Northern New York Agricultural Development Program
2022 Project Report

Whole Farm Sustainability Assessments – Protecting the Environment and Saving Dollars! 2022

Project Leader

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Collaborators

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- Miner Institute, Chazy, NY: Rick Grant, Laura Klaiber, Allen Wilder
- Cornell University Campus: Olivia Godber, Agustin Olivo, Kirsten Workman
- Three dairy farms in Northern NY

Background

A whole farm nutrient mass balance (NMB) assessment is a calculation of the difference in nitrogen (N), phosphorus (P), and potassium (K) imported (in the form of feed, fertilizer, animals, and bedding) onto a farm and nutrients exported off the farm in milk, crops, animals, and manure. In 2022, farms (3) in Northern New York and elsewhere (7) in New York participating in the annual whole farm nutrient mass balance assessment received farm-specific annual reports that show how they compare to their peers and to feasible benchmarks for NMBs per acre and per hundredweight of milk produced.

The farmer report also shows trends in balances over time for farms that participate in multiple years, and an "opportunity table" with key performance indicators (KPIs) that can be used to "trouble-shoot" (identify) areas for improvement). In the report, farm specific numbers are compared to all other dairy farms in the assessment (anonymously). The NMB report provides the farm with an assessment of its environmental sustainability and resource-use (fertilizer, manure, feed, etc.) efficiency, and can guide dairy farm management practices to maximize productivity on-farm while minimizing environmental impact.

Farms that have participated in the NMB assessment for multiple years tend to make improvements over time, for reduced cost of production and enhanced protection of the environment from excess nutrients. Key performance indicators that are currently in the opportunity table include %CP (crude protein) and %P (phosphorus) in the diet, feed-use efficiency, fertilizer use per acre, percent homegrown forage in the diet, etc.

While reducing a farm's nutrient balance will help reduce greenhouse gas (GHG) inventories and, while better distribution of manure will advance soil health and carbon (C) sequestration over time, we need better ways to document such improvements. This is especially important as the dairy industry is increasingly being asked to report more sustainability indicators, including GHG, water use, water quality impacts, animal and plant production efficiencies, animal welfare, and biodiversity on farms.

For this NNYADP-funded project, we worked with three dairies in Northern New York to determine NMBs and evaluate GHG inventories using Cool Farm Tool (CFT), adding to seven other dairies in the statewide project. The overall goal is to identify drivers for both nutrient use and GHG emissions that are relevant to dairy farming not only in the Northern New York region, but across New York State.

Methods

Three Northern NY dairy farms shared three years (2019–2021) of data needed to run the most relevant/promising sustainability tools, including the NMB and Cool Farm Tool GHG module. From this, we calculated their annual NMB and GHG inventory for three years. By combining the data from the three farms with seven farms located elsewhere in New York State, the research team has begun to identify the drivers, or KPIs, impacting the environmental footprint of these farms. Through what-if scenarios, using the CFT module, we modeled the impact of past management changes on individual farm GHG inventories, and potential impact of implementing additional beneficial management practices in the future.

Results

Whole-farm nutrient mass balance

In 2019, 2020, and 2021, the median P balances per acre and per cwt (hundredweight of milk) for farms in Northern NY were both within the feasible range, while the N and K balances per acre and per cwt milk exceeded the feasible range by 22 lbs N/acre and 1 lb K/acre, on average (Table 1). The red dots in Figure 1 show where the Northern NY farms operated, compared to the other NY farms in 2019, 2020, and 2021.

Table 1: Nutrient mass balances for Northern NY, other NY farms, and feasible balances in 2019, 2020, and 2021.

		Northern NY records (n = 23)	Other NY records (n = 99)	Feasible balances
		Balance per acre		
Nitrogen	Median balance (lbs/acre)	127	104	> 0 and ≤ 105
	% of farms meeting feasible limits	39%	43%	
Phosphorus	Median balance (lbs/acre)	9	9	> 0 and ≤ 12
	% of farms meeting feasible limits	**61%**	47%	
Potassium	Median balance (lbs/acre)	38	40	> 0 and ≤ 37
	% of farms meeting feasible limits	48%	36%	
		Balance per cwt milk		
Nitrogen	Median balance (lbs/cwt milk)	1.07	0.67	> 0 and ≤ 0.88
	% of farms meeting feasible limits	39%	51%	
Phosphorus	Median balance (lbs/cwt milk)	0.09	0.07	> 0 and ≤ 0.11
	% of farms meeting feasible limits	**70%**	57%	
Potassium	Median balance (lbs/cwt milk)	0.35	0.28	> 0 and ≤ 0.30
	% of farms meeting feasible limits	43%	48%	
		Optimal Operational Zone "Green Box"		
Nitrogen	% of farms meeting feasible limits	22%	36%	
Phosphorus	% of farms meeting feasible limits	**52%**	41%	
Potassium	% of farms meeting feasible limits	26%	31%	

