



Assessing whole-farm nutrient use efficiency in grazing systems through mass balances

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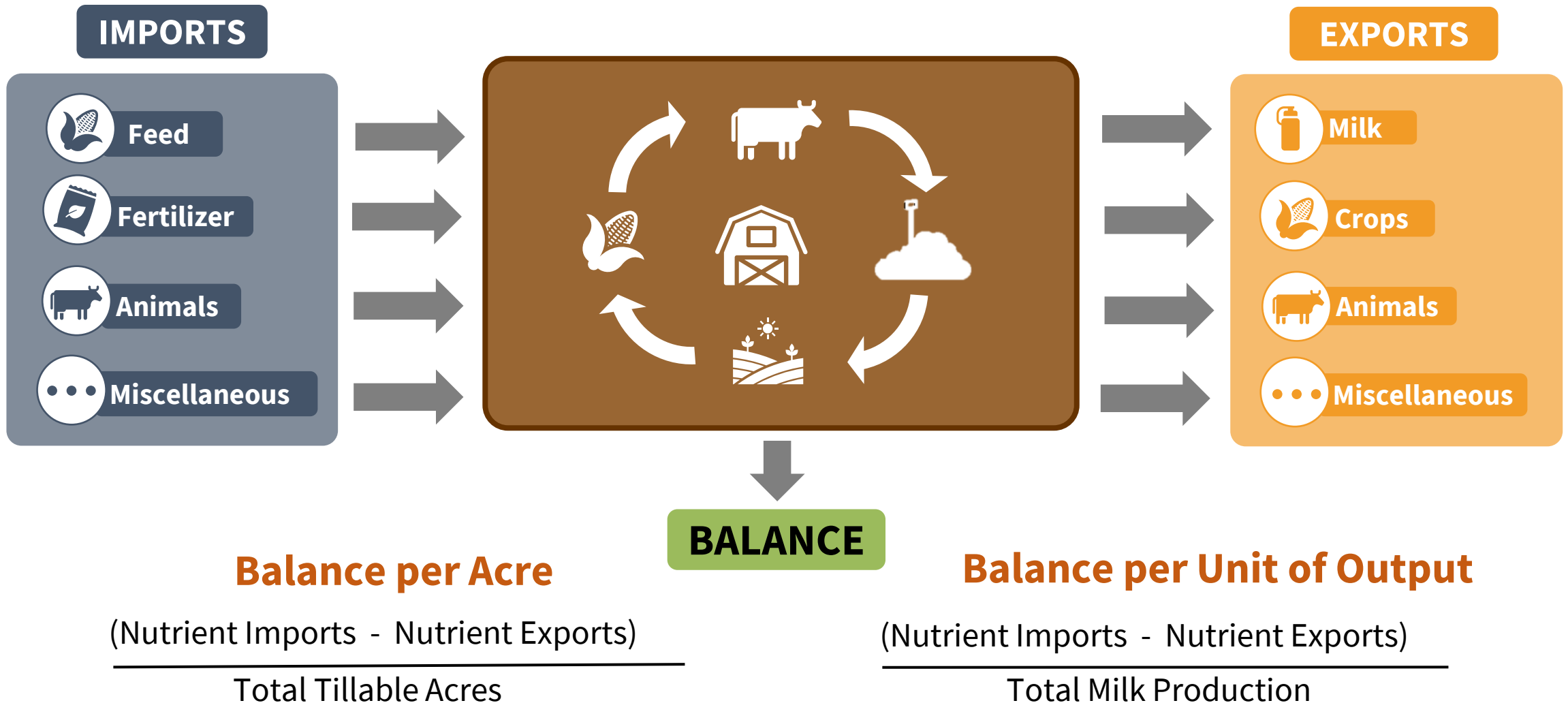


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Nutrient
Management
Spear Program

The **nutrient mass balance** is a whole-farm assessment of nutrient use efficiency



