



RODALE
INSTITUTE™

STROUD™
WATER RESEARCH CENTER

Reducing Pollution from Agriculture
in the Delaware River Watershed

THE PROBLEM

Agricultural contribution to water quality impairment:

- Sediment
- Pesticides
- Fertilizers

Agriculture comprises the greatest land-use category in the DRW
– 26%

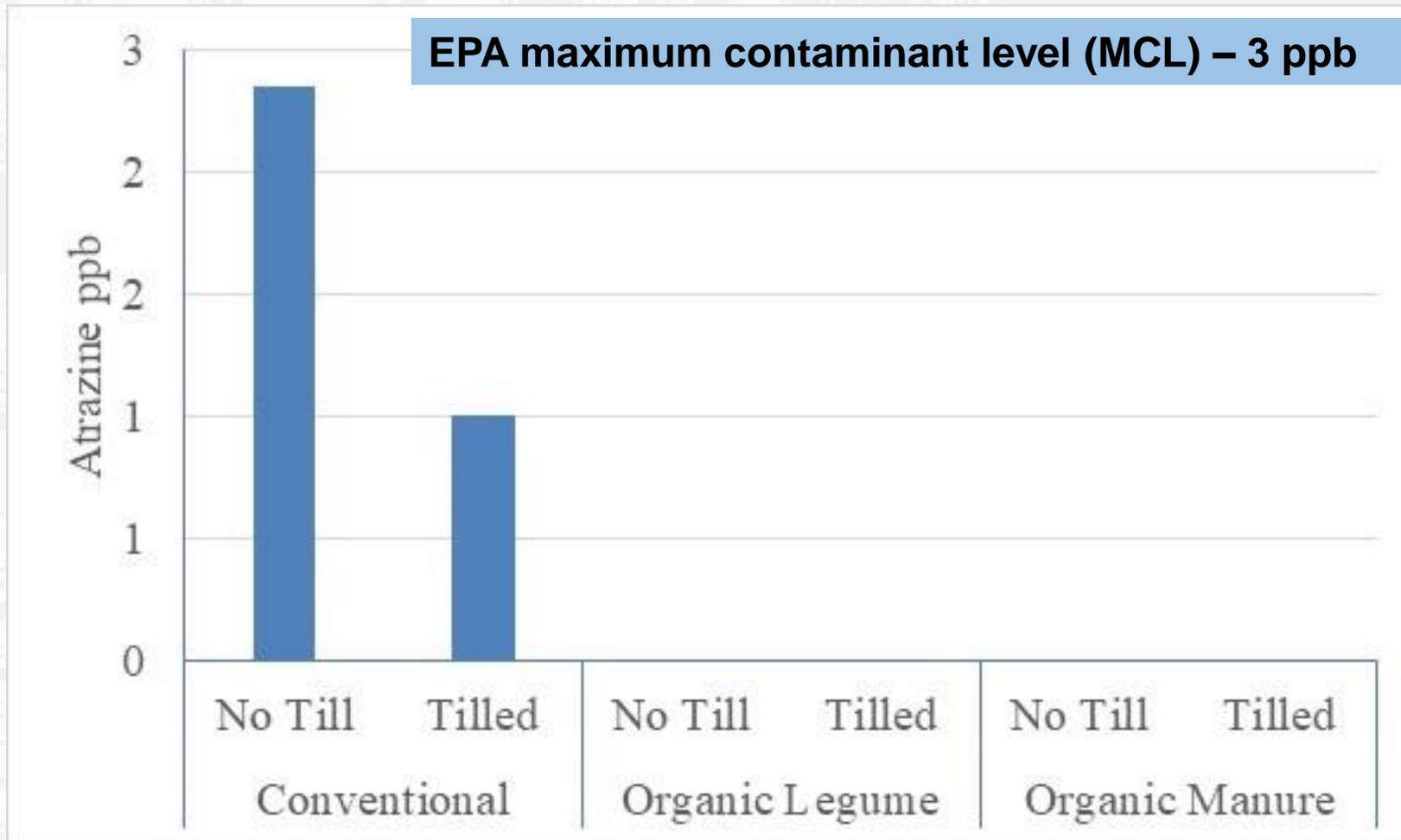
Maxatawny, Berks Co., February 15, 2018

Schaefer Run -> Little Lehigh Creek -> Lehigh River -> Delaware River



THE PROBLEM

FARMING SYSTEMS TRIAL, LYSIMETER DATA, 2017

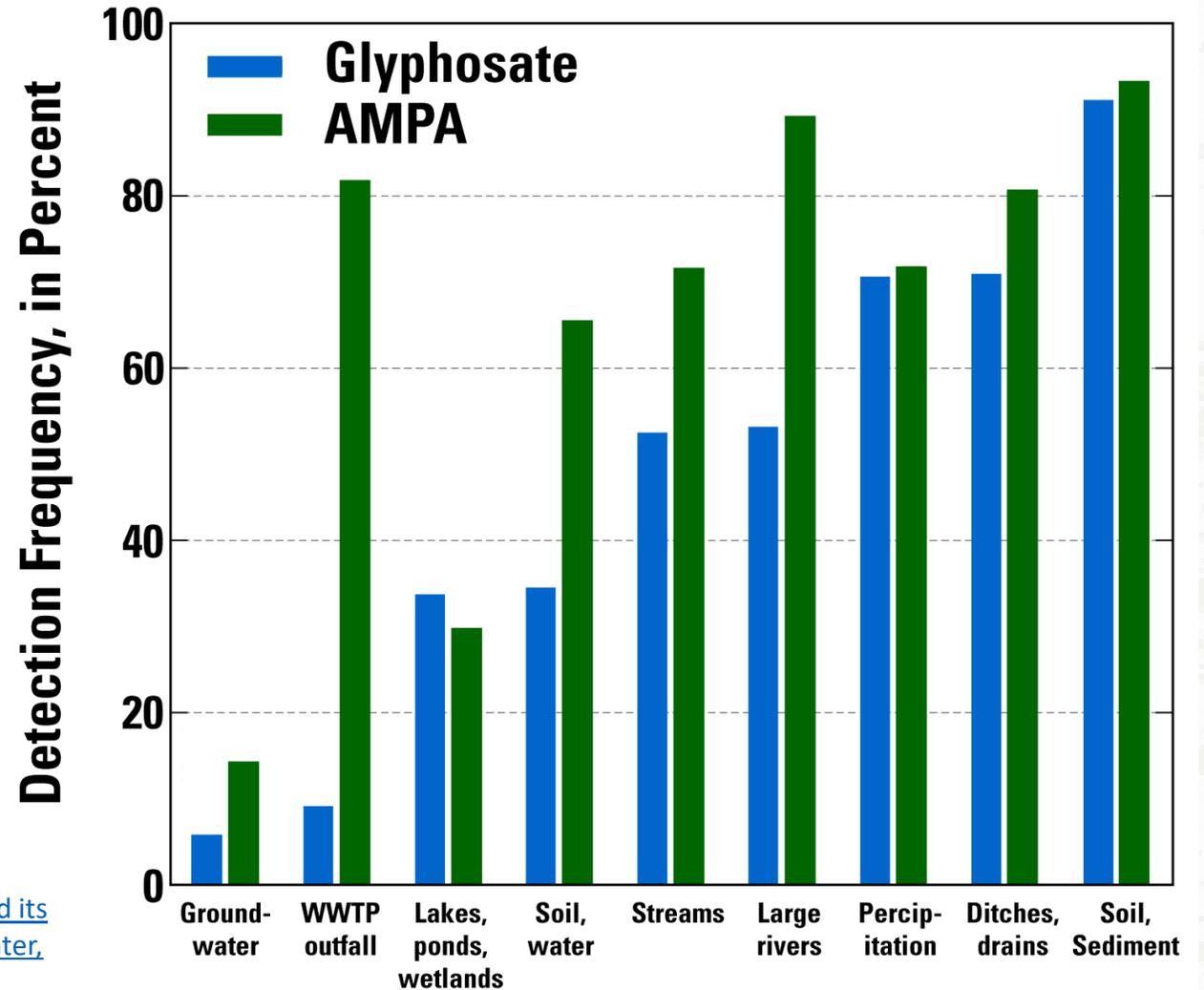


THE PROBLEM

Glyphosate and its derivative AMPA