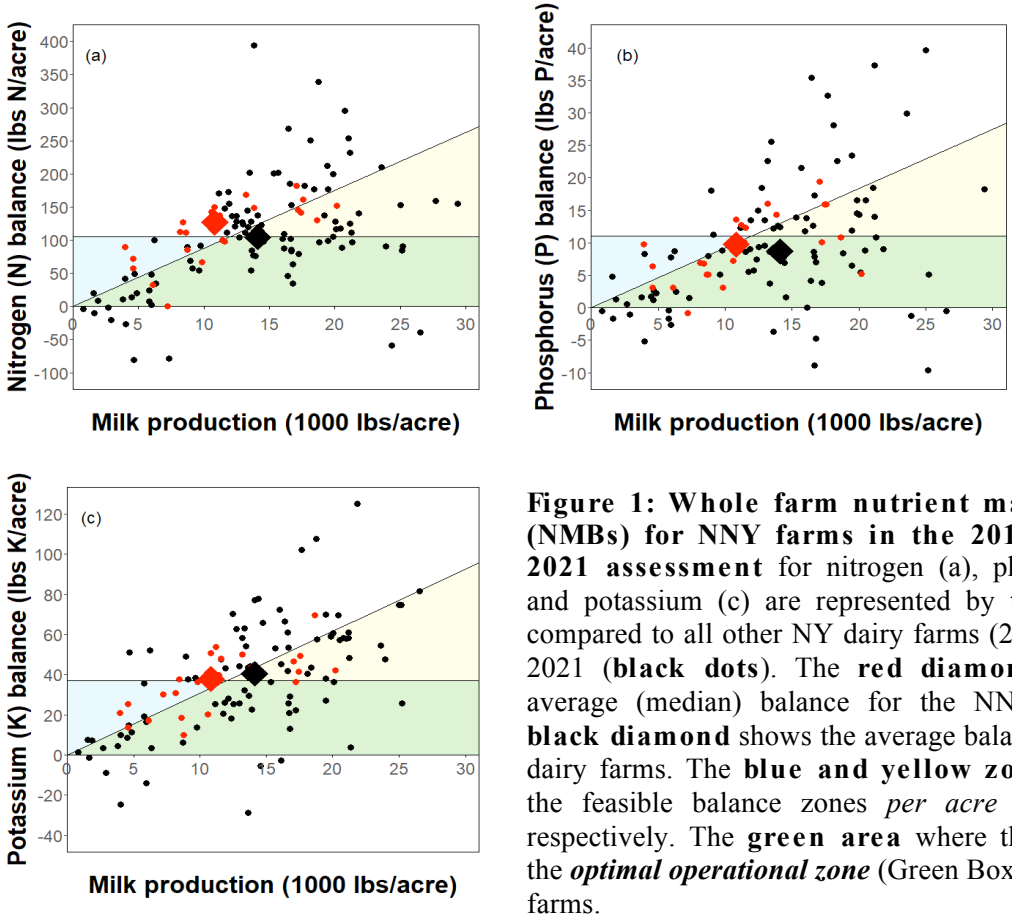

Figure 1: Whole farm nutrient mass balances (NMBs) for NNY farms in the 2019, 2020 and 2021 assessment for nitrogen (a), phosphorus (b), and potassium (c) are represented by the **red dots**, compared to all other NY dairy farms (2019, 2020 and 2021 (**black dots**). The **red diamond** shows the average (median) balance for the NNY farms; the **black diamond** shows the average balance for all NY dairy farms. The **blue and yellow zones** represent the feasible balance zones *per acre* and *per cwt*, respectively. The **green area** where they overlap is the ***optimal operational zone*** (Green Box) for NY dairy farms.

Table 2 presents indicators that contribute to the NMB and help predict the risk of exceeding feasible nutrient mass balances. The indicators in Table 2 do not show any major differences between the Northern NY farms and the other NY farms. As we saw in 2019, for both groups of farms, the average amount of nutrients imported in feed and in N fertilizer are slightly above the thresholds that indicate a higher risk of exceeding the N balances.