The **ideal** level for an NMB is **slightly positive**

Negative Balance

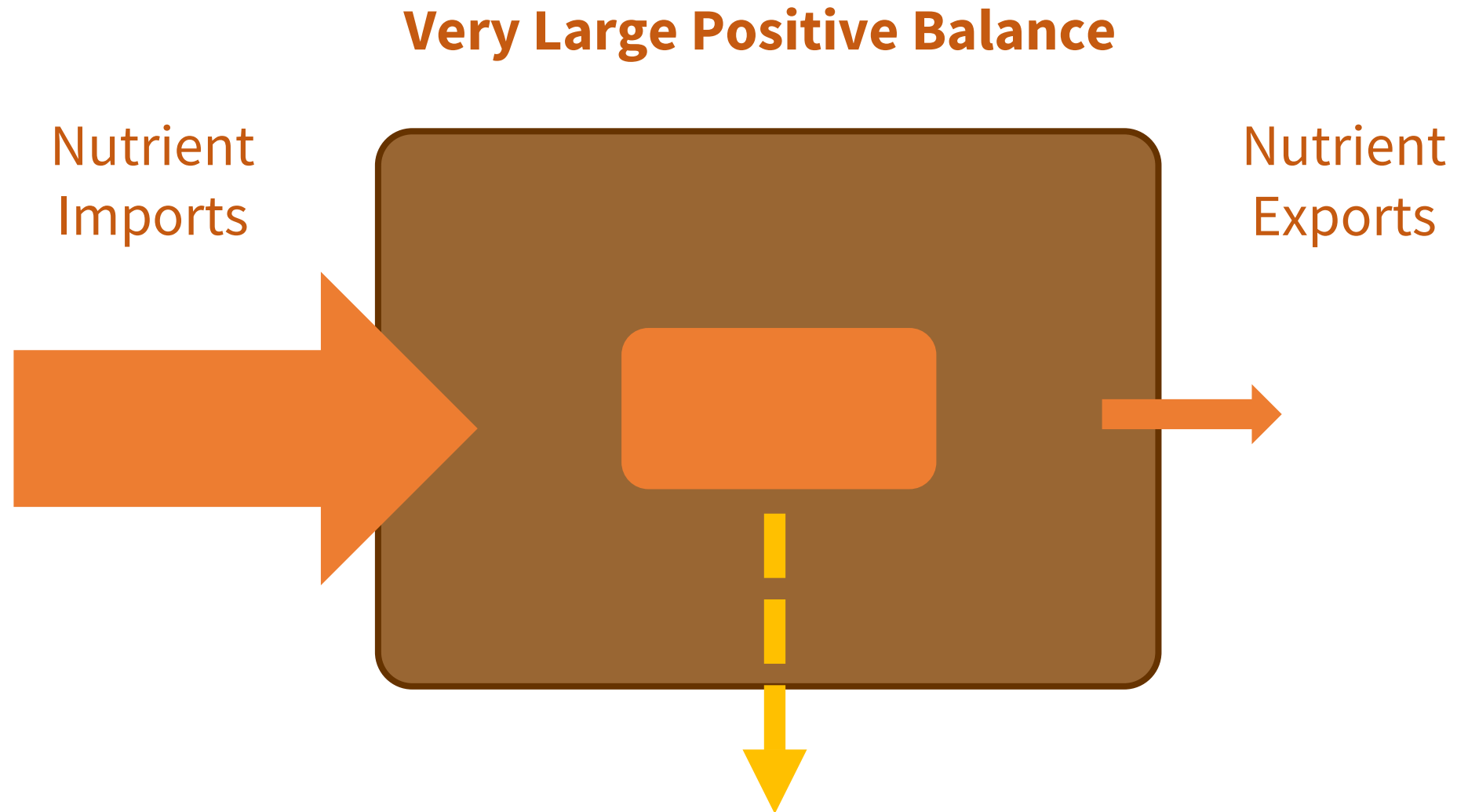
Nutrient
Imports



Nutrient
Exports



The **ideal** level for an NMB is **slightly positive**



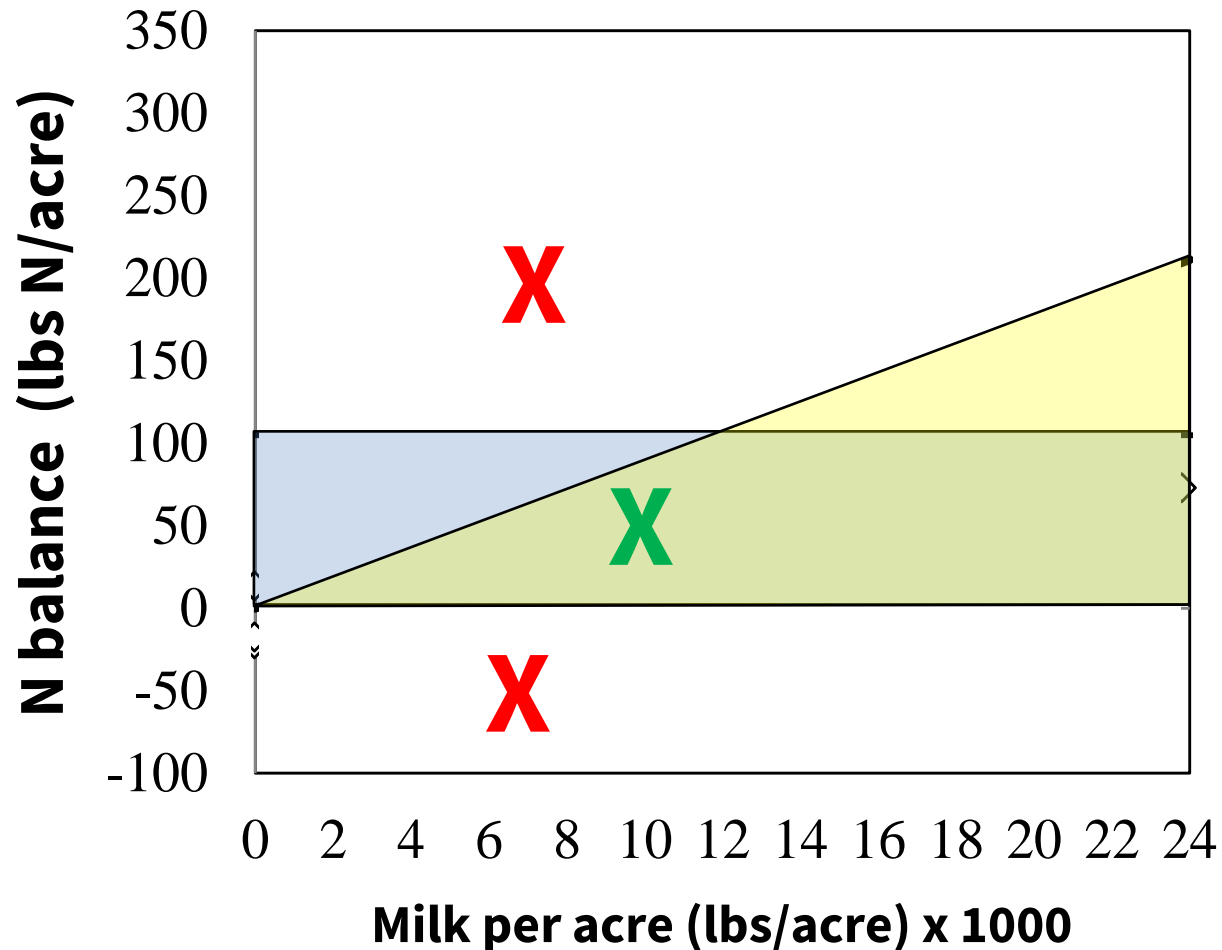
The **nutrient mass balance** is a whole-farm assessment of nutrient use efficiency

A feasible mass balance allows farms to be economically viable and environmentally sustainable

Feasible limits were set based on balances from commercial dairy farms in New York

	Mass Balances	
	(lbs/acre)	(lbs/cwt)
Nitrogen	0 to 105	0-0.88
Phosphorus	0 to 12	0-0.11

The **nutrient mass balance** is a whole-farm assessment of nutrient use efficiency