- High frequency in most water samples
- Even falling out of the sky (precipitation)

From USGS Survey across the United States



Battaglin, W.A., Meyer, M.T., Kuivila, K.M., and Dietze, J.E., 2014, [Glyphosate and its degradation product AMPA occur frequently and widely in U.S. soils, surface water, groundwater, and precipitation](#): Journal of the American Water Resources Association, v. 50, no. 2, p. 275-290, doi:10.1111/jawr.12159

SOLUTIONS - RIPARIAN BUFFERS

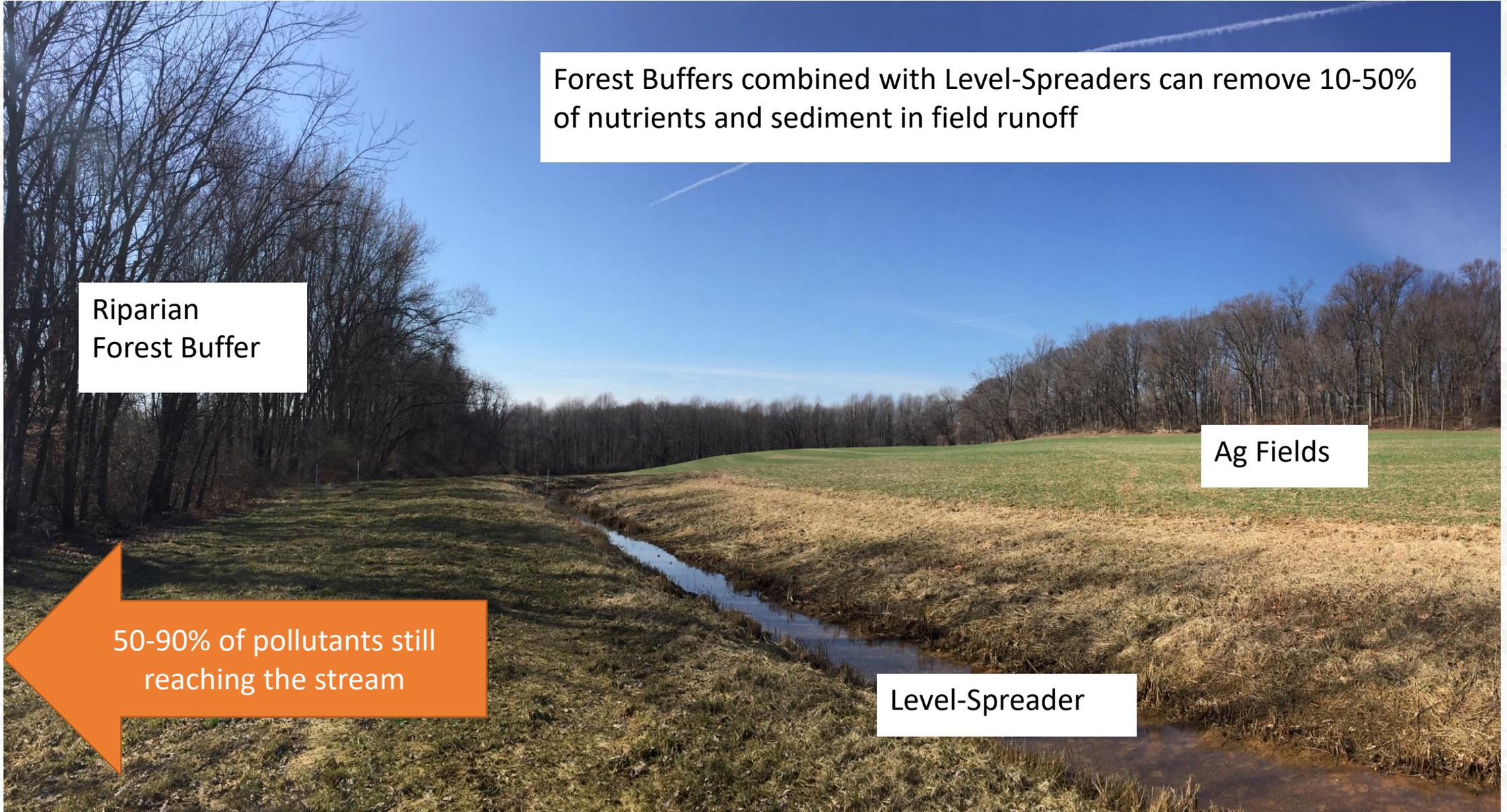
Forest Buffers combined with Level-Spreaders can remove 10-50% of nutrients and sediment in field runoff

