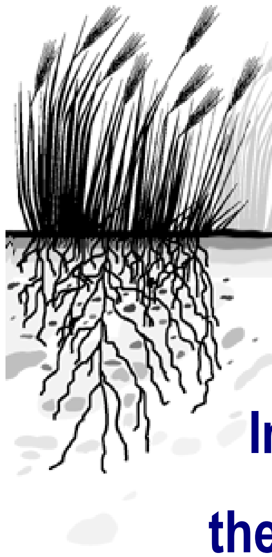
USDA United States Department of Agriculture

NRCS Natural Resources Conservation Service

Soil Quality Institute



Soil Quality – Agronomy Technical Note No. 14

Improving Soil Quality on the Southern Coastal Plain

One Farmer's Experience

For over 10 years, a Georgia farmer has been doing something that he is not supposed to be able to do on the Southern Coastal Plain — he is increasing soil organic matter levels while intensively farming 1,000 acres. In the process, he has lowered his input costs, gets more reliable yields, and is improving water quality and wildlife habitat. This technical note looks at this one farmer's experience using a high residue cropping system plus strip tillage to improve the productivity of his managed farm and improve the soil's health.

Technical Note No. 14

October 2002

This is the fourteenth in a series of technical notes about the effects of land management on soil quality.

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Tilmanstone Farm

Lamar Black operates the Tilmanstone Farm in Jenkins and Burke Counties on the Southern Coastal Plain of east-central Georgia, approximately 55 miles south of Augusta. The farm produces approximately 1,000 acres of corn, cotton, soybeans, and wheat along with rye and wheat cover crops that are left on the soil surface. Approximately one-third of the cropland is irrigated by center-pivot systems. The major soil type on the farm is Dothan loamy sand (a fine-loamy, kaolinitic, thermic Plinthic Kandiudult), which has slopes of dominantly 0 to 2 percent. Dothan soils are deep and well drained. They are low in content of organic matter and natural fertility, but they can be easily tilled, respond to improved management, and are well suited to row cropping.

Typical farming practices in the area

The dominant crop in the area is cotton, which is often grown in a continuous monoculture. The minimal residue from cotton, combined with conventional tillage, leaves cotton ground relatively bare and susceptible to erosion from both water and wind. Other common crops are wheat, soybeans, peanuts, and corn. Irrigation is used, especially on corn fields, to accommodate the naturally low available water capacity of the sandy soils. Even though the fields are relatively flat, erosion is a major concern because of the intensity of rainfall. Concern over erosion was the driving force that motivated Lamar to change his tillage system. Some area farmers use conservation tillage, but Lamar has been a local pioneer with his cover crop and continuous strip tillage system.

The cover crop and strip till system

During the winter months, Lamar’s entire farm is growing either a rye cover crop or winter wheat for grain. On the irrigated third of the farm, corn is rotated with cotton. In the late fall, a winter cover crop of rye is no-till drilled on the entire irrigated acreage. The nonirrigated acreage is used for corn, cotton, wheat, and soybeans. One-half of the soybean acreage is double cropped after wheat is harvested, while the other half is used for full-season soybeans following a rye winter cover.

The rye cover crop is grown to early head stage and then rolled with a roller constructed by Lamar and designed by the USDA-ARS Soil Dynamics Laboratory (Auburn, Alabama). The 6-foot-tall rye is laid down by the roller and then sprayed with a herbicide. If the cover crop is near maturity, the rate of herbicide application required is less than the rate without the use of the roller. The roller lays the rye in one direction, making it easy for Lamar to open a planting furrow with his strip tillage equipment.

Lamar kills the rye, subsoils, and plants corn in one operation. This method allows the rye to mature as much as possible prior to planting. Because the corn is irrigated, Lamar does not worry that the rye growth might reduce the soil moisture supply. Cotton is planted later, so he kills the rye about 3 weeks prior to planting to keep the soil from drying out during dry springs.

The roller is mounted to the front of the tractor, followed by a coulter and a subsoiler shank, and finally by the planter, which has a V-shaped bar

Top left: **The roller.**

Left: **After rolling, Lamar lifts up some rye to show off how tall it was.**

Above: **Planting cotton in the strips created by the subsoiler leaves plenty of cover on the soil.**

to push the rye residue neatly apart for the double disk openers to plant the seed. The subsoiling is necessary to break up the hardpan that forms annually in Dothan soils. It rips the soil at a depth of about 14 inches and causes very little surface disturbance.

Lamar has adjusted and changed his equipment many times over the years as he works to perfect his system of planting in extremely high amounts of residue.

