Northern NY Agricultural Development Program
2006-2007 Project Report

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

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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 the Northern New York region. This project is in its third year. It provides an assessment of the current status of N, P and K balances for the 11 Northern New York farms that participated in 2004/2005, the 22 farms that participated in 2006, and the 24 farms that participated in 2007. This assessment will facilitate evaluation of management changes (opportunities) that could lead to improved whole farm nutrient balances and hence reduced risk of losses to the environment over time. To date, this dataset includes 31 individual dairy farms.

Methods:

We assessed farm N, P and K balances for NNY farms using an Excel software program "Mass Nutrient Balance" v. 4.2 (http://nmsp.css.cornell.edu/projects/massbalance.asp). The Mass Nutrient Balance is an accounting for nutrients (N, P and K) inputs (feed, fertilizer, N fixation, bedding, animals) and exports (milk, animals, crops, manure) and inventories (farm produced and purchased feed). The analysis was refined in 2007 in response to experiences in the first two project years and input from participants and extension educators. The updated version of the Mass Balance calculator was refined and expanded to include:

- Atmospheric nitrogen deposition.
- A more user-friendly and complete farm mass nutrient balance report.
- A comparison of current mass nutrient balance results to previous years.

Caroline Rasmussen worked with CCE field staff to collect the farm assessments. Twenty-four farms were completed (seven in St Lawrence, seven in Clinton, four in Essex, three in Franklin, two in Lewis, and one in Jefferson County). Of the thirty-one individual farms participating to-date, seven have contributed three years of data (data collection years 2004, 2005 and 2006), twelve submitted data for two years (data collection year 2005 and 2006), and twelve participated for the first time in 2007 (data for 2006 calendar year). All farms received a farm-specific report as well as an assessment of how their farm compared to others included in the project. Those farms that participated for 2 or more years received a progress report, comparing their year to year results.

Results:

General farm characteristics:

The twenty-four farms, submitting 2006 data, varied in size from 36 to 1,469 milking cows with from 140 to 2,650 tillable acres, representing animal densities of 0.14 to 1.02 animal units[1] per acre. Milk production ranged from 1,172 to 16,708 lbs of milk per acre and from 7,698 to 28,661 lbs of milk per cow per year. Twelve of the twenty-four farms sold crops off the farm. The percentage of purchased feeds (percentage of all livestock feed on a dry matter basis) ranged from 5% to 35%. General farm characteristics are shown in Table 1.

Nitrogen balances:

The annual nitrogen balances are shown in Table 2. The difference between the N imported as feed, purchased fertilizer, animals and bedding and the N exported as milk, animals, crops and manure ranged from -35 pounds per acre (more exported than imported) to +188 pounds N per tillable acre (more imported than exported), with an average N remaining of +69 lbs N per tillable acre (Figure 1).

The N contribution from fixation by legumes was estimated from legume crop acreage, yield and crude protein content. Atmospheric deposition of N was estimated at 8 pounds per total farm acre per year. Atmospheric N deposition and N fixation added an average of 42 lbs N per tillable acre to the total N imported.

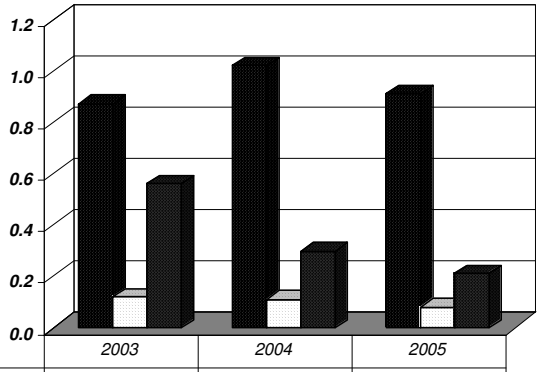
Purchased feed and fertilizer accounted for the bulk of N imported onto these farms. Together these major contributors accounted for 75% of all N imports (feed, fertilizer, purchased animals, bedding, atmospheric deposition and N fixation) and 99% of "manageable" imports (feed, fertilizer, animals and bedding) (Table 3 and Fig. 2). On all of the farms except two, the largest N export was in the form of milk sales and on average, milk accounted for 74% of all N exports on these farms. The major N export vehicle for two farms was crop sales. One of the farms exported manure at the rate of 52 lbs of N per tillable acre. Nitrogen fixation accounted for 0 to 39% of the total N imports on the farms.

[1] One animal unit equals 1000 lbs.

Phosphorus balances:
The study farms imported an average of 1.6 tons more P than they exported annually (Table 4). The P remaining varied from -3 (more exported than imported) to +20 lbs of P per tillable acre (Fig. 3). As with N, milk was the major P export item on all of the farms expect two, who both exported more P with crops than with milk. Purchased feed and fertilizer accounted for most of the P imports (on average 13 and 5 lbs of P imported per tillable acre, respectively). The P coming on the farm as either purchased animals or bedding averaged less than one half pound of P per tillable acre.

Potassium balances:
Three case study farms exported more K than they imported; each of these farms exported 36 to 84% of their K as crop sales or manure exports. The remaining farms annually imported 0.42 to 49.23 tons more K than they exported (Table 5). The remaining K ranged from -20 (more K exported than imported) to +81 lbs of K^2 per acre (Figure 4). The distribution of K imports differed from the distribution of N and P imports. For seven of the farms, purchased fertilizer was the major K import category. On six participating farms, most of the K was exported as crops sales.

Multiple year comparisons:
Seven Northern New York dairy farms participated in the mass nutrient balance over three years, providing data for calendar years 2004, 2005 and 2006. On average, these seven farms had an increase in mature cows and total animal units in each of these years (Table 6). During these 3 years, the average tillable crop and pasture acres remained constant, resulting in an average animal density increase from 0.73 in 2004 to 0.80 in 2005 and 0.86 animal units per acre in 2006. The average farm mass balance (imports-exports divided by total tillable acres) increased in each year from 2004 to 2006 for N, stayed constant for P and decreased for K. The N, P, and K remaining per cwt milk produced fluctuated over the years for N and decreased for P and K, showing improvement in P and K use efficiency. Yet, changes from 2004 to 2006 for N, P and K remaining per tillable acre vary dramatically from farm to farm (Fig. 5). Five of the seven farms had an increase in N remaining per tillable acre. Of the 7 farms, 3 had an increase and 4 had a decrease in P remaining per acre. Two farms had an increase and 5 showed a decrease in K remaining per acre.



