Report for 2005NY73B: Nutrient balances -- involving farmers and their advisors in addressing nutrient excesses for improved water quality for Upper Susquehanna Watershed farms

Publications

- Articles in Refereed Scientific Journals:
  - Czymmek, K.J.; Q.M. Ketterings; C. Ramussen; L. Chase, 2006, Striking the Right Balance, The Manager, Northeast Dairy Business 8(4), 21-22.
  - Rasmussen, C.N.; Q.M. Ketterings; J. Mekken; K.J. Czymmek, L.E. Chase, 2005, Statewide and Whole Farm Phosphorus Balances- Tools to Help with Long-term Nutrient Planning On Dairy and Livestock Farms, What's Cropping Up, 15(6), 7-9.
- Conference Proceedings:
  - Ketterings, Q.M.; C. Rasmussen; J. Mekken, K. Czymmek, 2005, Statewide, County-based, and Whole Farm Nutrient Balances: Tools to Help With Long-term Nutrient Planning, in Field Crop Dealer Meetings, Department of Crop and Soil Sciences Extension Series No. E05-1, 19-21.
  - Rasmussen, C.N.; Q.M. Ketterings; G. Albrecht; L. Chase; K.J. Czymmek, 2006, Mass Nutrient Balances- a Managment Tool for New York Dairy and Livestock Farms, in Silage for Dairy Farms; Growing, Harvesting, Storing, and Feeding, NRAES Conference, Harrisburg, PA, 396-414.

Report Follows

Final Report
USDA Competitive Grant – EPA Region 2

Nutrient Balances – Involving Farmers and their Advisors in Addressing Nutrient Excesses for Improved Water Quality for Four Upper Susquehanna Watershed Farms

26 June 2005

Principal investigator(s) name(s) and university:

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Collaborators:

Caroline Rasmussen (NMSP, ***project coordinator***), Jim Curatolo (Coordinator, Upper Susquehanna Coalition - UCS) and Soil and Water Conservation Districts (SWCD) in the New York Counties that fall within the boundaries of the Upper Susquehanna Watershed. The Upper Susquehanna Coalition (USC), established in 1992, is a network of county natural resource professionals who develop strategies, partnerships, programs and projects to protect the headwaters of the Susquehanna River and Chesapeake Bay watersheds. The USC is comprised of representatives from 13 counties in New York State (Allegany, Steuben, Schuyler, Chemung, Tompkins, Tioga, Broom, Cortland, Chenango, Madison, Onondaga, Otsego and Delaware) and three in Pennsylvania. Together the New York counties comprise 7 congressional districts (20, 21, 22, 24, 25, 26, and 29).

Justification and Scope:

At present, the Chesapeake Bay does not meet federal water quality standards. The Chesapeake Bay Program defines the water quality conditions necessary to protect aquatic living resources and assigns load reductions for nitrogen (N), phosphorus (P), and sediment needed from each tributary basin to achieve the necessary water quality. New York State is developing a Tributary Strategy to avoid additional environmental regulations in the Chesapeake Bay Watershed that will occur unless contributing states substantially reduce sediment and nutrient loads before 2011. The Susquehanna River contributes 50% of the fresh water to the Bay (http://www.u-s-c.org/html/CBP.htm). Typically more nutrients come onto farms as purchased feedstuffs and fertilizer than leave the farm as animal products and crops but an analysis of the nutrient flows onto and off of the farm, a mass nutrient balance (MNB), is essential to quantify current nutrient imbalances and identify farm practices which could be more efficient, thereby, increasing farm profitability and decreasing nutrient losses.

In January of 2005, a proposal submitted to the Water Resources Institute was awarded DEC funding to work with USC personnel to generate a 6-farm dataset of nutrient balances (N and P

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inputs and outputs). We proposed to expand the scope of this proposal by adding 4 additional farms and requested USDA funds to do so. This document is our final report on the 4 farms that were evaluated for their whole farm balance with USDA EPA Region 2 funds.

Approach:

Farm selection: Farms were identified by local Soil and Water Conservation District personnel working with the Upper Susquehanna Coalition. The 4 case study farms were located in four different counties within the Upper Susquehanna Watershed (Cortland, Chemung, Chenango, and Schuyler). The farms were dairy farms varying in size from 40 to 624 milking cows (Table 1). One of the four farms was a Jersey farm (Farm D) while the other three were Holstein farms.

Training: Three training sessions were held to raise awareness about the MNB project and provide instructions for data collection and analysis interpretation. These meetings were held on September 30, 2004 in Ithaca, on May 20, 2005 in Owego and on June 2, 2006 in Horseheads. The Ithaca and Owego sessions were directed towards training of Soil and Water Conservation District and Natural Resources Conservation Service personnel, and private sector service providers associated with the Upper Susquehanna Coalition. The training session in Horseheads was for producers in the Chemung River Watershed.

