Working Paper No. 2022-01

November 2022

Cornell Cooperative Extension

Northwest NY Dairy, Livestock and Field Crops Program

American Farmland Trust

Working Paper:

Achieving Improved Soil Health Outcomes While Maintaining or Improving Economic Viability: Case Study of Table Rock Farm, a Dairy Farm Business in the Genesee River Watershed, New York

John J. Hanchar[1] and Aaron Ristow[2]

[1]Cornell University/College of Agriculture & Life Sciences, and CCE/NWNY Dairy, Livestock, & Field Crops Program. [2]American Farmland Trust New York Agricultural Stewardship Program

Achieving Improved Soil Health Outcomes While Maintaining or Improving Economic Viability: Case Study of Table Rock Farm, a Dairy Farm Business in the Genesee River Watershed, New York

John Hanchar, Cornell University/College of Agric. & Life Sciences, and CCE/Dairy, Livestock & Field Crops Program, Batavia, NY 14020 USA <jjh6@cornell.edu>

Aaron Ristow, American Farmland Trust, New York Agricultural Stewardship Program, Saratoga Springs, NY 12866 USA <aristow@farmland.org>

Summary

- The owners and primary operators of Table Rock Farm, a dairy farm business in the Genesee River Watershed of New York, like many farm business owners today, seek to successfully implement soil health practices, systems while maintaining or improving economic performance.
- Table Rock Farm has successfully planned and implemented numerous cropping system changes designed to achieve improved soil health and related results.
- A comparison of 'before' and 'after' economic performance suggests that successful implementation of soil health improving practices coincided with improved economic performance.

Introduction

American Farmland Trust's Soil Health Case Study work seeks to offer interesting insights about yield and income benefits, input benefits, and environmental benefits farm business owners experienced from successfully adopting soil health practices (American Farmland Trust). As part of this overall effort, the Genesee River Demonstration Farms Network seeks to allow farms in the region to learn from one another and to see what practices are most cost effective and have the biggest impact on conservation. The reporting of findings from case studies is one way interested farm business owners and others enhance their understanding of soil health practice adoption.

The focus of this working paper is to describe the economic analysis component of the case study approach. The before-after analysis sought to answer the following question: *Can farm business owners in the Genesee River Watershed of New York (in this case, those of Table Rock Farm) achieve improved soil health and related outcomes while maintaining or improving economic performance?* Examples of related outcomes include those associated water, air and climate sustainability objectives.

Farm Background

Table Rock Farm is a family-owned, 1,250 cow dairy farm in the Genesee River Watershed of western New York. The farm produced almost 40 million pounds of milk in 2020. Table Rock Farm's milk production is made into Great Lakes cheeses in Cuba, NY. The family grows 1,800 acres of corn, alfalfa and other forages to feed its herd, and other crops to be sold. The family is deeply dedicated to environmental stewardship and successfully implements a soil health system comprised of nutrient management practices, including an innovative manure storage system, crop selection and rotation, conservation tillage, and cover crops to promote soil health, prevent erosion and protect water quality.

In the summer of 2021, Richard A. Ball, Commissioner, New York State Department of Agriculture and Markets, joined the Sand County Foundation in announcing the annual Agricultural Environmental Management (AEM)-Leopold Conservation Award winner for 2021. The annual award honors a farm for its extraordinary efforts to protect the environment through the preservation of soil and water quality while ensuring farm viability for future generations. Commissioner Ball announced that Table Rock Farm of Castile, Wyoming County, NY, having been nominated for the award by the Wyoming County Soil and Water Conservation District, was the 2021 recipient of the distinguished award.

Regarding the recognition, Meghan Hauser of Table Rock Farm said, "Our entire farm family is grateful for the AEM Leopold Award. It both recognizes the work we strive to do today, and the cumulative efforts of generations of Table Rock team members whose choices formed the core ethics of how we care for cows and how we work the land. We are pleased to be part of farms across New York State making sustainable choices every day to preserve soil health and water resources for future generations." Meghan's remarks perfectly summarize values and beliefs that direct the daily work of the team at the farm. Care of the farm's land and cows, and other farm business and farm family values guide decision making and farm practice implementation. For

example, Table Rock Farm's team of owner/operators, crop program manager and the crop crew provide feeds for the farm's dairy herd that meet or exceed quantity and quality objectives, while meeting soil health and water quality preservation objectives.

