Nutrient Accounting for NNY Dairy Farms
Basis for Environmentally Sound Nutrient Management

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Collaborators:

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  - Jen Beckman (Lewis County)
  - Julie Viveiros (Clinton County)
  - Matt Cooper (Franklin County)
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- Miner Institute:
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- Agricultural Industry:
  - Peg Cook, Cook's Consulting

Background:

Our overall goal is to improve farm profitability while protecting the environment. Having a clear understanding of the imbalances between farm nitrogen (N), phosphorus (P) and potassium (K) imports and exports and the causes of these imbalances is necessary for the development of best management practices that address nutrient accumulation and aid in achieving long-term sustainability of the dairy and livestock industry in Northern NY. This project provides an assessment of the current status of N, P and K balances for 11 Northern NY farms that participated in 2004/2005. This assessment will facilitate evaluation of intervention points that could lead to improved whole farm nutrient balances and hence reduced risk of losses to the environment over time. Once expanded upon with more farms and with assessments over multiple years, the project is expected to increase our understanding of causes of such imbalances. This knowledge is the basis for measuring progresss as farms make changes in management of soil, crops, fertilizers, feeds, and animal wastes for watershed protection and long-term farm sustainability in Northern NY.

Methods:

We proposed to assess farm N, P and K balances for Northern NY farms using an Excel software program "Mass Nutrient Balance" v.2 (http://nmsp.css.cornell.edu/projects/massbalance.asp). Such balances consist of N, P and K accounting for inputs (feed, fertilizer, N fixation, bedding,

animals) and exports (milk, animals, crops, manure) and inventories (feed, fertilizer). Caroline Rasmussen provided training to CCE field staff and accompanied several extension educators on their first farm assessments. Eleven farms were completed (four in Lewis Co., three in Clinton Co., and one each in St Lawrence, Jefferson, Franklin and Essex Co.). All farms received a farm-specific report as well as an assessment of how their farm compared to others included in the project. The farms were named "A" to "K", ordered by the number of milking cows.

Results:

General farm characteristics[1]***:*** The eleven farms varied in size from 38 to 838 milking cows representing animal densities of 0.51 to 1.13 animal units[2] per acre. Milk production ranged from 5,407 to 13,938 lbs of milk per acre and from 17,971 to 27,291 lbs of milk per cow per year. The annual milk production per cow on each of the farms was higher than the 2003-2004 state average of 17,786 lbs/cow (NYSDAM, 2005). All farms were conventionally managed (as opposed to "organic") Holstein dairy farms. Farm C had a beef cow-calf enterprise in addition to the dairy cows. Crop and tillable pasture acres ranged from 140 to 2,700 acres. Five of the eleven farms sold crops off the farm. The percentage purchased feeds (percentage of all livestock feed on a dry matter basis) ranged from 11% (farm F) to 49% (farm B). This metric was not available for Farm E. General farm characteristics for each of the farms are shown in Tables 1 and 2.

Nitrogen balances*:* Nitrogen balances are shown in Table 3. The percentage of N imported that could not be accounted for through farm exports of milk, animals, crops, and/or manure ([imported N–exported N]/imported N) ranged from 51 to 78% (65% on average across the farms). The total annual lbs of N/acre "remaining" ranged from 68 lbs N/acre for farm F to 270 lbs N/acre for farm K. There was greater farm to farm variation for N imports than for exports when nutrient flows were considered on a per animal unit basis (Figure 1). Purchased feed and fertilizer accounted for the bulk of N imported. Together these major contributors accounted for 63 to 93% of all N imports. The distribution between purchased feed and fertilizer N imports varied among farms. For example, farm K imported 82% of their N as feed and 9% as fertilizer while farm C imported 25% of imported N as feed and 62% as fertilizer (Table 4). On all of the farms except D and J, the largest N export was in the form of milk sales. The major N export for farms D and J was crop sales. None of the farms currently export manure. The N contribution from fixation by legumes was estimated from legume acreage, yield and crude protein content. Nitrogen fixation accounted for 5 to 37% of the total N imports on the farms with N fixation accounting for more than 30% of N imports on farms F (245 legume acres) and J (800 legume acres) (Figure 2). In this relatively small dataset, there was only a weak relationship between legume acres and N balance (Figure 3) but more farms need to be included to draw conclusions.

Phosphorus balances: The study farms imported 0.71 to 17.24 tons more P[3] than they exported annually (Table 5). The percent P remaining varied from 33 to 72%. The farm to farm difference between P imports and exports per animal unit varied from 7 to 25 lbs P (16-58 lbs P_2O_5) per animal unit (Figure 4). As with N, milk was the major P export item on all of the farms except farms D and J. Feed and fertilizer accounted for most of the P imports. Farms D and J's major P imports were in the form of purchased fertilizers (61% and 65%, respectively). On the other farms, 57 to 96% of the imported P was brought onto the farm in the form of feed (Table 4).

[1] The data collection year for Farm G was 2003 while for all other farms 2004 data were used.
[2] One animal unit equals 1000 lbs.
[3] Multiply by 2.3 to obtain units of P_2O_5.

Potassium balances: The case study farms imported 0.29 to 56.11 ton more K[4] than they exported in the year of the study (Table 6). The remaining K was 8 to 86 % of imports and 2 to 104 lbs of K (3 to 125 lbs K_2O) per acre. The farm to farm difference between K imports and exports per animal unit varied between 2 and 140 lbs K (3 to 168 lbs K_2O) per animal unit (Figure 5). The distribution of potassium imports differs from the distribution of N and P imports. For six of the farms purchased fertilizer was the major K import (Table 4). On nine participating farms most of the K was exported as milk. However, for the five farms that sold crops, off farm crop sales accounted for 18 to 72% of K exports.

