American Farmland Trust

SOIL HEALTH PREDICTIVE ASSESSMENT SUMMARY REPORT

For: Zac Weidner
Macoupin County, Illinois
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FARM DESCRIPTION

Zac Weidner owns and farms 540 acres in western Macoupin County, IL in close cooperation with his father. Together, they farm 1,400 total acres, sharing equipment, labor, and ideas. These acres fall within the Upper Macoupin Creek watershed, a HUC 10 watershed that flows to the Macoupin Creek, then the Illinois River, and ultimately the Mississippi River. Zac is a corn-soybean rotation farmer who wants to incorporate cover crops into much of his acreage. The topography is mostly flat, with a few fields having slight hills. The study area, or focus field, is a 40-acre flat and moderately to poorly drained field named "Janet's 40." Soil types for the study area include Cowden, Fishhook, Harrison, and Marine (all silt loam) and Virden (a silt clay loam). The percent Soil Organic Matter (SOM) is 3.317%.

CURRENT AND PLANNED PRACTICES IN THE STUDY AREA

In addition to cover cropping, Zac is interested in switching completely to no-till before corn planting and improving his nutrient management practices by no longer fertilizing in the fall.

Table 1: Current and Planned Soil Health Management Strategy

Conservation Practices		Corn	Soybeans
Tillage	Current	Reduced, vertical tillage	No-till
	Planned	No-till	(No change)
Cover Crops	Current	None	None
	Planned	Fall planting legume-cereal mix, spring termination using combination of spray and roller crimper	Fall planting of cereal-brassicas mix, spring termination using combination of spray and roller crimper
Nutrient Management	Current	Fall Anhydrous Ammonia, dry spring fertilizer spread before planting, dry spring side-dress application	Dry spring fertilizer spread before planting
	Planned	Dry spring fertilizer spread before planting, liquid 2x2 application with planter pass, and dry side-dress at appropriate V-stage	(No change)
Crop Rotation	Current	Corn – Soybean	
	Planned	Corn – Cover Crop – Soybean – Cover Crop	

Estimates of Soil Health Educational Time Needed: A default estimate of $2.81 per acre was used for cropland and is based on the average per acre costs reported by farmers in AFT's seven Row Crop Soil Health Case Studies (2019 & 2020).

PREDICTIVE ASSESSMENT

American Farmland Trust (AFT) conducted a Predictive Assessment using AFT's Predictive Soil Health Economic Calculator (P-SHEC) – an excel-based tool. The P-SHEC Tool employs a short-term partial budget analysis and a long-term economic benefits analysis to estimate the potential benefits and costs associated with the adoption of selected soil health practices.

SHORT-TERM PARTIAL BUDGET ANALYSIS

Potential Short-Term Annual Economic Effects

We conducted a partial budget analysis to estimate the potential marginal benefits and costs of adopting the soil health practices identified by the farmer as priority interests: no-till, cover crops, and nutrient management (see Table 1). The partial budget analysis is limited to only those income and cost variables expected to change by the adoption of these three practices following the first year or so of adoption. Below, Table 2 shows that, if these practices were adopted, net income could increase by an estimated $13 per acre per year, or by $516 annually on the 40-acre Study Area. This achieves a 22% return on investment meaning for every dollar spent, Zac's net income could increase by 22 cents (see Table 2).

Key Findings

- The greatest potential savings, $29 per acre per year, is the value of decreased erosion due to soil health practices. Most of this benefit comes from a farmer-estimated $1,200 savings per year in field repairs, such as filling in small gullies formed by erosion.
- Other potential savings stem from nutrient management changes—$12 per acre per year savings from reduced nutrient-related machinery costs and $10 per acre per year from fertilizer savings—for a combined potential savings of $22 per acre per year.
- The largest potential increase in cost is $44 per acre per year to establish and terminate cover crops.

