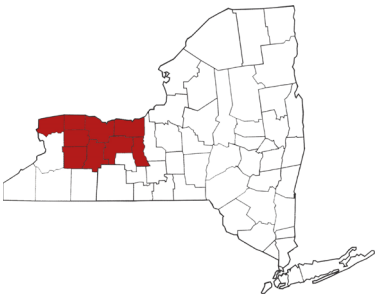
Working Paper No. 2021-01
July 21, 2021



Cornell Cooperative Extension

Northwest NY Dairy, Livestock and Field Crops Program

Working Paper

Cornell University/College of Agric. & Life Sciences/CCE
NWNY Dairy Livestock and Field Crops Program, Batavia, NY 14020 USA

Achieving Improved Soil Health Outcomes While Maintaining or Improving Economic Viability: Case Study of 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/CCE/NWNY Dairy, Livestock, and Field Crops Program. [2]American Farmland Trust

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

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

Aaron Ristow, American Farmland Trust, <aristow@farmland.org>

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

Summary

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

Background

Since 2008, Forrest Watson has farmed with the owners and primary operators of the Mulligan Farm -- Uncle, Jeff Mulligan, and Aunt, Lesa Mulligan. Other family members and non family employees comprise the balance of the labor force. Currently, land resources include about 2,600 tillable acres, while the average number of dairy cows for the year totals 1,500. Principals of the Mulligan Farm (est. 1920) seek to improve efficiencies and provide the best care for animals, land and employees.

Forrest, Equipment and Crop Manager, and the crop crew provide feeds for the Mulligan Farm's dairy herd that meet or exceed quantity and quality objectives. Environmentally friendly land practices, grounded in the farm's values regarding the care of land resources, receive emphasis. Means for achieving objectives include: crop selection and rotation choices; reduced relative to conventional, or zero tillage practices; cover crops; and nutrient management. Forrest draws upon participation in conferences, other educational activities including frequent reading on soil health topics, crop advisors, and investigation to plan and implement the cropping program.

Regarding a time line to identify before and after settings, Forrest identified 2015 as the year in which the farm implemented the current system. Conventional practices describe the cropping system prior to 2015. For the period 2015 to present, to achieve improved soil health results while maintaining or improving economic performance, the cropping program includes several soil health related practices.

Crops harvested include: an alfalfa, grass mix; corn (always for silage, some years, some acres for grain); wheat; other forage crops, for example, double cropped winter cereals for forage following corn silage. One year of wheat (about 300 acres) is followed by 3 years of alfalfa, grass mix (roughly 1,000 acres). The sequence ends with 4 years or corn (corn ground totals about 1,300 acres annually).

For corn production under the current cropping program, prior to planting with a conventional row crop planter, 800 of the 1,300 acres are strip tilled. The balance is not tilled. For current wheat crop production, prior to planting with a no till drill, land receives no tillage. The former wheat program included chisel plow and field cultivator passes before planting. For establishment of alfalfa hay crops, prior to planting with a no till drill, land receives no tillage. One pass with a moldboard plow, and multiple passes with a culti-mulcher or field cultivator characterized the former alfalfa crop program.

Alfalfa and wheat crops provide ground cover during the non growing season. On all 1,300 corn acres, during the non growing season, a 6 way mix or winter cereals, some double cropped for forage, provide cover.

Frequent soil sampling including zone and, or grid sampling; fall or spring manure application via drag hose and injection; split applications of chemical fertilizers characterize current practices.

The economic analysis component of the case study sought to answer the following question: *Can farm business owners in the Genesee River Watershed of New York (in this case, those of the Mulligan 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 quality.

Methods

Analysts used a case study approach to examine the particular conditions and outcomes associated with the Mulligan Farm's efforts to improve soil health. 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 the Mulligan Farm's soil health system adoption (American Farmland Trust). This work covers the economic analysis component of the case study.