	2003	2004	2005
lbs N/cwt	0.87	1.02	0.91
lbs P/cwt	0.12	0.11	0.08
lbs K/cwt	0.56	0.30	0.21

Mass nutrient balance benchmarks:
The quantity of excess nutrients on the case study farms varied considerably. Fig. 1, 3 and 4 display lbs of N, P and K remaining per tillable acre, with farms ranked along the x-axis by farm size as measured by total animal units. The per acre P excess seemed to decrease as farm size increased (Fig. 3); the two largest farms in the dataset, with herd sizes of more than 700 mature cows per farm, have some of the lowest excess P levels (negative 2 and 0 lbs P remaining

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

/tillable acre). On one farm, 70% of the total P exported left the farm as crops; on the other farm 42% of the total P exported was exported in manure. We hope to do more detailed farm assessments (within farm nutrient flows) to see what additional factors allow these farms to be more P efficient than the other farms in the project.

Three farm characteristics that help explain mass nutrient balance performance are (1) exporting nutrients as crops and or manure, (2) feeding a higher proportion of farm produced feeds (and a lower proportion of purchased feeds), and (3) nutrient use efficiency.

Crop Sales:
One farm exported more N, P and K than they imported in 2006. This farm is primarily a crop farm who exported 74, 70 and 84% of their N, P and K, respectively, as crop sales in 2006. High animal and crop productivity and a low animal density (0.27 animal units per acre) resulted in negative mass nutrient balances. In the short term, low nutrient balances can be sustained but an annual negative mass balance will result in nutrient "mining" of the farm and this will eventually (longer-term) result in a loss in productivity.

In the 2004 and 2005 Northern New York Mass Balance assessment, farms that sold crops had lower mass nutrient balances than farms that did not sell crops. In the 24 farms participating in 2006, this trend continued (Table 7). Farms with crop sales tended to be smaller with less tillable acres, cow numbers and animal units than dairy-only enterprises. Farms with crop sales had lower animal densities and spread manure on a smaller proportion of their tillable acres. Farms with off-farm crop sales had a smaller percentage of purchased feeds and less N, P and K imported as feed per tillable acre. In 2004, the average of the 5 farms that sold crops imported about twice as much fertilizer N and P than the 6 farms that did not sell crops. In 2005, the farms that sold crops imported N and P fertilizer per crop acre at about the same rate as farms that did not sell crops and K fertilizer as a slightly lower rate than the farms that did not sell crops. In 2006, the N imported as purchased fertilizer was the same for both groups and the P and K fertilizer purchases were greater for farms that sold crops. In 2006, the milk production per animal was essentially the same for both groups.

Although the N, P and K remaining per acre generally increased with production intensity (milk production per tillable acre), farms that export crops and manure had lower nutrient excess per acre over the 3 year period. Additionally, the difference between the groups widens with increased production density (Fig. 6).

Proportion of animal feed that is farm produced versus purchased:
NNY farms surveyed in 2005 and 2006, purchased 22.5% of the feedstuffs dry matter fed to both mature cows and young stock. For the most part, participating farms purchased feedstuff concentrates and produced forages on their farms. Of this purchased feed, 10% was purchased forage and 90% was purchased concentrates. Sixteen of the 22 farms participating in 2005 and 20 of the 24 farms participating in 2006 did not purchase any forages. Feed grains, farm produced on nine (41%) of the farms in 2005 and on 7 farms (30%) farms in 2006, accounted for between 2 and 77% of the individual farms total feed dry matter. Approximately one third of the N and P and one sixth of the K, in the livestock rations were from purchased sources (Table 8).

However, the proportion of feed nutrients purchased (versus farm-produced) ranged from 5% to 60% for N, 8% to 66% and 1% to 39% for K.

The proportion of total feed dry matter imported as purchased feed is positively related to the mass nutrient balance (Fig. 7) but only explain 25, 12, and 23% of the variability in N, P, and K remaining per acre, respectively.

Nutrient Use Efficiency:
An important measure of environmental impact is a firm's productive efficiency. The efficiency with which the participating dairy farms use N, P and K to produce milk is presented in Fig. 8, 9 and 10. In each of these figures, the nutrients remaining (imports – exports) are divided by the total quantity of milk sold (lbs nutrient per hundred weight of milk sold). The farms are ranked by annual per cow milk production. Within and across all production levels, these NNY dairy farms vary greatly in the total quantity of nutrients remaining per unit of milk production. Understanding the differences between these farms can help to find ways to improve dairy farm economics and reduce losses to the environment at the same time.

Conclusions/Outcomes/Impacts:

Although there is farm to farm variability, the proportion of nutrients remaining on the farm as a percent of imports was generally lower for P than for N. In 2006, 11 of the 24 participating farms had less than 5 lbs of P remaining per tillable acre. This may be a reflection on the extensive education and policy efforts to reduce P fertilizer use on high and very high P soils, reduce P ration levels to NRC requirements, and increase exports of crops and/or manure over the past several years. Farms that exported crops and/or manure had lower mass nutrient balances. Similarly, farms that produced more of their animal feed ingredients on the farm had lower balances. However, even farms with similar attributes in these areas had widely divergent mass nutrient balance results. An analysis of efficiency of farm nutrient use for milk production shows farms that operate at the same production level can vary in the lbs N used per cwt milk from negative 1.25 to 2.4 lbs N remaining per hundred pounds of milk sold, indicating possible opportunities for farms with the largest imbalances. A more detailed comparison between groups of farms with divergent nutrient use efficiencies may provide an insight into the characteristics which make some farms more efficient than others. Such assessment should be accompanied by analysis of farm business summary data to explore the impact of nutrient management strategies on both farm profitability and nutrient source reduction. Prices paid by producers for imported nutrients may play an important role in farm nutrient balances. Realized and forecasted price increases in fertilizers and purchased feeds will give producers additional incentives to minimize nutrient imports and recycle farm nutrients as effectively as possible.

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.

Next steps:

In 2007, we worked with two large dairy farms in central NY to evaluate farm data and develop whole farm and production system (crops, herd, etc.) performance indicators that could help identify the greatest opportunities for reducing nutrient mass balances. We identified the need for an on-farm fertilizer and manure use record keeping system and improved mass balance software program. Both are current under development with NYSDAM sponsorship and participation by Certified Nutrient Management planners (included NNY representation). We have contacted several Northern New York farms to participate in a more detailed farm efficiency analysis in 2008, if funding can be obtained (proposal submitted to NESARE). We hope to continue to collect mass balance farm data in 2008 as well to expand our NNY dataset. As producers participate in the project for multiple years, they can begin to use the Mass Nutrient Balance results as a bench-mark for farm environmental performance and progress.

