



Reading a Whole-Farm Nutrient Mass Balance Report

Whole-Farm Nutrient Mass Balance

Dairy farms can participate in the whole-farm nutrient mass balance (NMB) and receive a report that can help improve profitability and reduce environmental impacts. The NMB is the difference between the imported and exported nitrogen (N), phosphorus (P), and potassium (K), expressed as two key performance indicators (KPIs): per tillable acre (an environmental indicator) and per hundred weight (cwt) of milk (an efficiency indicator). Feasible balances for these KPIs have been set that allow dairy farms to be economically profitable and environmentally sustainable (Table 1). See [Agronomy Fact Sheet #85](#) for more detail on NMBs and feasible balances.

Table 1: Feasible nitrogen, phosphorus and potassium balances for New York dairy farms on a per acre and a per cwt milk basis.

Nutrient	<i>Do I have the land-base to cycle manure?</i>	<i>Am I efficiently producing milk?</i>
	lb per acre	lb of per cwt milk
Nitrogen (N)	> 0 and ≤ 105	> 0 and ≤ 0.88
Phosphorus (P)	> 0 and ≤ 12	> 0 and ≤ 0.11
Potassium (K)	> 0 and ≤ 37	> 0 and ≤ 0.30

When the feasible balances for both KPIs are met, the farm falls within the optimal operational zone ("green box"). The NMB report includes these green boxes (Figure 1). When a farm participates for multiple years, the report also includes trend figures to track the impacts of management changes over time (Figure 2). Also included is an opportunity table to highlight good management practices and aid in the identification of opportunities to improve nutrient efficiency (Table 2).

Opportunities for Improving NMBs

If the NMB for a nutrient falls outside the "green box", the opportunity table (Table 2) can be used to identify possible opportunities for improvement (flagged in orange). For example, farms with animal densities >1.0 animal unit (1000 lbs) per acre (line 4) and farms producing

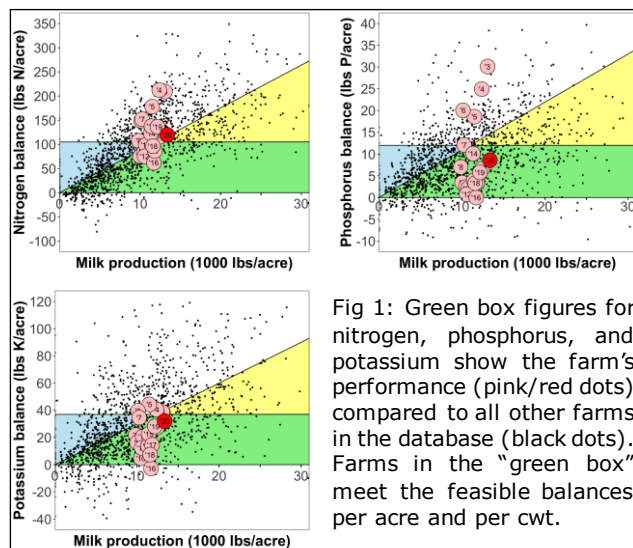


Fig 1: Green box figures for nitrogen, phosphorus, and potassium show the farm's performance (pink/red dots) compared to all other farms in the database (black dots). Farms in the "green box" meet the feasible balances per acre and per cwt.

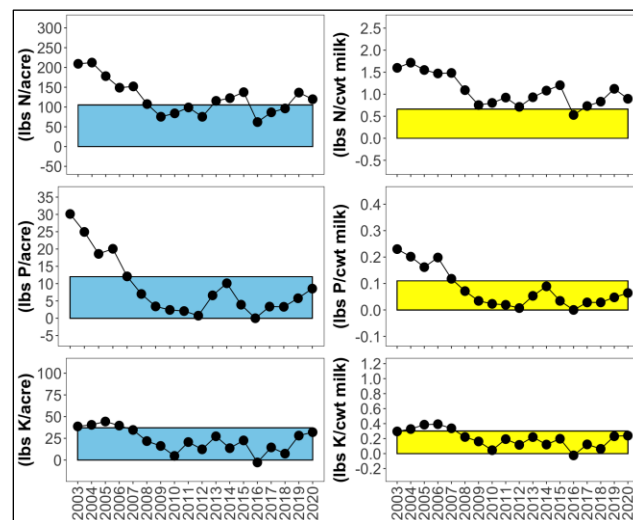


Fig 2: Nutrient balance trend lines expressed per acre (blue) and per cwt of milk (yellow).