Indicators of imbalance (preliminary!!): A sample size of 11 does not provide a sufficient database for rigorous statistical comparison. However, some general trends can be observed. The farms were ordered A to K on the basis of the number of milking cows. Figures 6, 7 and 8 display lbs of N, P and K remaining on each farm acre. Although farm K, the largest farm (838 milking cows), has the highest N and P remaining/acre, there does not appear to be a relationship between number of cows and nutrient excess on these 11 farms. Also when excess nutrients per acre is plotted against animal density and farm size (total animal units - with the exception of one farm all farms with less than 1 au/acre) there does not seem to be significant correlation between farm size and nutrient imbalance (Figures 9-14). A useful indicator of nutrient balance is the presence of a crop sales enterprise. Tables 7, 8 and 9 show selected farm and nutrient balance data for the 6 case study farms that did not sell any crops and 5 farms that did sell crops. Farms that exported crops had more land (average of 826 versus 625 tillable crop and pasture acres), and a slightly lower mean animal density (0.71 versus 0.75 au/acre). On average, the farms that did not export crops had a greater imbalance in N (tons, lbs/acre and %), and P (lbs/acre and %) than farms that did sell crops[5]. Purchased feed as a percentage of all livestock feed averaged 33% for farms that did sell crops and 21% for farms that did not. Farms with crop sale enterprises imported fewer nutrients as feed than their non-crop selling counterparts. However, those farms that sold crops imported more nutrients as fertilizer (total tons and per acre) than farms that did not sell crops. On average, those that sold crops imported 1.89x more fertilizer N and 2.68x more fertilizer P (tons). Naturally, farms with crop sales exported more nutrients off the farm. In the case of N, the average difference between the increased fertilizer purchases and the decreased feed purchases offset each other and the increased N exported as crops (12.6 tons) approximately equaled the N "remaining" (i.e. imports not exported with products).

Conclusions/Outcomes/Impacts:

Additional data (greater number of farms participating in the study and multiple years per farm) are needed to draw conclusions with regards to indicators of imbalances and improvement opportunities on the farm. This initial assessment suggests that there are great farm to farm differences in the quantity of nutrients remaining on farms. These disparities remain when nutrient loss is measure in total (tons/farm) and in proportion to farm size (animal units and tillable acres) and farm animal density (animal units/acre). The proportion of nutrients remaining on the farm as a percent of imports was generally lower for P than for N and K. This may be a reflection on the extensive education and policy efforts to reduce P loss from dairy farms over the past several years. Off-farm crop sales appeared to be a strategy that improves mass nutrient

[4] Multiply by 1.2 to obtain units of K_2O.

[5] K balances are difficult to generalize because data ranges are extreme. Average values are not representative.

balance. Detailed farm analyses are needed to quantify the impact (opportunities) of more precise feed and fertilizer management on whole farm balances. Such assessment should be accompanied by assessment of farm business summary data to explore the impact of nutrient management strategies on both farm profitability and nutrient source reduction.

Outreach

The project, by its nature, involves direct interactions between producers, consultants, extension, and on-campus research and extension teams in two departments (Animal Science and Crop and Soil Sciences). Producer involvement in the data acquisition and individualized farm analysis engaged producers to actively consider the causes of nutrient flows onto and off of their farms. Project results were communicated to each of the participating producers via farm specific reports. Summaries of all farms (without farm identification) were included in the report so producers could compare their nutrient balances to other farms in their region. This final report was added to our website for Northern NY projects (http://nmsp.cornell.edu/projects/nny.asp). Additional outreach will occur this fall and winter (see next steps).

Next steps:

The 2004/2005 results will be presented at NNY winter meetings and distributed through fact sheets that will be developed this fall. Each of the participating CCE offices agreed to continue with the project in 2005/2006 and the project will be expanded with a second year (2005) of data for farms that participated with 2004 data and an additional 10 farms. A larger dataset is needed to investigate the impact of changes in management on whole farm balances and to derive management indicators that have major impacts on these balances (i.e. identify management options to reduce imbalances for long-term sustainability of the farms).

Acknowledgments:

We gratefully acknowledge the cooperation of the participating producers. This project was funded with a grant from the Cornell University Agricultural Experiment Station for work to be done as part of the Northern New York Agricultural Development Program. Software development was supported with a grant from the Upper Susquehanna Coalition.

Literature cited:

- Czymmek, K.J., D. Beegle, and Q.M. Ketterings (2005). Implications of agronomic and environmental considerations in land application of manure in dairy farm systems of the Northeast and Mid-Atlantic Regions of the United States. NRAES Conference. March 15-17, 2005. Dairy Manure Management: Treatment, Handling and Community Relations. NRAES-176. pp 1-10.
- Ketterings, Q.M., J. Kahabka, and W.S. Reid (2005). Trends in phosphorus fertility of New York agricultural land. Journal of Soil and Water Conservation 59(1): 10-20.
- New York State Department of Agriculture and Markets (2005). New York State Agricultural Statistics, 2003-2004 Annual Bulletin. Accessible at: http://www.nass.usda.gov/ny/Bulletin/2005/AnnualBulletin.pdf.

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Table 1: General farm characteristics for eleven case study dairy farms located in Northern New York State (2004 data).