Table 2: Potential Short-Term Annual Economic Effects of Soil Health Practices

Positive Effects				Negative Effects			
Increase in Income				**Decrease in Income**			
Item	**Per Acre**	**Acres**	**Total**	**Item**	**Per Acre**	**Acres**	**Total**
None identified	$0.00	0	$0	None identified	$0.00	0	$0
Total Increased Income			**$0**	**Total Decreased Income**			**$0**
Decrease in Cost				**Increase in Cost**			
Item	**Per Acre**	**Acres**	**Total**	**Item**	**Per Acre**	**Acres**	**Total**
Machinery cost savings due to no-till	$6	40	$247	Typical learning costs	$3	40	$112
Herbicide savings for soybeans due to cover cropping	$22	20	$430	Cover crop costs	$44	40	$1,748
Machinery cost savings due to one less fertilizer application	$12	40	$492	Increased fertilizer cost for corn due to cover crops	$4	20	$84
Fertilizer savings for corn due to change in nutrient management	$10	20	$196	2x2 equipment upgrade	$4	40	$160
Work moves from spring to fall (better distribution of labor)	$8	40	$300	Liquid storage tanks	$2	40	$80
Reduced erosion keeps nutrients in-field and eliminates field repairs	$29	40	$1,155	Liquid tender	$3	40	$120
Total Decreased Cost			**$2,820**	**Total Increased Cost**			**$2,304**
Annual Total Increased Net Income			**$2,820**	**Annual Total Decreased Net Income**			**$2,304**
Total Acres in this Study Area			**40**	**Total Acres in this Study Area**			**40**
Annual Per Acre Increased Net Income			**$71**	**Annual Per Acre Decreased Net Income**			**$58**
Annual Change in Total Net Income = $516							
Annual Change in Net Income Per Acre = $13							
Return on Investment = 22%							

Notes:

- *This table represents costs and benefits over the entire study area (40 acres) as reported by the farmer.*
- *All values are in 2019 dollars except for fertilizer values.*
- *Farmer-supplied fertilizer prices: Nitrogen: $.28/Lb, Phosphate: $.37/Lb, Sulfur: $.54/Lb (Source: Zac Weidner, 2020).*
- *There was no estimated increase or decrease in income (top rows). The P-SHEC short-term partial budget analysis only considers changes in income from changing rotation or grazing cover crops, and Zac would not do either. Potential changes in crop yield are accounted for in the long-term analysis.*
- *Sheet & rill erosion benefits are based on estimated N & P content of the soil and 2020 farmer-supplied fertilizer prices (for methodology, see NRCS Interim Final Benefit-Cost Analysis for the EQIP Program, 2009) and farmer-estimated savings in field repairs.*
- *Return on Investment is the ratio of net profit to the cost of investment, or in this case, Annual Total Change in Net Income/Annual Total Decreased Net Income.*
- *For information about study methodology, see https://farmland.org/soilhealthcasestudies.*
- *This material is based on work supported by a USDA NRCS CIG grant: NR183A750008G008.*

LONG-TERM ECONOMIC BENEFITS ANALYSIS

AFT developed a long-term analysis to estimate the potential annual economic benefits related to changes in yield, soil fertility, and water storage capacity resulting from 5 and 20 years of soil health practice use. This analysis is based on the USDA NRCS Cover Crops Economics Tool.

Long-term improvements in crop yield, soil fertility, and water storage capacity are a function of potential increases in SOM. Potential increases in SOM were derived in the P-SHEC Tool from changes in soil carbon as estimated by the USDA COMET-Planner national dataset for the selected management changes in Macoupin County, IL. The specific soil health management changes used for the long-term analysis that best approximate Zac's interests are, "Add legume seasonal cover crop" and "Reduced till to no till or strip till."

General Data Inputs and SOM Results

- Planning horizon (up to 20 years): **5 and 20 years**
- Interest rate or discount rate (between 1 and 15%): **4%**
- Selected soil health management options and potential increases in SOM as estimated by the P-SHEC Tool:
    - ***"Add legume seasonal cover crop"*: 0.049% increase in SOM per year**
    - ***"Reduced till to no-till or strip-till"*: 0.026% increase in SOM per year**
    - Total potential increase in SOM per year is 0.075%
    - Over 5 years, the total potential increase in SOM is 0.375%
    - Over 20 years, the total potential increase in SOM is 1.496%

Crop Yield

The P-SHEC Tool estimates annual yield improvements by multiplying the total potential increase in SOM per year (0.075%) by the potential percent increase in crop yield associated with a 1% increase in SOM (see Table 3). If the farmer wishes to include potential yield improvements in their analysis, they are asked to estimate a potential percent increase in yield associated with a 1% increase in SOM for each crop. Since making such estimates can be quite difficult, farmers have the option of using the average of percent yield increases estimated by four "soil health successful" corn-soybean farmers in AFT's Retrospective Case Studies, with the understanding that these increases are not tied to a percent change in SOM (Row Crop Retrospective Soil Health Case Studies, 2019, 2020). Zac elected to use the AFT average yield increase.