Selected features of methods used follow.

- Ristow, AFT, identified the Mulligan Farm as a case study candidate, obtained required commitments and permissions. To answer the question above asked by farm business owners, Ristow and Hanchar (Cornell University/CALS/CCE) worked with Forrest Watson, the Mulligan Farm, to develop a before-after economic analysis.
- Ristow 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, systems assume important roles (American Farmland Trust)
- The study's measure of economic performance is a measure of change in profit, and equals the sum of changes in the value of crop production minus the sum of changes in selected costs associated with the cropping program (here, referred to as change in profit or change in the value of crop production above selected cropping program costs).

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

- Marginal analysis (partial budgeting) quantified the expected difference, change in profit that accompanied the implementation of soil health practices relative to the former, conventional cropping system. Note that this marginal approach considers only the differences between the periods for value of crop production and cost factors (Kay).
- Since the Mulligan Farm has been a Cornell University Cooperative Extension Dairy Farm Business Summary (DFBS) Program cooperator for over two decades, analysts compiled cropping program analysis data for the period 1998 through 2019. 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).
- Ristow and Watson
    - Defined the former, conventional cropping system as the relevant system for the period 1998 through 2014
    - Defined the after, current soil health system as the relevant system for the period 2015 through 2019
    - established the study area as comprising 2,618 tillable acres, the quantity currently reported for the farm
- Data items included acres harvested, yield, and production by crop harvested; expense per tillable acre for: fertilizer & lime, seeds & plants, spray and other crop expenses, and related machinery costs (fuel, oil & grease, machinery repair & farm vehicle expense, machine hire, rent & lease, and machine ownership costs).
- Analysts calculated the value of production by crop by year using the farm's production data over time, and prices received by crop by year (USDA/NASS, 2021a), assuming a constant 2,618 acres tillable for comparison purposes.
- Adjusted all nominal monetary values to values in real terms using Producer Price Paid and Price Received indices, 2011 = 100, (USDA/NASS, 2021b)
- Calculated averages and other simple descriptive statistics by factor for the before and after periods
- Calculated differences by factor and the change, difference in the value of crop production above selected cropping program costs associated with the implementation of soil health practices compared to the former, conventional cropping system
- 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, pre and post soil health practice adoption (Table 1).

Marginal analysis suggests that the Mulligan Farm adopted an environmentally friendly soil health system while realizing an estimated $196,350 increase in annual value of crop production above selected cropping program costs when compared to the former system, an increase of $75 per tillable acre given 2,618 tillable acres. (Image 1).

Discussion

Forrest notes that "with the no-till drill we're capable of planting more acres given available resources." Efficiency of operations, reduced inputs for tillage are notable. Changes in tillage practices, **in isolation**, can be expected to reduce machinery costs. However, cover crops, double cropping and other soil health practices can be expected to increase machinery costs. Image 1 reflects the combined effects of practices.

Regarding cover crops, Forrest notes, "… after rain, harvest continues the next day, operation efficiency goes up." Cover crops help the farm no till corn crops versus strip till – the improved soil is easier to no till. Forrest notes, we are "breaking up compaction with roots, not iron, saving time in the process." Resources freed up are now used for other purposes. Winter cereals for forage, for example, triticale following corn silage, provide cover, and forage quantity and quality to meet goals.

More frequent testing, measuring of key nutrient factors, helps to identify optimal rates, timings, location, and methods of nutrient use. Forrest notes "reduction in synthetic nutrients due to better nutrient capture with cover crops." Note the decreased cost of fertilizers and lime, and the increase in the total value of crop production in Image 1.

Practices work together to achieve improved soil health outcomes while impacting value of crop production and costs. The differences reported in Image 1 quantify the combined effects for value of crop production and costs items attributed to the system. For example, the value of production difference reflects Forrest's description of tillage changes that reduce input use -- labor, machinery, and others -- allowing resources to be allocated to other activities, for example, growing and harvesting double crops; and consistently growing and harvesting crops like wheat, and corn grain when conditions permit. For the Mulligan Farm, value of production accompanying the current cropping system with its emphasis on improving soil health (2015 through 2019) averaged $198,968 more when compared to the former, conventional cropping program.