Riparian
Forest Buffer

Ag Fields

50-90% of pollutants still
reaching the stream

Level-Spreader



SOLUTIONS — COVER CROPS



Multi-Species Mixtures:
Crimson clover, cereal rye,
hairy vetch, etc



SOLUTIONS — REGENERATIVE AGRICULTURE

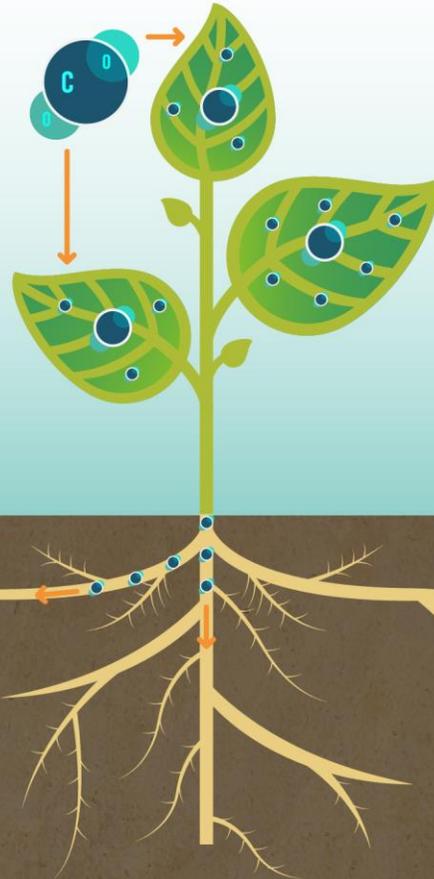
How Regenerative Organic Agriculture Removes Carbon from the Atmosphere and Stores It in the Soil

1 Photosynthesis

This is the process plants use to change carbon dioxide from the atmosphere into carbon-based sugars.

2 Nutrient Exchange

The carbon-based sugars created during photosynthesis then ooze out of the plant's roots, feeding bacteria and fungi living in the nearby soil. In turn, these microorganisms symbiotically transform organic matter and soil minerals into nutrients that feed the plant.



3 Capturing Carbon

During this exchange of nutrients, the root sugars and organic matter that is consumed by the bacteria and fungi is converted into more stable materials that help store carbon in the soil for decades, even centuries.

4 Restoring Balance

Increasing the number of microorganisms in the soil helps bring carbon levels back into balance, which leads to both healthier soil, healthier food, and a healthier planet.

Four Central Practices of Organic Farming



COVER CROPPING: Rather than leaving the soil bare between growing cash crops, cover crops ensure photosynthesis is an ongoing process, helping microorganisms thrive and actively store carbon all year round.