Acknowledgements:

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Person(s) to contact for more information:

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- Dr. Larry Chase, Professor, Department of Animal Science, 272 Morrison Hall, Cornell University

Table 1: General farm characteristics for twenty-four case study dairy farms located in Northern New York State (2006 data).

Selected farm characteristics	Mean	Median	Minimum	Maximum
Number of mature cows	254	118	36	1,469
Annual milk production per acre (lbs)	7,913	7,234	1,172	16,708
Annual milk production per cow (lbs)	20,050	19,942	7,698	28,661
Animal units (1000 lbs live weight)	462	234	43	2,472
Animal density (animal units/acre)	0.68	0.71	0.14	1.02
Tillable crop and pasture (acres)	658	399	140	2,650
Manured cropland (acres)	468	291	89	2,000
Legume crop (%)[1]	29%	26%	0%	91%
Purchased feeds (% total feed dry matter)	23%	23%	5%	35%

[1] Legume crop acres as a percentage of total tillable crop and pasture acres.

Table 2. Nitrogen balance factors, mean, median, minimum and maximum for twenty-four case study dairy farms located in Northern New York State (2006 data).

	Mean	Median	Minimum	Maximum
Nitrogen Mass Balance				
Tons N remaining *	21.46	10.15	(20.59)	123.30
N remaining/acre receiving manure (lbs) *	107	95	(77)	317
N remaining/acre (lbs) *	69	70	(35)	188
N remaining/au (lbs N per 1000 lbs live weight)	90	105	(129)	191
% N remaining (import-export/import) *	46%	56%	(131%)	75%
Distribution of imported N				
N from purchased feed (lbs N/tillable acre)	89	81	3	211
N from purchased fertilizer (lbs N/tillable acre)	36	37	1	91
N from N fixation (lbs N/tillable acre)	25	23	0	67
N from purchased animals (lbs N/tillable acre)	1	0	0	9
N from bedding (lbs N/tillable acre)	2	0	0	30
Distribution of exported N				
N from milk sales (lbs N/tillable acre)	41	37	6	87
N from animal sales (lbs N/tillable acre)	5	4	0	12
N from crop sales (lbs N/tillable acre)	10	0	0	76
N from manure export (lbs N/tillable acre)	2	0	0	52

* Does not include nitrogen fixation by legumes or atmospheric deposition.

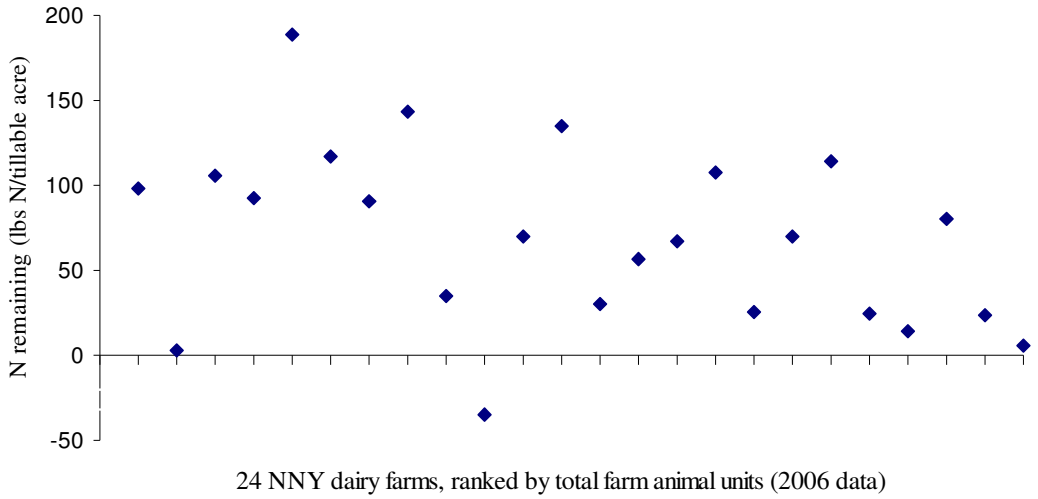


Figure 1: Nitrogen remaining (imports-exports) lbs per tillable acre on 24 Northern New York State dairy farms ranked by farm size (animal units); 1 animal unit=1,000 lbs.

Table 3: The average distribution of nitrogen, phosphorus and potassium imports and exports for 24 Northern New York State dairy farms (2006). Total N includes N from N fixation and atmospheric deposition as well as N from "managed" sources which include feed, fertilizer, purchased animals and bedding.

Annual imports	% total N	% managed N	% P imports	% K imports
Feed	50%	68%	70%	61%
Fertilizer	22%	30%	29%	38%
Animals purchased	0%	0%	1%	0%
Bedding	1%	1%	0%	1%
N fixation	15%			
Atmospheric deposition	12%			
Annual exports	% N exports		% P exports	% K exports
Milk	74%		73%	70%
Animals Sold	8%		11%	2%
Crops Sold	16%		14%	26%
Manure/Compost	1%		2%	2%

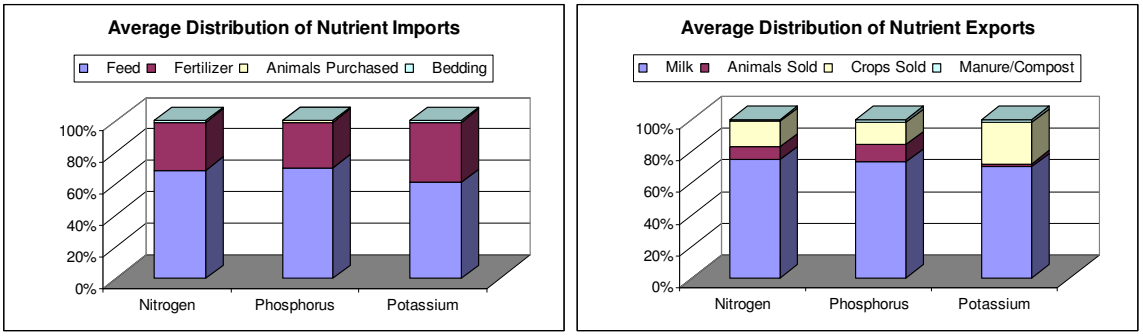


Figure 2: The average distribution of managed nitrogen, phosphorus and potassium imports and exports for 24 Northern New York dairy farms (2006 data). Imports items, feed, fertilizer, animals purchased, and bedding are displayed as a percentage of total annual imports. Export items, milk, animals sold, crops sold, manure and compost exports are displayed as a percentage of total annual exports.