Before-After Analysis of Economic Performance: Methods and Data

For before-after analysis purposes, owner, Meghan Hauser, and Crop Specialist, Jeffrey Jordan, identified the period 2001 through 2020 as reflecting the 'after' period with its emphasis on improving soil health. For the period 2001 to present, to achieve improved soil health results while maintaining or increasing economic performance, the cropping program incorporates several soil health related practices -- crop selection and rotation, reduced tillage, nutrient management, cover crops. Meghan and Jeffrey believe that the farm's current crop production system successfully implements a full complement of soil health practices when compared to the former cropping program.

For comparison purposes, the period 1993 through 2000 reflects the 'before' period. Cover crops, conventional tillage practices and experimentation with soil health practices characterized the cropping program. During this period, the farm's crop team implemented some soil health practices, for example, cover crops, but did not necessarily implement the full complement of practices when compared to the current cropping program.

Analysts used a case study approach to examine the particular conditions and outcomes associated with Table Rock Farm's efforts to achieve the farm's environmental stewardship objectives. American Farmland Trust's Soil Health Case Study framework guided the up-close, in-depth, detailed examination of the objectives, decisions, practices, and results associated with Table Rock Farm's soil health system adoption (American Farmland Trust). This work covers the economic analysis component of the case study.

Selected features of this work's methods and data follow.

- Ristow, AFT, identified Table Rock Farm as a case study candidate, and obtained required commitments and permissions.
- To answer the question "*Can farm business owners in the Genesee River Watershed of New York (in this case, those of Table Rock Farm) achieve improved soil health and related outcomes while maintaining or improving economic performance?"* Ristow and Ag Stewardship Coordinator Stephanie Castle (AFT), and Hanchar (Cornell University/CALS, and CCE) worked with Meghan Hauser and Jeffrey Jordan of Table Rock Farm, to develop a before-after economic analysis.
- Ristow and Castle applied AFT's Soil Health Case Study Methods and Tools, including its questionnaire tools, to collect information regarding former practices, and the current cropping system where soil health practices assume important roles (American Farmland Trust)
- Analysts used profit concepts to measure economic performance, where profit is defined generally as the value of production (revenue) minus costs of production. Specifically, for this study, to measure profit, analysts used the value of crop production over selected cropping program costs (value of crop production minus selected costs). Assume that

this measure contributes positively to overall economic performance, profit of the farm business.

- Marginal analysis (comparable to partial budgeting basics) quantified the difference in profit that accompanied the implementation of soil health practices relative to the former cropping program. The marginal approach considered only the differences between the periods for value of harvested crops and cost factors (Kay). Analysts calculated the difference by subtracting the sum of differences in selected costs associated with the cropping program from the sum of differences in the values of harvested crops (here, referred to as difference in profit, or difference in the value of harvested crops above selected cropping program costs).
- Since Table Rock Farm has been a Cornell University Cooperative Extension Dairy Farm Business Summary (DFBS) Program cooperator for over three decades, analysts compiled cropping program analysis data for the period 1993 through 2020. The DFBS is a farm level; rigorous with regards to diagnostics, accuracy and confidentiality; annual farm business summary and analysis effort (Cornell University/CALS/CCE).
- Operators of Table Rock Farm
    - Defined the former cropping program as the relevant system for the period 1993 through 2000, the 'before' period
    - Defined the current cropping program with its full complement of soil health practices as the relevant system for the period 2001 through 2020, the 'after' period
    - established the study area as comprising 1,800 tillable acres, the quantity currently reported for the farm
- Data items for the analysis included acres harvested, yield, and production by harvested crop and crop related accrual expenses and machinery expense per tillable acre for each year of the analysis. See Table 1 for an example farm's DFBS Cropping Program Analysis report. Table Rock Farm's annual Cropping Program Analyses for the study period provided all data for the analysis except for: crop prices; prices received and paid indices; milking system repairs detail by year (see results and Table 2 notes for additional text regarding this item).
- Analysts calculated the value of harvested crops by year using the farm's production data per acre over time, and prices received by crop by year (USDA/NASS, 2021a), assuming a constant 1,800 tillable acres for comparison purposes.
- To express all dollar values in real terms, the analysis applied Producer Price Paid and Price Received indices, 2011 = 100, (USDA/NASS, 2021b).
- Annual data were used to calculate averages for the 'before' and 'after' periods and other simple descriptive statistics by factor.
- Differences by expense category and the difference in the value of harvested crops yielded the difference in the value of harvested crop above selected cropping program costs associated with the implementation of soil health practices, the 'after' period, compared to the former, conventional cropping system, the 'before' period.
- Analysts summarized, and documented results guided by AFT soil health case study tools (American Farmland Trust).