When asked whether soil health practices had any effect on resilience when faced with varying weather outcomes, conditions, Forrest notes, the farm is realizing "More stable yields. Resiliency is a big, notable factor. …" Using the farm's annual farm business summary and analysis information for the period 1998 through 2019 analysts noted the following.

- For the 1998 to 2014 period, the pre soil health systems period, total value of crop production in real terms (2011 = 100) averaged $675 per acre annually, ranging from a low of $399 per acre to a high of $902 per acre.
- For the soil health system period (2015 through 2019), the measure averaged $751 per acre annually, about 11 percent greater than the average for the 1998 to 2014 period, ranging from a low of $663 per acre to a high of $880 per acre.
- Note that the average for the soil health system period is greater than the average for the former cropping system, while the range for the soil health system is less when compared to the conventional cropping system, suggesting less variability, greater stability.

Closing Thoughts

Owners of the Mulligan Farm, with contributions from individuals with key management responsibilities, seek to increase operational efficiencies while providing the best care for animal, land and people resources. Forrest Watson, Farm Equipment and Crop Manager, sees to the best care of land. Commitment to using the most environmentally friendly practices guides crop production. Crop selection and rotation, tillage, cover crop, and nutrient management practices come together as a system to improve results. Allocations of labor among possible uses have changed. For example, less labor allocated to tillage allows labor to be allocated to activities that provide additional crop value on a more consistent basis -- cover crop establishment, double cropping winter cereals for forage following corn silage, growing and harvesting wheat and other crops. Overall, the Mulligan Farm's investment in soil health practices coincides with improved economic performance.

Acknowledgements

The authors acknowledge and appreciate

- the time and effort that principals from the Mulligan Farm spent providing information, and the farm's willingness to allow access to a range of farm level information sources, for example, DFBS records
- the time and effort provided by reviewers Dayton Maxwell, Farm Business Management Specialist, Cornell University/Cooperative Extension, and Joan Petzen Farm Business Management Specialist, Cornell University/Cooperative Extension -- reviewers' valuable comments, questions, and suggested revisions improved this reporting of findings

This work benefitted from financial and other support provided by the American Farmland Trust.

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. Average values for selected cropping program analysis factors by period, the Mulligan Farm[a].

Cropping Program Analysis Factor per DFBS, units in ()'s	**Factor Average, Former Cropping System, Pre Soil Health System (1998 through 2014)**	**Factor Average, Soil Health System Period (2015 through 2019)**
Tillable land (acres per cow)	1.99	1.98
Crop Yields		
Total hay crop (tons DM per acre)	4.1	3.6
Corn silage (tons per acre)	17.7	17.4
Total forage production (tons DM per acre)	5.0	5.0
Wheat (bushels per acre)	66	81
Crop Related Accrual Expenses ($ per acre[b])		
Fertilizer & lime	55	44
Seeds & plants	48	56
Spray & other crop expenses	41	79
Fuel, oil & grease	67	48
Machinery repair & farm vehicle expense	101	103
Machine hire, rent & lease	63	37
Machine ownership costs	171	181

[a]Source: the Mulligan Farm business summary and analysis, various years (Cornell University/CALS/CCE)
[b]Real, inflation adjusted dollars, 2011 = 100 (USDA/NASS, 2021b)

Image 1. Differences, changes in annual profit ($ per acre and total $ for the farm), Mulligan Farm (Capture of worksheet table from R-SHEC workbook)

Farmer Name
Mulligan Farm, Inc. (Forrest Mulligan), Avon, NY
Watershed Name
Genesee River - New York

Table 1. Estimated Change in Profit, Marginal, Before Tax, Annual Analysis, Post Soil Health (SH) Practices/System Adoption Compared to Previous Crop/Soil Mangement Practices, Mulligan Farm, Inc., NY, Price Indices Adjusted $'s (2011 = 100).