	Animal density	Milking and dry cows	Milk production		Purchased feeds	Crop and tillable pasture	Legume crop
	AU[a]/acre	Number of cows	lbs/acre	lbs/cow per year	% dry matter	acres	acres
Farm A	0.74	38	10,234	27,291	21	240	120
Farm B	0.79	60	7,702	17,971	49	140	42
Farm C[b]	0.63	71	5,703	25,704	30	320	80
Farm D	0.75	90	7,756	19,820	15	230	80
Farm E	0.66	99	6,000	20,000	n/a	330	60
Farm F	0.76	139	7,769	21,295	11	381	245
Farm G[c]	0.64	180	6,499	22,206	30	615	180
Farm H	0.65	294	6,831	21,956	29	945	382
Farm I	0.81	340	12,527	21,258	36	577	148
Farm J	0.51	705	5,407	20,709	23	2700	800
Farm K	1.13	838	13,938	23,285	30	1400	600

[a] AU (animal units) = 1,000 lbs live weight.
[b] Farm C was composed of dairy and beef enterprises.
[c] 2003 data.

Table 2. Selected farm characteristics and farm nutrient balance factors, mean, median, minimum and maximum for eleven case study dairy farms located in Northern New York State (2004 data[f]).

	Mean	Median	Min	Max
Selected farm characteristics				
Animal units	509	289	110	1578
Animal density	0.73	0.74	0.51	1.13
Tillable crop and pasture (acres)	716	381	140	2700
Legume crop (acres)	249	148	42	800
Purchased feed %[g]	27%	29%	11%	49%
Selected nutrient balance factors				
N remaining (imports – exports)				
N remaining tons	44.80	18.88	7.74	189.21
N remaining lbs/acre	111	97	68	270
N remaining %	65%	66%	51%	78%
P remaining (imports – exports)				
P remaining tons	4.58	1.77	0.71	17.24
P remaining lbs/acre	12	13	4	18
P remaining %	55%	57%	33%	72%
K remaining (imports – exports)				
K remaining tons	17.16	12.42	0.29	56.11
K remaining lbs/acre	46	42	2	104
K remaining %	65%	74%	8%	86%

[f] This includes one farm with 2003 data.
[g] Mean, median, minimum and maximum values for "Purchased feed %" include 10 case study farms.

Table 3: Mass nitrogen balance for eleven case study dairy farms located in Northern New York State (2004 data). General characteristics of the farms are given in Tables 1 and 2.

Farm	A	B	C	D	E	F	G[a]	H	I	J	K
					Nitrogen (N) tons/year						
Annual imports											
Feed	12.69	6.39	6.18	7.80	9.36	12.56	22.13	40.73	32.74	75.88	198.65
Fertilizer	2.16	3.47	15.18	11.08	5.78	1.73	14.90	10.53	24.34	75.04	22.74
N fixation	4.50	0.61	2.76	2.15	2.43	8.47	7.28	12.28	2.88	65.40	17.60
Animals	0.00	0.00	0.24	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.64
Bedding	0.10	0.17	0.04	0.04	0.00	0.12	0.46	0.34	0.01	0.00	3.08
Total	19.45	10.64	24.41	21.12	17.57	22.88	44.77	63.88	59.98	216.32	242.71
Annual exports											
Milk	6.27	2.66	4.77	4.60	5.47	7.55	11.11	16.64	19.24	39.36	47.67
Animals	0.83	0.24	0.76	0.52	0.54	1.07	2.08	1.55	2.32	6.86	5.61
Crops	1.55	0.00	0.00	5.21	0.00	1.37	0.00	0.00	5.53	49.34	0.00
Manure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21
Total	8.65	2.90	5.53	10.33	6.01	9.98	13.19	18.19	27.09	95.56	53.50
Import-export	10.80	7.74	18.88	10.79	11.56	12.90	31.58	45.69	32.89	120.76	189.21
"Remaining"											
%[b]	56	73	77	51	66	56	71	72	55	56	78
lbs N/acre/yr	90	111	118	94	70	68	103	97	114	89	270

[a] 2003 data.

[b] [(Import-Export)/Import]*100.