**Feasible NMB per acre
(blue square)**

**Feasible NMB per cwt
(yellow triangle)**

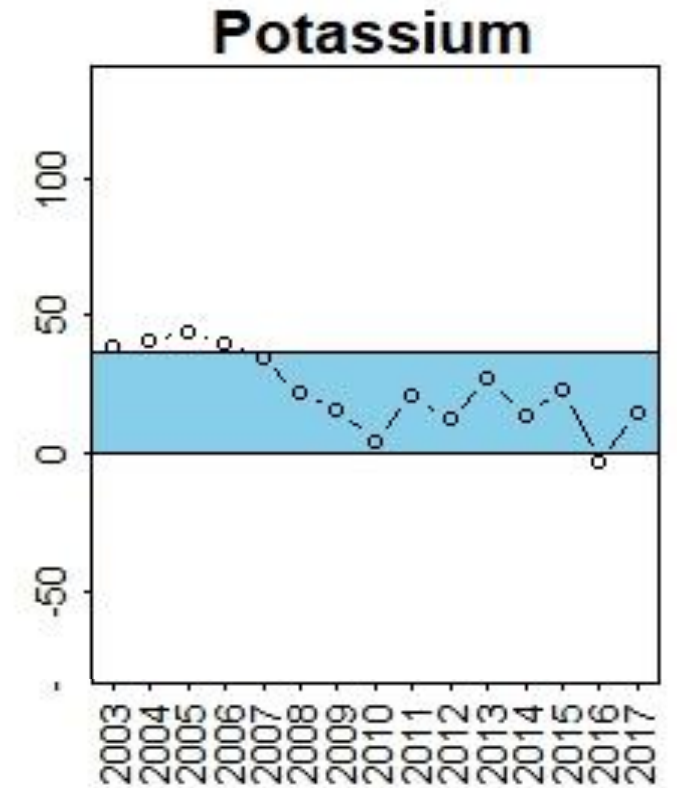
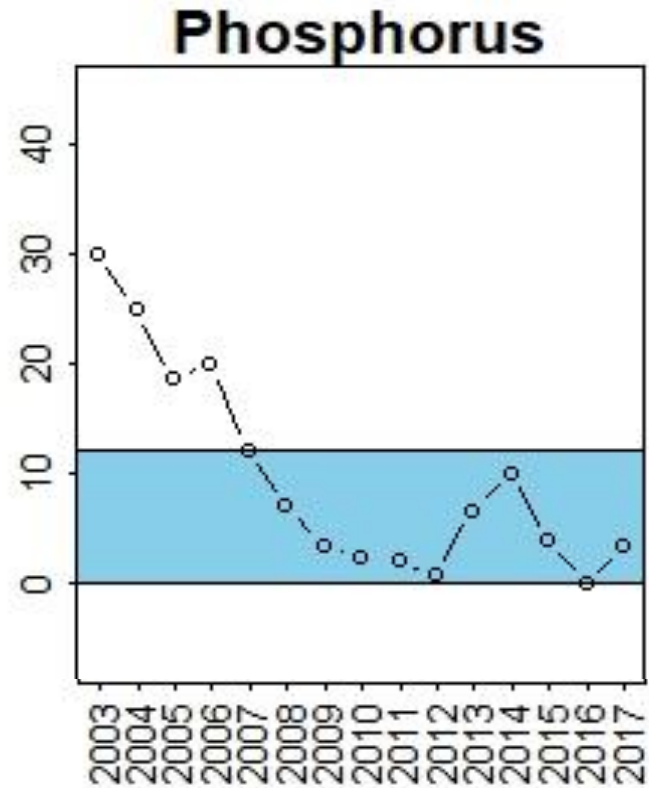
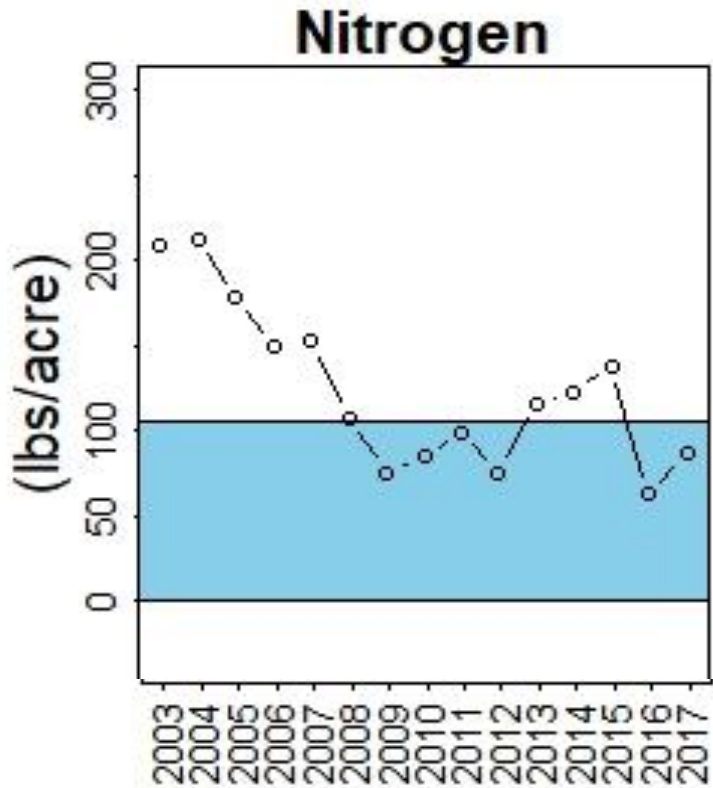
**Optimal Operational Zone
("Green Box")
Feasible NMB/acre &
NMB/cwt**

Other indicators can be estimated to inform nutrient management strategies at the whole-farm level

Indicator	High risk of exceeding the feasible balances if		
	N	P	K
Milk per cow (lbs/cow/year)	-	< 20,000	-
Animal density (animal units[AU]/acre)	-	> 1.0	-
Feed (tons dry matter[DM]/AU)	-	<3.5 or >7.5	-
Homegrown feed (% DM)	-	< 62-65	-
Crude protein (CP), P in all feed (%)	> 17	> 0.40	-
CP in homegrown feed (%)	< 11.8	-	-

Whole-farm nutrient balance assessments allow for **monitoring** whole-farm nutrient management efficiency **over time**