Results

Values for selected cropping program factors varied by period (Table 2).

The initial before-after analysis using data from the DFBS Cropping Program Analysis Report suggested that Table Rock Farm adopted an environmentally friendly soil health system while realizing an estimated $124,038 difference in annual value of harvested crops above selected cropping program costs when compared to the former system, a difference of $69 per tillable acre given 1,800 tillable acres (Table 3). Review and discussion of this initial analysis and results produced the following:

- Meghan noted the increased cost of $24 per acre for the "Machinery repairs & …" DFBS expense category, and asked about items included for the category.
- Analysts confirmed that the value from the Cropping Program Analysis report is the sum of equipment repairs, milking system repairs, farm vehicle expenses, and parts & supplies.
- Analysts and Meghan agreed that excluding milking system repairs from the related calculations would yield a more appropriate analysis – assuming record detail availability.
- DFBS cooperator records vary with respect to the level of detail available for expense categories, for example, machinery repairs and farm vehicle expense, and any sub categories, for example, equipment repairs, milking system repairs, farm vehicle expense, parts & supplies. Some provide detail, some do not. For some, frequency of reporting is quite variable year to year.
- Meghan provided necessary detail for the 'after' period, but the farm's DFBS records did not provide the necessary detail for the 'before' period.
- Analysis incorporates an estimate of average milking system repairs for the 'before' period. For additional detail please see Table 2 and its notes.

The analysis where milking system repairs are excluded from the "after minus before" calculation for the machinery repairs and farm vehicle expense item suggests that Table Rock Farm adopted an environmentally friendly soil health system while realizing an estimated $142,857 difference in annual value of harvested crops above selected cropping program costs when compared to the former system, a difference of $79.37 per tillable acre given 1,800 tillable acres (Table 4).

Discussion

Practices work together to achieve improved soil health outcomes while impacting the value of harvested crops and costs. Results reported in Tables 3 and 4 quantify differences in economic performance associated with the 'before' and 'after' periods. Note, we do not attribute differences to specific practices, because the DFBS data do not breakdown all cost categories by crop or specific farm operations.

The analysis using DFBS data excluding the milking system repairs does suggest that Table Rock Farm was able to successfully adopt soil health practices, alongside other changes in their field operations, while improving economic performance (Table 4).

- during the 'after' period, the farms' value of harvested crops above selected cropping program costs was on average $79 per acre greater than the value for the 'before' period, or$142,847 greater per year for the farm assuming a study area of 1,800 acres
- the ratio of the difference in profit to the sum of decreases to profit (a measure of return) equaled 125 percent

Given the farm's DFBS records, analysis indicates that the average value of harvested crops (price x yield) for the 'after' period was $111 per acre greater than the average for the 'before' period, and notably, more consistent year-to-year (Table 4). The soil health system – crop selection and rotation, tillage, nutrient management, and cover crops -- makes changes in resource allocation possible, allowing for the allocation of labor, machinery and other inputs to other activities.

While the above soil health system elements encompass numerous aspects of the farm's cropping program, Meghan noted the following practices for each's role in achieving the economic and environmental objectives of the farm.

- Changes in harvesting practices, notably, adoption of a "hay in a day" system
- Changes in seed selection – shorter season corn, BMR corn, Roundup Ready® (herbicide resistant) corn varieties, low lignin alfalfa and others

The analysis summarized in Table 4 reflects other positive effects on economic performance, decreased costs. The average "fertilizers and lime" expense for the 'after' period was $7 per acre less than the average for the 'before' period. Meghan attributes the difference to improving soil health and reducing synthetic fertilizer use by accounting for nutrients in applied manure. Meghan also notes that the since 2002 the farm develops and implements a Comprehensive Nutrient Management Plan (CNMP). Additionally, the average "spray and other crop expenses" for the 'after' period was $25 less than the average for the 'before' period. Jeffrey commented that, "we are spraying less," thanks to greater weed suppression and more resilient crops, outcomes of soil health system adoption.

