Soil health management systems on-farms support improvements in indicators of soil properties in Nebraska*

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There is a need to ensure that the currently used soil health assessments are capable of detecting changes in soil properties amongst various soil health management systems. The current report summarizes preliminary findings on different soil health assessments and the impacts of various management systems on soil properties in Nebraska.

- The Haney Soil Health Test (HSHT) and the Nebraska NRCS Soil Health Assessment Protocol were conducted in 2017, the first year of the five-year experiments established at eight on-farm fields as part of the Nebraska USDA-NRCS Soil Health Initiative.
- Fields were classified into two categories of management systems (conventional and soil health) based on the number of management practices utilized, which are related to the key principles associated with soil health (e.g. crop rotation, conservation tillage, cover crop, crop-livestock integration, nutrient source).

Table 1. Matrix used to assign fields to conventional or soil health management systems. The composite rank scores are based on the number of management practices used on a particular field. Farmers whose composite scores were higher or equal to 4 were considered practicing soil health management systems, whereas those with rank scores lower than 4 were considered in the conventional practice category.

County	Fallow no:1, yes:0	Cover crop yes:1, no:0	Cover crop multispecies yes:1, no:0	3+ cash crop rotation yes:1, no:0	Grazing yes:1, no:0	Manure yes:1, no:0	Tillage no:1, yes:0	Composite rank
Greeley	0	0	0	0	0	0	1	1
Greeley	1	1	1	0	0	0	1	4
Howard	0	0	0	0	0	0	0	0
Howard	1	1	1	0	0	0	1	4
Howard	0	0	0	0	0	0	1	1
Merrick	0	0	0	0	0	0	0	0
Merrick	1	1	0	0	0	0	0	2
Colfax	0	0	0	1	1	1	1	4
Colfax	1	1	1	1	1	1	1	7
Otoe	1	1	0	1	0	1	1	5
Otoe	1	1	1	1	0	1	1	6
Nemaha	1	1	1	1	1	1	1	7
Nemaha	1	1	1	1	1	1	1	7
Knox	1	1	1	1	1	0	1	6
Knox	1	1	1	1	0	0	1	5
Stanton	1	1	0	1	0	0	1	4
Stanton	1	1	1	1	0	0	1	5

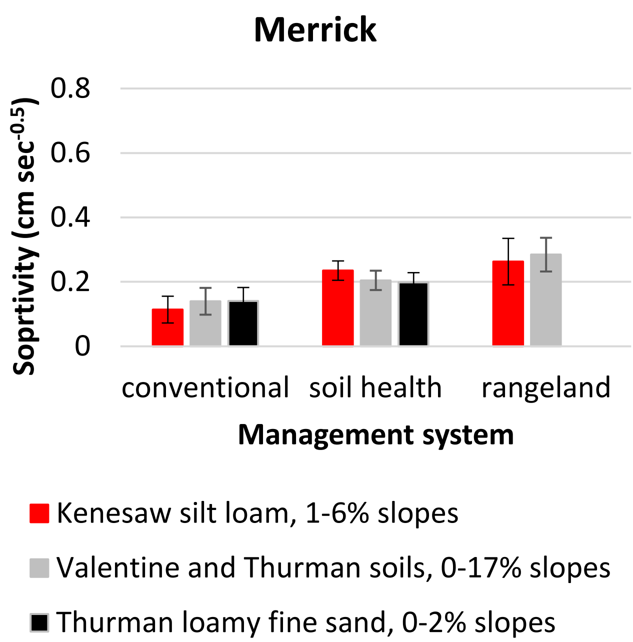
Table 2. Soil health assessments on conventional and soil health management systems.