Results of cover crop strip till system

Lamar Black's yields are higher than those on adjacent farms, especially during short-term droughts. Nitrogen inputs are similar to those on nearby conventional farms. Lamar takes advantage of the nitrogen mineralized from the high residues. He applies 70 lbs/acre of nitrogen to cotton and 200 lbs/acre to irrigated corn. The fields have little disease, weed, and insect pressures because of his diverse crop rotations. Weed pressure is low because the strip till system does not bring weed seeds to the surface and the residue from the cover crops and wheat delays weed germination for several weeks.

Lamar spends about $13.00 per acre on his rye cover crop. This investment is more than paid for by increased yields, reduced erosion, reduced runoff, less nitrogen use on cotton, fewer trips across the field, a better available water capacity that reduces the effects of short-term droughts, and better irrigation efficiency.

Soil quality improvements

In the fall of 2001, the Soil Quality Institute visited the Tilmanstone Farm and sampled four fields. The first field had been in long-term cover crops and strip tillage since 1993. The second field had been in cover crops and strip tillage since 1998. The third field was a conventional tillage demonstration area that had been in conventional tillage for 2 years with a chisel, multiple disking, and no winter cover. (Previously, it had been in no-till.) Lamar set up the field in replicates, so he could compare changes between his cropping system and conventional tillage. The fourth field was on an adjacent farm that had been in conventional monoculture cotton for several decades. Samples were taken at 0-1 inch for carbon, aggregate stability, and slaking. Bulk density was taken at 0-3 inches. Carbon was measured by a laboratory combustion method. The other soil quality measurements were done according to the USDA Soil Quality Test Kit Guide (NRCS, 2001). Table 1 shows differences in soil quality resulting from management.

Table 1.–Soil measurements from Lamar Black's farm (Millen, GA), 11/15/01.

Treatment	Bulk density (g/cm^3)	Aggregate stability (%)	Slaking (class)	Soil carbon (%)	Approx. soil org. matter* (%)	Moisture content (g/g)
Long-term cover crop/strip till	1.40	39	5.8	1.4	2.4	0.13
Short-term cover crop/strip till	NA	36	6.0	1.3	2.2	NA
2-year conventional tillage	1.46	12	5.0	0.5	0.9	0.02
Monocrop cotton conventional	1.58	21	3.8	0.7	1.2	0.03

* Soil carbon was converted to approximate soil organic matter by multiplying by 1.72.

Benefits of soil quality improvements

Carbon sequestration.–Lamar's cropping system shows the potential for using high residue systems to sequester carbon. Table 2 shows the amounts of carbon in Lamar's soil. Prior to converting to this system, Lamar would disk up to four times, V-rip, and plant. Gains have come in 10 to 12 years. The key to his system is producing high amounts of biomass and protecting the benefits with strip tillage. The conventionally tilled demonstration plot shows how quickly–in a mere 2 years–all the carbon benefits are lost because of tillage (table 2).

Water-holding capacity.–Increased carbon results in more pore space, lower bulk density, and a greater ability of the soil to hold water (table 1, moisture content). The samples in table 1 were collected after about 40 days without rain. Remarkably, the strip-tilled field with a cover crop had 13% moisture compared to 2% and 3% in the conventional fields.

After 40 days without rain, the strip-tilled field with a cover crop had 13% moisture compared to 2% and 3% in the conventional fields.

Yield.–In 2001, Lamar's cotton yield, averaged over the entire farm, was 680 lbs of lint per acre for dryland cotton and 1,269 lbs of lint per acre for irrigated cotton. These yields are comparable to those obtained during a good year under a conventional tillage system. During a dry year, however, yields will exceed those obtained under a conventional tillage system because of the increased water-holding capacity.

Table 2.–Carbon in pounds per acre in top inch and by volumetric basis

Treatment	Carbon (lbs/A)	Carbon (kg/m^3)
Long-term cover crop/strip-till	4,451	19.6
2-year conventional	1,658	7.2
Monocrop cotton conventional	2,511	11.0

Irrigation efficiency and erosion.–Increased carbon has improved aggregate stability, as is shown by the numbers in the columns "Aggregate stability" and "Slaking" in table 1. The higher numbers in these columns indicate that the soil is more stable than other soils when exposed to water. A soil that has a relatively high aggregate stability percentage will crust less and have a better infiltration rate. As a result, the efficiency of irrigation is greater and the soil is less susceptible to erosion. Prior to his current high residue system, Lamar could apply only 0.5 inch of water during an irrigation run because of excess runoff. After 3 years of using cover crops and strip tillage, he could apply 1.5 inches of water, if needed, without any runoff. Today, he can apply over 2.5 inches without any runoff. In the 1980s, he noticed sheet and rill erosion on relatively flat slopes. Today, erosion is negligible. Soil quality has truly improved as a result of Lamar's continuous high residue management system.