<65% of homegrown feed (line 9), have a high likelihood of exceeding the feasible NMBs per acre. Table 2 shows a farm where purchased feed (line 6) is flagged orange suggesting a closer look at the feeding program may show room for improvement. In general, options for improvement may include increasing acreage, precision feeding, adjusting fertilizer use, exporting crops or manure, and improving crop yield and quality (homegrown feed).

Table 2: The opportunity table shows the balances and indicators that predict the likelihood of exceeding the feasible nutrient mass balances. Values highlighted in orange indicate potential areas for improvement.

	Indicator to predict likelihood of exceeding feasible balances	Example Farm			High risk of exceeding the feasible balances if		
		N	P	K	N	P	K
1	Balance per acre (lbs/acre)	120	9	32	> 105	> 12	> 37
2	Balance per cwt milk (lbs/hundredweight milk)	0.90	0.06	0.24	> 0.88	> 0.11	> 0.30
3	Milk per cow (lbs/cow/year)		26,607		-	< 20,000*	-
4	Animal density (animal units/acre)		1.04		-	> 1.00	-
5	Whole-farm nutrient use efficiency (%)	43	63	47	< 44	< 51	< 39
6	Purchased feed (lbs/acre)	174	22	57	> 121	> 20	> 38
7	Feed (tons dry matter/animal unit)		6.9		-	3.5 to 7.5	-
8	Feed use efficiency (milk, %)	21	25	12	< 20	< 25	< 11
9	Homegrown feed (% dry matter)		69		-	< 65	-
10	Homegrown forage (%)		69		-	-	-
11	Homegrown grain (%)		0		-	-	-
12	Homegrown nutrients (% dry matter)	48	55	68	< 50	< 50	-
13	Crude protein (CP) and P in all feed (%)	15	0.34	1.26	> 17	> 0.40	-
14	CP and P in purchased feed (%)	25	0.49	1.30	> 30	> 0.60	-
15	CP in homegrown feed (%)	10.2			< 11.8	-	-
16	Fertilizer (lbs/acre)	32	1	3	> 39	> 6	> 38
17	Crop exports (lbs/acre)	1	0	1	< 1	< 1	< 1
18	Manure exports (lbs/acre)	11	1	5	< 1	< 1	< 1
19	Overall crop yield (tons dry matter/acre)		5.0				
20	Acres receiving manure (%)		82				

* Based on Holstein cows

P-Index 2.0 and Adaptive Management

The P balance per acre can be used in relation to the New York Phosphorus Index 2.0 (NY-PI 2.0). State regulated farms with a whole-farm NMB (3-yr running average) at or below 12 lbs P/acre (feasible limit for P/acre) are permitted to apply manure at N-based rates on fields with STP ≤ 100 lbs/acre, even if the initial NY-PI 2.0 assessment for the field limits rates to P-based, as long as the selected beneficial management practices to get to the P-based score are implemented (see [Agronomy Fact Sheet # 110](#) for details). This adaptive management option promotes whole-farm P management by rewarding good P management.

Summary

Whole farm NMB indicators can be used to identify potential areas for improvement in N, P, and K management across the integrated farm system. The NMB is also a useful tool to track the impact of management changes on whole farm nutrient use efficiency over time. Three-year running averages can be used with the NY-PI 2.0 to create more flexible manure application options, rewarding farms for excellent whole-farm P management.

Additional Resources

- Cornell Nutrient Management Spear Program Agronomy Fact Sheets #25: Whole Farm Nutrient Mass Balance; #85: Feasible Whole-Farm Nutrient Mass Balances; #110: The New York Phosphorus Index 2.0: <http://nmisp.cals.cornell.edu/guidelines/factsheets.html>
- Whole-farm Nutrient Mass Balance program webpage: <http://nmisp.cals.cornell.edu/NYOnFarmResearchPartnership/MassBalances.html>

Disclaimer

This fact sheet reflects the current (and past) authors' best effort to interpret a complex body of scientific research, and to translate this into practical management options. Following the guidance provided in this fact sheet does not assure compliance with any applicable law, rule, regulation or standard, or the achievement of discharge levels from agricultural land.

For more information



Cornell University
Cooperative Extension

Nutrient Management Spear Program
<http://nmisp.cals.cornell.edu>

Julianna Lee, Olivia Godber, and Quirine Ketterings

2025