SOIL HEALTH INSTITUTE
Enriching Soil, Enhancing Life

Benchmarking Soil Health

Southern Mississippi River Alluvium, Arkansas

Long-term adoption of soil health management systems can reduce production costs, build resilience to extreme weather, and increase yield. What's been missing, however, is an understanding of how healthy local soils can be and which management practices are helping growers in the region improve their soil health.

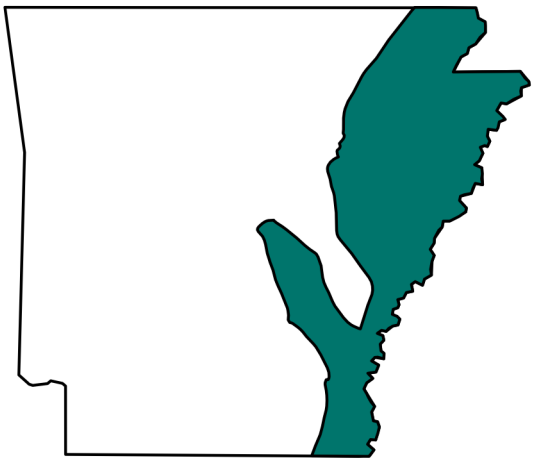
To address this gap, the Soil Health Institute compares minimally disturbed **REFERENCE** sites where soil health is optimal to two types of crop production systems in the same region: typical **BASELINE** management and regenerative **SOIL HEALTH PRACTICES**.

In 2021 and 2022, SHI sampled soils at 110 Arkansas fields in the Southern Mississippi River Alluvium, Major Land Resource Areas 131A and 131B, representing 480,000 acres of cropland.

The results show that growers in the Southern Mississippi River Alluvium improved their soil health by adopting management practices to reduce soil disturbance and maximize living roots.

BASELINE	SOIL HEALTH PRACTICES	REFERENCE
Irrigated corn-cotton and corn-soy rotations on annually prepared beds	Irrigated corn-cotton and corn-soy rotations on multi-year beds with annual or biennial cover crops for at least 3 years	Hardwood forests, unirrigated pecan orchards, ungrazed grass
		
29 FIELDS	**50 FIELDS**	**31 FIELDS**

About the region



- **69% of the region is used for crop production, primarily cotton, corn, soy, and rice.**
- **Conventional tillage (e.g., chisel, disk, and field cultivator) is used on 40%, reduced tillage on 42%, no-till on 18%, and cover crops on 6% of cropland in this region.**
- **Mean annual temperature for the region ranges from 59 to 65°F, and mean annual precipitation ranges from 50 to 61 inches.**
- **Crop production is on a wide variety of soils, from well drained sands to poorly drained clays.**
- **Crop production challenges include:**
  - Seasonal in-field flooding resulting in yield loss or crop failure
  - A history of intensive farming that has eroded topsoil
  - Declining groundwater levels, resulting in less water available for irrigation

What we measured

At each location, we measured these essential indicators of soil health:

- **Organic carbon concentration** (0 to 6 inch depth) promotes soil structure, microbial activity, plant-available water, and plant-available nutrients.
- **Aggregate stability** (0 to 3 inch depth) measures soil structure and resistance to disturbance. Soils with greater aggregate stability are more resistant to erosion and have improved aeration, water infiltration, and water storage.
- **Carbon mineralization potential** (0 to 6 inch depth) is the amount of CO_2 produced by soil microbes after rewetting the soil. Increases in carbon mineralization potential indicate a greater biological capacity to cycle nutrients and plant residues.

To give growers an estimate of their soils' current and potential carbon storage, we calculated **organic carbon stock** (0 to 12 inch depth) — the amount of organic carbon stored in the soil — using both soil organic carbon concentration and bulk density measurements. We also calculated **available water holding capacity**, predicted from soil texture and soil organic carbon, to show the amount of water the soil can store in the top 6 inches and provide to plants, improving resilience to drought and flooding.

What we found

In the fields sampled, **BASELINE** row crop practices included corn-cotton and corn-soy rotations on annually prepared beds. **SOIL HEALTH PRACTICES** primarily involved corn-cotton and corn-soy rotations on multi-year beds with annual or biennial cover crops for at least 3 years. All row crop fields sampled were irrigated. **REFERENCE** fields included hardwood forest, pecan orchards, and ungrazed grasslands, the majority of which were unirrigated.

In addition to management, soil texture influenced the essential indicators. The table below shows average values for two representative soil textures in the Southern Mississippi River Alluvium.

	LOAMY SAND SOIL (5% CLAY)			SILT LOAM SOIL (20% CLAY)		
	BASELINE	SOIL HEALTH PRACTICES	REFERENCE	BASELINE	SOIL HEALTH PRACTICES	REFERENCE
Organic carbon concentration (%)	0.62	0.67	1.17	0.93	1.00	1.76
Aggregate stability (Index from 0 to 1)	0.57	0.65	0.76	0.42	0.50	0.63
Carbon mineralization potential (mg C/kg soil/day)	10	11	27	11	12	28
Organic carbon stock (metric tons C/acre)	8	9	13	12	13	18
Available water holding capacity (inches)	1.15	1.16	1.21	1.08	1.09	1.19

Values were calculated using hierarchical models to adjust for differences in soil texture, pH, mean annual temperature, and mean annual precipitation across sampled locations.

Comparing minimally disturbed **REFERENCE** samples to row crop fields with **BASELINE** practices shows just how much healthier soils in crop production systems in the region can be.

Compared to BASELINE, samples from REFERENCE fields had on average:

+90% organic carbon concentration

+158% carbon mineralization potential

+8% predicted available water holding capacity

+42% aggregate stability

+57% organic carbon stocks

What's working?

Compared to BASELINE, samples from fields with SOIL HEALTH PRACTICES had on average:

+8% organic carbon concentration *(not statistically significant)*

+7% carbon mineralization potential *(not statistically significant)*

+1% predicted available water holding capacity

+16% aggregate stability

+11% organic carbon stocks *(driven by significant change in organic carbon concentration at 15 to 30 cm)*

In addition, some growers in the region were able to achieve 50% or more of the soil health values seen in minimally disturbed **REFERENCE** fields.

Crop fields sampled achieving 50% or more of REFERENCE values:

52% **41 of 79 fields** organic carbon concentration

32% **25 of 79 fields** carbon mineralization potential

100% **79 of 79 fields** predicted available water holding capacity

84% **66 of 79 fields** aggregate stability

82% **65 of 79 fields** organic carbon stocks

These results indicate that **planting on multi-year beds and adding annual cover crops are improving soil health and resistance to flooding for corn, soy, and cotton farmers in the Southern Mississippi Alluvium of Arkansas**. However, with cover crops used on less than 10% of cropland, more farmers in the region could benefit from improving the health of their soils.

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