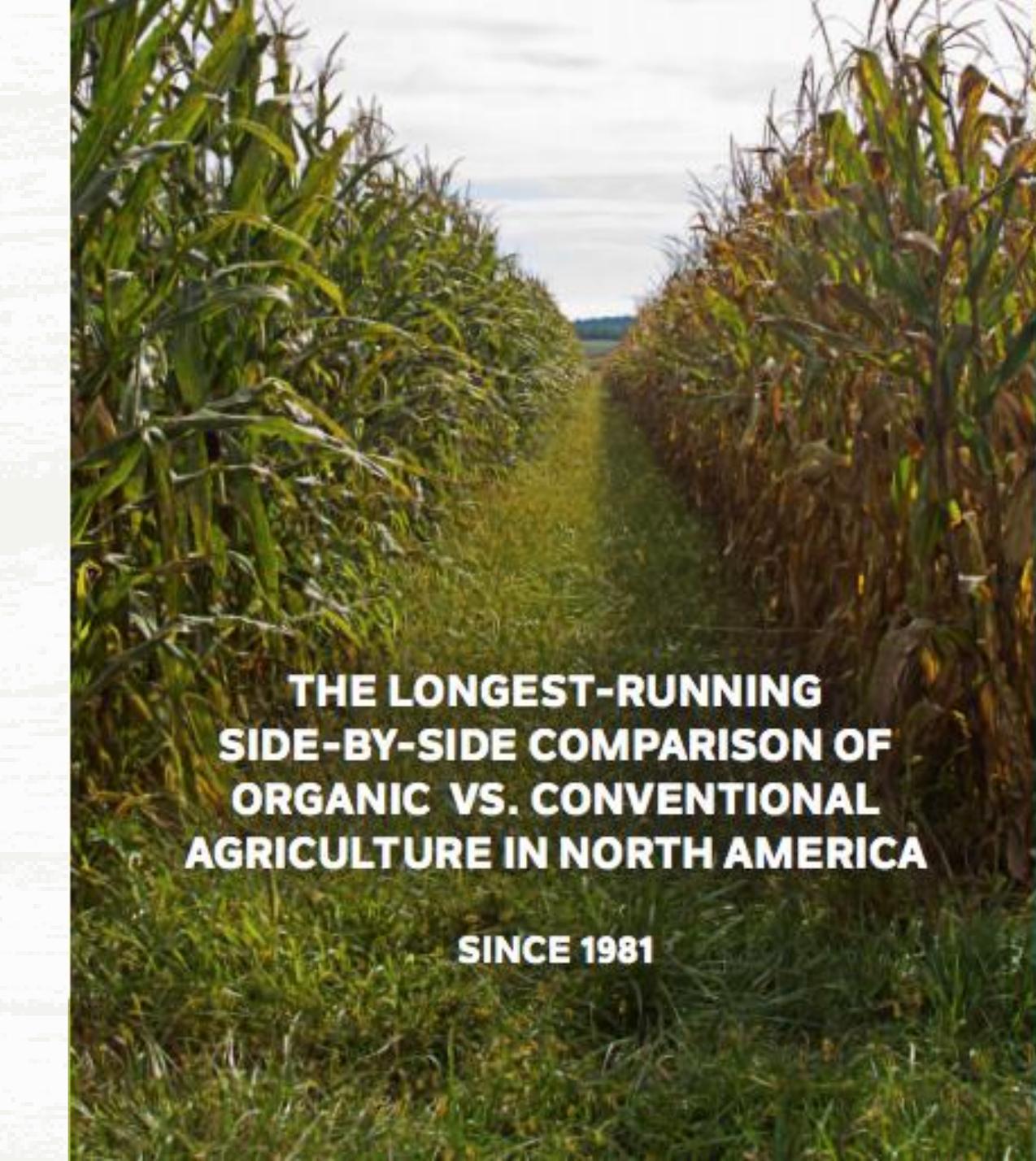
NATURAL FERTILIZER: Instead of nitrogen fertilizer, organic farmers use compost as fertilizer, which is typically just decomposed food waste, manure, and organic plant matter. Compost is a natural pesticide and since it is made from food waste, it also reduces waste sent to landfills.



ROTATING CROPS: Instead of conventional monocropping—or planting the same crop in the same soil year after year—organic farmers rotate crops strategically to cultivate plenty of microorganisms that enable carbon storage and increase soil health.



REDUCED TILLAGE: The practice of tilling, or breaking up the soil in preparation for planting crops, is common in conventional agriculture. However, during this process, microorganisms living in the soil are killed off. Soil health improves dramatically when an organic, no-till method is employed.



**THE LONGEST-RUNNING
SIDE-BY-SIDE COMPARISON OF
ORGANIC VS. CONVENTIONAL
AGRICULTURE IN NORTH AMERICA**

SINCE 1981



**FARMING SYSTEMS
TRIAL**

The Farming Systems Trial (FST)[®] at Rodale Institute is America's longest-running side-by-side comparison of organic and conventional agriculture. In 1981, Bob Rodale designed the FST to assist farmers transitioning from conventional to organic agriculture. Now, after nearly 40 years, scientific data from the FST has established that organic management practices match or outperform conventional systems. The FST continues to study the benefits of organic agriculture to soil, human and environmental health.

THE DIFFERENT SYSTEMS



ORGANIC MANURE

This system represents an organic dairy or beef operation. It features a long rotation including both annual feed grain crops and perennial forage crops. The system's fertility is provided by leguminous cover crops and periodic applications of composted manure.



ORGANIC LEGUME

Representing organic cash grain farming, this system features a mid-length rotation consisting of annual grain crops and cover crops. The system's sole source of fertility is leguminous cash and cover crops. Crop rotations provide the primary line of defense against pests.