Results summarized in Table 4 suggest that the farm experienced increases in "fuel, oil, and grease," "machinery repairs and farm vehicle expenses (excluding milking system repairs)," and "machine hire, rent, and lease" expense categories of $32, $13, and $10 per acre, respectively. These differences in costs cannot be attributed to any one change given DFBS data, but Meghan believes the addition of newly leased land, which required clearing, installing drainage, and manure applications, contributed to these increases. Note, these values reflect the cumulative effects of increases and decreases for the expense categories. The former increases combine with other increases and decreases to yield the difference in the cumulative expense for a category. For example, Jeffrey noted that as a practice in isolation, the adoption of no-till results in lower costs for the above machinery related expense categories when compared to conventional tillage with its numerous passes with multiple pieces of equipment.

Additionally, the average “seeds and plants” expense for the ‘after’ period was $7 per acre greater than the average for the 'before' period. Meghan and Jeffrey note the practice of purchasing improved seed varieties as a factor. For this before-after analysis using DFBS data, the seeds and plants expense category would also reflect expense increases and decreases associated with other crop management decisions over time – for example, seed expense associated with crop selection and rotation. Here, note that the farm has planted winter cover crops following corn for as long as Meghan remembers. Note again that this before-after analysis given DFBS captures, accounts for all items in an expense category, but does not isolate any single item in a category, for example, ‘seeds and plants’ expense by harvested crop. Despite these overall, cumulative cost increases, results suggest that generally, the Table Rock Farm successfully implemented a soil health system while improving economic performance.

Based upon the farm’s annual farm business summary and analysis information for the period 1993 through 2020, analysts noted the following:

- For the 1993 to 2000 period, the ‘before’, former cropping program period, value of harvested crops in real terms (2011 = 100) averaged $784 per acre annually, ranging from a low of $630 per acre to a high of $916 per acre.
- For the soil health system period, the ‘after’ period (2001 through 2020), the measure averaged about $895 per acre annually, about 14 percent greater than the average for the 1993 to 2000 period, ranging from a low of $636 per acre to a high of $1,143 per acre.
- In real terms,
    - the value of harvested crops for the ‘before’ period was less than or equal to $800 per acre, approximately the period average, four times during the 8 years of the period, 50 percent of the period’s years, while
    - the value of harvested crops for the soil health (after) period was less than or equal to $800 per acre four times during the period’s 20 years, 20 percent of the period’s years,

  suggesting that the soil health system provides a more favorable environment for managing risk and uncertainty, that is, fewer chances for unfavorable value of crop production outcomes.

For discussion purposes only, analysts calculated a value attributed to the more favorable risk management environment. This initial, preliminary analysis resulted in a value of $5 per acre per year (Apprendix A). Please note that this estimate was not included in the analyses described above and shown below in Tables 3 and 4.

Closing Thoughts

Table Rock Farm’s team of owners/operators, and family and non family managers and employees work to achieve farm business and family objectives, including those related to soil health and water quality preservation. Crop selection and rotation, tillage, cover crop, and nutrient management practices come together as a system to improve results. Overall, Table Rock Farm’s investment in soil health practices coincides with improved economic performance. The farm achieved improved soil health outcomes by successfully implementing soil health practices while increasing economic performance.

Acknowledgements

The authors acknowledge and appreciate

- the time and effort that owner Meghan Hauser and Crop Manager Jeffrey Jordan, Table Rock Farm, spent providing information, comments and suggestions for improving this work, and the farm's willingness to allow access to a range of farm level data, for example, DFBS records
- the time and effort provided by AFT reviewers Ellen Yeatman, Ben Wiercinski and Michelle Perez, and USDA/NRCS reviewers Courtney King, Laura Starr, and Bryon Kirwan -- reviewers' valuable comments, questions, and suggested revisions improved the analysis and reporting of its findings

This analysis is supported by a 2019 GLRI grant (00E02807) and a 2018 USDA NRCS CIG grant (NR183A75008G008).

The authors welcome questions, comments, suggestions, etc. to improve the value of this work. Please contact John Hanchar, <jjh6@cornell.edu>

References

American Farmland Trust. 2021. Soil Health Case Study Methods and Tool Kit. https://farmland.org/soil-health-case-studies-methods/. Washington, DC: American Farmland Trust, National office.

Cornell University/CALS/CCE. 2021. Dairy Farm Business Summary Program. http://dfbs.dyson.cornell.edu/. Ithaca, NY: Cornell University/College of Agriculture & Life Sciences/CCE.