Table 4: Phosphorus balance factors, mean, median, minimum and maximum for twenty-four case study dairy farms located in Northern New York State (2006 data).

	Mean	Median	Min	Max
Phosphorus Mass Balance				
Tons P remaining	1.63	1.06	(3.57)	8.36
lbs P remaining/acre receiving manure	11	11	(4)	36
lbs P_2O_5 remaining/acre receiving manure	26	23	(9)	84
lbs P remaining/acre	7	7	(3)	20
lbs P_2O_5 remaining/acre	16	16	(7)	45
lbs P remaining/au	10	12	(5)	28
% P remaining (import-export/import)	41%	47%	(16%)	66%
Distribution of imported P				
P from purchased feed (lbs P/tillable acre)	13	11	1	27
P from purchased fertilizer (lbs P/tillable acre)	5	4	0	12
P from purchased animals (lbs P/tillable acre)	0	0	0	2
P from bedding (lbs P/tillable acre)	0	0	0	1
Distribution of imported P				
P from milk sales (lbs P/tillable acre)	7	7	1	15
P from animal sales (lbs P/tillable acre)	1	1	0	3
P from crop sales (lbs P/tillable acre)	1	0	0	1
P from manure/compost (lbs P/tillable acre)	1	0	0	13

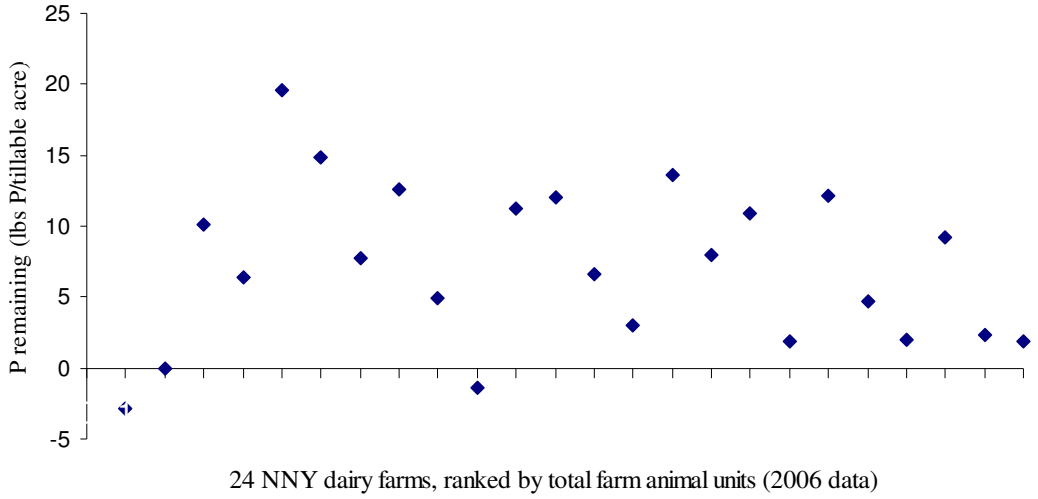


Figure 3: Phosphorus remaining (imports-exports) lbs per tillable acre on 24 Northern New York State dairy farms ranked by farm size (animal units); 1 animal unit=1,000 lbs.

Table 5. Potassium balance factors, mean, median, minimum and maximum for twenty-four case study dairy farms located in Northern New York State (2006 data).

Potassium Mass Balance	Mean	Median	Min	Max
Tons K remaining	6.22	2.20	(11.96)	49.23
lbs K remaining/acre receiving manure	30	26	(45)	109
lbs K_2O remaining/acre receiving manure	37	31	(54)	131
lbs K remaining/acre	20	17	(20)	81
lbs K_2O remaining/acre	25	20	(24)	97
lbs K remaining/au	28	25	(75)	82
% K remaining (import-export/import)	35%	52%	(236%)	86%
Distribution of imported K				
K from purchased feed (lbs K/tillable acre)	25	23	1	75
K from purchased fertilizer (lbs K/tillable acre)	17	13	0	89
K from purchased animals (lbs K/tillable acre)	0	0	0	1
K from bedding (lbs K/tillable acre)	0	0	0	6
Distribution of imported K				
K from milk sales (lbs K/tillable acre)	13	12	2	27
K from animal sales (lbs K/tillable acre)	0	0	0	1
K from crop sales (lbs K/tillable acre)	7	1	0	52
K from manure/compost (lbs K/tillable acre)	1	0	0	33