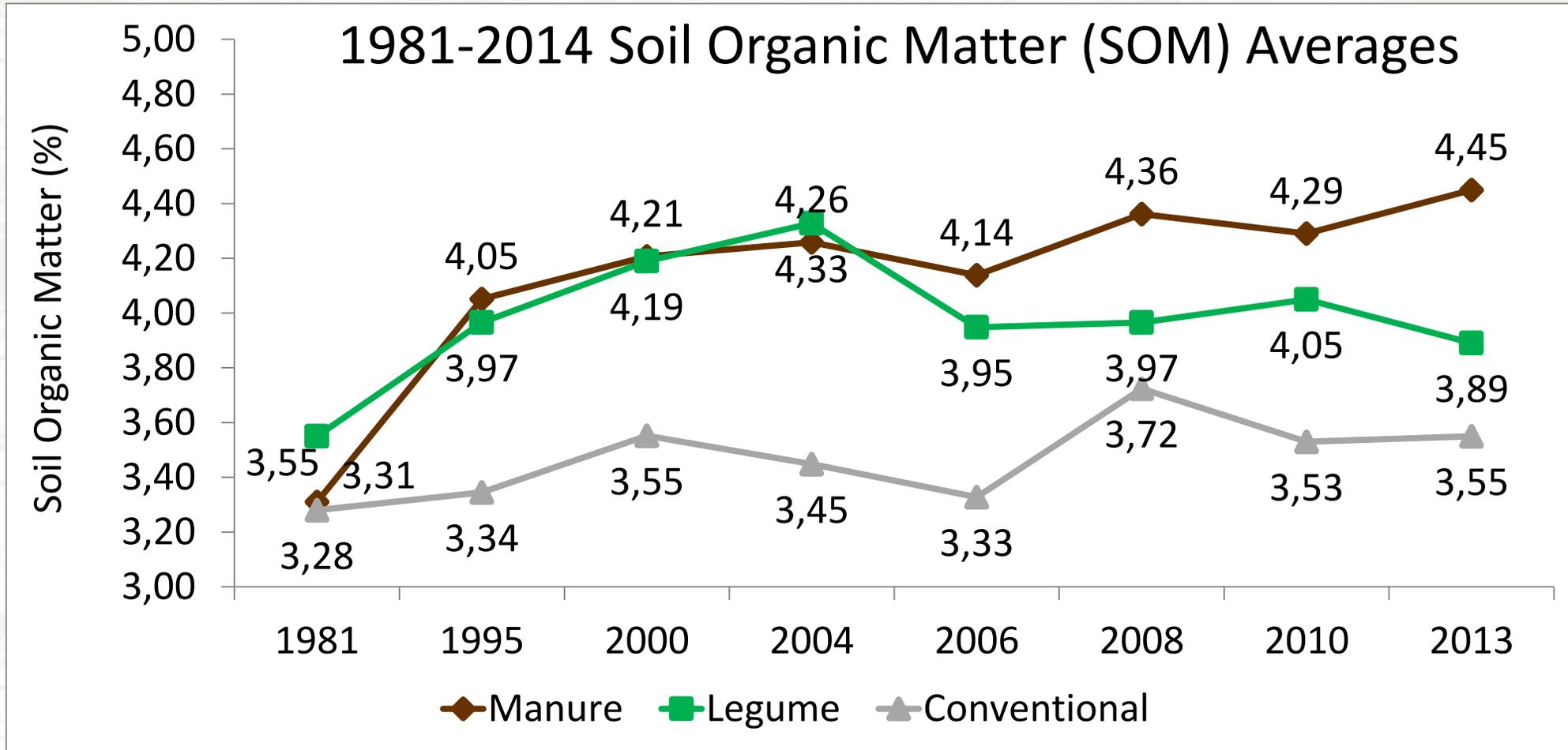


CONVENTIONAL SYNTHETIC

The conventional system represents the majority of grain farms in the U.S. It relies on synthetic nitrogen for fertility, and weeds are controlled by synthetic herbicides selected by and applied at rates recommended by Penn State University Cooperative Extension. In 2008, genetically modified (GM) corn and soybeans were added to this system.



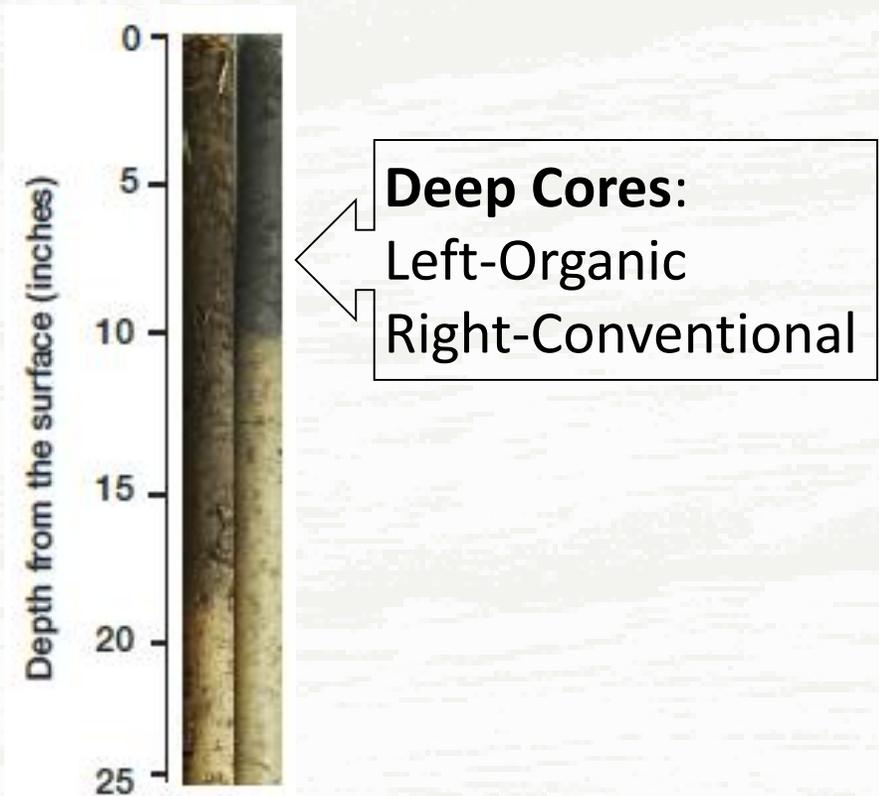
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SOM feeds soil biology -> biology builds SOM -> SOM holds water and nutrients

SOLUTIONS — REGENERATIVE AGRICULTURE

Soil biology builds soil structure,
Soil structure increases water infiltration



- Greater percentage of water stable aggregates in organic (left)
 - More microbes
 - More glomalin