Kay, Ronald D. 1981. Farm Management: Planning, Control, and Implementation. New York, NY: McGraw-Hill Book Company.

United States Department of Agriculture (USDA)/National Agricultural Statistics Service (NASS). 2021. Agricultural Statistics Annual Bulletin New York (various years). Washington, DC: USDA/NASS. https://www.nass.usda.gov/Statistics_by_State/New_York/

USDA/NASS. 2021. Quick Stats, (Searchable Database), various queries. Washington, DC: USDA/NASS. https://www.nass.usda.gov/Statistics_by_State/New_York/

Table 1. Selected items, Cropping Program Analysis report, page 11 of an annual DFBS report for an example farm[1].

LAND	Owned	Rented	Total
Tillable	300	150	450
Non tillable pasture	10	0	10
Other non tillable	13	0	13
Total	323	150	473
CROP YIELDS	Acres	Total Production	Production per Acre
Dry hay			
Baleage			
Hay crop silage			
Total Hay Crop Production	180		4.3 tons DM
Corn silage	110	2,300 tons	20.91 tons
			7.32 tons DM
Other forage			
Total Forage	290	1,620 tons DM	
Corn grain	100	12,000 bushels	
Oats	15	800 bushels	
Wheat	15	700 bushels	
Other crops			
Tillable pasture	30		
Idle tillable land			
Less double cropped acres			
Total tillable acres	450		
CROP RELATED ACCRUAL EXPENSES[2]			
Crop Expenses	Total Per Tillable acre		
Fertilizer & lime	$62.22		
Seeds & plants	$66.67		
Spray & other crop expense	$16.67		
Total Crop Expense	$145.56		
Machinery	Total for Farm	Per Tillable Acre	
Fuel, oil & grease	$15,700	$34.89	
Machinery repair & farm ve	$25,600	$56.89	
Machine hire, rent & lease	$7,700	$17.11	
Interest (5.000% of average leased)	$14,313	$31.81	
Depreciation	$15,000	$33.33	
Total Machinery Cost	$78,313	$174.03	

[1]See <http://dfbs.dyson.cornell.edu/>, click on "Sample Report.pdf"

[2]Expense values by category reflect information from a farm's annual DFBS and analysis report. To complete a DFBS record for a given year, the cooperating farm business owner provides information from the farm's record keeping system given the farm's chart of accounts. A key task during data collection and entry is the transfer of data from the farm's chart of accounts to the DFBS expense categories per DFBS/PRO-DAIRY guidance. Users, for example, analysts for this soil health case study, of information from a farm's annual DFBS reports, assume that a report's values reflect guidance, while acknowledging deviation is possible, but infrequent.

Table 2. Average values for selected cropping program analysis factors by period, Table Rock Farm[1].

Cropping Program Analysis Factor per DFBS, units in ()'s	Factor Average, Former Cropping Program (1993 through 2000)	Factor Average, Current, Soil Health System Period (2001 through 2020)
Tillable land (acres per cow)	1.2	1.5
Selected Crop Yields & Acres		
Total hay crop (tons DM per acre)	4.06	3.66
Corn silage (tons per acre)	20.90	23.57
Total forage production (tons DM per acre)	5.60	5.36
Other crops (acres)	0	59.24
Double Cropped (acres)	0	24.53
Crop Related Accrual Expenses ($ per acre[2])		
Fertilizer & lime	38.54	31.84
Seeds & plants	49.46	56.70
Spray & other crop expenses	73.55	49.05
Fuel, oil & grease	57.53	89.64
Machinery repair & farm vehicle expense	130.66	154.58
Estimated machinery repair & farm vehicle expense, excluding milking system repairs[3]	109.74	123.15
Machinery hire, rent & lease	8.77	19.22
Machinery ownership costs	296.81	221.93

[1]Source: Table Rock Farm business summary and analysis, various years (Cornell University/CALS & CCE).

[2]Real, inflation adjusted dollars, 2011 = 100 (USDA/NASS, 2021b)

[3]The Cropping Program Analysis page of a farm's DFBS report does not report this measure. Please see the results section above for this measure's use in analyses. To exclude milking system repairs from the general repair expense category, Meghan provided cash detail for the 'after' period, and analysts calculated the average milking system repairs cost per acre in real terms for the period, $31.43 per tillable acre. Estimated average machinery repair & farm vehicle excluding milking system repairs for the 'after' period equaled $154.58 minus $31.43, or $123.15 per acre in real terms.