Items that Increase Profit			
Total Value of Production (TVP), Increases			
Item	**Per Acre**	**Acres**	**Total**
Value of crop production	$76.00	2,618	$198,968
TVP Increases, Total			**$198,968**
Costs, Decreases			
Item	**Per Acre**	**Acres**	**Total**
Fertilizers & lime	$11.00	2,618	$28,798
Fuels, oils & greases	$19.00	2,618	$49,742
Machinery hire, rent & lease	$27.00	2,618	$70,686
Costs, Decreases Total			**$149,226**
Items that Increase Profit, Total			**$348,194**
Total Acres in this Study Area			**2,618**
Items that Increase Profit, Total per acre			**$133**

Items that Decrease Profit			
TVP, Decreases			
Item	**Per Acre**	**Acres**	**Total**
			$0
TVP Decreases, Total			**$0**
Costs, Increases			
Item	**Per Acre**	**Acres**	**Total**
Seeds & plants	$8.00	2,618	$20,944
Spray & other crop expenses	$38.00	2,618	$99,484
Machinery repair & farm vehicle expenses	$2.00	2,618	$5,236
Other machinery expenses	$10.00	2,618	$26,180
	$0.00	0	$0
Costs, Increases Total			**$151,844**
Items that Decrease Profit, Total			**$151,844**
Total Acres in this Study Area			**2,618**
Items that Decrease Profit, Total per acre			**$58**

Estimated Change in Profit, Farm (Annual)	**= $196,350**
Estimated Change in Profit, ($ per acre, Annual)	**= $75**
Estimated Change in Profit/Profit Decreases Total (%)	**= 129%**

Selected assumptions, notes (please see Methods section for greater detail).

Marginal, before tax, annual analysis estimating the change, difference in profit (tvp - costs), $/acre and $ for the farm, associated with the cropping system that incorporates soil health practices, systems compared to the former, conventional cropping system (prior to full range of soil health practice, system adoption).

Table reflects differences in average valus for only those value of production and cost items that differ between the current and former scenarios.

This table represents costs and benefits over the entire study area (2,618 tillable acres) as reported by the farmer.

All values expressed in real terms, $ where 2011 = 100 (Producer Price Index and Prices Received Index from USDA/Ag Statistics Service. Various reports, years). A difference is calculated by subtracting the value for the former scenario from the value for the current scenario, where a former value is the average calculated for the period, 1998 through 2014, and a current value is the average calculated for the period 2015 through 2019.

Averages for current and former time periods calculated using: 1) historical cropping program analysis data reported annually via farm business summary and analysis work (Cornell University Cooperative Extension's Dairy Farm Business Summary Program, <dfbs.cornell.edu>); and 2) prices received data (USDA/NASS/NYS Agricultural Statistics Service).

Except for prices paid and received indices, and prices received by crop, data are from the "Cropping Program Analysis" page from the farm's DFBSs over time -- acres harvested, production, yield per acre by crop; and fertilizer & lime, seeds & plants, sprays and other crop expenses, variable and fixed machinery costs per acre.

Here, per AFT tools, the return on investment value as a percent equals the estimated change in profit associated with soil health system adoption ($75 per acre) divided by the sum of items that decrease profit ($58 per acre) times 100.

For information about: (1) study methodology, see https://farmland.org/soilhealthcasestudies; (2) USDA's Nutrient Tracking Tool, see https://www.oem.usda.gov/nutrient-tracking-tool.ntt; (3) USDA's COMET-Farm Tool, see http://cometfarm.nrel.colostate.edu/.

This material is based on work supported by American Farmland Trust, and other state and local funding.