Table 2. Indicators to predict high risk of exceeding feasible balances.

Indicators to predict high risk of exceeding feasible balances				
Indicator		Median NNY farms (n = 23)	Median other NY farms (n = 99)	High risk of exceeding the feasible balances if
Animal density	AU/acre	0.90	1.05	>1.00
Milk per cow	lbs/cow/year	26,470	26,715	20,000
Homegrown feed	% of total feed DM	71 %	68 %	< 65%
Homegrown forage	% of total feed DM	69 %	66 %	-
N in purchased feed	lbs N/acre	128	148	> 121
P in purchased feed	lbs P/acre	16	22	> 20
K in purchased feed	lbs K/acre	38	46	> 11
CP in all feed	%	15.3 %	15.3 %	> 17
P in all feed	%	0.34 %	0.36 %	> 0.40
Feed use	Tons DM / AU	6.7	6.3	3.5 to 7.5
N fertilizer imports	lbs N/acre	48	43	> 39
P fertilizer imports	lbs P/acre	3.4	3.0	> 6
K fertilizer imports	lbs K/acre	17	16	> 38
CP in homegrown feed	%	11.5 %	11.6 %	< 11.8
Overall crop yield	Tons DM/acre	4.4	4.4	-
% legume acres	%	32 %	36 %	-
Acres receiving manur	%	68 %	83 %	-

Whole-farm greenhouse gas inventory

Figure 2 shows the three year-average (2019, 2020, and 2021) whole-farm GHG inventory for the Northern NY (yellow label) and other NY case-study farms, and the distribution of GHG emissions from each source: grazing and grassland fermentation, feed production, enteric fermentation, manure management, and energy, processing and transport.

For all farms, enteric fermentation was the major source of GHG emissions, with feed production and manure management also having important contributions.

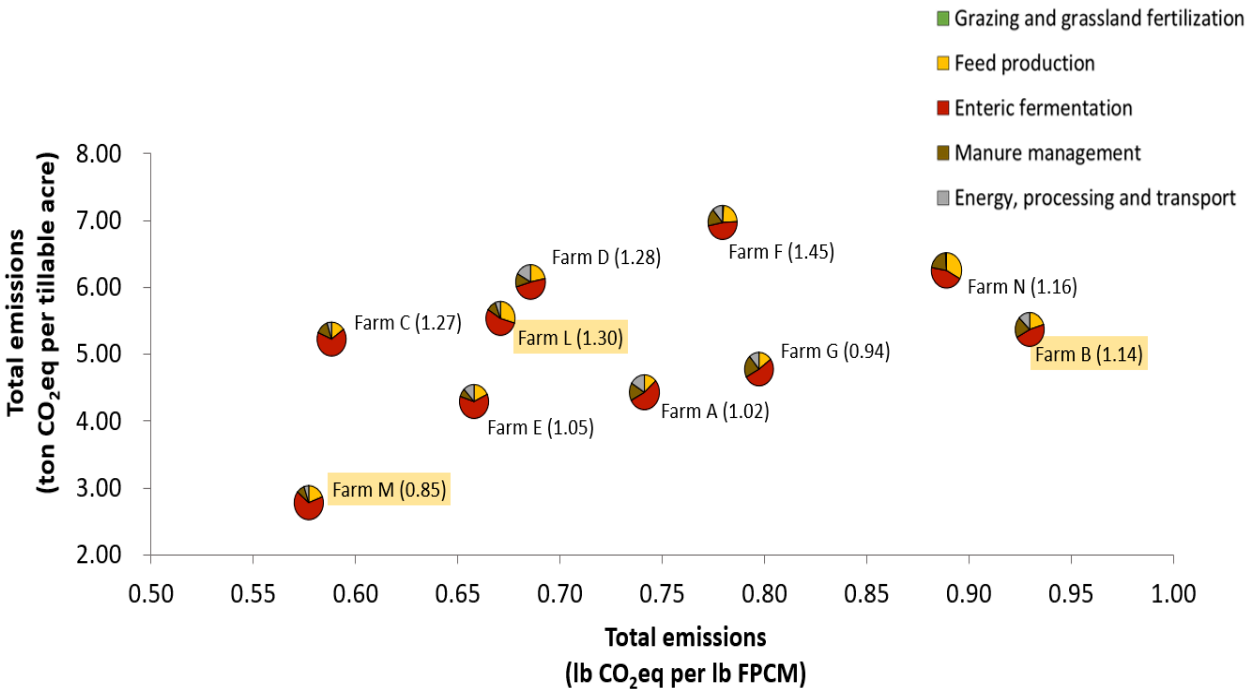

Figure 2: The sources of greenhouse gases (GHGs) in carbon dioxide equivalents (CO_2eq) contributing to whole-farm GHG inventories, per lb of fat and protein corrected milk (FPCM; horizontal axis), and per tillable acre (vertical axis). The number in parentheses indicates the animal density in animal units per tillable acre, where 1 animal unit = 1000 lb live animal weight. Three Northern NY farms are highlighted in yellow.

