Cover Crops | Crop Rotation | No Till or Low Till | Nutrient Management

Racine Family Farm, MD
SOIL HEALTH CASE STUDY

MAY 2024

Bryan Racine is the chief operator of his family's 243-acre farm situated on gently rolling hills in Cecil County, just above the Chesapeake Bay. Their current crop rotation is 2-years corn, 1-year soybeans, and 1-year wheat. This case study focuses on the 127 acres of cropland where Bryan has adopted conservation crop rotation, cover crops, no-till, and nutrient management.

Bryan started his soil health journey in 2016 after watching a video of long-time soil health advocate Steve Groff explaining the soil health benefits of no-till and diversifying one's crop rotation. Bryan was inspired to purchase a 15′ no-till drill to plant soybeans. He says, "I liked the idea of less work in the spring and more diversity in the crop rotation." He added wheat to his rotation in 2017, diversifying from a 1-year corn, 1-year soybean rotation to the current 4-year rotation. In 2017, Bryan rebuilt his existing John Deere corn planter, adding new row units so that he could begin no-tilling all three of his crops.

Bryan began experimenting with cover crops in 2019, planting cereal rye after corn under the guidance of University of Maryland Extension educator Sarah Hirsh, Ph.D. Pleased with the results, he expanded to planting a diverse 10-way summer mix after harvesting wheat in July, then a rye/crimson clover/red clover mix after the first year of corn, and a cereal rye/rapeseed mix after the second year of corn (before soybeans). Bryan generally sees higher corn yields following the longer-growing summer mix. He especially appreciates the nitrogen fixation the legumes in both the mixes provide. With the addition of wheat alongside these cover crops, Bryan maintains a living root throughout his 4-year crop rotation. Since 2021, the farm has received state, federal, and non-profit financial assistance to maintain its use of cover crops.[1]

After soil tests revealed low soil organic matter (SOM) levels for his region, in 2019, Bryan began applying organic fertilizers in the form of chicken litter (3 tons/ac/yr on corn) and spent mushroom substrate (SMS) (8 tons/ac/yr on soybeans). These organic amendments have, in part, helped to raise his SOM levels from 1.5% in 2019 to 1.9% in 2023. With organic fertilizers as his base, he began annually adjusting his rate of applied synthetic fertilizers based on cover crop growth and weather for that year. Overall, Bryan has reduced the amount of synthetic fertilizer applied.

One of the biggest challenges Bryan has faced in his soil health journey is resistance from many in his circle, such as veteran farmers, local ag suppliers, and other family members, who believe that no-till, cover crops and NM don't work in their area and aren't profitable. Bryan says, "They don't like change and think farming is only about yield numbers, not your return on investment or the health of the soil."

Soil Health Economic and Environmental Estimated Outcomes

Partial budgeting analysis was used to estimate the marginal benefits and costs of adopting conservation crop rotation, cover crops, no-till, and nutrient management on Racine Family Farm. The study was limited to only those income and cost variables affected by the adoption of these soil health practices. The table on page 2 presents a summary of these economic effects, revealing that, due to the four practices, Racine Family Farm's net income increased by $71/ac/yr on the 127-acre study area, achieving a 52% return on investment.

The largest per-acre increase attributed to soil health adoption is the 20% higher yields on corn and 22% higher yields on soybeans, an additional $130/ac/yr income for the farm. Additionally, the adjustment in crop rotation to include wheat results in a significant $99/ac/yr increase in net income as compared to soybeans in the farm's original rotation.

Bryan has been able to lower his machinery costs[2] substantially by switching to no-till for his corn and soybean crops, reducing his machinery passes by four on corn and three on soybeans, with an annual $70/ac/yr cost savings for both crops combined. This cost savings accounts for changes in chemical and fertilizer machinery costs as well. The use of cover crops has lowered weed pressure in Bryan's fields, resulting in reduced herbicide product needed on corn. Cover crops have also improved soil and plant health, which has led to reduced fungicide applications on corn and soybeans, a total savings of $4/ac. With

Bryan Racine with his children

Farm at a Glance

COUNTY: Cecil, MD

WATERSHED: Northeast River

CROPS: Corn, soybeans, & wheat

FARM SIZE: 243 acres (127-acre study area)

SOILS: Silty loam on gently rolling hills, 2–5% slopes

SOIL HEALTH PRACTICES: Conservation crop rotation, cover crops, no-till, & nutrient management

Insects thriving with cover crops

the adoption of cover crops and offsetting commercial fertilizer with chicken manure and SMS, Bryan reduced his synthetic fertilizer applied by 11% overall, and 100% on corn and soybeans, respectively, resulting in a $34/ac/yr cost savings.

Bryan estimates his erosion repair costs have been reduced by $200/yr, the result of reduced runoff stemming from soil health practice adoption. NRCS's soil erosion calculation software, RUSLE2, estimates that Racine Family Farm is saving 1.6 tons of soil/ac/yr, equating to $421/yr in saved nutrients.[3] "Runoff occurs," says Bryan, "but it is incredibly clearer than when we were using heavy tillage. Our pond out back is clearer than it used to be after a big rain, and we have less standing water in fields compared to neighbors."