SOLUTIONS — REGENERATIVE AGRICULTURE

Water Use Efficiency

Wheat fields at Rodale Institute's Farming Systems Trial



Conventional



Organic

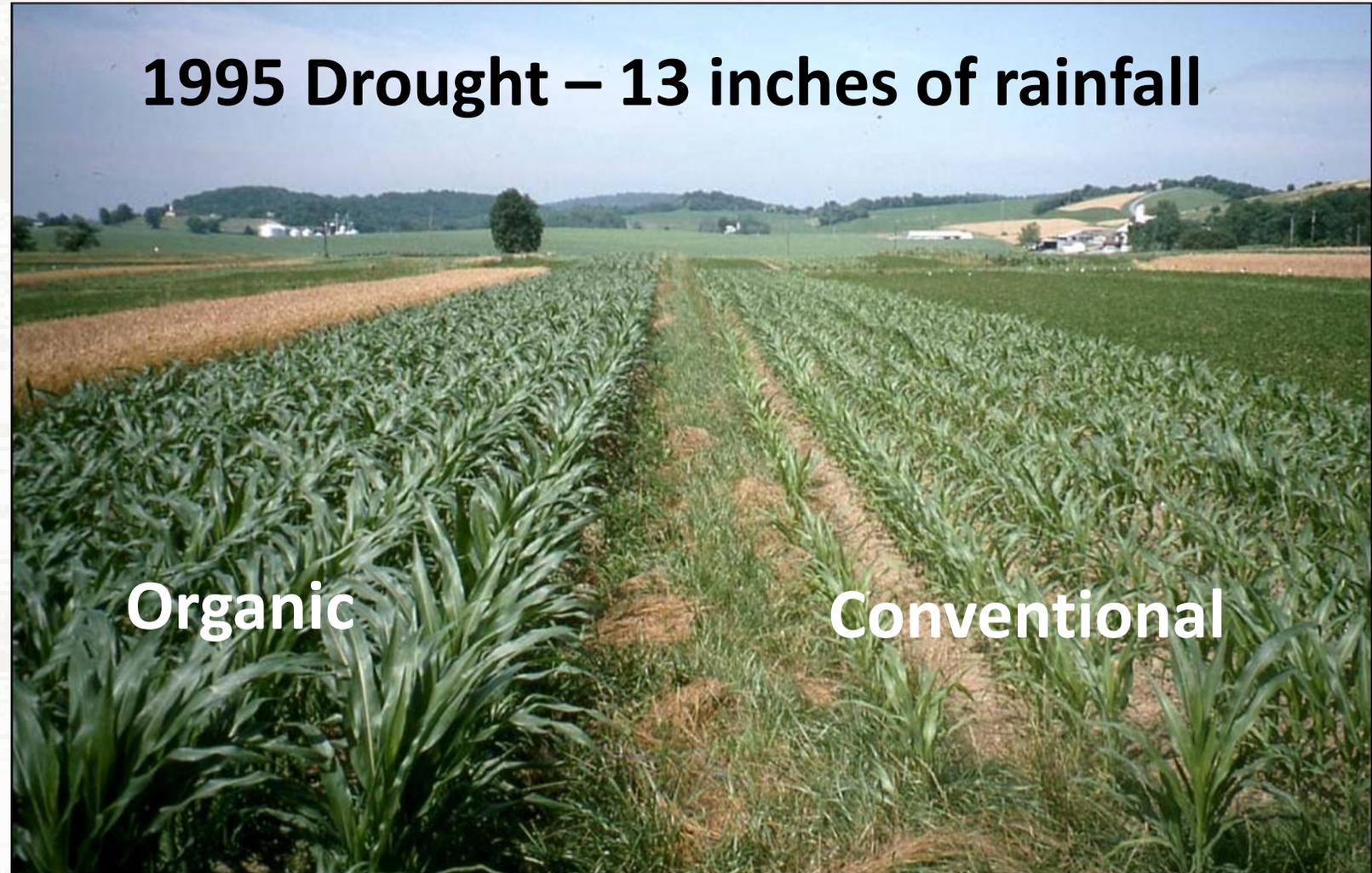
SOLUTIONS — REGENERATIVE AGRICULTURE

Agroecosystem Resilience

1988 and 1999 — 5 drought years

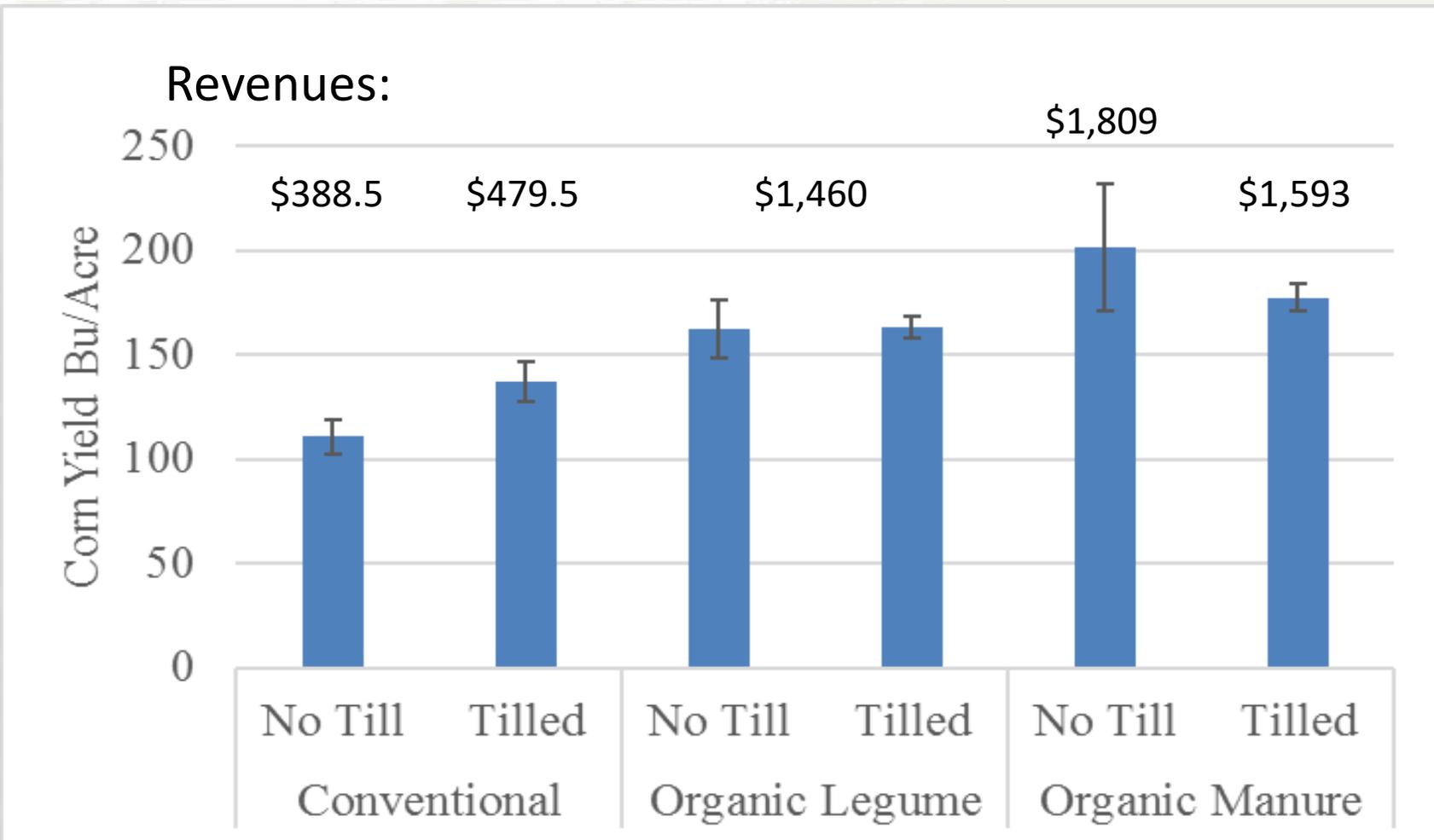