The lower sample is from the cover crop/strip tilled field. It is much darker because it has more soil carbon and retains more moisture. Structure is evident whereas the conventional tillage sample has no structure.

Why did soil quality improve?

On Dotham loamy sand, which has a naturally low content of organic matter, Lamar's major contribution to improved soil quality was increased soil carbon. Lamar increased the carbon by using crop rotations and 6-foot-tall rye cover crops to increase residue inputs and by using strip tillage instead of conventional tillage to reduce the rate of organic matter decomposition. It has been assumed that soil organic matter levels could not be increased in sandy soils of the Southern Coastal Plain, but previous research included tillage as part of the cropping system. Lamar has shown that the content of organic matter can be increased by eliminating tillage and by adding residue from the dominant crops and from cover crops.

Other benefits of the system

Lamar has noticed other benefits of his cropping system in addition to higher yields and enhanced soil quality. By rolling his cover crops at the same time as in-row subsoiling and planting for corn, Lamar has eliminated several trips across the field compared with the conventional tillage systems used in the area. His system saves time, fuel, labor, and equipment repair costs. Conventional tillage uses an average of 4.8 gallons more fuel per acre than conservation tillage (Bradley, 1991). Lamar has maintained phosphorus and potassium levels along with pH by applying fertilizer and lime on the surface. His system disproves the myth that fertilizers and lime must be incorporated to maintain pH and fertility.

Earthworms are a rarity in sandy soils of the Southern Coastal Plain where conventional tillage is practiced, but they are now very common on the Tilmanstone Farm. Lamar's management system has converted his fields to a haven for earthworms, as illustrated by the numerous macropores in the soil sample in the photograph at the top of this page.

Bobwhite quail populations are also increasing on his farm. This increase is significant, since local wildlife authorities have noted that Georgia bobwhite quail populations are decreasing by 3 percent each year.

Macropores made by earthworms.

The Bottom Line

How does Lamar Black's strip till, cover crop system compare to conventional monocrop cotton production?

Yield: Similar under average conditions; slightly better under drought conditions.

Field work: Six to eight fewer passes each year.

Fertilizer: Somewhat lower than typical rates.

Weed and pest control: Lower herbicide rates.

Other inputs: Reduced equipment and maintenance costs. Cover crops cost $13 per acre.

Irrigation efficiency: Soil can take in and hold 2.5 inches of water in each irrigation run or rain event, compared to 0.5 inch under conventional management.

Erosion: Negligible runoff and erosion.

Carbon storage: Storage of an additional 300 pounds of carbon per acre per year.

Wildlife: Bobwhite quail populations are increasing locally, even though they are declining statewide.

Earthworms: Earthworms are evident in Lamar's system and are rare in conventional systems.

National implications

Specific techniques will vary, but virtually all farms across the country can benefit from crop rotations, conservation tillage, and cover crops. Crop rotations help to reduce disease, insect, and weed pressures. Crop rotations combined with cover crops can increase the organic biomass or residue contributed to the soil. Conservation tillage reduces the loss of soil organic matter and the time and expense of tillage.

Improving soil quality on the Southern Coastal Plain presents particular challenges and opportunities. The sandy soils and high temperatures and rainfall make for soils that are naturally low in organic matter, nutrients, and pH. On the other hand, the high temperatures and rainfall can be harnessed by a system in which high biomass cover crops are grown.

Although the challenges and solutions vary across the country, increasing soil organic matter levels is possible and beneficial almost everywhere. The Tilmanstone Farm has reaped economic, environmental, and agronomic benefits by improving soil quality. By adopting many of these practices, other farms can reap similar benefits.

For more information. . .

Tilmanstone farm:
http://gcta-ga.org/farmtour1.htm

Reduced tillage and cover crops for your region:
Visit your local Soil and Water Conservation District office.

References

Bradley, John. 1991. Conservation tillage: a force changing southern agriculture. p. 13-16. *In* Proceedings of the 1991 Southern Conservation Tillage Conference. Arkansas Agricultural Experiment Station Special Report 148. Little Rock, AR.

NRCS. 2001. Soil Quality Test Kit Guide. http://soils.usda.gov/sqi/