Since farm records did not provide necessary detail for the 'before' period, analysts estimated an average for the 'before' period. Meghan noted that a new milking system was installed during

the 'before' period. Repair and maintenance expense for equipment tends to increase with age. Given the above, analysts identified the three lowest milking system repairs cost values from the 'after' period. Milking system repairs equaled $21.41, $20.31, and $21.04 per acre in real terms in 2013, 2014, 2018, respectively; and averaged $20.92 per acre in real terms. Estimated average machinery repair & farm vehicle excluding milking system repairs for the 'before' period equaled $130.66 minus $20.92, or $109.74 per acre in real terms.

Table 3. Calculated difference in value of harvested crops above selected cropping program costs, 'after' vs 'before' cropping programs, analysis version A, Table Rock Farm, Wyoming County, NY

Economic Effects of Soil Health Practices for Table Rock Farm, Wyoming County, NY (2021)							
Items that Increase Profit				**Items that Decrease Profit**			
Increases in Revenue				**Decreases in Revenue**			
Item	Per Acre	Acres	Total	Item	Per Acre	Acres	Total
Value of crop production	$111.42	1,800	$200,556	None Identified			
Total Increased Revenue			$200,556	**Total Decreased Revenue**			$0
Decreases in Selected Cropping Program Costs				**Increases in Selected Cropping Program Costs**			
Item	Per Acre	Acres	Total	Item	Per Acre	Acres	Total
Fertilizer & lime expenses	$6.70	1,800	$12,060	Seeds & plants expenses	$7.24	1800	$13,032
Spray & other crop input expenses	$24.50	1800	$44,100	Fuel, oil & grease expenses	$32.11	1800	$57,798
				Machinery repairs & farm vehicle exper	$23.91	1800	$43,038
				Machine hire, rent & lease expenses	$10.45	1800	$18,810
Total Decreased Cost			$56,160	**Total Increased Cost**			$132,678
Sum of Items that Increase Profit (A)			$256,716	**Sum of Items that Decrease Profit (B)**			$132,678
Total Acres in this Study Area			1,800	**Total Acres in this Study Area**			1,800
Annual Per Acre Profit Increases			$143	**Annual Per Acre Profit Decreases**			$74
Annual Change, Difference in Profit ((A) - (B))			= $124,038				
Annual Change, Difference in Profit per acre			= $69				
(Change in Profit/Sum of Profit Decreases)x100			= 93%				

Notes

For this analysis,

- the measure of profit (value of harvested crops above selected cropping program costs) is equal to the value of harvested crops minus selected cropping program costs
- The “Machinery repairs …” values do not separate, exclude detail by subcategory, for example, milking system repairs

For methods, data and other details see the text in the sections titled “… Methods and Data” and “Results”.

Table 4. Calculated difference in value of harvested crops above selected cropping program costs, 'after' vs 'before' cropping programs, analysis version B, Table Rock Farm, Wyoming County, NY

Economic Effects of Soil Health Practices for Table Rock Farm, Wyoming County, NY (2021)

Items that Increase Profit				Items that Decrease Profit			
Increases in Revenue				Decreases in Revenue			
Item	Per Acre	Acres	Total	Item	Per Acre	Acres	Total
Value of harvested crops	$111.42	1,800	$200,556	None Identified			
Total Increased Revenue			$200,556	Total Decreased Revenue			$0
Decreases in Selected Cropping Program Costs				Increases in Selected Cropping Program Costs			
Item	Per Acre	Acres	Total	Item	Per Acre	Acres	Total
Fertilizer & lime expenses	$6.70	1,800	$12,060	Seeds & plants expenses	$7.24	1800	$13,032
Spray & other crop input expenses	$24.50	1800	$44,100	Fuel, oil & grease expenses	$32.11	1800	$57,798
				Machinery repairs & farm vehicle exp.	$13.46	1800	$24,228
				Machine hire, rent & lease expenses	$10.45	1800	$18,810
Total Decreased Cost			$56,160	Total Increased Cost			$113,868
Sum of Items that Increase Profit (A)			$256,716	Sum of Items that Decrease Profit (B)			$113,868
Total Acres in this Study Area			1,800	Total Acres in this Study Area			1,800
Annual Per Acre Profit Increases			$143	Annual Per Acre Profit Decreases			$63