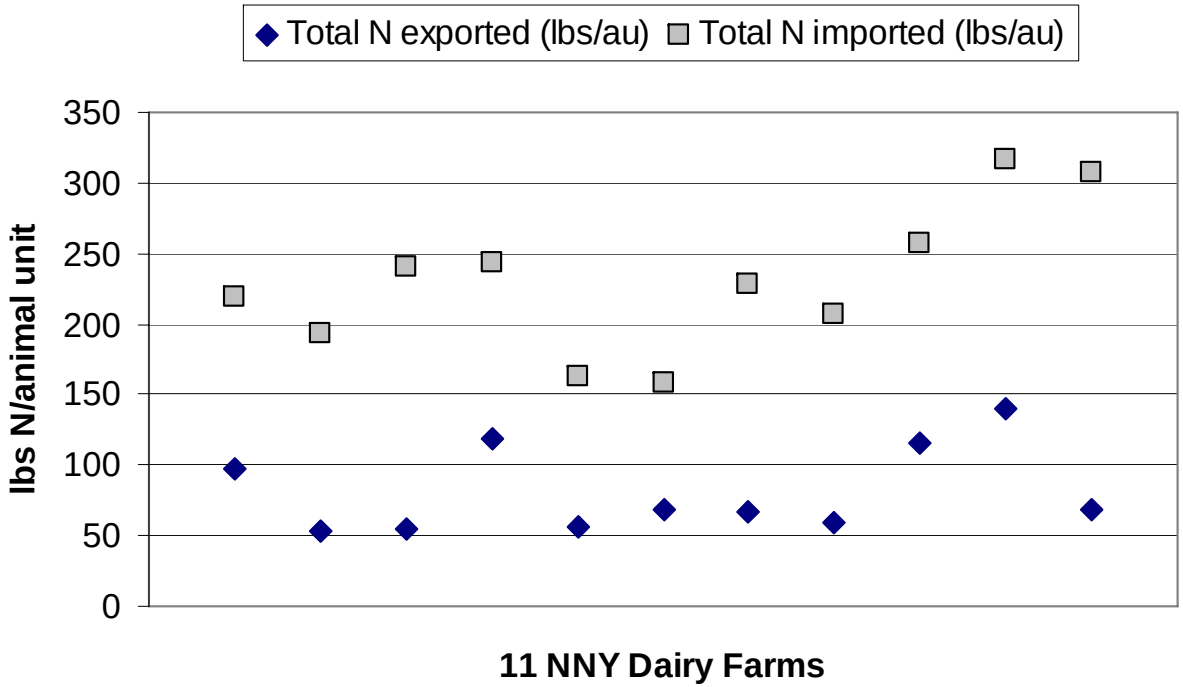

Figure 1: Annual total N imports and exports for eleven NNY case study farms (lbs N/animal unit); 1 animal unit equals 1000 lbs live weight.

Table 4: Distribution of nitrogen, phosphorus and potassium imports and exports for eleven case study dairy farms located in Northern New York State (2004 data).

Farm	A	B	C	D	E	F	G [a]	H	I	J	K
	*Percent of total **nitrogen (N)** imports*										
Annual imports											
Feed	65	60	25	37	53	55	49	64	55	35	82
Fertilizer	11	33	62	52	33	8	33	16	41	35	9
N fixation	23	6	11	10	14	37	16	19	5	30	7
Animals	0	0	1	0	0	0	0	0	0	0	0
Bedding	0	2	0	0	0	1	1	1	0	0	1
	*Percent of total **nitrogen (N)** exports*										
Annual exports											
Milk	73	92	86	45	91	75	84	91	71	41	89
Animals	10	8	14	5	9	11	16	9	9	7	11
Crops	18	0	0	50	0	14	0	0	20	52	0
Manure	0	0	0	0	0	0	0	0	0	0	0
	*Percent of total **phosphorus (P)** imports*										
Annual imports											
Feed	72	57	96	39	63	67	58	68	70	35	73
Fertilizer	28	42	0	61	37	33	41	32	30	65	24
Animals	0	0	4	0	0	0	0	0	0	0	1
Bedding	0	1	0	0	0	0	2	0	0	0	2
	*Percent of total **phosphorus (P)** exports*										
Annual exports											
Milk	67	87	79	39	85	70	75	86	62	37	84
Animals	15	13	21	8	15	17	25	14	13	11	16
Crops	18	0	0	53	0	13	0	0	25	52	0
Manure	0	0	0	0	0	0	0	0	0	0	0

Table 4 (continued): Distribution of nitrogen, phosphorus and potassium imports and exports for eleven case study dairy farms located in Northern New York State (2004 data).

Farm	A	B	C	D	E	F	G [a]	H	I	J	K
	---------- *Percent of total **potassium (K)** imports* ----------										
Annual imports											
Feed	24	63	99	20	61	83	39	46	40	14	56
Fertilizer	76	37	0	80	39	17	54	49	60	86	27
Animals	0	0	1	0	0	0	0	0	0	0	0
Bedding	0	0	0	0	0	0	0	0	0	0	0
	---------- *Percent of total **potassium (K)** imports* ----------										
Annual exports											
Milk	61	97	96	27	98	62	95	98	80	26	96
Animals	2	3	4	1	3	2	5	2	3	1	3
Crops	37	0	0	72	0	36	0	0	18	72	0
Manure	0	0	0	0	0	0	0	0	0	0	1

[a] 2003 data.

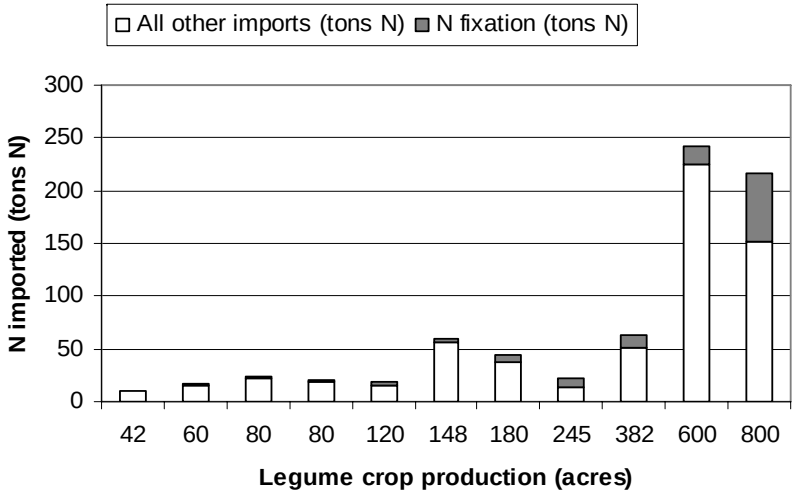

Figure 2: Nitrogen imported in the form of N fixation increases with legume crop acres.