Table 3: Yield Information

Cash Crop	Corn	Soybeans
Unit	Bushel	Bushel
Current Average Yield per Acre	210	72
Potential % Increase in Yield due to a 1% Increase in SOM*	8%	12%
Potential % Increase in Yield after 5 years of SH practices	3%	4.5%
Potential % Increase in Yield after 20 years of SH practices	12%	18%
National Crop Price per Unit**	$3.85	$8.75

** Source: AFT, Row Crop Retrospective Soil Health Case Studies, 2019, 2020.*
*** Source: USDA NASS, Crop Values 2019 Summary, February 2020.*

Soil Fertility

The P-SHEC Tool estimates annual soil fertility improvements in a similar fashion to crop yield, i.e., based on the annual potential increases in SOM multiplied by nutrient mineralization rates associated with a 1% increase in SOM. Nutrient mineralization rates are either supplied by the farmer or estimated by the P-SHEC Tool. The P-SHEC estimation is a function of the dominant soil texture and standard calculations[1] assuming an 8-inch sampling depth and a 1.5% annual mineralization factor. Zac decided to use the P-SHEC Tool estimated nutrient mineralization rates.

Table 4: Soil Fertility Information

Dominant Soil Texture: Silt Loam		
Nutrient	**Price per Pound***	**Nutrient Mineralization Rates (lb/acre)****
Nitrogen	$0.28	18.1
Phosphorous	$0.37	1.8
Sulfur	$0.54	0.7

**Prices per pound of nutrients supplied by farmer. For comparison, the national averages are $0.34/lb Nitrogen, $0.34/lb Phosphorous, and $0.45/lb Sulfur.*
***P-SHEC Tool default nutrient mineralization rates.*

Water Storage

The P-SHEC Tool estimates annual water storage improvements in the soil based on the annual probability of experiencing a yield-impacting drought combined with a comparison of historic yield loss due to drought and a potential yield loss due to drought after a 1% increase in SOM. The annual probability of yield-impacting drought and the historic percent yield loss due to drought can be farmer-estimated or calculated by the P-SHEC Tool.[2] Potential percent yield loss due to drought after a 1% increase in SOM must be estimated by the farmer. Since there is very little guidance for estimating this variable, the farmer must base their estimate on current yield losses and how those losses might be minimized due to the improvement in SOM. Zac decided to use the P-SHEC Tool estimated annual probability of yield-impacting drought, and his estimated historic yield loss due to drought.

Table 5: Water Storage Information

Dryland Farming Drought Resistance Data	Corn	Soybeans
Unit	**Bushel**	**Bushel**
National Crop Price per Unit*	$3.85	$8.75
P-SHEC Annual Probability of Yield-Impacting Drought	5%	5%
Farmer-estimated Historic Yield Loss due to Drought	15%	60%
Farmer-estimated Potential Yield Loss due to Drought after a 1% increase in SOM	10%	25%

**Source: Crop Values 2019 Summary, USDA NASS, February 2020*

[1] Soil Organic Matter, Soil Health -Guides for Educators, USDA NRCS, May 2014.
[2] The P-SHEC Tool uses historic data from the Palmer Drought Severity Index and National Agricultural Statistics Service.

Potential Long-Term Annual Benefits for 20 years of Soil Health Practice Use

After 20 years of potential implementation of the two practices in the P-SHEC tool that best resembled Zac's long-term conservation plans (i.e., "legume seasonal cover crops" and "reduced till to no till or strip till"), the analysis shows a total potential increase in net income of $57 per acre per year on the 40-acre Study Area (see Table 6). Note that 85% of the potential increase in net income is attributed to the potential yield increases. The P-SHEC Tool estimates a 1.496% increase in SOM could result in a 12% increase in corn yields and an 18% increase in soybean yields, on average, after 20 years of soil health practice adoption (see Table 3).