Whole-farm balance



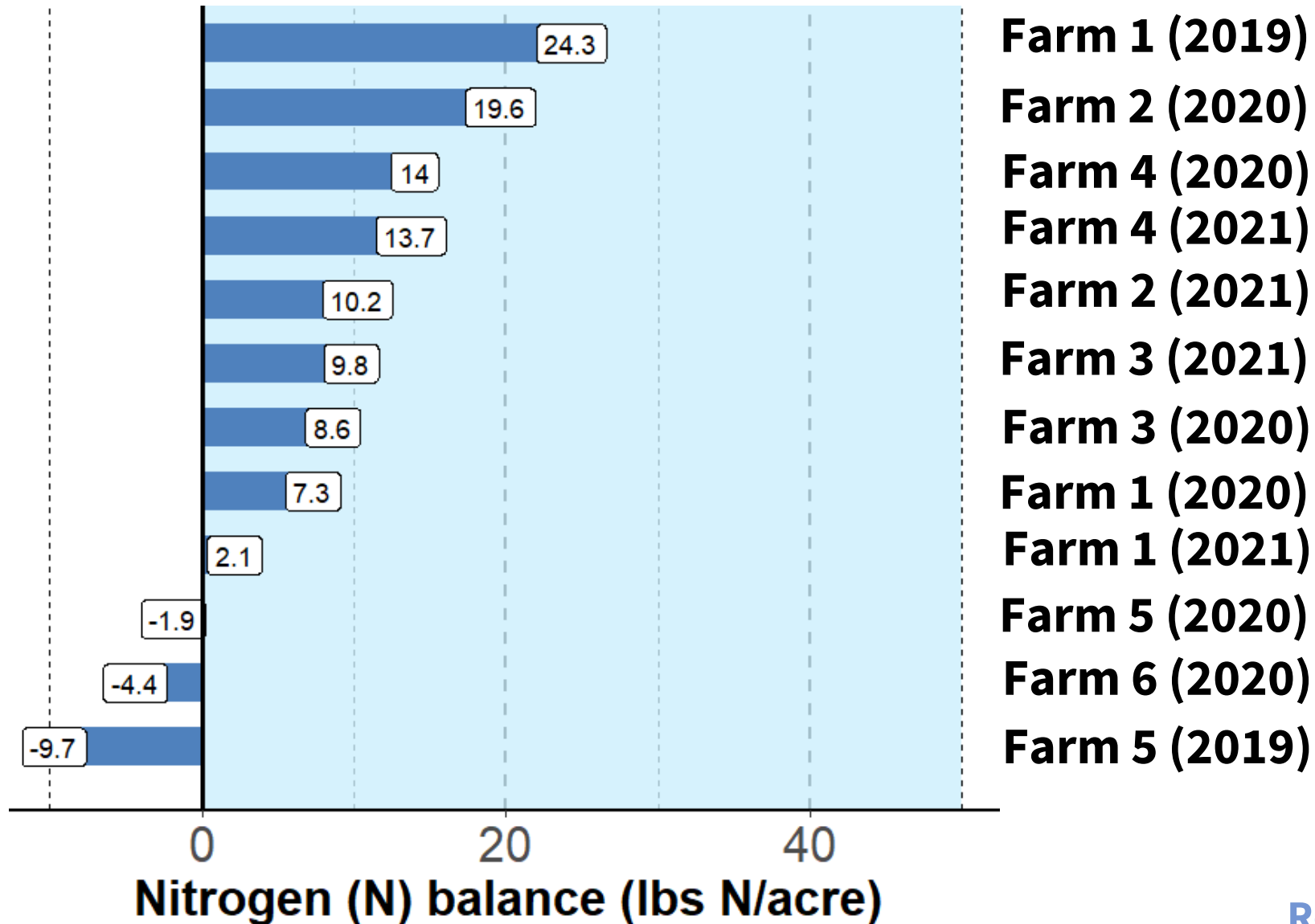
Six organic case-study farms were selected in southern and central NY.



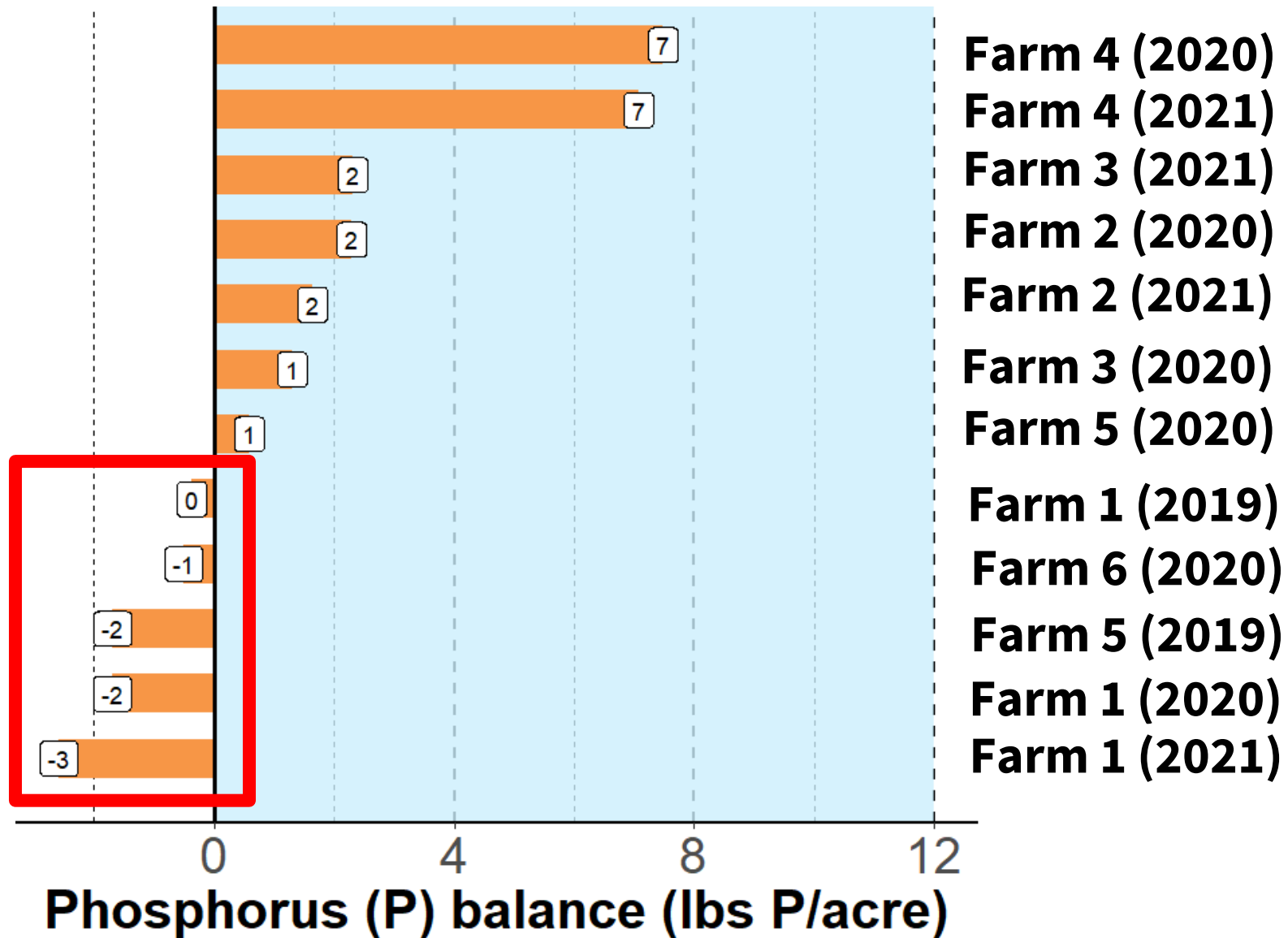
Six organic, grazing, case-study farms were selected in southern and central NY.