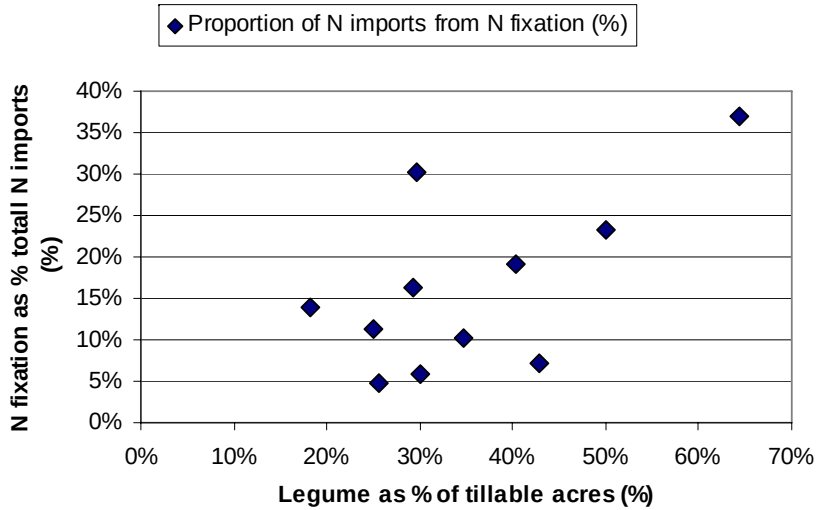

Figure 3: Farms with the highest proportion of legume acres also have the highest N fixation imports.

Table 5:Mass phosphorus balance for eleven case study dairy farms located in Northern New York State (2004 data). General characteristics of the farms are given in Table 1.

Farm	A	B	C	D	E	F	G[a]	H	I	J	K
					Phosphorus (P) tons/year						
Annual imports											
Feed	2.25	0.78	1.51	1.03	1.42	2.20	3.23	6.76	4.51	11.08	15.61
Fertilizer	0.87	0.58	0.00	1.62	0.85	1.10	2.27	3.14	1.94	20.96	5.06
Animals	0.00	0.00	0.06	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.16
Bedding	0.01	0.02	0.00	0.00	0.00	0.01	0.09	0.03	0.00	0.00	0.41
Total	3.13	1.38	1.57	2.66	2.27	3.30	5.59	9.93	6.44	32.04	21.24
Annual exports											
Milk	0.91	0.40	0.68	0.66	0.73	1.10	1.48	2.39	2.67	5.40	7.22
Animals	0.20	0.06	0.18	0.13	0.13	0.26	0.50	0.37	0.56	1.66	1.35
Crops	0.25	0.00	0.00	0.91	0.00	0.21	0.00	0.00	1.06	7.74	0.00
Manure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Total	1.36	0.46	0.86	1.70	0.86	1.56	1.98	2.76	4.29	14.80	8.59
Import-export	1.77	0.93	0.71	0.96	1.40	1.74	3.61	7.17	2.15	17.24	12.64
"Remaining"											
%[b]	57	67	45	36	62	53	65	72	33	54	60
lbs P/acre/yr[c]	15	13	4	8	9	9	12	15	7	13	18

[a] 2003 data.
[b] [(Import-Export)/Import]*100.
[c] To convert to lbs of P_2O_5, multiply by 2.3.

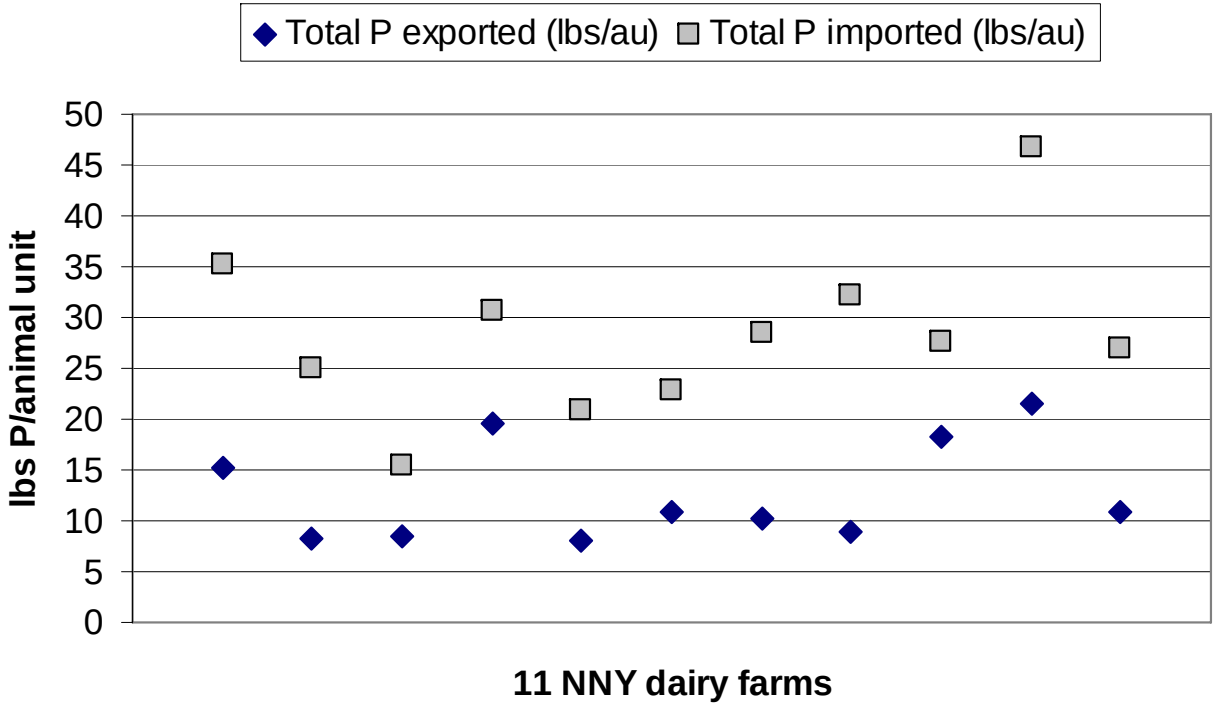

Figure 4. Annual total P imports and exports for eleven NNY case study farms (lbs P/animal unit); 1 animal unit equals 1000 lbs live weight.

