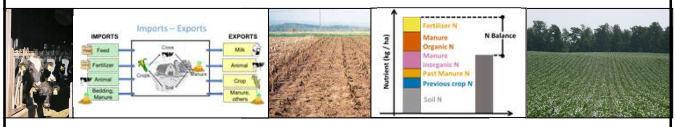
Cornell University

Assessment Tools to Advance Management Whole Farm and Field N and P Balances

Quirine Ketterings, Agustin Olivo, Olivia Godber

3/15/2024



Nutrient Management Spear Program

Implications of managing manure on a nitrogen basis
LPELC Webinar

CornellCALS
College of Agriculture and Life Sciences

Nutrient Management Spear Program (NMSP) 1

1

Cornell University

New York Agriculture - Background

- ~30700 farm operations
- ~630000 milking cows
- ~500 CAFOs
- 4th in milk production
- 3rd in corn silage production

Dairy farming is important for NY

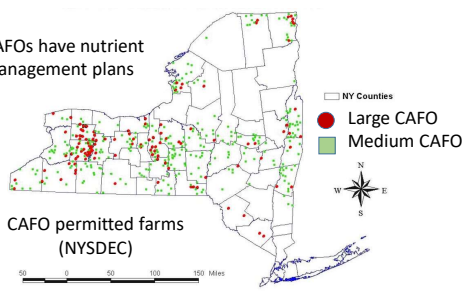
Nutrient Management Spear Program (NMSP) 2

2

Cornell University

NY Concentrated Animal Feeding Operations

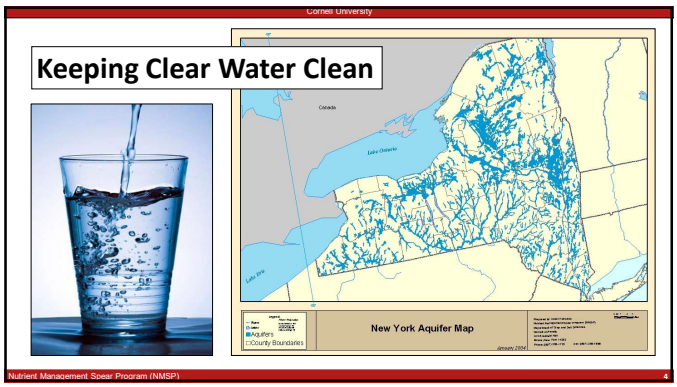
CAFOs have nutrient management plans



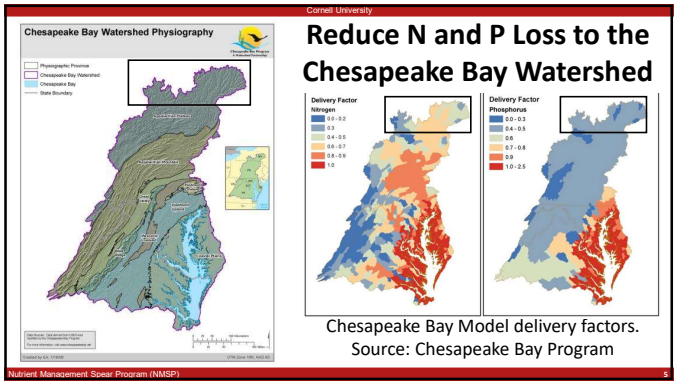
CAFO permitted farms (NYSDEC)