		Land Base (Acres)	Cows	Row-Crop (Acres)	Grazing	Predominant Breed
	Farm 1	250	48	0	Yes	Holstein
	Farm 2	658	138	137	Yes	Holstein
	Farm 3	189	30	0	Yes	Jersey
	Farm 4	254	35	12.5	Yes	Jersey
	Farm 5	230	60	0	Yes	Ayrshire
	Farm 6	264	43	0	Yes	Ayrshire

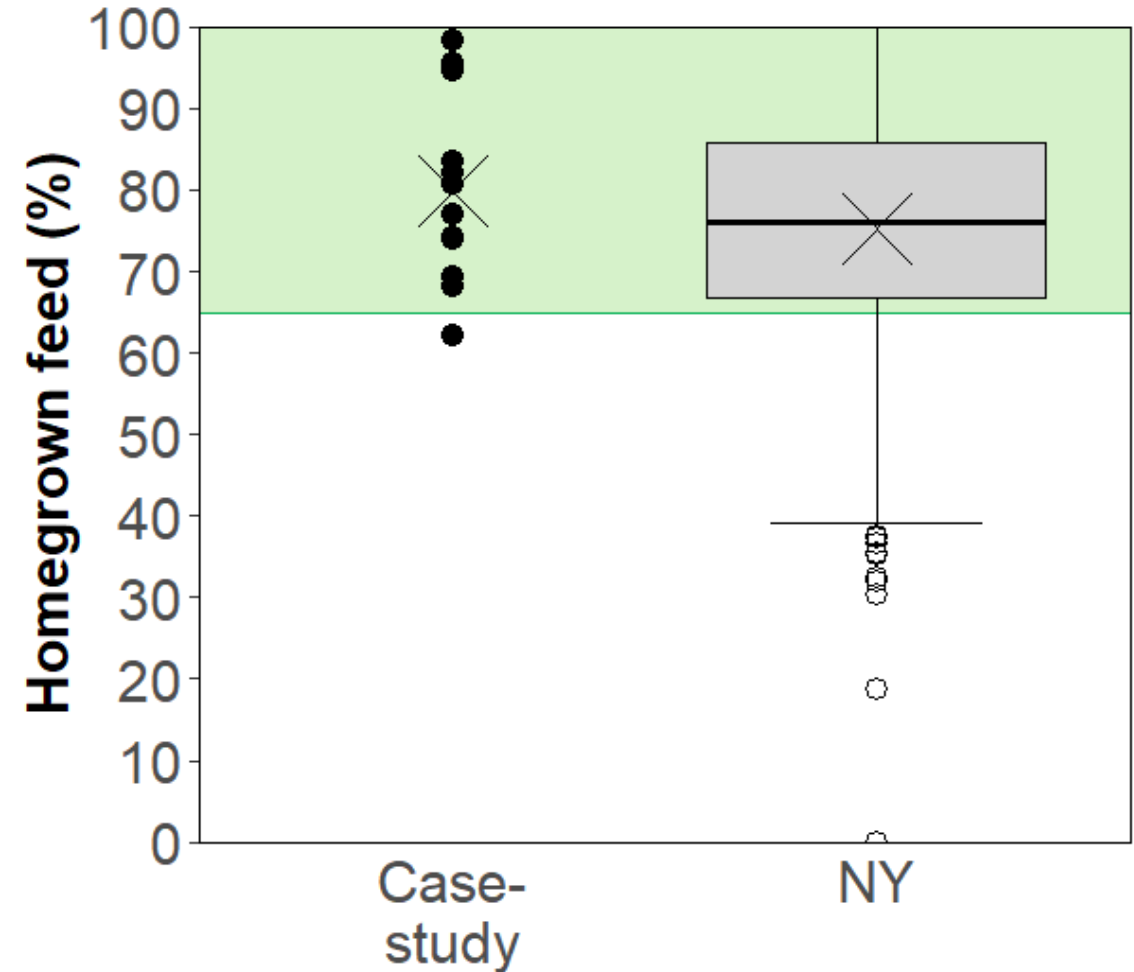
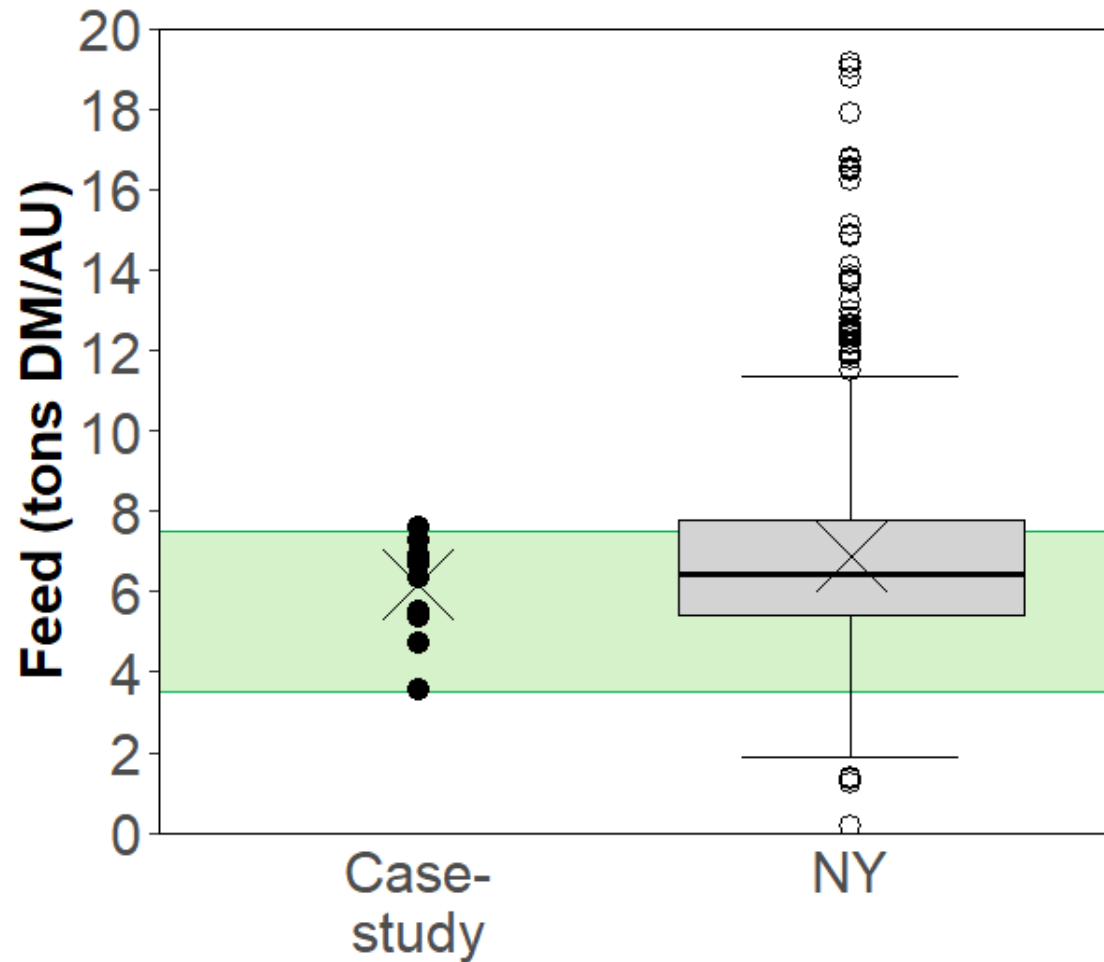
Whole farm mass balances for N and P were in general low