Table 6:Mass potassium balance for eleven case study dairy farms located in Northern New York State (2004 data). General characteristics of the farms are given in Table 1.

Farm	A	B	C	D	E	F	G[a]	H	I	J	K
	Potassium (K) tons/year										
Annual imports											
Feed	3.61	1.89	2.37	2.16	2.55	3.04	8.10	11.25	12.67	13.09	33.03
Fertilizer	11.62	1.12	0.00	8.73	1.64	0.61	11.25	11.99	19.01	81.75	15.92
Animals	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04
Bedding	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	15.23	3.01	2.38	10.89	4.19	3.65	20.70	24.47	31.67	94.85	58.85
Annual exports											
Milk	1.72	0.75	1.28	1.25	1.39	2.07	2.80	4.52	5.06	10.22	13.66
Animals	0.06	0.02	0.05	0.04	0.04	0.07	0.14	0.11	0.16	0.47	0.39
Crops	1.03	0.00	0.00	3.32	0.00	1.21	0.00	0.00	1.13	28.04	0.00
Manure	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11
Total	2.80	0.77	1.33	4.60	1.42	3.36	2.94	4.63	6.35	38.74	14.16
Import-export	12.43	2.24	1.05	6.29	2.77	0.29	17.76	19.84	25.32	56.11	44.69
"Remaining"											
%[b]	82	74	44	58	66	8	86	81	80	59	76
lbs K/acre/yr[c]	104	32	7	55	17	2	58	42	88	42	64

[a] 2003 data.
[b] [(Import-Export)/Import]*100.
[c] To convert to lbs of K_2O, multiply by 1.2.

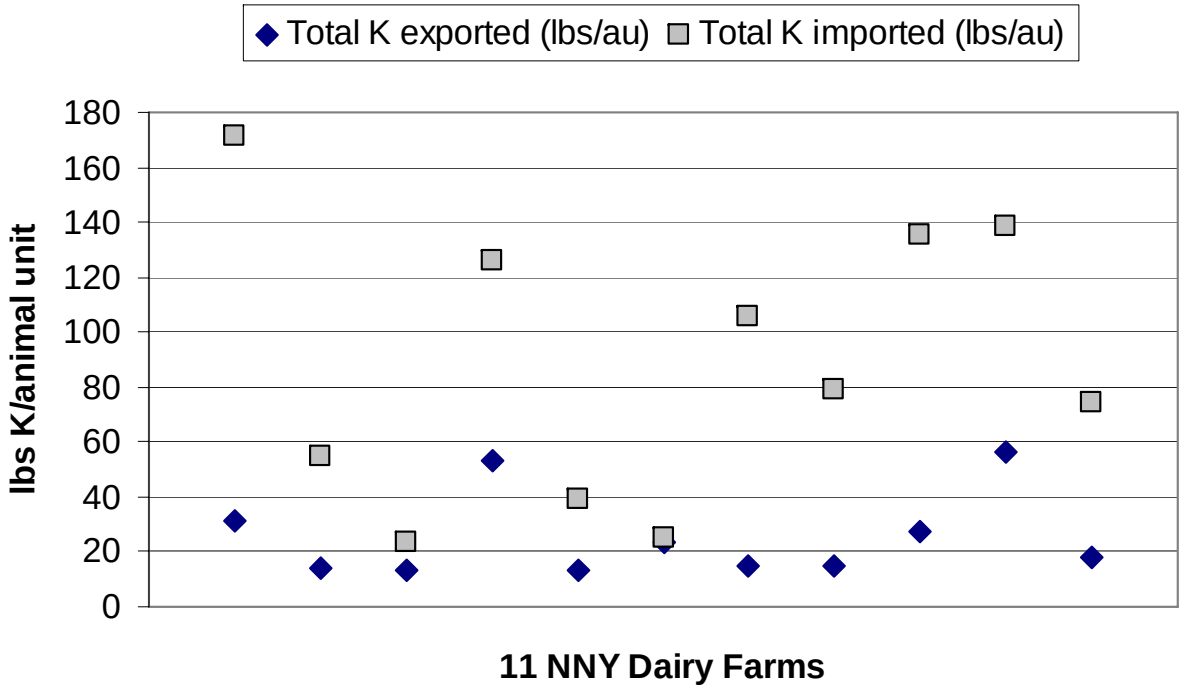

Figure 5: Annual total K imports and exports for eleven NNY case study farms (lbs K/animal unit); 1 animal unit equals 1000 lbs live weight.

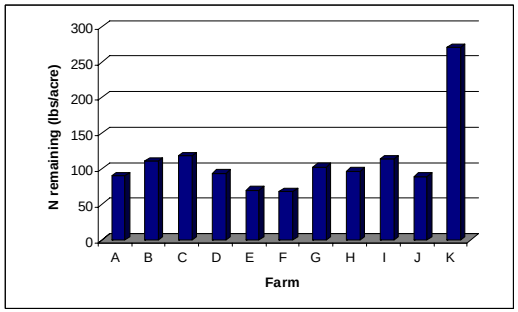

Figure 6. N remaining on eleven NNY dairy farms (lbs/acre).