Annual Change, Difference in Profit ((A) - (B))	= $142,848
Annual Change, Difference in Profit per acre	= $79
(Change in Profit/Sum of Profit Decreases)x100	= 125%

Notes

For this analysis,

- the measure of profit (value of harvested crops above selected cropping program costs) is equal to the value of harvested crops minus selected cropping program costs
- The “Machinery repairs …” values exclude milking system repairs detail

For methods, data and other details see text in the sections titled “… Methods and Data” and “Results”

Appendix A. Valuing the Risk Management Environment Associated With Soil Health Systems: Potential Uses for Reservation Price for Insurance Concepts, Table Rock Farm, Wyoming County, NY

For discussion purposes only …

Hanchar, John J.[1] and Aaron Ristow[2]

[1]Cornell University/College of Agriculture & Life Sciences, [2]American Farmland Trust

Summary

- Farm business owners that adopt soil health systems frequently note experiencing greater stability with respect to crop production – relatively fewer occurrences of unfavorably low crop production, greater consistency regarding crops produced – harvested acres, yields, etc.
- Analysts used reservation price for insurance concepts to value greater stability, a more favorable risk and uncertainty environment.
- Preliminary results suggest that the value of stability, a more favorable risk management environment, in terms of a lower annual insurance premium per acre when compared to former cropping program, equals $5 per acre per year.

Introduction

Soil health system adoption by farm business owners plays a key role in achieving soil health, water quality, air quality and other environmental objectives. Work to achieve climate sustainability objectives, for example, the dairy industry's "Net Zero Initiative," will draw upon decades of work in the soil health systems area (Quaassdorff). At the farm level, business owners depend upon research based knowledge to make decisions regarding soil health practices, and to successfully adopt changes in practices.

Farm business owners seek comprehensive, thorough information regarding expected changes, differences in benefits and costs to plan and successfully implement soil health systems. A prominent and frequently mentioned topic from recent American Farmland Trust (AFT) Case Study work, including work in New York, is the observation by farmers that successful adoption of a soil health system leads to increased stability in outcomes – increased resiliency, reduced variability (American Farmland Trust). To date, based upon a limited review of previous work, work to quantify the value of increased stability is lacking, minimal.

The purpose of this work is to estimate the value of increased stability associated with successful adoption of soil health systems at the farm level. Likely included will be identification and evaluation of alternative analytical approaches. Content that follows reflects progress etc. to date.

Method, Approach (in progress)

Selected features of the method, approach follow.

- Review relevant previous work, literature – initial focus, "quantifying, valuing increased stability, resiliency associated with soil health systems adoption."

- Apply "reservation price for insurance" concepts designed to answer, "What is the most a consumer would be willing to pay for insurance against a loss?" (Frank). For discussion purposes only, analysts used data for Table Rock Farm for the analysis reported here.
- Select farms for analysis, collect data, calculate reservation prices and expected premiums by coverage level by farm.
- Incorporate findings into the AFT Economics of Soil Health Case Study work, and report findings via the case study network and other outlets.

Results and Discussion (preliminary)

Based upon the farm's annual farm business summary and analysis information for the period 1993 through 2020, analysts noted the following.

- For the 1993 to 2000 period, the former cropping program period, value of crop production in real terms (2011 = 100) averaged $784 per acre annually, ranging from a low of $630 per acre to a high of $916 per acre.
- For the soil health system period (2001 through 2020), the measure averaged about $895 per acre annually, about 14 percent greater than the average for the 1993 to 2000 period, ranging from a low of $636 per acre to a high of $1,143 per acre.
- In real terms,
    - the value of crop production for the pre soil health period was less than or equal to $800 per acre 4 times during the 8 years of the period, 50 percent of the period's years, while
    - the value of crop production for the soil health period was less than or equal to $800 per acre 4 times during the period's 20 years, 20 percent of the period's years

The relative frequency with which value of crop production amounts in real terms fell below $800 per acre, approximately the average for the pre soil health period, when compared to the soil health system period suggests that the soil health system provides a more favorable environment for managing risk and uncertainty, that is, fewer chances for unfavorable value of crop production outcomes, fewer occurrences of loss, less variability, greater stability.