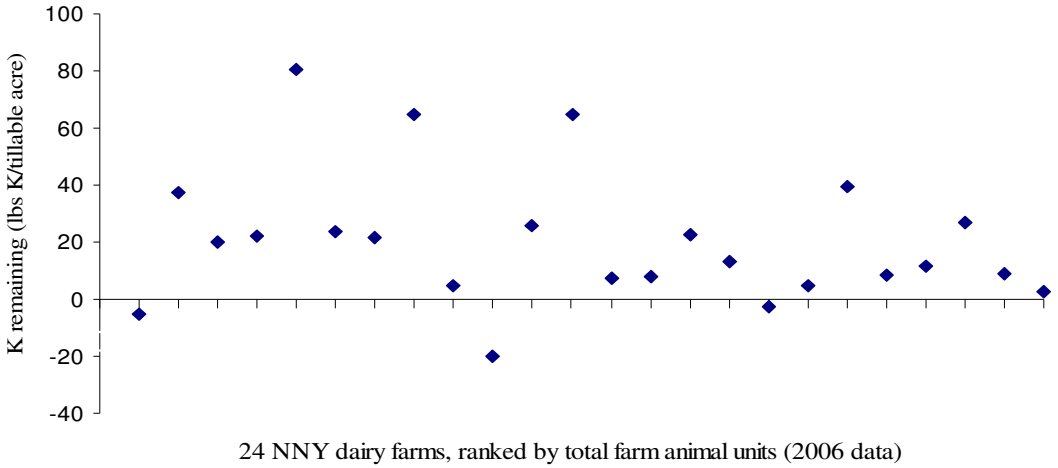


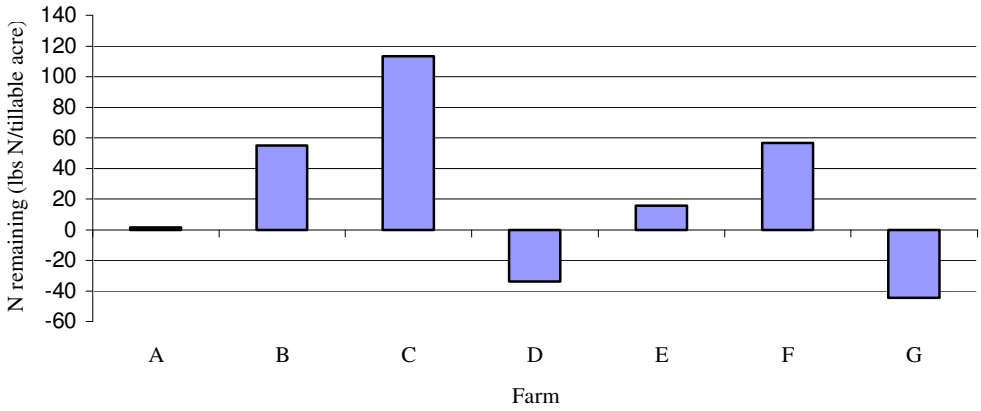
Figure 4: Potassium remaining (imports-exports) lbs per tillable acre on 24 Northern New York State dairy farms ranked by farm size (animal units); 1 animal unit=1,000 lbs.

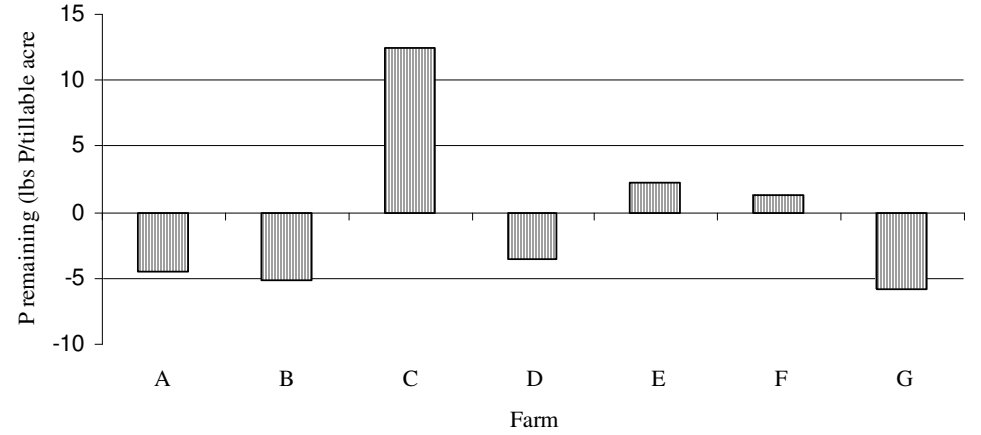
Table 6. Selected farm characteristics and mass nutrient balance factors, average for same 7 Northern New York dairy farms with balance data in 2004, 2005 and 2006.

Business Size and Production	2004	2005	2006
Mature Cows	143	165	181
Animal units	261	301	323
Animal density (animal units/tillable acre)	0.73	0.80	0.86
Milk sold (lbs/tillable acre)	8,355	9,260	10,151
Milk sold (lbs/cow)	21,406	21,276	21,382
Tillable acres	359	357	358
Acres receiving manure	*na*	236	303
% purchased feed (% of total feed DM)	38%	20%	21%
% farm produced forage (% of total forage DM)	97%	75%	72%
Nitrogen Mass Balance			
Tons N remaining *	12.85	17.41	19.44
Lbs N remaining/tillable acre *	70	90	94
Lbs N remaining/acre receiving manure *	*na*	154	126
Lbs N remaining/au *	126	115	108
% N remaining (import-export/import) *	61	56	57
Lbs N remaining/cwt milk sold *	0.87	1.02	0.91
Milk N/total feed N (%)	*na*	17%	16%
Distribution of imported N	2004	2005	2006
N from purchased feed (lbs/tillable acre)	82	94	108
N from purchased fertilizer (lbs/tillable acre)	49	58	49
N from N fixation (lbs/tillable acre)	23	44	36
N from purchased animals (lbs/tillable acre)	0	2	1
N from miscellaneous imports (lbs/tillable acre)	1	1	0

Table 6 (continued). Selected farm characteristics and mass nutrient balance factors for the same 7 Northern New York dairy farms in 2004, 2005 and 2006.

	2004	2005	2006
Distribution of exported N			
N from milk sales (lbs/tillable acre)	44	52	53
N from animal sales (lbs/tillable acre)	5	5	6
N from crop sales (lbs/tillable acre)	12	9	6
N from miscellaneous exports (lbs/tillable acre)	0	0	0
Phosphorus Mass Balance			
Tons P remaining	1.56	1.89	1.97
Lbs P remaining/acre	9	10	9
Lbs P remaining/acre receiving manure	*na*	18	12
Lbs P remaining/au	13	13	10
% P remaining (import-export/import)	47	47	39
Milk P/total feed P (%)	*na*	19%	19%
Distribution of imported P			
P from purchased feed (lbs/tillable acre)	12	13	15
P from purchased fertilizer (lbs/tillable acre)	8	8	5
P from purchased animals (lbs/tillable acre)	0	1	0
P from miscellaneous imports (lbs/tillable acre)	0	0	0
Distribution of exported P			
P from milk sales (lbs/tillable acre)	8	8	9
P from animal sales (lbs/tillable acre)	1	1	1
P from crop sales (lbs/tillable acre)	2	2	1
P from miscellaneous exports (lbs/tillable acre)	0	0	0
Lbs P remaining/cwt milk sold	0.12	0.11	0.08
Potassium Mass Balance			
Tons K remaining	9.32	5.09	5.54
Lbs K remaining/acre	49	26	23
Lbs K remaining/acre receiving manure	*na*	51	29
Lbs K remaining/au	67	33	26
% K remaining (import-export/import)	62	51	43
Milk K/total feed K (%)	*na*	7%	8%
Distribution of imported K			
K from purchased feed (lbs/tillable acre)	26	23	29
K from purchased fertilizer (lbs/tillable acre)	43	23	15
K from purchased animals (lbs/tillable acre)	0	0	0
K from miscellaneous imports (lbs/tillable acre)	1	0	0
Distribution of exported K			
K from milk sales (lbs/tillable acre)	13	15	16
K from animal sales (lbs/tillable acre)	0	0	0
K from crop sales (lbs/tillable acre)	7	5	5
K from miscellaneous exports (lbs/tillable acre)	0	0	0
Lbs K remaining/cwt milk sold	0.56	0.30	0.21