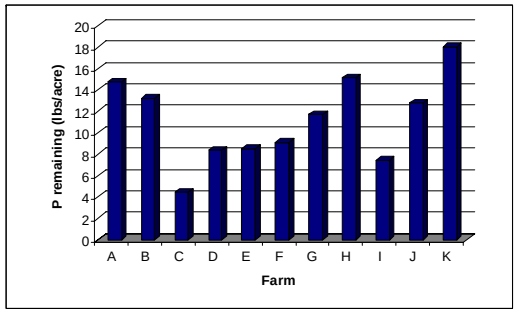

Figure 7. P remaining on eleven NNY dairy farms (lbs/acre).

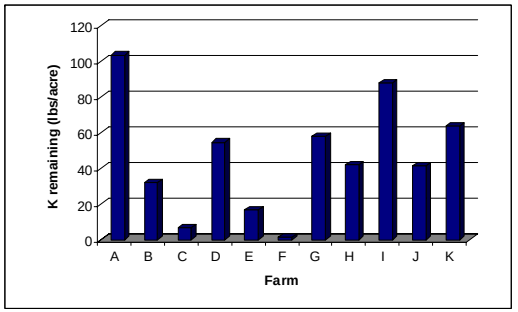

Figure 8. K remaining on eleven NNY dairy farms (lbs/acre).

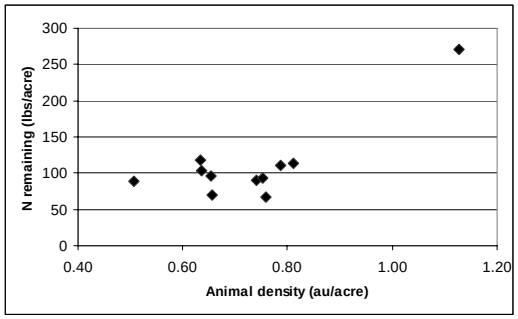

Figure 9. N remaining (lbs/acre) in relation to farm animal density on eleven NNY dairy farms; 1 animal unit = 1,000 lbs live weight.

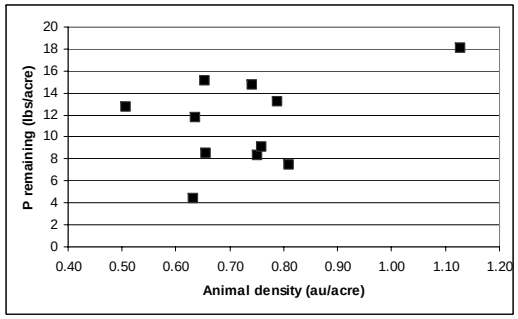

Figure 10. P remaining (lbs/acre) in relation to farm animal density on eleven NNY dairy farms; 1 animal unit = 1,000 lbs live weight.

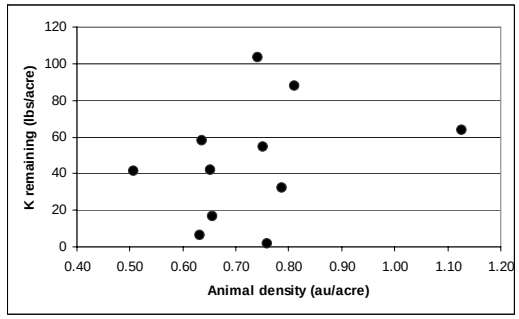

Figure 11. K remaining (lbs/acre) in relation to farm animal density on eleven NNY dairy farms; 1 animal unit = 1,000 lbs live weight.

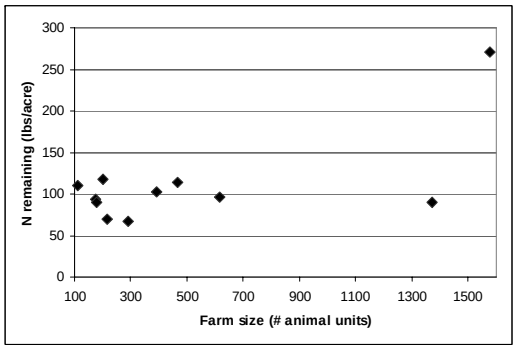

Figure 12. N remaining (lbs/acre) in relation to farm size (animal units) on eleven NNY dairy farms; 1 animal unit=1,000 lbs live weight.

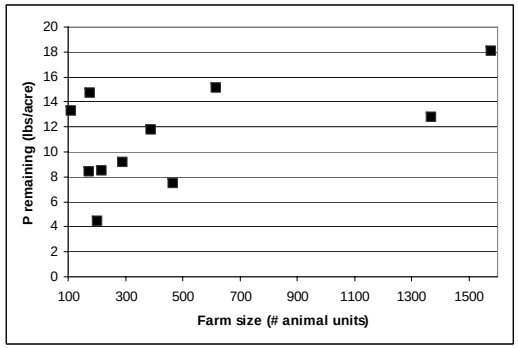

Figure 13. P remaining (lbs/acre) in relation to farm size (animal units) on 11 NNY dairy farms; 1 animal unit = 1,000 lbs live weight.

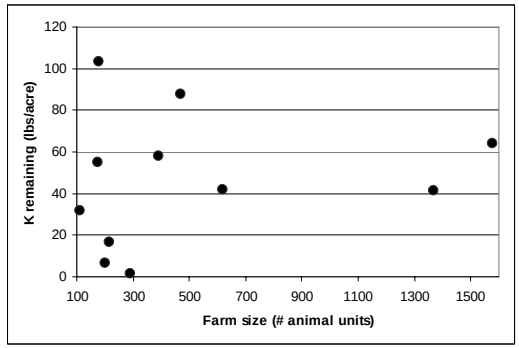

Figure 14. K remaining (lbs/acre) in relation to farm size (animal units) on 11 NNY dairy farms; 1 animal unit = 1,000 lbs live weight.