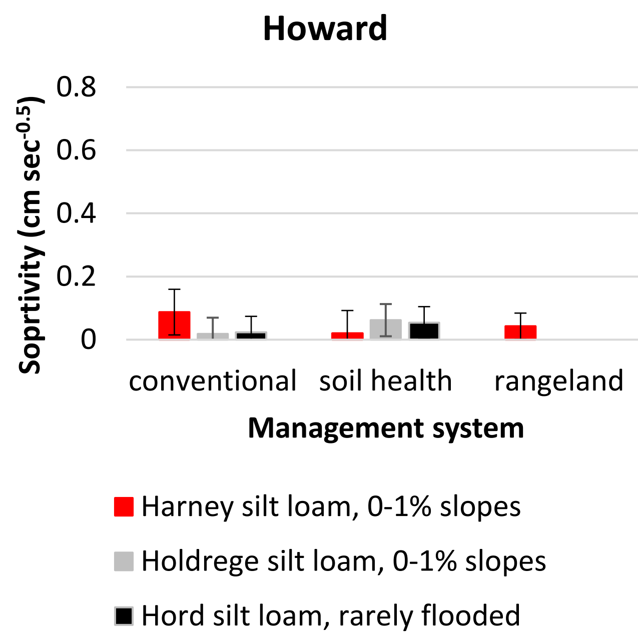
Haney Soil Health Test	Conventional	Soil health	F value; p-value	% difference
Organic matter, % LOI	1.43	2.78	F(1,60)=48.16; p=<0.0001	+49
Soil respiration CO_2-C, ppm	54.77	81.77	F(1,60)=6.05; p=0.0168	+33
Total organic C, ppm C	122.12	146.66	F(1,48)=5.78; p=0.0202	+17
Organic N, ppm N	9.85	12.67	F(1,48)=7.07; p=0.0106	+22
Total nitrogen, ppm N	15.71	19.56	F(1,48)=6.19; p=0.0164	+20
Ammonium, ppm NH_4-N	0.86	1.25	F(1,48)=5.36; p=0.025	+31
Inorganic N, ppm N	3.09	6.15	F(1,36)=13.29; p=0.0008	+50
Calcium, ppm Ca	339.13	413.75	F(1,60)=3.45; p=0.0681	+18
Sodium, ppm Na	21.83	13.32	F(1,56)=14.57; p=0.0003	-64
Cooper, ppm Cu	0.31	0.23	F(1,32)=9.49; p=0.0042	-35
Iron, ppm Fe	127.28	83.59	F(1,60)=4.99; p=0.0293	-52
Potassium, ppm K	119.67	101.75	F(1,60)=3.15; p=0.0810	-18
Total P, ppm P	22.00	36.43	F(1,36)=6.13; p=0.0181	+40
Inorganic P, ppm P	16.90	29.20	F(1,36)=5.63; p=0.0231	+42
Organic P, ppm P	5.12	7.34	F(1,36)=7.86; p=0.0081	+30
Aluminum, ppm Al	251.92	175.07	F(1,60)=4.78; p=0.0328	-44
Soluble salts, mmho/cm	0.13	0.16	F(1,48)=3.48; p=0.0683	+21
Organic C : organic N	13.66	12.97	F(1,60)=1.08; p=0.3021	-5
Organic N : Inorganic N	4.14	2.86	F(1,32)=4.95; p=0.0332	-45
Organic N release, ppm N	7.66	14.13	F(1,36)=18.44; p=0.0001	+46
Organic N reserve, ppm N	3.29	0.67	F(1,36)=8.14; p=0.0071	-391
Organic P reserve, ppm P	2.04	0.75	F(1,36)=6.31; p=0.0167	-172
Microbially active carbon, %	26.55	37.41	F(1,32)=1.79; p=0.1907	+29
Soil Health Score	8.63	10.73	F(1,60)=4.26; p=0.0433	+30
NRCS Soil Health Assessment				
Bulk density (g cm^{-3})	1.23	1.13	F(1,44)=3.47; p=<0.0690	-8
Soil porosity	0.54	0.57	F(1,44)=3.47; p=<0.0690	+6
Water holding capacity	6.45	6.88	F(1,44)=3.16; p=<0.0690	+6