Suppose the owners/operators of Table Rock Farm equipped with historical data

- wish to mitigate risks and uncertainties associated with value of crop production variability (see columns 1 and 2, Table 1, Appendix A below)
- define a loss equal to the actual value of production minus a coverage target value for all values of production less than the coverage target (please see Table 1, Appendix A for explanation of the coverage target used for the analysis)
- feel that when outcomes fall below the coverage target the business' abilities to achieve financial and other objectives -- for example, meeting cash obligations in a timely manner, meeting the quantity and quality objectives for feed, and others -- decline

For the 1993 through 2000 period, loss(es) (as defined above) occurred 2 times during the 8 year period, totaled about negative $49 per acre for the period, and averaged about negative $6 per acre per year. In comparison, for the 2001 through 2020 period, loss(es) occurred 1 time during

the 20 year period, totaled about negative $24 per acre for the period, and averaged about negative $1 per year (Table 1, Appendix A).

Analysis for the 'before' period suggests that the farm business owner would be willing to pay at most $6 per acre per year for fair gamble coverage (actuarially fair) insurance against a loss, excluding administrative and other risk shifting charges. In exchange for premium payments the insured mitigates, reduces the negative, undesirable effects of unfavorable outcomes, risks and uncertainties. Analysis for the 'after' period suggests that the farm business would be willing to pay at most $1 per acre year to shift risk to an insurer **given the conditions etc. for this "for illustration and discussion purposes only" analysis**. A decision maker would be willing to pay at most $1 per acre per year for insurance coverage against a loss given the soil health period's variability in outcomes.

Closing Thoughts

Analysis suggests that given the risk and uncertainty environment of the soil health systems period 2001 through 2020 farm managers from a case study farm would be willing to pay at most $1 per acre per year for fair gamble insurance, excluding administrative and other risk shifting charges, against a loss (value of crop production less than a target coverage level). Compare this value to $6 per acre per year for the former cropping program period 1993 through 2000. The lower maximum pay value, suggests that a more favorable risk management environment – reduced variability, increased stability with respect to value of crop production outcomes – is characteristic of the soil health system when compared to the former cropping program.

References

American Farmland Trust. 2021. Genesee River Demonstration Farms Network. < https://farmland.org/project/genesee-river-demonstration-farms-network/>

Frank, Robert H. 1991. MICROECONOMICS AND BEHAVIOR. New York, NY: McGraw-Hill, Inc. pp. 189 – 196.

Quaassdorff, Margaret. 2021. "Dairy Farms as the Leaders of Climate Neutrality." AG FOCUS. Batavia, NY: Cornell University/CALS/CCE/NWNY DL&FC Program. (April 2021): pp. 13 & 14.

Table 1, Appendix A. Value of Crop Production (Real Terms, 2011 = 100) (dollars per acre) and Loss (dollars per acre) by Year, Table Rock Farm, Wyoming County, NY

Year	Value of Crop Production[1]	Loss[2]
	($/acre)	($/acre)
1993	629.54	-30.46
1994	665.29	0
1995	790.88	0
1996	641.86	-18.14
1997	850.63	0
1998	932.06	0
1999	915.65	0
2000	849.63	0
2001	787.25	0
2002	875.35	0
2003	885.57	0
2004	635.86	-24.14
2005	789.16	0
2006	1024.22	0
2007	698.97	0
2008	1025.40	0
2009	900.11	0
2010	892.23	0
2011	847.07	0
2012	1147.65	0
2013	1088.51	0
2014	880.58	0
2015	914.03	0
2016	950.23	0
2017	906.19	0
2018	942.07	0
2019	893.76	0
2020	854.63	0

[1]annual crop production valued in real terms, 2011 = 100

[2]Loss in real terms equals the value of crop production minus the coverage target when the result is less than 0, else loss equals 0. For discussion, illustration purposes, suppose the coverage target equals the mean value of crop production for the 1993 through 2000 minus 1 standard deviation, or $784 per acre minus $124 per acre, or $660 per acre. For example, consider the year 1993 -- $629.54 minus $660 equals negative $30.46 per acre, a loss. In contrast, for 2020, $854.63 is greater than the target and the loss is 0.

Authors: John J. Hanchar[1] and Aaron Ristow[2]
Author Affiliations: [1]Cornell University/CALS and CCE/NWNY Dairy, Livestock & Field Crops Program
[2]American Farmland Trust
Publisher: Washington, DC: American Farmland Trust
Page numbers: 20
Publication date: November 2022
Publication type: Working Paper
Publication number: 2022-01
State: NY
Keywords: soil health, economic, environmental, benefits, costs, cover crops, tillage, nutrient management