BY *Susan Winsor*

Diverse Rotation Builds Durable Soils

Increased soil carbon fuels higher crop returns with more nutrients retained and recycled.

NORTHEAST IOWA RC&D AND JESSICA RILLING

Loran Steinlage stands with his wife, Brenda, on his home-built cover-crop interseeder.

Loran Steinlage has a more permanent solution to heavy downpours than tile drain. He's improving his soil structure. By increasing soil carbon he's built resilient soil that drains well and stores water for droughts.

His financial returns are highest on the fields with the most diverse cover crops, cash crops and relay crops. By "relay," he means growing a second crop (soybeans, rye or wheat) in the same growing season.

This diversified soil allows microbes to retain and recycle nutrients, stores nutrients and prevents erosion through winter while adding income from cover-crop seed. By comparison, a conventional crop rotation has a "brown winter season" vulnerable to nutrient and soil loss, and the death of beneficial soil microbes.

THE POOR FARM

Town elders once called Steinlage's Fayette County, Iowa, farm "the poor farm," an unproductive parcel until Loran's father, Florian, bought it in 1968. Fifty years later, this self-described "po' dirt farmer" (his comic term for conservation tillage) now speaks internationally on how his family transformed poor glacial till soil into resilient, productive soil. His clever tillage adaptations are nationally recognized by soil-health experts. Steinlage also works as a practical field engineer for DAWN/UndergroundAg.

He no-tills 750 acres of corn, soybeans, wheat, rye, malt barley and buckwheat near West Union, Iowa. Steinlage farms 25 glacial-till soil types, ranging "from gravel to peat in the same pass."

Fast-forward through 26 years as a dairy, then continuous corn to the past 10 to 12 years of reduced/strip-till/no-till, interseeding and multispecies cover-crop mixes, and a relay crop of soybean, rye or wheat in the same field. His FLOLOfarms won the 2017 Iowa Environmental Award, and his name dominates soil-health forums and meetings. "I've never been conventional," Steinlage says.

YIELD STABILITY

Soil resilience is Steinlage's top priority. Why? Soil resilience brings yield stability despite precipitation extremes, says Jerry Hatfield, director, USDA National Laboratory for Agriculture and the Environment, based in Ames, Iowa. ➤

"We're gearing for feast-or-famine weather patterns," Steinlage says. "We're building our soils with cover crops, diverse crop mixes and no-till. We're erosion-proofing our soils. We had 21 inches of rain in one week the summer of 2017. The neighbors had runoff, but we did not.

"In 2012, we had a big rain the day after planting. I was worried about getting back in to spray the clovers (cover crop). That's why I now band herbicide with the planter—to give the cash crops an edge." The cost is about $6 per acre. He uses Acuron or combines acetochlor or metolachlor and atrazine. "If we don't disturb the soil, we don't have weed problems," Steinlage adds. He customized row cleaners that move residue but not soil.

After 10 years of these practices, a $15-per-acre cover-crop seed investment and diverse species in the same field, his corn yields are 15 bushels per acre ahead of any other fields he farms.

The result of these practices is more soil carbon, the fuel for crops and nutrient recycling. "Liquid carbon is the 'underground currency' that feeds soil microbes," Steinlage says. He explains carbon is what microbes exchange for more plant-available nutrients, which they recycle from residue. (See "The Underground Economy.")

The per-acre revenue for ground planted to cereal rye cover crops, cash soybeans and buckwheat cover crops is a minimum of $660, he says. "We can easily double that; I just don't like to promise the moon."

In 2018, he switched to non-GMO soybeans to capture an additional $60,000 in IP (identity preserved) premiums ($2 per bushel non-GMO premium) and $50,000 in lower seed costs.


SUSAN WINSOR
LORAN STEINLAGE

Steinlage tailors cover crops to the crop that will follow them. "You want all four plant families in a mix (warm-season broadleafs and grasses, and cool-season broadleafs and grasses)," Steinlage says. For continuous corn, he plants into live N-rich (nitrogen) legumes like clovers and vetch. On ground going to soybeans, he mixes annual ryegrass with brassicas.

On a test field, Steinlage interseeds a varying "jungle mix" of 17-species combinations of tillage radish, dwarf Essex rape, vetch, buckwheat, phacelia, flax, oats, several clovers and more, depending on the field and rotation. This test field has 15-bushel higher yields than his others on some of the poorest county soils.

GIFTED WITH A WRENCH

Known far and wide for his mechanical creativity, Steinlage has built and modified at least eight cover-crop interseeders in the past 10 years.

When he could afford to build from the ground up, he mounted a Montag dry fertilizer box on a Dalton custom bar, adding customized Dawn DuoSeed row units with a seed sensor that precisely monitors cover-crop seeding rates. This feature is now standard on Dawn's new DuoSeed Pro. Steinlage's interseeder also has Precision Planting monitoring, seed firmers and a wide drop tube ➤

The Underground Economy

Increasing soil carbon is Loran Steinlage's main goal. Soil carbon supports the residue and nutrient recycling that improves soil aggregate structure. The space between soil aggregates drains or stores moisture as needed, and circulates oxygen and nutrients.