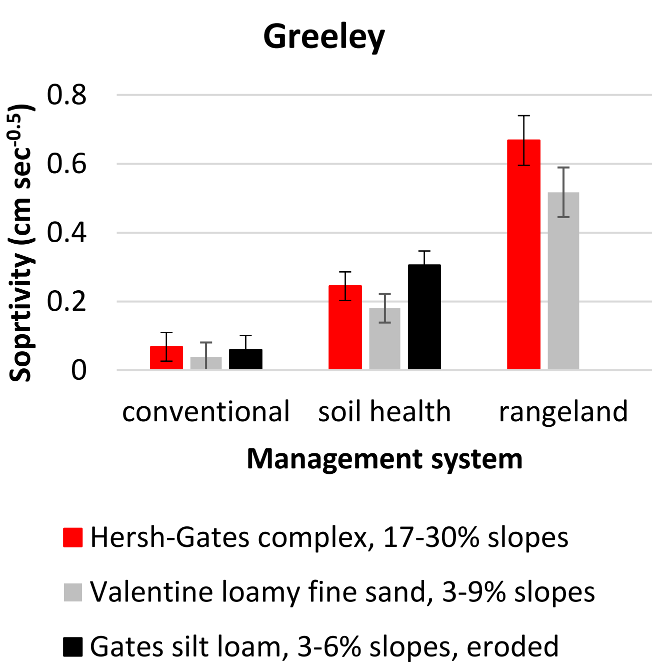
- Most of the chemical and biological soil indicators integrated into the HSHT were statistically different between conventional and soil health management systems (Table 2).
- The HSHT results and the NRCS Soil Health Assessment found higher scores or values in the soil health management systems compared to the conventional system.
- These results provide a basis for a common framework for soil health assessment in systems-level shifts to more regenerative farm systems.

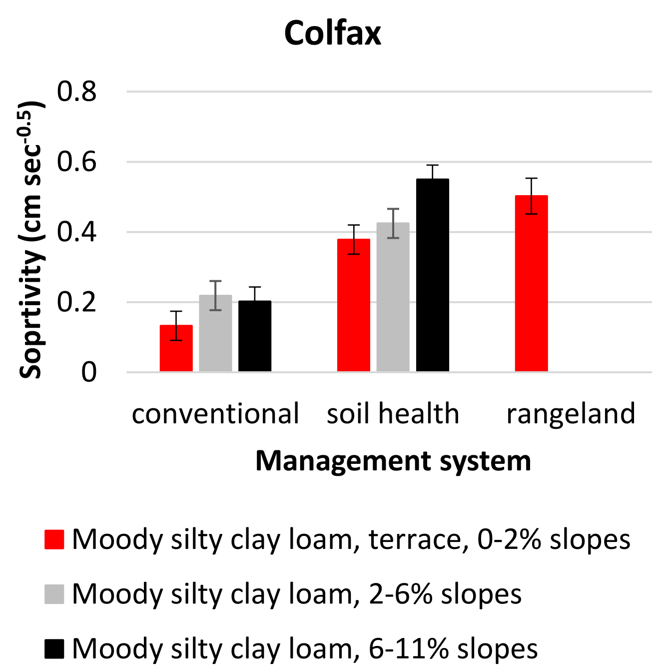
Understanding water dynamics under changes in land use and soil type

- Sorptivity measurements (initial water infiltration) were conducted in 2019 at 4 on-farm fields as part of the Nebraska USDA-NRCS Soil Health Initiative.
- These fields have varying histories of tillage practices: Merrick (strip-till), Howard (2 years of no-till), Greeley (10 years of no-till), and Colfax (20 years of no-till).









- Long term benefits of cover cropping and soil health management systems are more evident under reduced soil disturbance (soil that has not been tilled for many years).
- Averaged across different soil type and sites, cover cropping increased initial soil water infiltration by 59% compared to conventional farming systems (no cover cropping).

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