ECONOMICS OF SOIL HEALTH MANAGEMENT SYSTEMS ON FIVE COTTON FARMS IN NORTH CAROLINA

U.S. REGENERATIVE COTTON FUND
SOIL HEALTH INSTITUTE

CLIMATE SMART • U.S. COTTON TRUST PROTOCOL

Highlights

- The Soil Health Institute conducted partial budget analyses to provide North Carolina farmers with the economic information they need when deciding whether to adopt soil health practices and systems.
- The five farmers interviewed grew crops on an average of 1,599 acres, using no-till on 74% and reduced tillage on 22% with cover crops on 96% of those acres.
- No farmers interviewed reported decreased cotton yield from using a soil health management system, and three farmers reported increased yield that averaged 120 lb./acre across the five farms.
- Based on the information provided by these farmers, it cost an average of $65/acre less to grow cotton using a soil health management system.
- Based on standardized prices, soil health management systems increased net income for these five farmers by an average of $149/acre for cotton.
- Soil health management systems for other crops in the cotton rotation also increased net income by an average of $109/acre for corn and $75/acre for soybean.
- Farmers reported additional benefits of their soil health management system, such as increased resilience to extreme weather and improved access to their fields.
- Current adoption rates in North Carolina of no-till (50%) and cover crops (11%) indicate that other North Carolina cotton farmers may improve their profitability by adopting soil health management systems.

Introduction

Improving soil health can build drought resilience, reduce wind and water erosion, increase nutrient availability, reduce nutrient losses, and enhance management of some plant diseases. Many soil health management systems (SHMS - i.e., a suite of soil health practices) also benefit the environment by storing soil organic carbon, reducing greenhouse gas emissions, and improving water quality. However, investing in SHMS is a business decision that must be economically viable. This project was conducted in North Carolina by the Soil Health Institute (SHI) to provide cotton growers with the economic information they need when making that decision.

SHI interviewed five North Carolina farmers who have adopted SHMS to acquire production information for evaluating their economics based on partial budget analysis (Fig. 1). In using this approach, the costs and benefits of a SHMS are compared before and after adoption of that system. A detailed description of the partial budget methodology can be found on the SHI website: https://soilhealthinstitute.org/economics/.

Figure 1. *Geographic distribution of the five farms used for economic analysis of soil health management systems.*

Farm Characteristics

The five cotton farms assessed in this project raised crops on an average of 1,599 acres, cropping cotton, soybean, corn, peanut, and winter wheat. All wheat acreage was double cropped with soybean (Table 1).

Table 1. *Average annual precipitation[1], temperature[1], and crop acres reported for the five cotton farms.*

Characteristics	Value
Mean Annual Precipitation[1] (inches)	40 to 60
Mean Annual Temperature[1] (°F)	57 to 64
Cotton (acres)	878
Soybean (acres)	438
Corn (acres)	223
Peanut (acres)	60
Wheat (acres)	25
Double Crop (acres)	25
Total Crop Acres	1,599

[1] *PRISM Climate Group 30 Year Normals (1991-2020) (https://prism.oregonstate.edu/normals/).*

Three farmers interviewed reported that they have adopted no-till on all acreage and two reported SHMS using reduced tillage. For interviewed farmers, reduced tillage included acreage with strip tillage and other acreage with use of a Phillips harrow to incorporate cover crop seed. No-till averaged 74% of planted acreage, and reduced tillage averaged 22% of planted acreage. This compares to no-till adoption rates of 50% for North Carolina and 38% for the U.S. Reduced tillage adoption rates were 22% for both the interviewed farmers and the state of North Carolina, and the adoption rate of reduced tillage for the U.S. was 35% (Fig. 2). The five farmers used intensive tillage on 4% of their acreage, which was associated with peanut production. The five farmers interviewed also reported using cover crops on 96% of their cropland, which is considerably greater than 11% for North Carolina and 7% for the U.S. (Fig. 2).