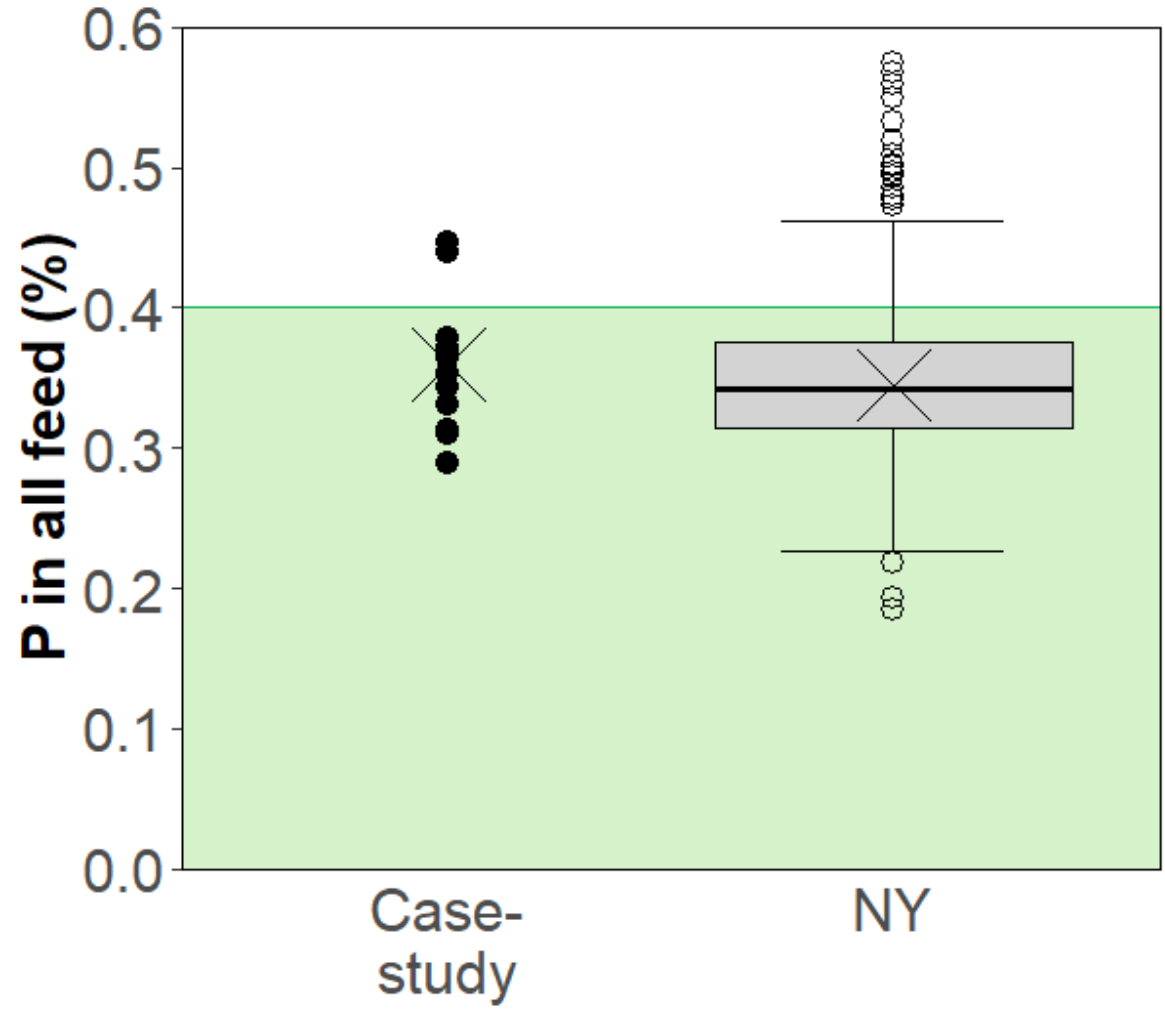
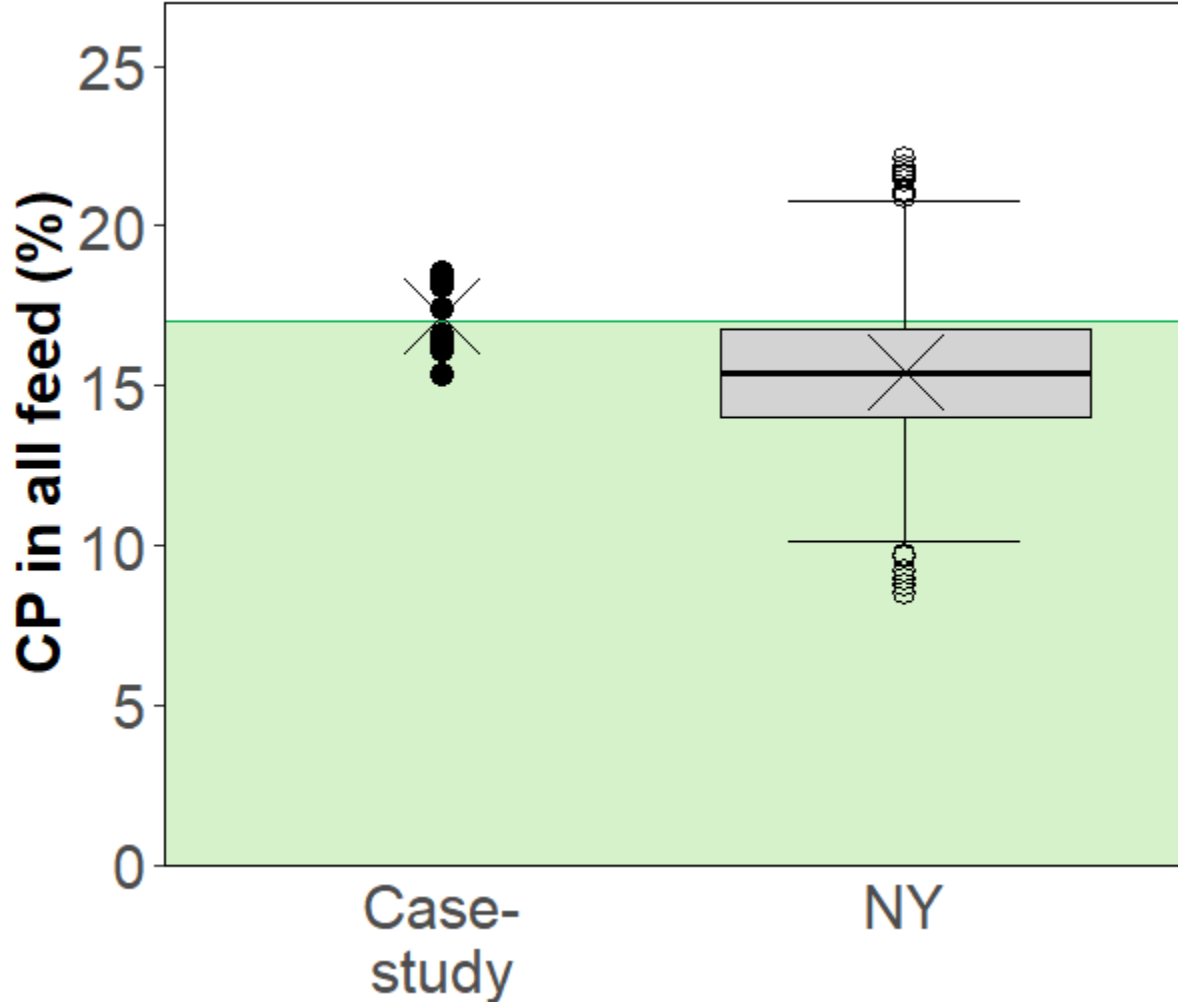
Whole farm mass balances for N and P were in general low