Data collection and mass nutrient balance calculations: The whole farm mass balance assessments included quantification of imports through feed, fertilizer, nitrogen fixation from legumes, animals purchased and bedding and exports in the form of milk, animals and crops sold, manure transported off the farm. These data were collected by interviewing the producer (and nutritionist, crops consultant or feed company where needed) using the survey forms shown in Appendix A. Data were collated from available farm records which included farm financial records, crop recordkeeping and animal nutrition records. Acres of legumes, percent legume in the stand, yield and crude protein content were used to estimate symbiotic N fixation. A description of the calculations used in the program can be found in Appendix B.

Animal nutrition consultants and feed mill operators commonly provided feed nutrient composition data. Changes in purchased and farm produced feed inventories were accounted for as well. The farm data were entered into the Excel spreadsheet during the farm visit and the producer was provided with a farm specific MNB Analysis Report (example shown in Appendix C) at the time of data collection.

Results:

General farm characteristics: The four farms varied in size from 40 to 640 milking cows representing animal densities of 0.42 to 1.13 animal units[2] per acre. Milk production per acre ranged from 3,911 to 12,090 lbs of milk per acre and from 13,688 (the Jersey farm) to 22,886 lbs of milk per cow per year. Farm purchased feeds as a percentage of all livestock feed (dry matter basis) ranged from 33% in farm D to 60% in farm A. The general farm characteristics for each of the 4 farms are shown in Table 1.

[2] One animal unit equals 1000 lbs.

Table 1: General farm characteristics for four case study dairy farms located in the Upper Susquehanna Watershed (2004 data).

		Farm A	Farm B	Farm C	Farm D
Animal density	animal units/acre	0.99	0.86	1.13	0.42
Milking cows	cows	471	110	624	40
Milk production	lbs/acre	10,024	8,943	13,090	3,911
	lbs/cow per year	20,490	16,259	22,886	13,688
Purchased feeds	% dry matter	60	40	36	33
Crop and tillable pasture	acres	963	200	1091	140
Legume crop	acres	200	140	350	41

Nitrogen balances: Nitrogen balances for the 4 farms are shown in Table 2. Three of the four farms were very similar in the percentage of N imported that did not leave the farm through exports of milk, animals, crops, and/or manure (73-76% "remaining" on the farm). The fourth farm showed a higher percentage, most notably because of lower milk sales. The total lbs of N per acre "remaining" ranged from 143 lbs N/acre for farm A to 240 lbs N/acre for farm C (the farm with the highest animal density).

Table 2: Mass nitrogen balance for four case study dairy farms located in the Upper Susquehanna Watershed (2004 data). General characteristics of the farms are given in Table 1.

		Farm A	Farm B	Farm C	Farm D
		---------- *Nitrogen (N)* ----------			
Annual imports					
Feed	tons/year	71.59 (76%)	9.15 (39%)	129.43 (75%)	11.44 (93%)
Fertilizer	tons/year	14.02 (15%)	8.88 (38%)	24.56 (14%)	0.45 (4%)
N fixation	tons/year	3.80 (4%)	4.94 (21%)	16.80 (10%)	0.40 (3%)
Animals	tons/year	0.04 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)
Bedding	tons/year	5.17 (5%)	0.66 (3%)	1.19 (1%)	0.00 (0%)
Total	tons/year	94.62 (100%)	23.62 (100%)	171.97 (100%)	12.28 (100%)
Annual exports					
Milk	tons/year	24.23 (93%)	5.58 (87%)	37.06(90%)	1.52 (95%)
Animals	tons/year	1.72 (7%)	0.79 (87%)	3.97(10%)	0.08 (5%)
Crops	tons/year	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)
Manure	tons/year	0.00 (0%)	0.02 (0%)	0.00 (0%)	0.00 (0%)
Total	tons/year	25.95 (100%)	6.39 (100%)	41.03 (100%)	1.60 (100%)
Import-export	tons/year	68.67	17.23	130.94	10.68
"Remaining"	%	73	73	76	87
	lbs/acre per year	143	172	240	153

Purchased feed and fertilizer accounted for the bulk of N imported onto these farms. Together these major contributors accounted for 79% to 97% of all N imports. The distribution between purchased feed and fertilizer N imports varied between farms. Farm D imported 93% of their N as feed and only 4 % as fertilizer; Farm B imported 39% of imported N as feed and 38% as fertilizer (Table2). On all 4 farms the largest N export was in the form of milk sales. None of the farms exported crops and only one farm exported a small quantity of manure off the farm.

