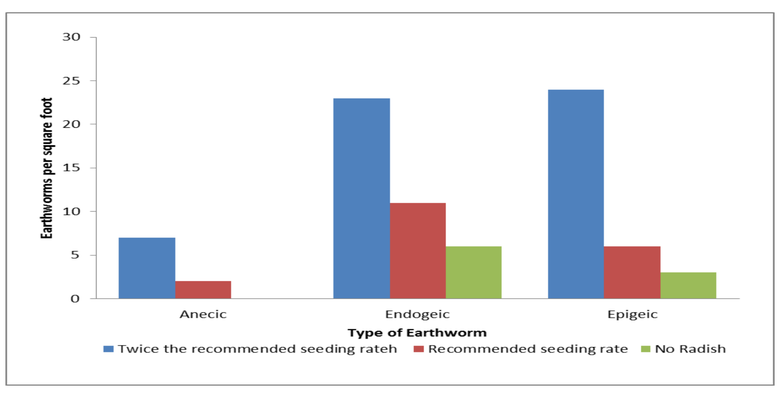


Figure 3: *Earthworm community changes in the radish treatment.*

	Key Line Plowing	Radishes
Moisture benefits	✓	✓
Earthworms	✓	✓
Improved Organic Matter	?	?
Lower penetration resistance	?	?
Improved Pasture Quality	?	?
Cost	$ $	$
Risks	Bumpy soil surface	Overseeding

Table 1: *Status of expected benefits.*

Figure 1: *Recommended seeding rate (left), twice the recommended seeding rate (middle), the area seeded at twice the rate, the spring after (right). Planting too many radishes may outcompete perennial forages.*

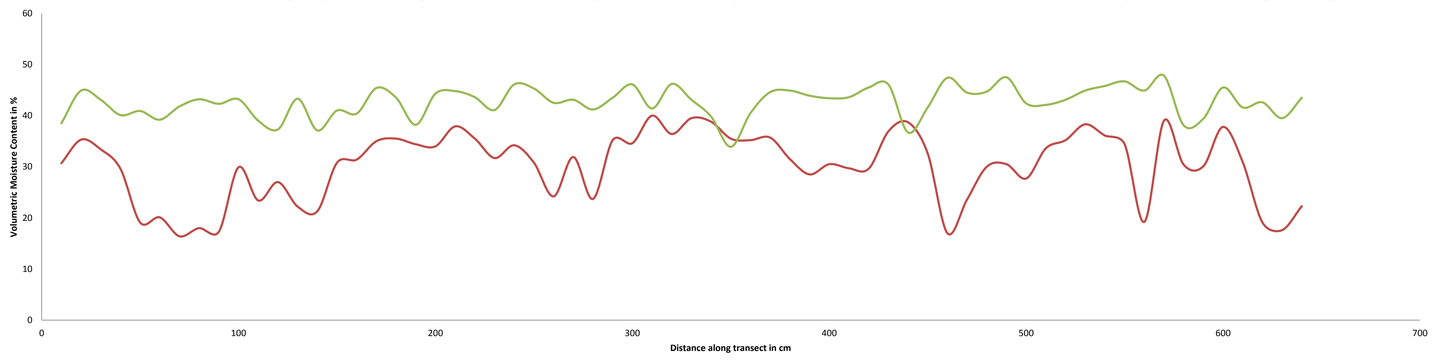
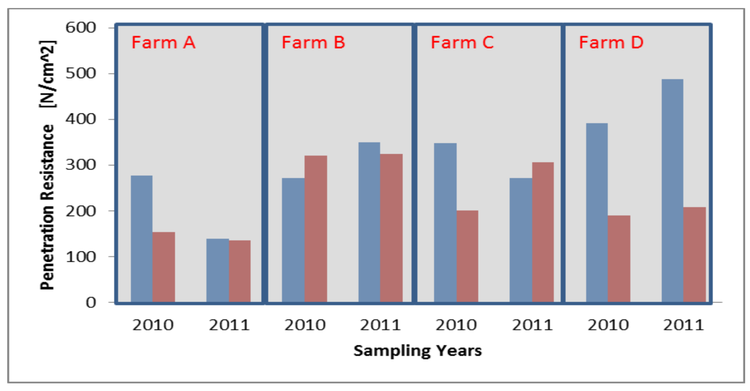


Figure 2: *Moisture variation along transects across a keyline treatment (red) and across the corresponding control pasture (green).*



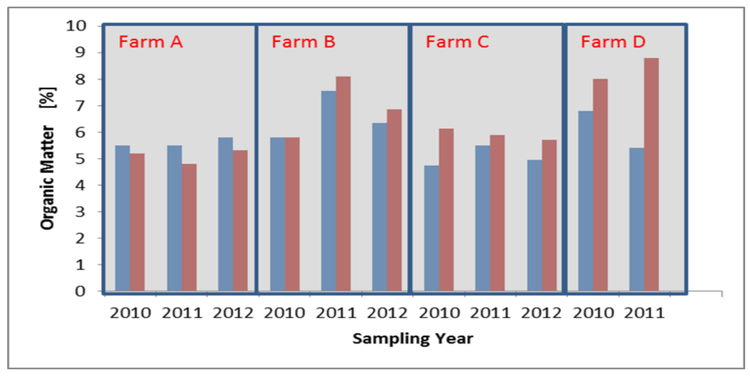


Figure 4: *Penetration resistance and organic matter content for keyline treatment. Blue are data from Control Areas, Red from Keyline Areas. Note: At Farm D's site, management intensive grazing was not regularly practiced during the project. There were no differences observed between treatment and control areas.*

New Questions for the Team

- How would the two practices improve pastures on clay and clay loam soils where compaction and water relations are more prevalent?
- Could these practices improve the resilience of a pasture that is in flood or drought prone lands?
- Could the effects of these practices be more visible when "snapshots" were taken more often during the year and in more locations of the pasture? Or, could increases in carbon be seen when long term sampling is done over 5 to 10 years?
- How does grazing management interact with tillage radish and keyline tillage in the soil-building aspects of keyline plowing?
- Should we set up replicated studies in areas where tillage radish has been used in the previous season to better understand the implications on specific forage species?
- Can cocktails of tap-rooted plants provide greater forage diversity and more pasture functions? What is a good seeding rate for radishes?

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