Nutrient Management

Burrier's Linganore Farm, MD
SOIL HEALTH CASE STUDY

APRIL 2024

David Burrier, his wife Belinda, and their nephew Jesse Moats operate 1,100 acres of rolling farmland in Frederick County, Maryland. David purchased the farm from his father in 2002, transitioning it from a dairy to a row crop operation. Soon after, David's agronomist recognized a reduction in soil fertility due to no longer applying dairy cow manure. Together, they updated the farm's nitrogen (N)-based nutrient management (NM) plan, focusing on building soil organic matter. In 2008, Maryland mandated that farm fields with high phosphorous (P) levels and/or surface water proximity adopt P-based NM plans,[1] which led the Burriers to approach NM differently, the focus of this case study. The study area is 900 acres where the Burriers grow 1-year corn, 1-year soybeans, 1-year wheat, and 6-years grass or alfalfa hay, which they market at a premium to Baltimore's Pimlico racetrack.

David was initially skeptical of the state mandate, believing the farm would see yield reductions. But soon after, the Burriers were managing their cropland according to the "4Rs" of NM (right time, right rate, right place, right source). Prior to 2008, David and Belinda would only apply a dry fertilizer mix in the spring before planting. By following "right time" and "right rate" guidelines, they added split N applications at V4 and V8 for corn and at green-up and Feekes stage 5 for wheat. For soybeans, they added split liquid foliar applications at V4 and R2. For grass hay, they began a split dry fertilizer application and added a spring liquid N with sulfur application. As a result, crops receive nutrients at critical growth stages. In 2008, 87 fields had a high P Fertility Index Value (FIV) of 150 or greater. As of 2023, all but two fields are below 150 FIV in accordance with the P-based NMP.

In 2016, to address "right place" of NM, the Burriers switched from banding 11-37-0 on corn to setting up their corn planter to apply 6-24-6 liquid in-furrow. This resulted in less P applied while also making nutrients more available to corn seedlings. They further improved the rate and placement of their nutrients in 2021 by switching from grid sampling to zone soil sampling and implementing variable rate applications of N, P, and potassium (K).

Also in 2016, David and Belinda began experimenting with "right source" to improve nutrient use and yields, settling on coated urea for corn, MAP (a switch from DAP) for soybeans, and Ammonium Thiosulfate (ATS) for corn, wheat, and grass hay. Adopting tissue sampling on their row crops in 2018 identified a need to apply micronutrients, which led to the use of foliar spray applications with humic acid and sugar on corn, soybeans, and wheat.

David says, "We have great respect for Linganore Creek (a tributary to the Chesapeake Bay). Our water quality tests validate that the water is leaving cleaner than when it comes to our property. We are committed to preserving this great natural resource." The Burriers' stewardship ethic earned their family the Maryland Leopold Conservation Award in 2023.

Soil Health, Economic, Water Quality, and Climate Benefits

Partial budgeting analysis was used to estimate the marginal benefits and costs of a change in NM on Burrier's Linganore Farm. The study was limited to only those income and cost variables affected by the adoption of NM. The table on page 2 presents a summary of the economic effects revealing that, due to NM, Burrier's Linganore Farm's net income increased by $70/ac/yr on the 900-acre study area, achieving a 108% return on investment.

The largest increase in net income was due to significant increases in average crop yield. Of the Burriers' total average yield increases since 2008, David attributed 35% of the per acre row crop yield increases (29 bu corn, 5 bu soybean, and 14 bu wheat) and 50% of the per acre hay yield increases (0.6 ton grass, 0.5 ton alfalfa, and 0.2 ton wheat straw) to NM, recognizing that other factors influence yield. This resulted in an estimated increase of $122/ac/yr on average. Additionally, he receives $48/ac/yr more on the 100 acres of wheat from straw harvest.

David notes, "In a dry or wet year, our crop is more resilient than our neighbors. Those years when we see the benefits so clearly, we are re-motivated to continue to tweak our operation to make it better!"

David & Belinda Burrier

Farm at a Glance

COUNTY: Frederick, MD

WATERSHED: Chesapeake Bay

CROPS: Corn, soybeans, wheat, grass hay, & alfalfa hay

FARM SIZE: 1,100 acres (900-acre study area)

SOILS: Silt loam on rolling hills of 3–8% slopes

SOIL HEALTH PRACTICES: Nutrient management

100% no-till for over 20 years

American Farmland Trust
MILLION ACRE CHALLENGE
USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

David also adds, "Increased yield is not the only benefit we see from improving fertilizer use efficiency. We also see greater water holding capacity, less weed pressure, and organic matter levels increasing from 2% in 2003 to 4.5% in 2023."

AFT estimated the average change in pounds of N, P, and K applied historically (pre-2008) compared to recent years. The Burriers initially reduced their N and K applications, but with increased crop yields, adopting split application, and banding, they have now increased their N and K applied to all crops, resulting in a $30/ac/yr average cost increase. They have reduced their P application on all crops, saving $6/ac/yr. Based on the Burrier's records, their plant Nutrient Use Efficiency[2] has improved for P on all crops, for N on all crops but hay, and for K on wheat and alfalfa, applying fewer pounds of N, P, and K per unit of production across all crops.