Nutrient Management Spear Program (NMSP) 3

3

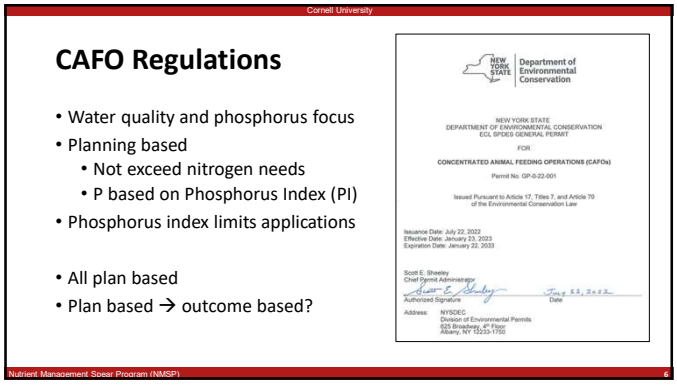


4



Chesapeake Bay Model delivery factors.
Source: Chesapeake Bay Program

5

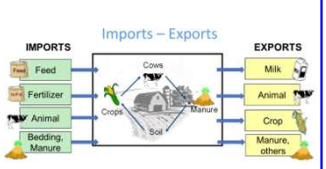


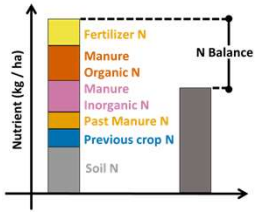
6

Cornell University

Two Evaluation Tools

Whole Farm Nutrient Mass Balance	Field-Based Nutrient Balances



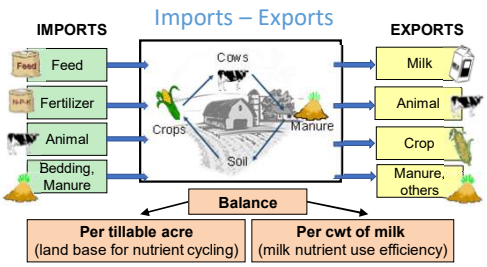


Nutrient Management Spear Program (NMSP) 7

7

Cornell University

Whole-farm nutrient mass balance (NMB)



Per tillable acre (land base for nutrient cycling)

Per cwt of milk (milk nutrient use efficiency)

Nutrient Management Spear Program (NMSP) 8

8

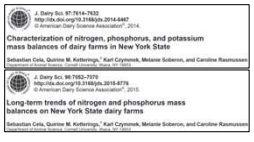
Cornell University

Feasible Balances

	Do I have the land to recycle manure?	*Am I efficiently producing milk?*
	lb nutrient per acre	**lb of nutrient 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

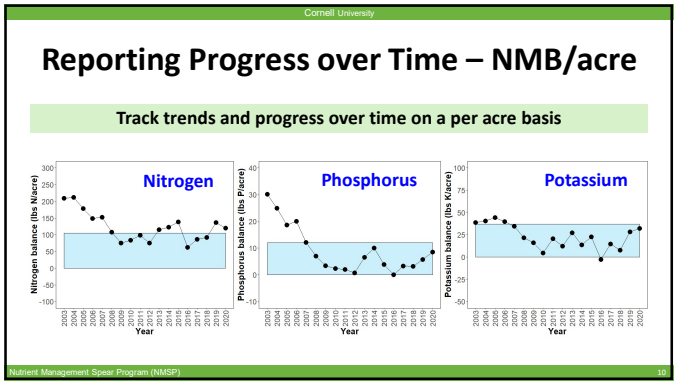
Set based on:

- Data from 102 dairy farms
- Long-term records from farms
- Carrying capacity calculations
- Farmer agreement on the feasibility