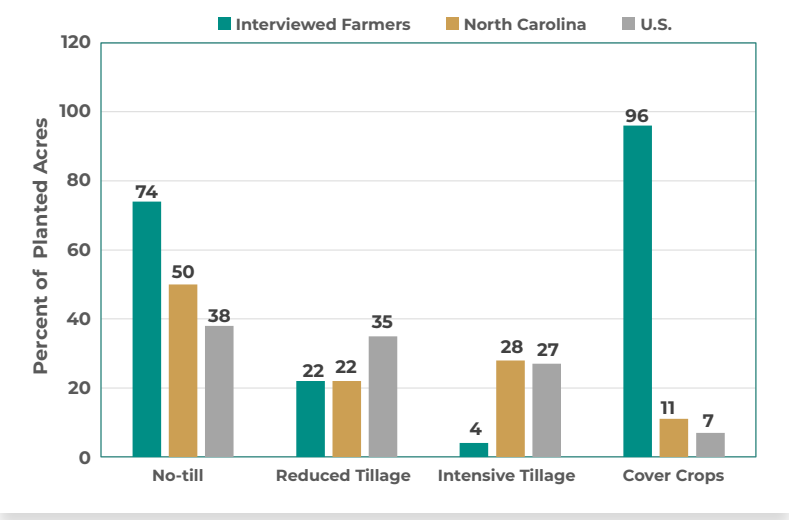

Figure 2. *Percentage of planted acres in no-till, reduced tillage, intensive tillage, and cover crop practices for the five interviewed farmers in North Carolina as compared to cropland adoption of those practices in all of North Carolina and the U.S. (2022 U.S. Census of Agriculture, Volume 1, Table 41).*

Interviewed farmers who were practicing no-till have been doing so for an average of 17 years, while those practicing reduced tillage have been doing so for an average of 33 years. The farmers planting cover crops have been doing so for an average of 25 years. Such levels of experience indicate substantial opportunity for learning from these farmers when considering the business case for adopting SHMS.

Soil types were representative of row crop fields in North Carolina and ranged in texture from fine sandy loam to silty clay loam (Table 2). One farm practiced reduced tillage for all cotton acreage. All farms planted cover crops before cotton consisting of seed mixes having one to six species (Table 2). Irrigated acreage ranged from no irrigation to 27% of cropland acreage (Table 2).

Table 2. *Soil type, soil health management system tillage practice, cover crop species, and percent of crop acreage irrigated for five cotton farms.*

Farm	Surface Soil Texture	Tillage Type for SHMS[1]	Cover Crop Species	Percent Irrigated
1	silt loam	no-till	winter/cereal rye, crimson clover, hairy vetch, radish	0
2	loam, silt loam, fine sandy loam	reduced tillage	triticale, crimson clover	9
3	fine sandy loam, silt loam	no-till	triticale	10
4	silty clay loam	reduced tillage	triticale, crimson clover	0
5	loam	no-till	triticale, tillage radish, winter/cereal rye, oats, crimson clover, hairy vetch	27

[1] *SHMS is soil health management system.*

Partial Budget Analysis

Partial budgets were calculated to assess changes in cotton expenses and revenue associated with adopting a SHMS. Results were averaged across the five cotton farms, as presented in Table 3.

Table 3. *Partial budget analysis[1] of adopting a soil health management system for cotton production on five farms. Expense, revenue, and net farm income units are $/acre (2024 dollars).*

	Cotton	
	Benefits	**Costs**
Expense Category	**Reduced Expense**	**Additional Expense**
Seed	0.00	24.80
Fertilizer & Amendments	44.91	4.50
Pesticides	33.88	7.35
Round Module Covers	0.00	1.17
Fuel & Electricity	5.31	2.60
Labor & Services	19.40	14.60
Post-harvest Expenses	0.00	0.00
Equipment Ownership	33.52	17.05
Total Expense Change	**137.02**	**72.07**
	Additional Revenue	**Reduced Revenue**
Yield, lb./acre	120.00	0.00
Price Received[2], $/lb.	0.70	0.70
Revenue Change	**84.00**	**0.00**
	Total Benefits	**Total Costs**
Total Change	221.02	72.07
Change in Net Farm Income	**148.95**	

[1] *Expenses and expected yields based on farmer reported production practices. https://soilhealthinstitute.org/economics/*

[2] *Commodity prices applied to yields based on long-term average prices. S. Irwin, "IFES 2018: The New, New Era of Grain Prices?" Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign, January 11, 2019.*

All farmers reported using cover crops and planting them prior to cotton production. Cover crop seed expenses ranged from $8/acre for triticale to $45/acre for a four-way species mix with a five-farm average of $24.80/acre (Table 3).

Adopting SHMS can reduce some expenses and increase others. For example, long-term use of SHMS can increase nutrient availability in soils, and indeed, all farmers reduced their fertilizer expenses, while also implementing nutrient management programs that included costs associated with soil testing and tissue analysis. Net fertilizer and amendment expenses were reduced by an average of $40.41/acre ($44.91 minus $4.50 in Table 3).

Reducing tillage and planting cover crops can potentially suppress weeds and lead to changing or eliminating some herbicides. In other situations, herbicides are increased to terminate cover crops or to control weeds that had previously been controlled with tillage. In addition, farmers in North Carolina reported reduced insecticides because of cover crops attracting beneficial insects and reduced fungicides due to better crop disease resistance attributable to improved soil health. Consequently, when averaging across all five farms, we found that pesticide expenses were both reduced by $33.88/acre and increased by $7.35/acre (Table 3).