The largest cost increase Bryan has incurred is purchasing organic chicken litter, which has increased his costs by $123/ac/yr. Chicken litter is substantially more expensive than commercial dry fertilizer, and while the SMS is free (collected from local mushroom growers), he must pay for hauling, spreader rental, and application (included in the machinery costs line item). Cover crop establishment and termination costs have also added an additional cost of $91/ac/yr. Most of the species in Bryan's cover crop mixes overwinter, and he applies burndown chemicals to terminate the cover crop in the spring.

Finally, Bryan estimates that he spends an average of 36 hours a year on learning activities related to soil health practices, resulting in an annual cost of $1,032.

Closing Thoughts

Bryan has observed ecological benefits throughout his soil health journey, noting, "I love seeing the increased wildlife activity on my farm. I love having the soil covered and growing all year like mother nature intended it to be." Since Bryan works a full-time job in addition to farming, an added benefit of adopting no-till and introducing wheat into his rotation is that it allows him to spread his workload out over the year. "No-till lets me spend just a third of the time operating equipment while still increasing my return on investment. It allows me to spend more time with my family."

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ECONOMIC EFFECTS OF SOIL HEALTH PRACTICES ON RACINE FAMILY FARM (2023 PRICES)[4]

Increases in Net Income

Increase in Income

ITEM	PER ACRE	ACRES	TOTAL
Yield increase due to soil health practices (+20% corn & +22% soybean yields)	$130	96	$12,526
Increase in net income due to adding wheat to the rotation (acres switched from soybeans)	$99	31	$3,067
Total Increased Income			**$15,593**

Decrease in Cost

ITEM	PER ACRE	ACRES	TOTAL
Machinery cost savings on corn & soybeans due to no-till & nutrient management	$70	96	$6,738
Fungicide cost savings on corn & soybeans due to adopting cover crops	$4	96	$378
Less fertilizer applied to corn & soybeans due to cover crops & nutrient management	$34	96	$3,292
Decrease in soil erosion (1.6 tons/ac/yr) & erosion repair costs due to all soil health practices	$5	127	$621
Total Decreased Cost			**$11,029**
Annual Total Increased Net Income			**$26,622**
Total Acres in this Study Area			**127**
Annual Per Acre Increased Net Income			**$210**

Decreases in Net Income

Decrease in Income

ITEM	PER ACRE	ACRES	TOTAL
None identified			$0
Total Decreased Income			**$0**

Increase in Cost

ITEM	PER ACRE	ACRES	TOTAL
Cover crop establishment, termination, & machinery costs	$91	95	$8,641
Chicken litter material applied to corn (3 tons/ac/yr)	$123	64	$7,872
Soil health practices learning activities (36 hrs/yr)			$1,032
Total Increased Cost			**$17,545**
Annual Total Decreased Net Income			**$17,545**
Total Acres in this Study Area			**127**
Annual Per Acre Decreased Net Income			**$138**

Annual Change in Total Net Income = $9,077

Annual Change in Net Income Per Acre = $71

Return on Investment = 52%

[1] Bryan received $42/ac through the NRCS EQIP program (2021), $33/ac/yr from the Maryland Department of Agriculture (2022-2023), and $27/ac from Future Harvest (2023), all for cover crops. This is not included in the economic analysis because cost-share is temporary and not received by all. [2] Machinery costs include the cost of equipment, custom hire, labor, depreciation, interest, insurance, housing, repairs, and fuel (Univ. of IL at Urbana-Champaign, 2023, Farm Business Management Machinery Cost Estimates: Field Operations; Iowa State University, 2023, Ag Decision Maker: Iowa Farm Custom Rate Survey). [3] Value of decreased erosion is based on estimated N & P content of the soil (2.32 lbs N/ton, 1 lb P/ton) and fertilizer prices (USDA NRCS, May 2010, Benefit-Cost Analysis for the EQIP). [4] This table represents estimated average costs and benefits attributed to adopting conservation crop rotation, no-till, nutrient management, and cover crops over the 127-acre study area, as reported by Bryan Racine. • All values are in 2023 dollars. • Prices are stated as per acre values for items that vary by area. Prices such as learning costs, which don't vary by area, are only given as total costs. • Prices used: Corn Grain: $5.45/bu, Soybeans: $13/bu, Wheat: $7.30/bu (USDA NASS, Crop Values: 2023 Summary); fertilizer and chemical prices provided by the farmer. • Return on investment is the ratio of Annual Total Change in Net Income to Annual Total Decreased Net Income, as a percent. • For information about (1) study methodology, see farmland.org/soilhealthcasestudies • This material is based on AFT's work supported by a USDA NRCS Cooperative Agreement #NR223A750010C003 and National Fish and Wildlife Federation Innovative Nutrient and Sediment Reduction award #73981

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To read more case studies, visit farmland.org/soilhealthcasestudies