Impact of beneficial management practices for GHG reduction

Through scenario analysis, we estimated the impact of beneficial management practices already taking place on the ten farms (Figure 3). These practices include a combination of reduced tillage, the use of cover crops, covering liquid manure storages, and installing anaerobic digesters. Uptake of these beneficial management practices is more feasible on some farms than others, due to factors such as land characteristics, existing infrastructure, and available financial capital. We present the aggregated results for all ten farms to indicate the progress already made collectively by a cross section of dairy farms in New York State.

Figure 3 also shows the potential of these farms to further reduce their aggregated GHG inventory if all beneficial management practices could be implemented on all ten farms. However, the feasibility of this needs to be assessed.

Some potential mitigation strategies, such as the use of feed additives to reduce methane emissions from enteric fermentation, are in the development stage, and a high level of uncertainty remains about their potential impact and regulation for use. These are therefore "speculative" opportunities at this point.

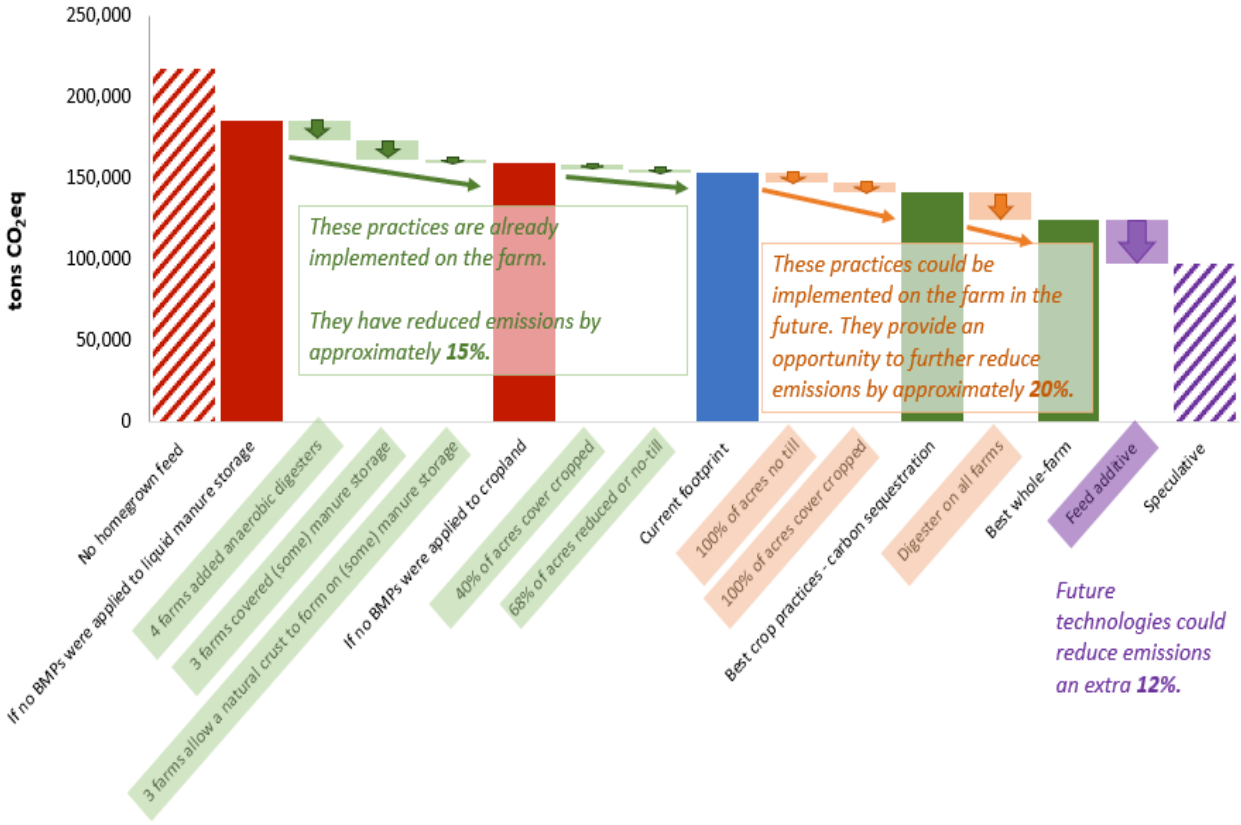

Figure 3. The progress made through implementation of beneficial management practices to reduce the greenhouse gas (GHG) inventory of the ten NY farms combined, and potential future reductions that could be made.