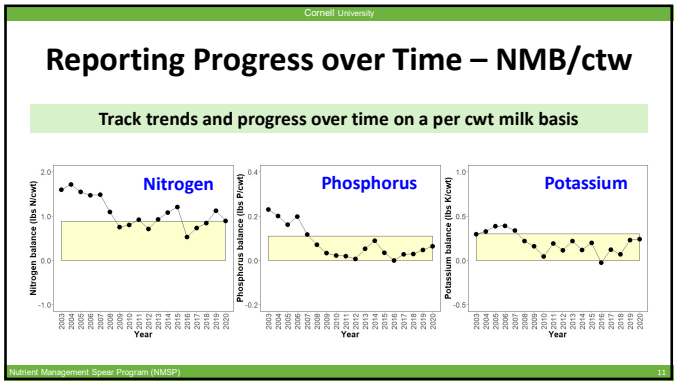


Nutrient Management Spear Program (NMSP) 9

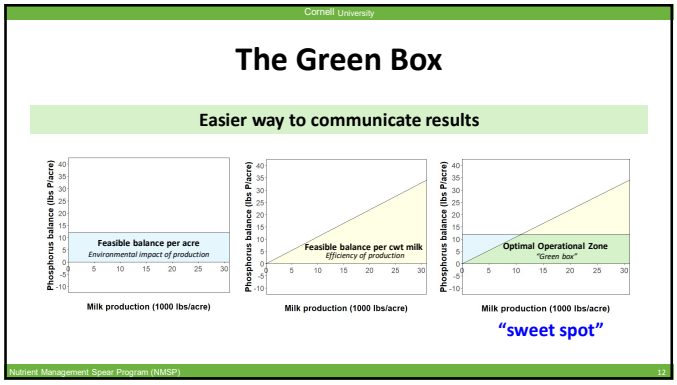
9


Cornell University
Reporting Progress over Time – NMB/acre
Track trends and progress over time on a per acre basis
Nitrogen
Phosphorus
Potassium
Nitrogen balance (lbs N/acre)
Phosphorus balance (lbs P/acre)
Potassium balance (lbs K/acre)
Year
Nutrient Management Spear Program (NMSP)
10

10


Cornell University
Reporting Progress over Time – NMB/ctw
Track trends and progress over time on a per cwt milk basis
Nitrogen
Phosphorus
Potassium
Nitrogen balance (lbs N/cwt)
Phosphorus balance (lbs P/cwt)
Potassium balance (lbs K/cwt)
Year
Nutrient Management Spear Program (NMSP)
11

11

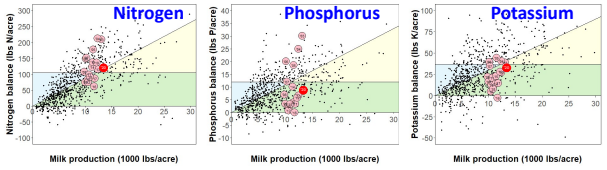

Cornell University
The Green Box
Easier way to communicate results
Phosphorus balance (lbs P/acre)
Feasible balance per acre
Environmental impact of production
Feasible balance per cwt milk
Efficiency of production
Optimal Operational Zone
"Green box"
Milk production (1000 lbs/acre)
"sweet spot"
Nutrient Management Spear Program (NMSP)
12

12

Cornell University

The Green Box

Allowed farms to compare themselves to peers



Nutrient Management Spear Program (NMSP) 13

13

Cornell University

Opportunity Table

Farm-specific KPIs to predict high risk of exceeding feasible balances

Key Sustainability Indicators (KPIs):

- **Feed** & **fertilizer** imports are the biggest drivers of NMBs
- **Animal density** is a key driver
- **Manure export has** big potential

Nutrient Management Spear Program (NMSP) 14

14

Cornell University

Whole Farm NMB Current Status (2022)

Growing database: summary of NY dairy farms 2022

Year	Number of farms	Total tillable acres	Total milk (lb)	% of total NY milk
2019	58	120,000	2.0 billion	13%
2020	60	140,000	2.3 billion	15%
2021	65	160,000	2.5 billion	16%
2022	**85**	**210,000**	**3.3 billion**	**21%**

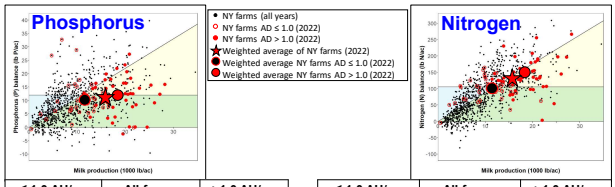
Nutrient Management Spear Program (NMSP) 15

15

Cornell University

Whole Farm NMB Current Status (2022)