Tons of feed per animal unit exhibited a wide range. **Percent of home-grown feed** was relatively high for all farms.

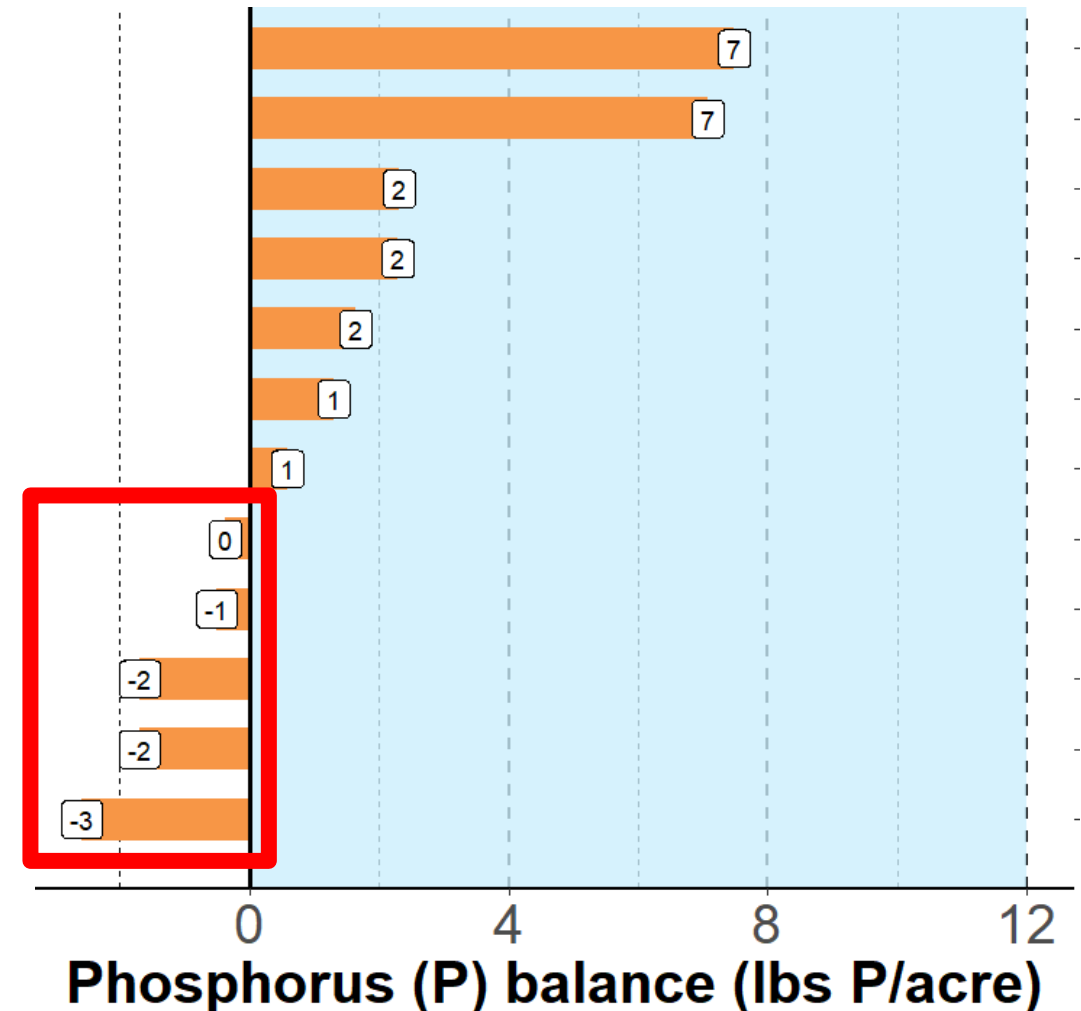


Percent crude protein and phosphorous in the feed showed a range, exhibiting potential opportunities for improvement in some farms.