Adopting no-till and reduced tillage decreases costs for equipment ownership, fuel, labor, and other expenses associated with conventional tillage practices. Reduced expenses in Table 3 for equipment ownership ($33.52/acre) and associated expenses ($5.31/acre and $19.40/acre) totaled $58.23/acre. Additional expenses for equipment ownership ($17.05/acre) and associated expenses ($2.60/acre and $14.60/acre) totaled $34.25/acre (see Table 3). Examples of additional expenses included planting cover crops and applying chicken litter.

Three farms reported increased cotton yield from adopting SHMS with a five-farm average increase of 120 lb./acre (Table 3). Increased module cover expense for farmers using module building cotton harvesters was $1.17/acre. Increased post-harvest expenses associated with hauling, ginning, and other fees were assumed to be paid by the increased value of cottonseed.

Because market prices for crops fluctuate, revenue was calculated by applying a long-term average cotton price, which is explained in the footnote to Table 3. Using those prices, revenue from growing cotton in a SHMS increased $84/acre.

Combining the changes in expenses and revenue showed that implementing a SHMS increased net income for these five farms by an average of $148.95/acre for cotton (Table 3). Although greater yield contributed substantially to this increase, it cost $64.95/acre less to grow cotton using a SHMS when averaged across all five farms ($137.02 minus $72.07 in Table 3). Even when yield does not increase, the SHMS was still more profitable because of the reduced expense of growing cotton with a SHMS.

While economic benefits ranged from $42 to $205/acre, all farmers reported an increase in net farm income when growing cotton with a SHMS (Fig. 3). The farm with the greatest net farm income increase of $205/acre had no yield increase, but had the greatest decrease in production expenses. Fertilizer expenses were reduced by substituting purchased fertilizer with chicken litter and a cover crop mix that included winter/cereal rye, crimson clover, hairy vetch, and radish. Pesticide expenses were reduced as cover crops attracted beneficial insects for reduced insecticides and enhanced disease resistance reduced fungicide expenses. The farm with a net farm income increase of $42/acre had no yield increase with an expense decrease of $42/acre. The other three farms had combinations of yield increases and expense decreases (Fig. 3).

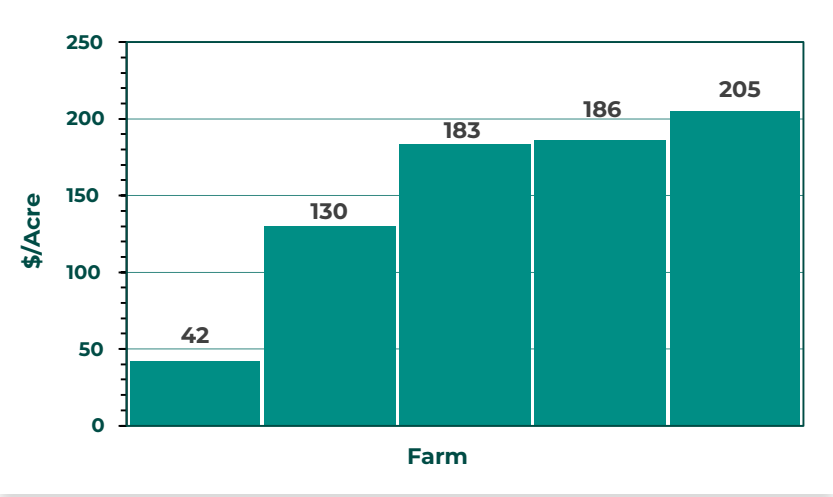

Figure 3. *Change in net farm income for five farms after adopting a soil health management system compared to a conventional system, cotton, $/Acre.*

Financial benefits for growing other crops with SHMS were also reported by these five farmers. Three farmers growing corn reported net farm income to increase from $63.30/acre to $160.98/acre (average $108.64/acre) from adopting SHMS. Four farms growing soybean with a SHMS increased net farm income from $46.41/acre to $97.41/acre (average $75.18/acre).

Additional Benefits

In addition to benefits that directly impact profitability, these farmers also reported other benefits from a SHMS, such as increased crop resilience (100%), more timely access to their fields (100%), and improved water quality (100%). Changes in water quality were based on visual differences in water clarity observed by the farmers. All farmers stated that adoption of SHMS improved public perception of agricultural production (Table 4).

These farmers were visually monitoring for observable changes in their soil organic matter levels, and all reported that those levels appeared to have increased due to the SHMS (Table 4). Two monitored soil organic matter, and one reported an increase of 1.5% while the other reported an increase of 2%. Research has shown that higher soil organic matter increases available nutrients and available water holding capacity, which is consistent with reduced fertilizer applications, increased crop resilience, and improved field access observed by these cotton farmers.