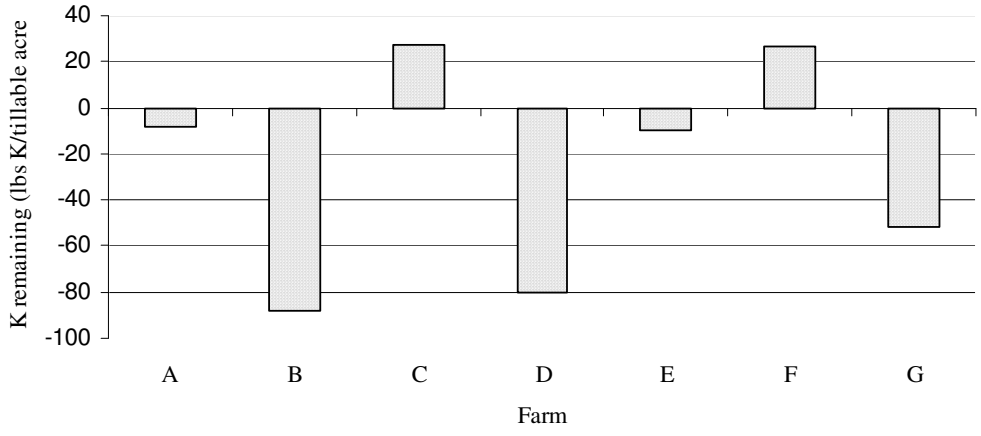


Figure 5. The changes from 2004 to 2006 for N, P and K remaining per tillable acre vary from farm to farm and between nutrients.

Table 7. Selected farm characteristics and average farm nitrogen, phosphorus and potassium balance factors, for 12 NNY dairy farms with crop sales and 12 NNY dairy farms without crop sales, 2006 data.

Business Size and Production	Farms with crop sales	Farms without crop sales
Mature cows	180	328
Animal units	343	581
Animal density (animal units/tillable acre)	0.59	0.78
Milk sold (lbs/tillable acre)	6,524	9,302
Milk sold (lbs/cow)	20,042	20,058
Tillable acres	633	683
Proportion of tillable acres receiving manure (%)	65	77
% purchased feed (% of total feed DM)	21	24
% farm produced forage (% of total forage DM)	1	2
Nitrogen Mass Balance		
Lbs N remaining/tillable acre *	49	90
Lbs N remaining/acre receiving manure *	103	111
N from purchased feed (lbs/tillable acre)	67	111
N from purchased fertilizer (lbs/tillable acre)	36	36
N from milk sales (lbs/tillable acre)	34	48
N from crop sales (lbs/tillable acre)	20	0
Phosphorus Mass Balance		
Lbs P remaining/acre	6	8
Lbs P remaining/acre receiving manure	13	10
P from purchased feed (lbs/tillable acre)	10	15
P from purchased fertilizer (lbs/tillable acre)	6	3
P from milk sales (lbs/tillable acre)	6	8
P from crop sales (lbs/tillable acre)	3	0
Potassium Mass Balance		
Lbs K remaining/acre	15	18
Lbs K remaining/acre receiving manure	27	34
K from purchased feed (lbs/tillable acre)	18	31
K from purchased fertilizer (lbs/tillable acre)	20	15
K from milk sales (lbs/tillable acre)	10	15
K from crop sales (lbs/tillable acre)	15	0

