# Managed Grazing Provides Positive Effects on Soil Quality and Structure

*Janet Hedtcke and Rhonda Gildersleeve, University of Wisconsin*

A long-term cropping systems study in southern Wisconsin shows managed grazing can have positive impacts on soil quality and structure. Since 1989, the Wisconsin Integrated Cropping Systems Trial (WICST), located at the UW-Arlington Research Station, has provided field scale comparisons of three cash grain cropping systems and three forage-based systems. University of Wisconsin researchers Josh Posner and Janet Hedtcke of the Agronomy Department and their collaborators analyzed six systems:

| | |
|---|---|
| Cropping System 1 (CS1) | All years – corn |
| Cropping System 2 (CS2) | Year 1 – strip till corn;<br>Year 2 – no till soybeans |
| Cropping System 3 (CS3) | Organic: Year 1 – corn;<br>Year 2 – soybeans;<br>Year 3 – winter wheat/red clover |
| Cropping System 4 (CS4) | Year 1 – corn;<br>Years 2, 3, 4 – alfalfa |
| Cropping System 5 (CS5) | Organic: Year 1 – corn; Year 2 – oats/alfalfa;<br>Years 3, 4 – alfalfa |
| Cropping System 6 (CS6) | All years – managed grazing dairy heifers |

Of the forage systems studied, CS6 was managed as improved pastures that were rotationally grazed with yearling dairy heifers (starting weight of ~500 lbs) from May-October each year. Prior to turnout on research pastures, heifers were acclimated to pasture conditions for a few weeks. Research pastures were seeded in 1992 with red clover, smooth bromegrass, timothy, and orchardgrass. Red clover was overseeded biennially and pastures received 40 lbs N per year as commercial fertilizer applied in June or August according to forage availability.

To compare soil quality under all six cropping systems, a suite of modeled and measured soil properties was utilized that found some interesting differences between the six systems with managed grazing being superior in variables measured. In addition to estimating soil erosion losses, the Revised Universal Soil Loss Equation (RUSLE2) generates a Soil Conditioning Index (SCI) which reflects changes in soil structure and organic matter. RUSLE2 also generates a Soil Tillage Intensity Rating (STIR), an indication of frequency and intensity of machinery passes that may impact organic matter, soil structure, compaction, and erosion potential. RUSLE2 estimated minimal erosion losses (0.2 tons/ac) for managed grazing, with the establishment phase as the primary concern point. The SCI and STIR ratings were both excellent under managed grazing at 1.46 and 15, respectively (Table 1).

Soil parameters measured for each type of cropping/forage system included earthworm counts, percent of water-stable aggregates, and soil organic carbon (SOC) levels. Earthworm counts (conducted from 1999-2001) were significantly higher in the three forage rotations than in the cash grain systems (Table 1). Earthworm numbers for the managed grazing system was not significantly different than for the other two forage systems, both of which incorporated manure and had a two or three year forage phase. Earthworm counts for soils under no-till systems were intermediate to those of forage systems and tilled annual systems, which had the lowest numbers of earthworms counted.

In 2008, the percentage of water stable aggregates (WSA) was measured on each system to estimate resiliency of soils to withstand the destructive forces of tillage and water or wind erosion. The managed grazing system had a significantly higher percentage WSA than the other systems.

Increased soil organic carbon (SOC) levels can improve soil structure, reduce erosion, and increase soil fertility. Arlington Research Station soils developed under tallgrass prairie and oak savannahs, which allocated carbon to below-ground fine root mass deep into the soil profile. In 1989 and 2009, SOC levels over a 3' soil profile were

Table 1. Soil variables compared for six long-term cropping systems at UW-Arlington Research Station.

| Crop Rotation | Modeled (4% slope, 150' length) | | | Measured (linear contrast, p<0.05) | | |
|---|---|---|---|---|---|---|
| | Soil Erosion *(tons/ac)* | SCI[1] *( -2 to +2)* | STIR[2] *(<30 is ideal)* | Earthworms, System Mean *(#/ yard²)* *(1999 – 2001)* | % of Water Stable Aggregates *(2008)* | Change in Soil Organic Carbon (1989- 2009) Over 3' Soil Profile *(ton C/ac)* |
| **CS1** | 1.5 | 0.27 | 165 | 23[c] | 77.8[c] | -17.8[a] |
| **CS2** | 1.1 | 0.63 | 22 | 103[b] | 74.2[c] | -6.2[b] |
| **CS3** | 3.6 | -0.36 | 185 | 54[c] | 66.5[c] | -5.8[b] |
| **CS4** | 2.0 | 0.44 | 71 | 125[a] | 80.9[b] | -3.1[b] |
| **CS5** | 2.7 | 0.17 | 120 | 129[a] | 79.8[b] | -5.6[b] |
| **CS6** | **0.2** | **1.46** | **15** | **157[a]** | **88.9[a]** | **-0.3[b]** |

*[a]Values with different letters within each column were statistically different from each other.*

*[1]SCI = Soil Conditioning Index, measure of soil structure and organic matter changes, with positive values reflecting a gain in soil C and OM and negative values implying a loss.*

*[2]STIR = Soil Tillage Intensity Rating, an indication of frequency and intensity of machinery passes that may oxidize soil organic matter, destroy soil structure, and increase compaction and potential for erosion. STIR can range from 0 – 200 with values < 30 considered ideal.*

measured in all of the WICST systems. Results showed only those soils under the managed grazing system came close to no net loss (Table 1). Use of no-till practices and forages in the rotation reduced SOC losses, but did not sequester carbon over the entire soil profile. The greatest SOC loss occurred in the continuous corn system.

This study demonstrates managed grazing systems can have a positive overall effect on soils in comparison to other typical Upper Midwest cropping systems by reducing impacts of tillage, increasing plant diversity impacts and soil carbon inputs, and re-integrating livestock and manure into land management.

Additional project information and outcomes of the WICST trials are available at http://WICST.wisc.edu. Data was summarized from the following publications:

*Jokela, W, J.L. Posner, J.L. Hedtcke, T. Balser, and H. Reed. 2011. Midwest cropping systems effects on soil properties and on a soil quality index. Agronomy Journal, 103:1552-1562.*

*Sanford, G.R., J.L. Posner, R.D. Jackson, C.J. Kucharik, J.L. Hedtcke, and T. Lin. 2012. Soil carbon lost from Mollisols of the North Central U.S.A. with 20 years of agricultural best management practices. Agriculture, Ecosystems, and Environment, 162:68-76.*

*Simonsen, J., J.L. Posner, M.E. Rosemeyer, and J.O. Baldock. 2010. Endogeic and anecic earthworm abundance in six Midwestern cropping systems. Applied Soil Ecology, 44:147-155.*