Soil microbes feed on soil carbon and produce carbon dioxide (CO_2), which happens to be a crops' primary nutrient requirement, says Will Brinton, Solvita soil-health test inventor and founder of Woods End Soil Laboratories, Mount Vernon, Maine. And, soil is the world's largest active carbon reservoir.

Carbon, in the form of soil humus and crop residue and roots, feeds soil insects, bacteria, fungi, algae, protozoa and nematodes. These tiny soil animals release CO_2, mineralize (release) nitrogen and release phosphorus (P) and minerals in crop-available forms.

Half of soil humus—what gives healthy soil its structure and smell—is carbon, Brinton says. Soil microbes may produce CO_2 at rates up to 100 pounds per acre per day, the amount required in crop photosynthesis, he adds. Crops may get more CO_2 from soil than from the air. So, soil carbon is a crops' lifeblood.

"Now that we can measure CO_2, metabolism, we'll find crop nutrient uptake can also be CO_2-limited," Brinton says.

More diverse crops can support more diverse soil microbes, which can boost soil structure and speed nutrient recycling.

The bottom line is resilient soil in wet and dry seasons. Resilience is stable yields over time and less variation within fields, says Jerry Hatfield, director, USDA National Laboratory for Agriculture and the Environment. As rain falls in more concentrated bursts, and droughts hang on longer than before, carbon improves your "factory"—your soil.

High earthworm counts correlate strongly with an active soil-carbon life cycle in 17-year Swedish field plot studies, Brinton says. The Solvita test uses soil CO_2 respiration as a key indicator of soil health.

"We need to change our farming practices to be more CO_2-oriented," Brinton says.

BOB RECKER

for larger seeds. He designed his own row cleaners and rollers. This rig drills fertilizer, soybeans and fall cover-crop seeds, and can sidedress urea at V4 on the same pass based on soil-nitrate test results.

The goal is to have permanent cover and roots between corn and soybean rows. "We were there in 2012, but Mother Nature is a formidable foe," Steinlage says. "Since 2012, our 'yo-yo' springs have killed most covers in March."

A close friend of Steinlage's describes him: "The Steinlage family's on the forefront of redefining the future of crop production and soil-health management, while still recognizing that we need to be profitable," says Jacob Bolson, Hubbard, Iowa. "With the economic, regulatory, public perception and environmental constraints facing farmers, we must be willing to challenge the norm and take strategic risks."

PLANTING GREEN

After planting corn or soybeans, Steinlage used to crimp or roll cover crops to terminate them or slow them down … or he just leaves them if there's no moisture shortage. Why? Because cover crops crowd out weeds and store nutrients that otherwise leach in downpours. Cereal rye's allelopathy is nature's herbicide. Cover crops can also add to soils' carbon levels.

He experiments a lot, including trials with Bob Recker, a retired John Deere engineer and founder of Cedar Valley Innovation, Waterloo, Iowa. One of many successful tests was 60-inch corn rows with cover-crop mixes in between the rows. Higher corn populations (54,000 per acre) is equal to conventional populations in 30-inch rows; and yields were 230 bushels per acre. The wider rows allow more sunlight to boost corn yields.

Steinlage shut off Rows 2, 5, 8 and 11 on his 12-row planter resulting in a 2-row, skip-1 pattern for this 1-acre plot. He interseeded a mix of buckwheat, oilseed radish, annual ryegrass and dwarf Essex rape at corn's V4 stage. With no yield hit to these "skipped rows," he'll now add livestock to the mix.

"Loran has a unique willingness to experiment with widely varying approaches, accepts that some things will not work and, most importantly, is very open in sharing his results and learning," Recker says.

Steinlage has proven that no-till soil is 10 to 15°F warmer than conventionally tilled soil using a $200 Flir thermal camera and temperature sensors. (The University of Minnesota and North Dakota State University have similar findings.) Underground microbial activity warms the soil, insulating germinating corn against broad temperature swings.

PIE DROPS

Most of Steinlage's crop nutrients come from semicomposted dairy manure (traded for crop residue) and N-rich cover crops. Steinlage will borrow sheep to graze his interseeded cover crops in exchange for "Pie Drops" (his version of Y Drops). Free fertility and weed control harken back to farming in the 1950s, he says.

The Steinlages have been 100% controlled traffic since 2009. Equipment is 30 feet wide on 120-inch centers, limiting soil compaction. "I think aerial drone footage will sell the concept: Aerial photos make compaction's impact so evident," he says.

The family has weathered far more than its share of family health crises and accidents. When asked about how stress has swayed his farming decisions, Steinlage says he uses the 100-year rule: "Will this decision be important 100 years from now?" If you're talking about resilient soil, the answer is yes. ///

FOR MORE INFORMATION

USDA Natural Resources Conservation Service video "The Science of Soil Health: Cycle, Re-Cycle, Repeat:"

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