Corn Yields: 31% higher in organic

Soybean Yields: 100% higher in organic



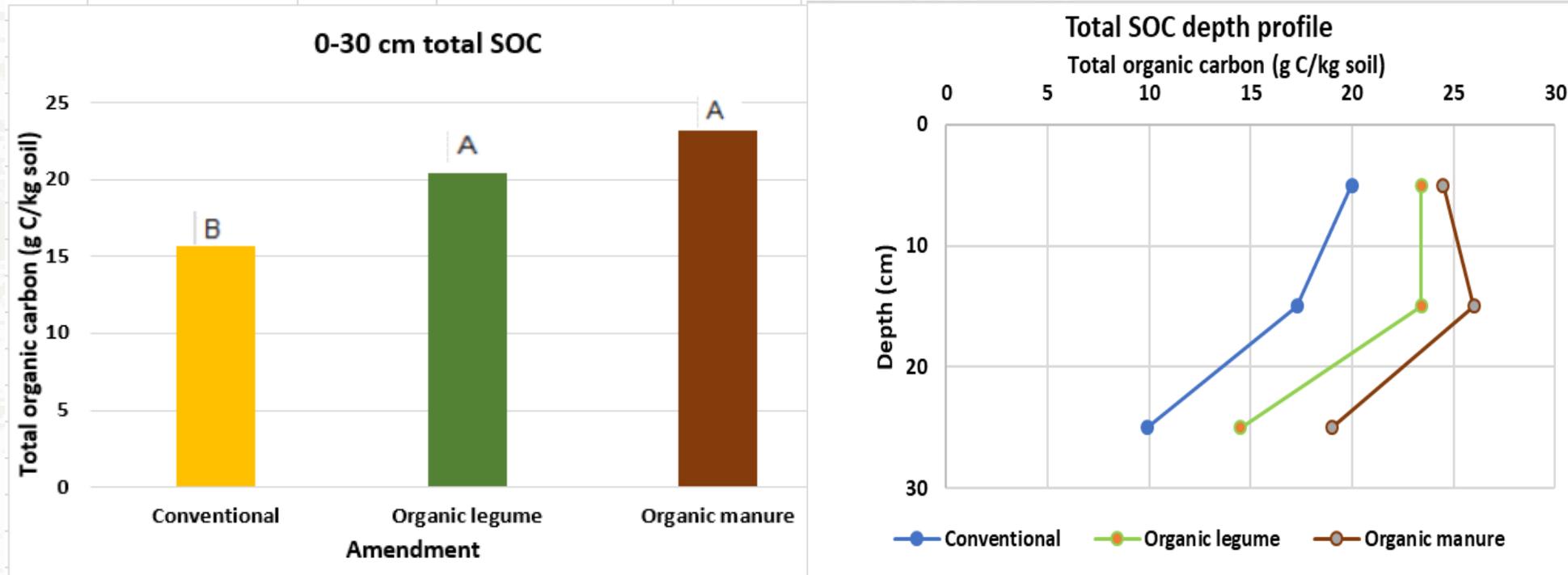
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2016 Corn Yields – Bushels per acre



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Farming Systems Trial Carbon Data