Key Findings

- **Yield Increase:** Should Zac's yields increase in similar magnitude to the four "soil health successful" row-crop farmers in AFT's Retrospective Case Studies, Zac may experience an increase in net income by $48 per acre per year after 20 years of soil health practice use.
- **Soil Fertility Benefit:** Enhanced nutrient availability due to improved mineralization rates may increase net income by $4 per acre per year after 20 years of soil health practice use.
- **Water Storage Benefits**: Improved water storage capacity of the soil, which enhances drought resistance, could increase net income by $4 per acre per year after 20 years of soil health practice use.

Table 6: Potential Long-Term Annual Benefits for 20 years of Soil Health Practice Use

Benefit Category	Per Acre	Affected Acres	Study Area
Discounted Annual Yield Increase	$48	40	$1,932
Discounted Annual Soil Fertility Benefit	$4	40	$169
Discounted Annual Water Storage Benefits	$4	40	$180
Total Annual Long-Term Benefits	**$57**	**40**	**$2,281**

Potential Long-Term Annual Benefits for 5 years of Soil Health Practice Use

A 5-year long-term analysis is included to estimate benefits that may occur on a timeline closer to the 3-year Soil Health Partnership (SHP) trial occurring on this field. Five years is the shortest planning horizon possible in the P-SHEC Tool. After 5 years, with improved soil health, the analysis shows a total potential increase in net income of $18 per acre per year on the 40-acre Study Area (see Table 7). Eighty-five percent of the increase in net income is attributed to the potential yield increase (see Table 3). The P-SHEC Tool estimates a 0.375% increase in SOM, realized as a 3% increase in corn yield and a 4.5% increase in soybean yield, on average, after 5 years of soil health practice adoption (see Table 3).

Table 7: Potential Long-Term Annual Benefits for 5 years of Soil Health Practice Use

Benefit Category	Per Acre	Affected Acres	Study Area
Discounted Annual Yield Increase	$15	40	$613
Discounted Annual Soil Fertility Benefit	$1	40	$54
Discounted Annual Water Storage Benefits	$1	40	$57
Total Annual Long-Term Benefits	**$18**	**40**	**$724**

CONCLUSION

This study analyzed both the short-term and long-term predicted change in net income due to adopting no-till, cover crops, and nutrient management soil health practices. The combined results are presented in Table 8. The short-term annual change in net income was estimated by a partial budget analysis of soil health practice adoption (Table 2). The short-term analysis estimated a $13 potential improvement in net income per acre per year.

The total annual long-term benefits depend on the planning horizon. The long-term benefits result from the potential annual economic benefits related to changes in yield, soil fertility, and water storage capacity over a certain planning-horizon.

The long-term 5-year analysis indicates that, with improved soil health, net income could improve by an additional $18 per acre per year, resulting in a total long-term and short-term annual change in net income of $31 per acre per year. This is a 53% return on investment, meaning for every dollar spent, Zac's net income could increase by 53 cents.

The long-term 20-year analysis indicates that, with improved soil health, net income could improve by an additional $57 per acre per year, resulting in a total long-term and short-term annual change in net income of $70 per acre per year. This is a 121% return on investment, meaning for every dollar spent, Zac's net income could increase by $1.21.

The break-even analysis determines the year that cumulative total benefits exceed cumulative total costs. In Zac's case, the break-even analysis indicates that in year one of soil health practice adoption, Zac's investment in soil health practices is profitable.

Table 8: Predictive Assessment Combined Results

20-Year Planning Horizon			
Result Category	**Per Acre**	**Affected Acres**	**Study Area**
Short-Term Annual Change in Net Income	$13	40	$516
Total Annual Long-Term Benefits	$57	40	$2,281
Total Long-Term and Short-Term Annual Change in Net Income	**$70**	**40**	**$2,797**
Return on Investment	**121%**		
Number of Years before Break Even	**0**		

5-Year Planning Horizon			
Result Category	**Per Acre**	**Affected Acres**	**Study Area**
Short-Term Annual Change in Net Income	$13	40	$516
Total Annual Long-Term Benefits	$18	40	$724
Total Long-Term and Short-Term Annual Change in Net Income	**$31**	**40**	**$1,240**
Return on Investment	**53%**		
Number of Years before Break Even	**0**		