***** Values do not include N from N fixation or atmospheric deposition.

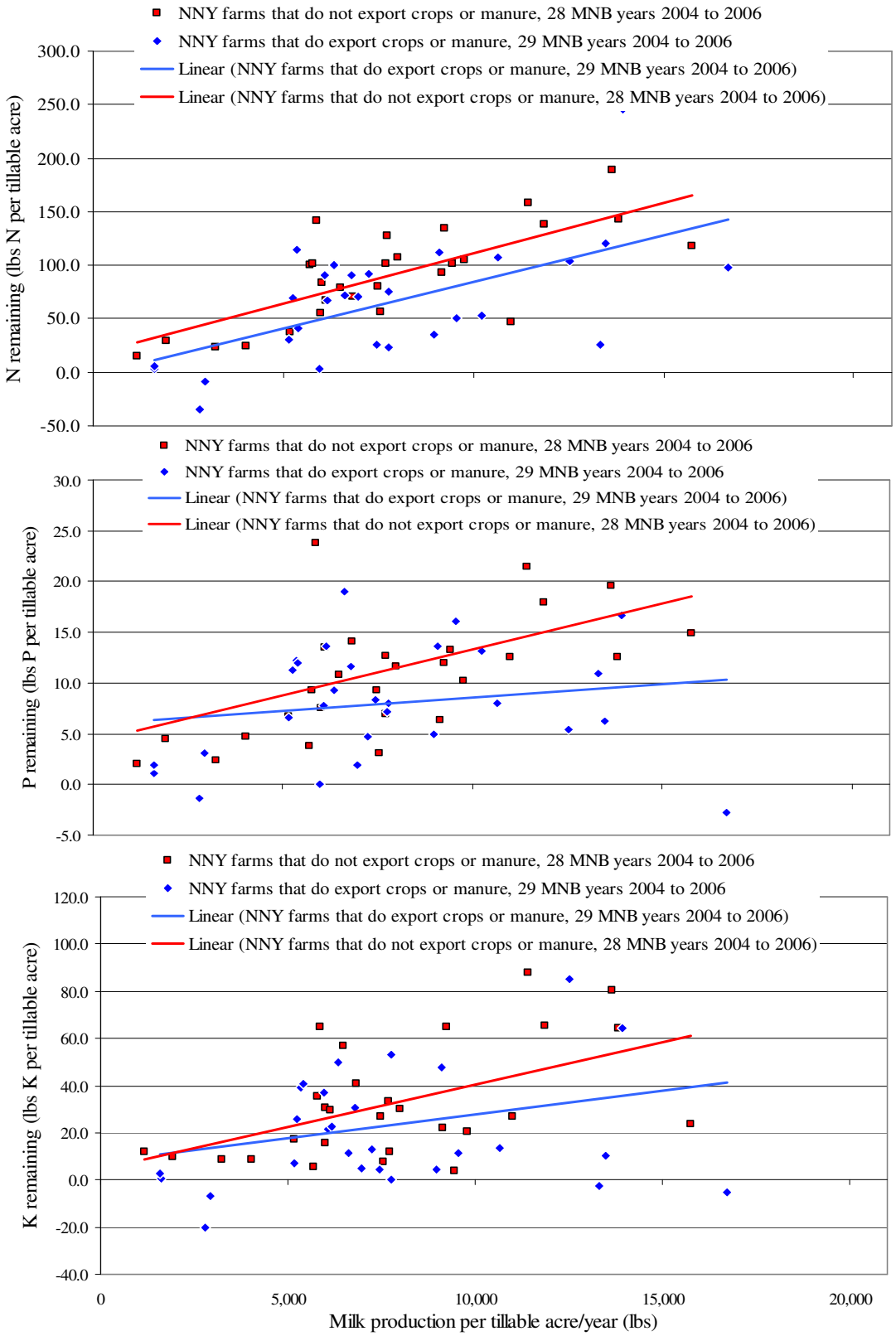


Figure 6. Dairy farms with off-farm crop sales generally had lower N, P and K remaining per tillable acre, a difference which increased with production intensity on Northern New York State dairy farms (57 Mass Nutrient Balances, 2004 to 2006).

Table 8. The proportion of purchased N, P and K fed on Northern New York Dairy Farms (46 mass nutrient balances, 2005 and 2006 data).

	N	P	K
Average (%)	34%	35%	16%
Median (%)	32%	31%	13%
Minimum (%)	5%	8%	1%
Maximum (%)	60%	66%	39%

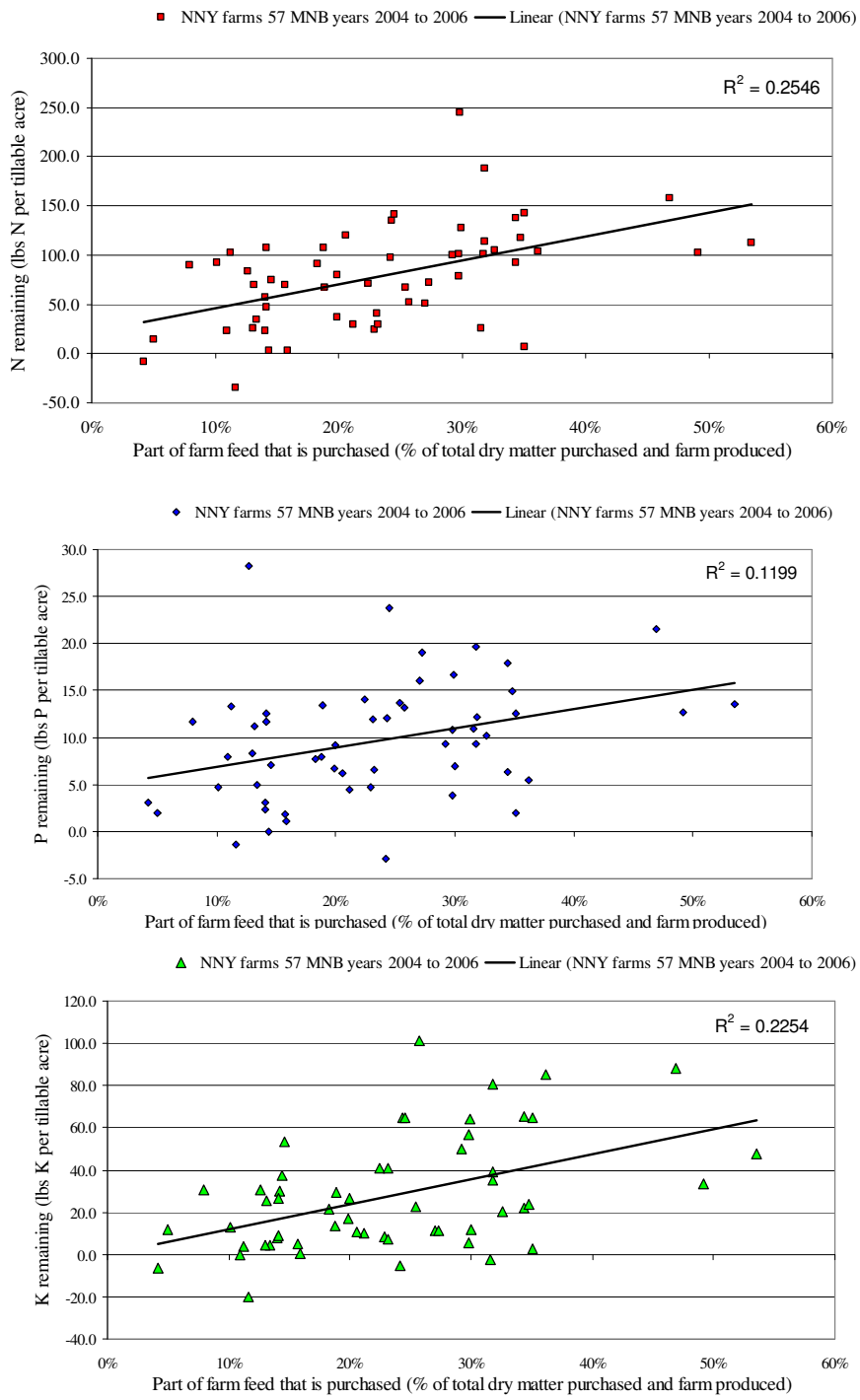


Figure 7. The N, P and K remaining per tillable acre is positively correlated to the proportion of feedstuffs that are purchased on 57 Northern New York dairy farm mass nutrient balances (2004 to 2006 data).