Table 7. Selected farm characteristics and farm nitrogen balance factors, mean, median, minimum and maximum for six NNY dairy farms without crop sales and five NNY dairy farms with crop sales.

	6 farms with no crop sales				5 farms with crop sales			
Selected farm characteristics	Mean	Median	Min	Max	Mean	Median	Min	Max
Animal units	519	304	110	1578	496	289	173	1370
Animal density	0.75	0.65	0.63	1.13	0.71	0.75	0.51	0.81
Tillable crop and pasture (acres)	625	473	140	1400	826	381	230	2700
Legume Crop (acres)	224	130	42	600	279	148	80	800
Purchased feed %[a]	33%	30%	29%	49%	21%	21%	11%	36%
N remaining (imports – exports)								
N remaining tons	50.78	25.23	7.74	189.21	37.63	12.90	10.79	120.76
N remaining lbs/acre	128	107	70	270	91	90	68	114
N remaining %	73%	72%	66%	78%	55%	56%	51%	56%
N imported as purchased feeds								
N feed import tons	47.24	15.75	6.18	198.65	28.33	12.69	7.80	75.88
N feed import lbs/acre	105	79	39	284	82	68	56	114
N imported as purchased fertilizer								
N fertilizer import tons	12.10	12.72	3.47	22.74	22.87	11.08	1.73	75.04
N fertilizer import lbs/acre	47	42	22	95	53	56	9	96
N imported as nitrogen fixation								
N fix import	7.16	5.02	0.61	17.60	16.68	4.50	2.15	65.40
N fixation lbs/acre	19	20	9	26	32	38	10	48
N exported as crop sales								
N crop sales tons	0.00	0.00	0.00	0.00	12.60	5.21	1.37	49.34
N crop sales lbs/acre	0	0	0	0	13	5	1	49

[a] Mean, median, minimum and maximum values for "Purchased feed %" include 5 case study farms.

Table 8. Selected farm characteristics and farm phosphorus balance factors, mean, median, minimum and maximum for six NNY dairy farms without crop sales and five NNY dairy farms with crop sales.

	6 farms with no crop sales				5 farms with crop sales			
	Mean	Median	Min	Max	Mean	Median	Min	Max
Selected farm characteristics								
Animal units	519	304	110	1578	496	289	173	1370
Animal density	0.75	0.65	0.63	1.13	0.71	0.75	0.51	0.81
Tillable crop and pasture (acres)	625	473	140	1400	826	381	230	2700
Legume Crop (acres)	224	130	42	600	279	148	80	800
Purchased feed %[a]	33%	30%	29%	49%	21%	21%	11%	36%
Selected farm P balance factors								
P remaining (imports – exports)								
P remaining tons	4.41	2.51	0.71	12.64	4.77	1.77	0.96	17.24
P remaining lbs/acre	12	12	4	18	10	9	7	15
P remaining %	62%	63%	45%	72%	47%	53%	33%	57%
P imported as purchased feeds								
P feed import tons	4.88	2.37	0.78	15.61	4.21	2.25	1.03	11.08
P feed import lbs/acre	22	15	1	51	13	12	8	19
P imported as purchased fertilizer								
P fertilizer import tons	1.98	1.56	0.00	5.06	5.30	1.62	0.87	20.96
P fertilizer import lbs/acre	6	7	0	8	10	7	6	16
P exported as crop sales								
P crop sales tons	0.00	0.00	0.00	0.00	2.03	0.91	0.21	7.74
P crop sales lbs/acre	0	0	0	0	4	4	1	8

[a] Mean, median, minimum and maximum values for "Purchased feed %" include 5 case study farms.

Table 9. Selected farm characteristics and farm potassium balance factors, mean, median, min and max for 6 NNY dairy farms without crop sales and 5 NNY dairy farms with crop sales.

	6 farms with no crop sales				5 farms with crop sales			
	Mean	Median	Min	Max	Mean	Median	Min	Max
Selected farm characteristics								
Animal units	519	304	110	1578	496	289	173	1370
Animal density	0.75	0.65	0.63	1.13	0.71	0.75	0.51	0.81
Tillable crop and pasture (acres)	625	473	140	1400	826	381	230	2700
Legume Crop (acres)	224	130	42	600	279	148	80	800
Purchased feed %[a]	33%	30%	29%	49%	21%	21%	11%	36%
Selected farm K balance factors								
K remaining (imports – exports)								
K remaining tons	14.73	10.26	1.05	44.69	20.09	12.42	0.29	56.11
K remaining lbs/acre	36	37	7	64	58	55	2	104
K remaining %	71%	75%	44%	86%	57%	59%	8%	82%
K imported as purchased feeds								
K feed import tons	9.86	5.33	1.89	33.03	6.91	3.61	2.16	13.09
K feed import lbs/acre	26	25	15	47	24	19	10	44
K imported as purchased fertilizer								
K fertilizer import tons	6.99	6.45	0.00	15.92	24.35	11.62	0.61	81.76
K fertilizer import lbs/acre	18	19	0	37	60	66	3	97
P exported as crop sales								
K crop sales tons	0.00	0.00	0.00	0.00	6.94	1.21	1.03	28.04
K crop sales lbs/acre	0	0	0	0	14	9	4	29

[a] Mean, median, minimum and maximum values for "Purchased feed %" include 5 case study farms.