Conclusions/Outcomes/Impacts

Farms engaged in this project contributed relevant scenarios for "what-if" evaluations. Farm NMBs show drivers for balances for N and P and possible opportunities to reallocate nutrients for greater nutrient use efficiency. Potential impact of beneficial management practices on GHG inventories has been quantified.

Outreach

- June 14, 2022: What's Cropping Up? Farmer's Produce More Milk with Less Phosphorus and Nitrogen! Godber, O.F., Ros, M.B., Olivo, A.J., Redd, K.F., Amburgh, M., Workman, K., Ketterings, Q.M. https://blogs.cornell.edu/whatscroppingup/2022/06/14/farmers-produce-more-milk-with-less-phosphorus-and-nitrogen/
- June 14, 2022: What's Cropping Up? Homegrown Feed for Dairy Farms in New York; Godber, O.F., Ros, M.B., Olivo, A.J., Redd, K.F., Amburgh, M., Workman, K., Ketterings, Q.M. https://blogs.cornell.edu/whatscroppingup/2022/06/14/homegrown-feed-for-dairy-farms-in-new-york/

- October 20, 2022: Cornell Nutrition Conference 2022, East Syracuse, NY. Connecting Whole-Farm N and P Balances with Greenhouse Gas Emissions and Carbon Footprints presentation by Q.M. Ketterings and O.F. Godber. Approximately 300 attendees
- January 2023: NMSP External Advisory Committee and Cornell University Ag In-Service, presentation of project's results to date, 50 attendees
- Extension article: Godber, O.F., Workman, K. and Ketterings, Q. M. (2023). Northeast Dairy and The Circular Economy. Progressive Dairy. PRO-DAIRY's The Manager. March 2023 issue
- Agronomy Factsheet in review: Tillage Intensity Classifications for Greenhouse Gas Emission Footprinting (including CFT and COMET (Carbon Management & Emissions Tool); will post to NMSP Dairy Sustainability Key Performance Indicators website and Agronomy Factsheet page: http://nmsp.cals.cornell.edu/NYOnFarmResearchPartnership/DairySustainabilityIndicators.html and http://nmsp.cals.cornell.edu/guidelines/factsheets.html

Software Tools

- Whole-farm NMB: http://nmsp.cals.cornell.edu/software/Cornell_NMB_2.1.msi
- Cool Farm Tool: https://app.coolfarmtool.org/

Next Steps

- We will continue the work with the three NNY dairy farms, their staff, and advisors to add NMB and GHG inventory data for the 2022 calendar year.
- We aim to identify additional beneficial management practices and develop recommendations for use of tools or specific KPIs that can be utilized by farmers to obtain a most robust and comprehensive sustainability assessment with data readily available to them, and to accurately monitor impact of management changes on progress over time.
- We aim to use the 10-farm whole-farm N balances to estimate the whole-farm nitrous oxide (N_2O) emissions, a potent and important GHG for dairy farmers.
- Work is also ongoing to evaluate the impact of by- and waste-product use on dairy rations on whole farm NMBs and GHG footprints.

Acknowledgments

We thank the farmers participating in this project for sharing data and providing valuable feedback on findings and scenarios to evaluate.

For More Information:=

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Nutrient Management Spear Pro... · 6/17/22 ···

Did you know ❓

More milk is now produced by NY dairy farms using less phosphorus and nitrogen/lb of milk. 🐄📊🥛

See the great progress made by dairy farms participating in the whole farm nutrient mass balance in our new What's Cropping Up article 👇

bit.ly/3xTOygl

Nutrient Management Spear Pr... · 6/21/22 ···

Did you know ❓

On average, 70% of feed was homegrown on NY dairy farms participating in the whole farm nutrient mass balance (NMB) in 2017 to 2019!

See how this compares to the rest of the US and learn why homegrown feed is so important in dairy farming.

bit.ly/3MUGnVq