Table 4. *Summary of additional soil health management system benefits reported by five cotton farmers.*

Benefit	% Responding Yes
Increased Crop Resilience	100
Increased Field Access	100
Improved Water Quality	100
Improved Public Perception of Agriculture	100
Increased Soil Organic Matter	100

Summary

The Soil Health Institute conducted partial budget analyses to provide farmers with the economic information they need when deciding whether to adopt soil health management systems (SHMS). The five farmers interviewed in North Carolina grew crops on an average of 1,599 acres, no-till on 74%, reduced tillage on 22%, and cover crops on 96% of those acres. Based on information provided by these farmers, it cost an average of $64.95/acre less to grow cotton using a SHMS. Three farmers reported increased cotton yield from using a SHMS. Based on standardized prices, the SHMS increased net income for these five farmers by an average of $148.95/acre for cotton. Average net farm increases for farmers adopting a SHMS with other crops were $108.64/acre for corn and $75.18/acre for soybean. Farmers also reported additional benefits of their SHMS, such as increased resilience to extreme weather and increased access to their fields. The current adoption rates of combined no-till and reduced tillage (72%) and cover crops (11%) in North Carolina indicate that additional cotton farms may improve their profitability by adopting a soil health management system.

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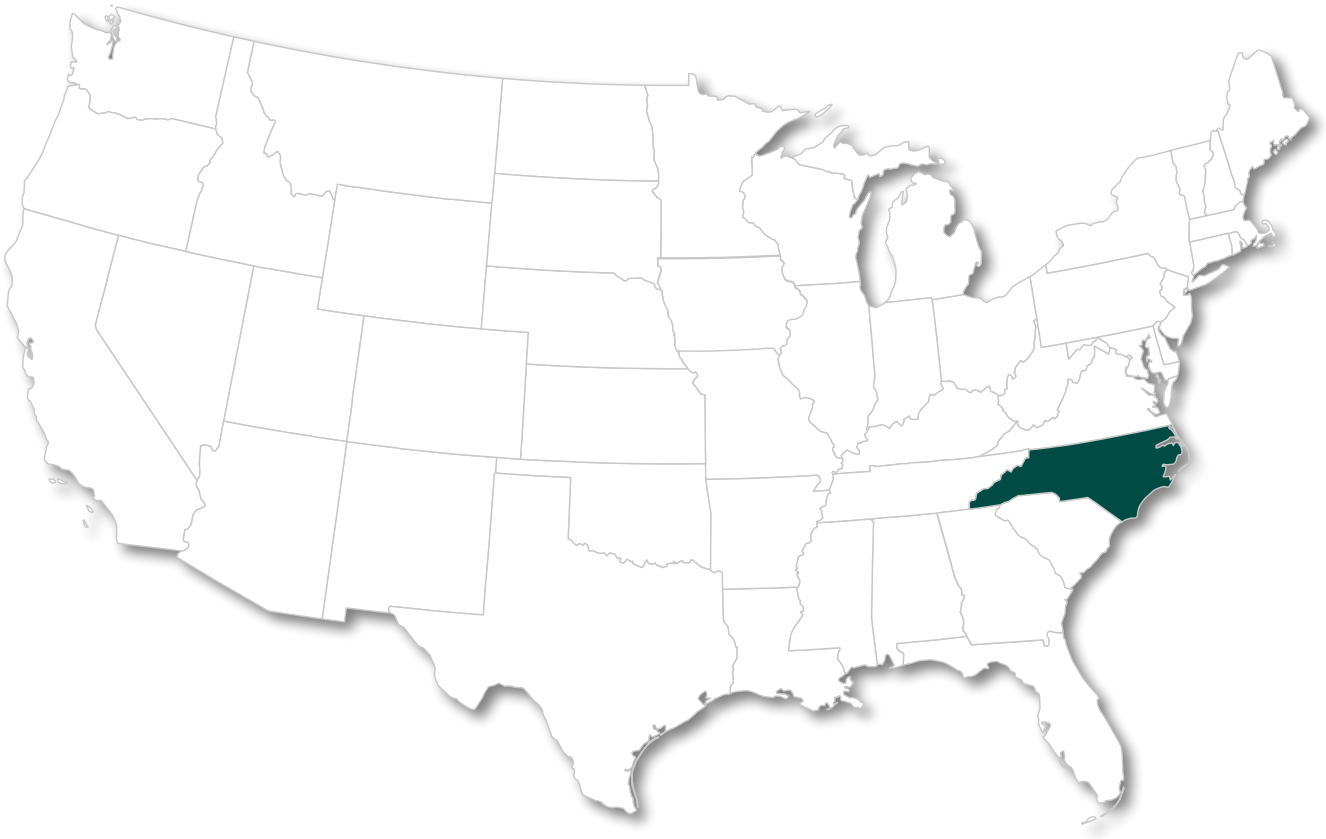

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