Littrell, Jagadamma, Omondi, Xu 2018

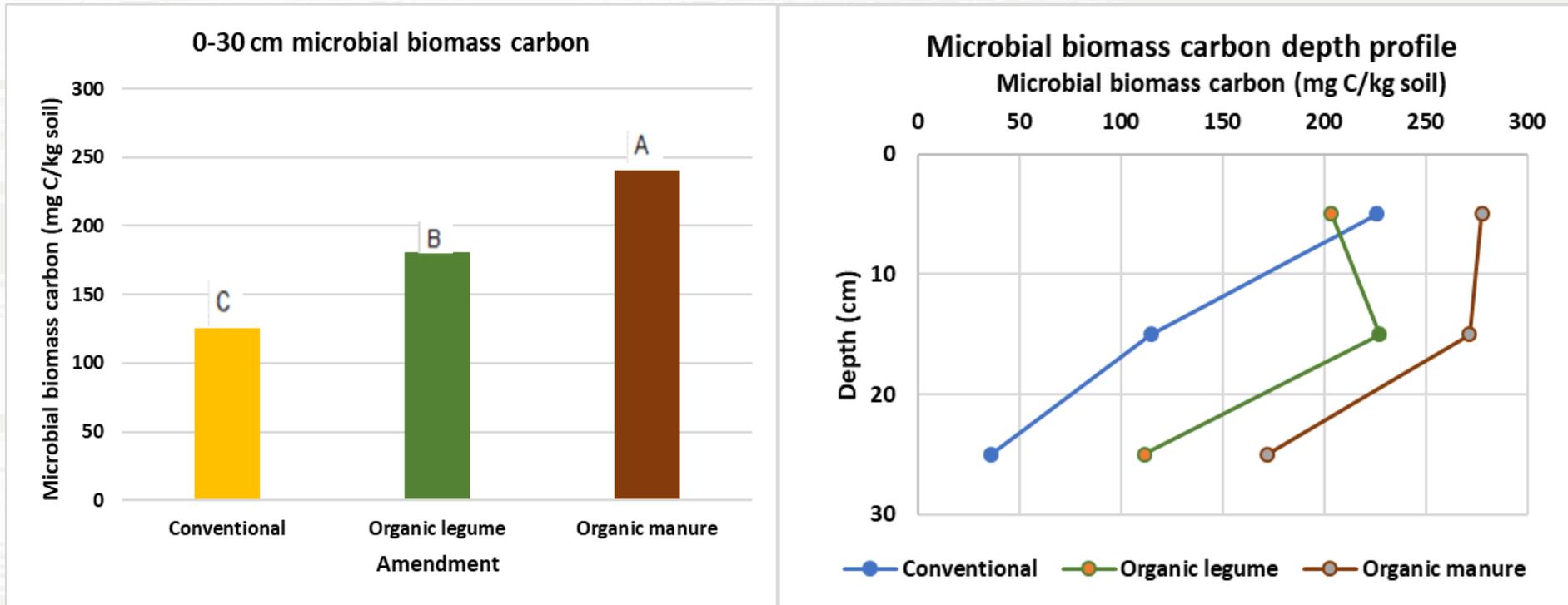
Several studies showing the same result – greater levels of carbon at surface and deeper depths in the organic systems



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Farming Systems Trial Carbon Data



Littrell, Jagadamma, Omondi, Xu 2018

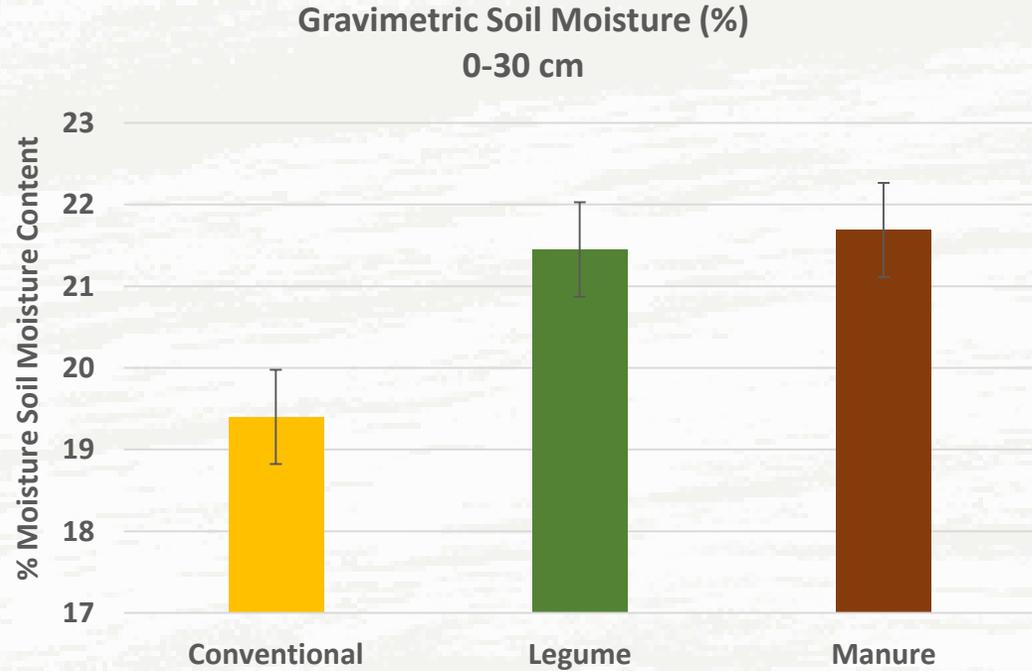
Carbon associated with soil microbes



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Farming Systems Trial Soil Moisture Data



Littrell, Jagadamma, Omondi, Xu 2018

Carbon holds more water, more water is available for plants



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Organic No-till

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