- For P: in Green Box
- For N: improved but work to do



≤ 1.0 AU/ac	All farms	>1.0 AU/ac
10 lb P/ac	11 lb P/ac	12 lb P/ac
0.09 lb P/cwt	0.07 lb P/cwt	0.06 lb P/cwt

≤ 1.0 AU/ac	All farms	>1.0 AU/ac
98 lb N/ac	126 lb N/ac	144 lb N/ac
0.85 lb N/cwt	0.80 lb N/cwt	0.78 lb N/cwt

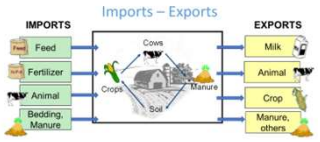
Nutrient Management Spear Program (NMSP) 16

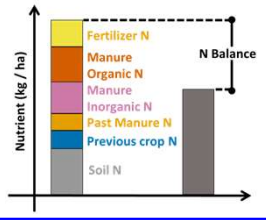
16

Cornell University

Two Evaluation Tools

Whole Farm Nutrient Mass Balance	Field-Based Nutrient Balances



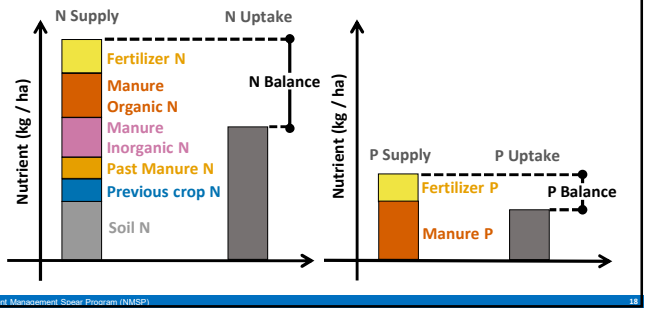


Nutrient Management Spear Program (NMSP) 17

17

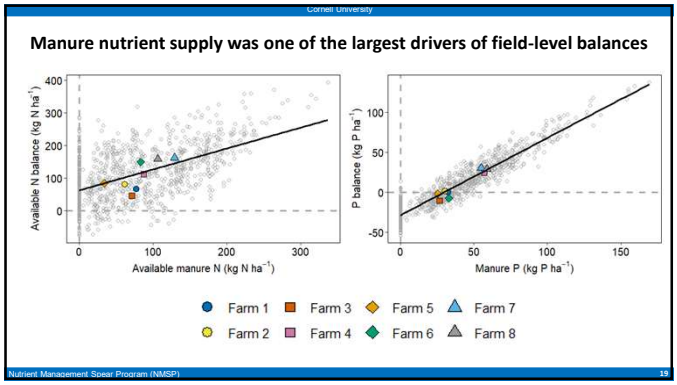
Cornell University

Phosphorus and nitrogen balances were estimated for 994 field*year observations across 8 New York dairy farms