Whole-farm nutrient mass balances can be an effective tool to monitor nutrient management efficiency in multiple areas of the farm

- Running a whole-farm mass balance for your farm and the associated indicators (animal density, tons feed per animal unit, % homegrown feed, %CP and %P in feed) can help identify opportunities for improvement.
- Very large positive balances or negative balances may impact long-term sustainability of the farming operation.
- Multiple years of data can help monitor changes in nutrient management over time.



Relatively simple input data is needed to estimate whole-farm mass balances and associated indicators



**Cornell Nutrient Management Spear Program
Mass Nutrient Balance Calculator Input Sheet**
N, P and K imports and exports: 1/1/2021 to 12/31/2021

Producer Contact Information		Data Collection	
Producer name		By	
Farm name		Email	
Address			
County and State			
Phone			
E-mail	Balance year	2021	

Farm Information		Watershed	
Total farm acres	250	Primary watershed	
All tillable owned and rented crop and pasture acres	140	Secondary watershed	
Legume acres (perennial and annual) >10% legume	140	Soil Type	
Acres receiving manure (crop and pasture)	100	Primary soil type	Palmyra
Milk marketing co-operative	Organic Valley	Secondary soil type	Honeyoe

Have you completed a Cornell Dairy Farm Business Summary (DFBS) for the balance year?

Have you completed a Farm Credit Business Summary for the balance year?

Are you a Certified Organic producer?

Intensive grazing (grazed at least 3 months/yr, moved to a new pen every 3 days or more)?

Do you have a Comprehensive Nutrient Management Plan (CNMP) for the balance year?

Do you have a Cropware plan for the balance year?

Are heifers raised off-farm? If yes, what age group? _____

Average number and weight of farm livestock			
	Animal Group	Number	Weight (lbs/head)
Cattle	Milking and dry cows	48	1400
	Heifers 1-2 year	1	1200
	Heifers <1 year	1	600
	Calves		
	Bulls and steers		
Other livestock			

Dairy cow breed(s)	Holstein
Cull rate (%)	14.5



General Information



Farm Crop Production



Imports, Feed



Imports, Fertilizer



Imports, animals



Imports, miscellaneous



Exports, milk



Exports, animals



Exports, crops



Exports, miscellaneous



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	Calves		
	Bulls and steers		
Other livestock			

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Farm contact information

Acres of land

Miscellaneous characteristics

Animal types, numbers, weights, breeds.



Relatively simple input data is needed to estimate whole-farm mass balances and associated indicators

FARM CROP PRODUCTION

Crop name	Area (acres)	% Legume	Manure applied	CP (%DM)	P (%DM)	K (%DM)	Crop type*	Yield (t/a)	DM (%)	Inventory (tons)	
										Beginning year	Ending year
Pasture	70	70	<input checked="" type="checkbox"/>	23.89	0.37	2.81	Forage	6	29.9	0	0
1st cutting	70	50	<input checked="" type="checkbox"/>	12.6	0.27	2.38	Forage	3.14	44.1	0	0
2nd cutting	70	50	<input checked="" type="checkbox"/>	15.8	0.4	2.35	Forage	1.08	57.4	0	0
3rd cutting	70	50	<input checked="" type="checkbox"/>	15.7	0.5	2.98	Forage	1.41	47.5	0	0
4th cutting	40	50	<input checked="" type="checkbox"/>	15.7	0.5	2.98	Forage	0.69	47.5	0	0
			<input type="checkbox"/>								
			<input type="checkbox"/>								
			<input type="checkbox"/>								

* Crop type = "Forage", "Grain" or "Bedding"

IMPORTS

Feeds (purchased)	Tons /year	%DM	CP (%DM)	P (%DM)	K (%DM)	Feed type*	% forage (if TMR)	Inventory	
								Beginning year (as fed tons)	Ending year (as fed tons)
grain	24	90	18	.34	.85	Grain		0	0
dry hay(228)	34.2	91.83	12.39	0.26	1.91	Forage		0	0
1st baleage(222)	106.89	67.2	10.2	0.14	1.36	Forac		0	0
						Forac		0	0
2nd baleage(25)	12.04	67.2	10.2	0.14	1.36	Forac		0	0
2nd baleage(30)	14.45	67.2	10.2	0.14	1.36	Forac		0	0

* Feed type = "Grain", "Forage" or "TMR"

Farm crop production
 These values will not impact the balance calculation (inside the farm boundaries) but accurate data will help with identification of "issues" or "opportunities to improve"

Feed imports



Relatively simple input data is needed to estimate whole-farm mass balances and associated indicators

Purchased fertilizers	Tons/year	% N	% P ₂ O ₅	% K ₂ O	Protected N source*? If yes, which one?
none					<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>

* Enhanced efficiency fertilizer, e.g. nitrification inhibitors, urease inhibitors, slow release fertilizer

Purchased animals	Type*	Description	Number	Weight/hd (lbs)
none				

* Type = "Dairy", "Beef", "Swine", "Poultry", "Goats", "Sheep" or "Horses"

Bedding, manure and miscellaneous imports	Amount	Units*	% DM (% solids)	N	P	K	Units** (as sampled)
straw 60 bales@600#	18	tons/year					
sawdust 50 10cubic yards	1.8	tons/year	<input type="checkbox"/>				

* Units = "tons/year" or "gallons/year"

** Units = "%", "lbs/ton" or "lbs/1000 gallons"

EXPORTS

Milk sold (lbs/year)	Milk protein (%)	Milk fat (%)	Milk urea nitrogen (MUN) (mg/dl)
835,000	3.08	4.12	8.64

Animals sold	Type*	Description	Number	Weight/hd (lbs)
7	Dairy	holstein cull dairy		1300

* Type = "Dairy", "Beef", "Swine", "Poultry", "Goats", "Sheep" or "Horses"

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Fertilizer purchases

Animal purchases

Bedding and miscellaneous imports

Milk sold and CP

Animals sold or exported off the farm

Relatively simple input data is needed to estimate whole-farm mass balances and associated indicators

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Crops sold or exported off the farm

Manure, compost or other exports

Crops sold	Tons/year	%DM	CP (%DM)	P (%DM)	K (%DM)	Feed type*
60 bales baleage	40.25	49.67	14.7	0.39	2.57	Forage
		Values	average	from	cuttings	
						% forage
TMR						

* Feed type = "Grain", "Forage" or "TMR"

Manure, compost and other exports	Amount	Units*	% solids	N	P	K	Units** (as sampled)
none							

* Units = "tons/year" or "gallons/year"

** Units = "%", "lbs/ton" or "lbs/1000 gallons"