An additional cost increase is the slightly higher machinery costs of $11/ac/yr due to the additional passes with the switch to split application.[3] The second largest increase in cost is the addition of foliar spray and micronutrients: $26/ac/yr. David also incurred additional costs of $1.18/ac/yr for adopting zone soil sampling and tissue sampling.

AFT used USDA's Nutrient Tracking Tool to evaluate the Burriers' changes in NM on a 47-acre representative field and found that they reduced their N, P, and sediment losses by 22%, 10%, and 11%, respectively.

Closing Thoughts

Though initially skeptical of the 2008 mandate, Belinda now says, "We have a wide-open view and ask why we do this or that. At first, the answer was, 'Well, we've always done it that way,' but we soon realized change and innovation are good." As a result, adds David, "Now we have visitors come to Maryland to see what is working here and what might fit their own farm. Our mandatory nutrient management plan is the toughest in the nation, and it's made Maryland farmers environmental leaders of our country."

Writers: Lia Raz & Kent Bohnhoff

ECONOMIC EFFECTS OF SOIL HEALTH PRACTICES ON BURRIER'S LINGANORE FARM, MD (2023 PRICES)[4]

Increases in Net Income

Increase in Income

ITEM	PER ACRE	ACRES	TOTAL
Increase in all cash crop yields	$122	900	$110,148
Increase in wheat straw yield (0.2 ton/ac)	$48	100	$4,800
Total Increased Income			**$114,948**

Decrease in Cost

ITEM	PER ACRE	ACRES	TOTAL
Decrease in phosphorus applied due to adoption of phosphorus-based nutrient management plan	$6	900	$5,819
Total Decreased Cost			**$5,819**
Annual Total Increased Net Income			**$120,767**
Total Acres in this Study Area			**900**
Annual Per Acre Increased Net Income			**$134**

Decreases in Net Income

Decrease in Income

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

Increase in Cost

ITEM	PER ACRE	ACRES	TOTAL
Increase in nitrogen & potassium applied due to increase in crop yield	$30	900	$26,649
Switch from applying liquid fertilizer on the surface to in-furrow on corn	$0.50	370	$185
Increase in machinery operations due to adopting split application practices	$11	870	$9,370
Introduced foliar & micronutrient applications	$26	800	$20,601
Switched to zone soil sampling every 2 yrs from traditional grid sampling every 3 yrs	$0.75	900	$675
Adopted tissue sampling (15 samples/yr)	$0.43	900	$387
Learning activities (8 hrs/yr)			$243
Total Increased Cost			**$58,110**
Annual Total Decreased Net Income			**$58,110**
Total Acres in this Study Area			**900**
Annual Per Acre Decreased Net Income			**$65**

Annual Change in Total Net Income = $62,657

Annual Change in Per Acre Net Income = $70

Return on Investment = 108%

[1] For more information on how Maryland farms were identified to implement a P-based NM plan, see mda.maryland.gov/resource_conservation/counties/PMTUMD.pdf [2] Nutrient Use Efficiency is a measurement of how efficiently plants convert absorbed nutrients into biomass or yield considering the total amount of nutrients available in the soil and applied through fertilizers. [3] Machinery costs include cost of equipment, custom hire, labor, depreciation, interest, insurance, housing, repairs, and fuel (ISU, 2023, *Ag Decision Maker: Custom Rate Survey*.) [4] This table represents estimated average costs and benefits attributed to adopting a P-based NM plan over the entire study area (900 acres) where corn, soybeans, wheat, & hay are grown, as reported by the farmer.

• Rounding of per acre values may result in minor discrepancies in totals. • All values are in 2023 dollars. • Prices used in the analysis: Corn Grain: $5.65/bu, Soybeans: $13.26/bu, Wheat: $7.06/bu (USDA NASS, *Crop Values Summary,* 2019-2023 average); Alfalfa: $400/ton, Grass Hay: $280/ton, Wheat Straw: $280/ton (farmer-provided); Nitrogen: $.63/lb, Phosphate: $.61/lb, Potash: $.54/lb (ISU, Ag Decision Maker: *Estimated Costs of Crop Production, 2019-2023 average*). • For information about (1) study methodology, see farmland.org/soilhealthcasestudies; (2) USDA's Nutrient Tracking Tool, see ntt.tiaer.tarleton.edu. • This material is based on work supported by a USDA NRCS CIG grant NR183A750008G008 and a National Fish and Wildlife Federation Innovative Nutrient and Sediment Reduction award #73981.

For more information about this case study, contact:
Amanda Cather, American Farmland Trust, Mid-Atlantic Senior Program Manager, acather@farmland.org
To discuss soil health practices, contact: Brent Cammauf, NRCS District Conservationist, brent.cammauf@usda.gov, 301-695-2803 ext. 8580; or Heather Hutchinson, SWCD District Manager, hhutchinson@frederickcountymd.gov, Frederick County Office, 301-695-2803