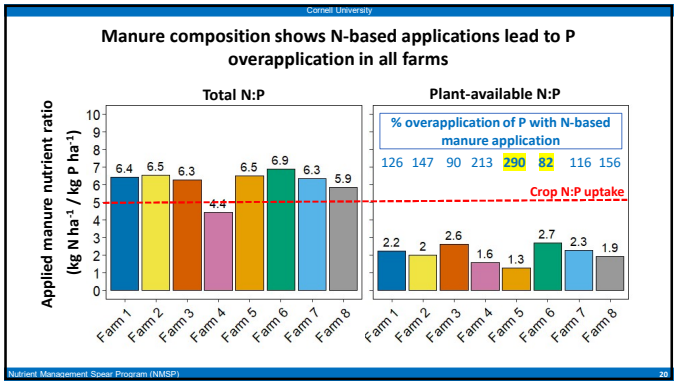


Nutrient Management Spear Program (NMSP) 18

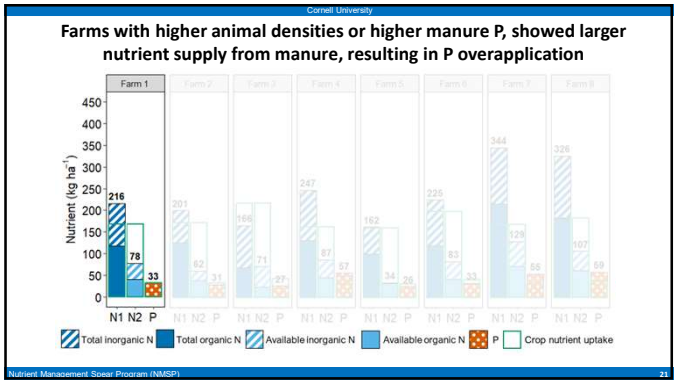
18


Cornell University
Manure nutrient supply was one of the largest drivers of field-level balances
Available N balance (kg N ha⁻¹)
Available manure N (kg N ha⁻¹)
P balance (kg P ha⁻¹)
Manure P (kg P ha⁻¹)
Farm 1
Farm 2
Farm 3
Farm 4
Farm 5
Farm 6
Farm 7
Farm 8
Nutrient Management Spear Program (NMSP)
19

19


Cornell University
Manure composition shows N-based applications lead to P overapplication in all farms
Total N:P
Plant-available N:P
Applied manure nutrient ratio (kg N ha⁻¹ / kg P ha⁻¹)
% overapplication of P with N-based manure application
126 147 90 213 290 82 116 156
Crop N:P uptake
6.4 6.5 6.3 4.4 6.5 6.9 6.3 5.9
2.2 2 2.6 1.6 1.3 2.7 2.3 1.9
Farm 1 Farm 2 Farm 3 Farm 4 Farm 5 Farm 6 Farm 7 Farm 8
Nutrient Management Spear Program (NMSP)
20

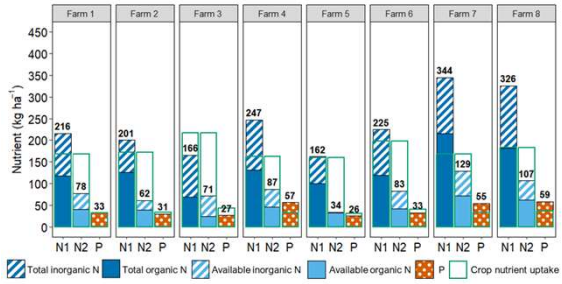
20


Cornell University
Farms with higher animal densities or higher manure P, showed larger nutrient supply from manure, resulting in P overapplication
Farm 1
Nutrient (kg ha⁻¹)
216
78
33
N1 N2 P
Total inorganic N
Total organic N
Available inorganic N
Available organic N
P
Crop nutrient uptake
Nutrient Management Spear Program (NMSP)
21

21

Cornell University

Farms with higher animal densities or higher manure P, showed larger nutrient supply from manure, resulting in P overapplication



Nutrient Management Spear Program (NMSP) 22

22

Cornell University

Lessons Learned

- Whole farm assessment tools help identify opportunities for improvements across farm components (cows, cropland, storage, etc.)
- Assessment tools are needed to (1) evaluate outcomes, (2) document progress, and (3) share achievements
- Nutrient imports are key drivers for whole farm and field balances
- Animal density drives balances and the need for manure exports
- Whole farm mass balances give farm-level pictures
- Field based balances can help reallocate nutrients more efficiently across cropland

Nutrient Management Spear Program (NMSP) 23

23

Cornell University

Thank You!

Funding:
NYFVI, NYCSA, USDA NIFA, NESARE, USDA NRCS, NYSAGM, NYSDEC

People:
Farmers and their consultants
Cornell Cooperative Extension
NMSP team members

More info: nmsp.cals.cornell.edu

qmk2@cornell.edu
ajo54@cornell.edu
@CornellNMSP

Nutrient Management Spear Program

CornellCALS
College of Agriculture and Life Sciences

Nutrient Management Spear Program (NMSP) 24

24