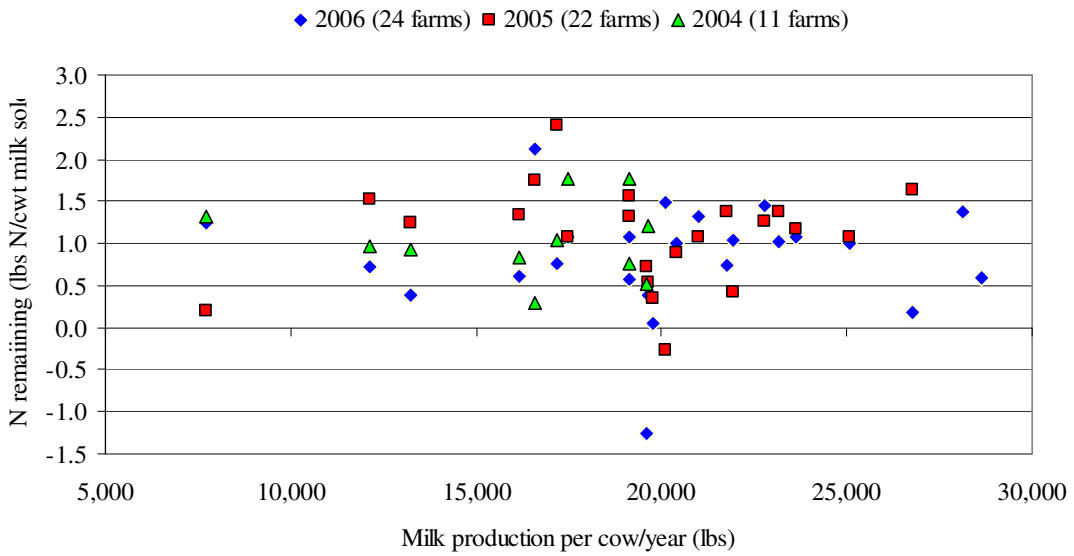


Figure 8. Nitrogen remaining per unit of milk (lbs N/cwt milk sold) for 57 Northern New York dairy farm mass nutrient balances (2004-2006 data).

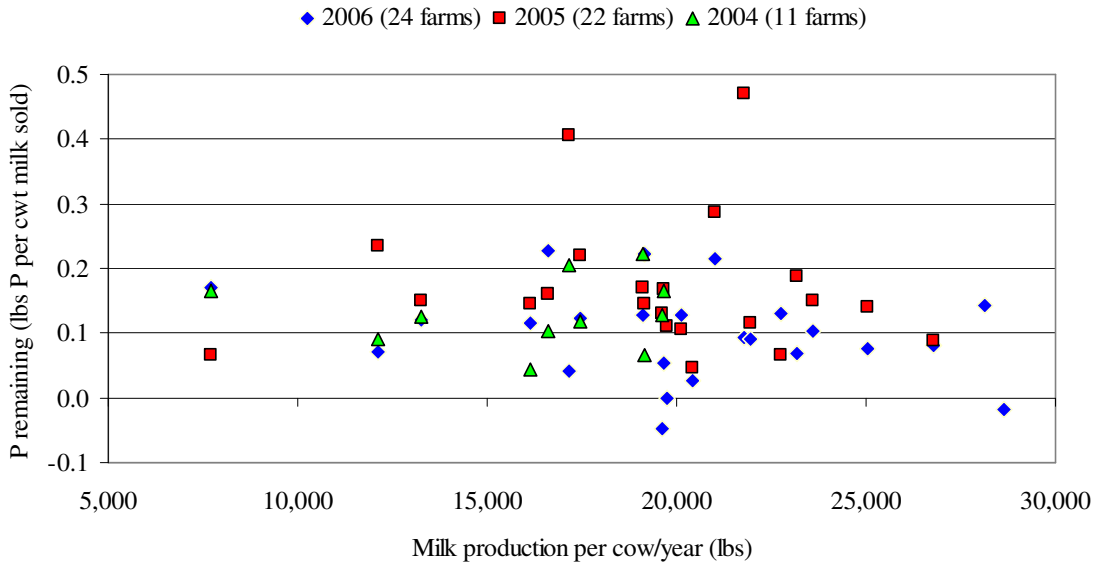


Figure 9. Phosphorus remaining (imports-exports) per unit of milk (lbs P/cwt milk sold) for 57 Northern New York dairy farm mass nutrient balances (2004-2006 data).

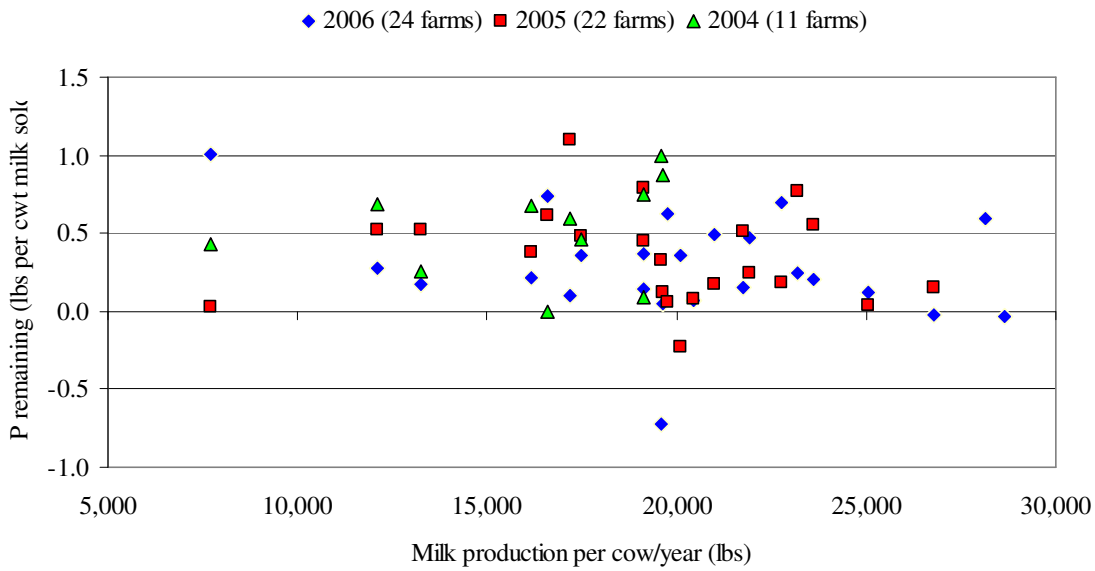


Figure 10. Potassium imports and exports per unit of milk (lbs K/cwt milk sold) for 57 Northern New York dairy farm mass nutrient balances (2004-2006 data).