Nitrogen contribution from fixation by legumes was estimated from legume crop acreage, yield and crude protein content. Nitrogen fixation accounted for 3 to 21% of the total N imports on the farms. One farm (Farm A) used low cost shredded newspaper for bedding which resulted in higher nutrient imports for bedding than on the other farms.

Phosphorus balances: The 4 study farms imported 0.94 to 16.36 tons of more P than they exported annually (Table 3). As with nitrogen, milk was the major P export item while feed and fertilizer accounted for most of the P imports. On Farms A, B and D, 60 to 67% of the imported P was brought onto the farm in the form of feed while 31 to 33% of all P imports on these 3 farms were purchased fertilizer. Farm C had a higher proportion (88%) of imported P carried on as purchased feed.

Table 3: Mass phosphorus balances for four case study dairy farms located in the Upper Susquehanna Watershed (2004 data). General characteristics of the farms are given in Table 1.

		Farm A	Farm B	Farm C	Farm D
		Phosphorus (P)			
Annual imports					
Feed	tons/year	7.88 (62%)	1.24 (60%)	20.00 (88%)	0.78 (67%)
Fertilizer	tons/year	4.15 (33%)	0.65 (31%)	2.47 (11%)	0.39 (33%)
Animals	tons/year	0.01 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)
Bedding	tons/year	0.71 (6%)	0.18 (9%)	0.14 (1%)	0.00 (0%)
Total	tons/year	12.70 (100%)	2.07 (100%)	22.61 (100%)	1.17 (100%)
Annual exports					
Milk	tons/year	3.57 (89%)	0.66 (77%)	5.28 (85%)	0.20 (91%)
Animals	tons/year	0.42 (11%)	0.19 (22%)	0.96 (15%)	0.02 (9%)
Crops	tons/year	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)
Manure	tons/year	0.00 (0%)	0.00 (0%)	0.00 (0%)	0.00 (0%)
Total	tons/year	3.99 (100%)	0.86 (100%)	6.24 (100%)	0.22 (100%)
Import-export	tons/year	8.76	1.22	16.36	0.94
“Remaining”	%	69	59	72	81
	lbs/acre per year	18	12	30	13

Preliminary Discussion and Summary:

The methodology of using MNB as a tool to diagnose individual farm nutrient management practices was used by Klausner and others (Klausner, 1992, Klausner, 1993, Klausner et al., 1998). These assessments, done in the early 1990s, indicated that the percent of the N and P that remained [(inputs-exports/imports] on the selected New York State dairy farms each year ranged from 64-76% and 59-81%, respectively.

The results of the 4 Upper Susquehanna Watershed farms show a similar order of magnitude for nitrogen (73-87% in our study) and identical ranges for P (59-81%). The phosphorus balances by Klausner et al. (1998) included three farms which ranged in size from 45 to 120 milking cows. The four farms in our study ranged from 40 to 624 milking cows (2004 data). The 40 cow dairy had a P balance of 81% while the 624 cow dairy had a P balance of 72%. When the mass balance is measured in tons P "remaining" per year, the 40-cow dairy showed a balance of just under 1 ton of P remaining per year, while the larger dairy had a balance of more than 16 tons of P per year. This shows the importance of looking at these balances in several different ways.

Another important finding in the studies by Klausner and others was that purchased feed accounted for 45-87% of the imported nitrogen and phosphorous. The same trends were seen for the four Upper Susquehanna farms: 39-93% of the N and 60-88% of the P was brought onto the farm as purchased feed. Klausner et al. (1998) showed that these proportions could be decreased on case study farms when rations were reformulated to limit excess nutrients in the diets. Further analysis of the four farms is needed to see if similar options exist for these producers.

To date, nutrient management regulations in New York and most other states in the US have addressed the Clean Water Act through implementation of the NRCS 590 standard for nutrient management. The NRCS 590 standard focuses on reducing risk to water quality as the result of over-application of fertilizer and manure, and prevention of direct manure losses to our streams and lakes; this is accomplished through development of plans that include the use of the P runoff index, the nitrate leaching index, and land grant university crop nutrient guidelines. Unfortunately, current nutrient management practices may not sufficiently address importation and subsequent loading of nutrients onto farms and watersheds as shown, among others, by a steadily increasing number of acres testing high or very high in P in New York (Ketterings et al., 2005).

Losses could be significantly reduced if fewer nutrients were imported onto the farm in the first place (Wang et al., 1999). ***The key solution lies in finding ways to increase nutrient use efficiency on farms and, thereby, decrease nutrient imports and reduce loadings to watersheds such as the Upper Susquehanna Watershed.*** Results of this study will be combined with the 6 farms that are being assessed with WRI funds (final report due February 28, 2006) and 6 farms that are part of a pilot study funded by the Upper Susquehanna Coalition. We hope to secure additional funds to expand the scope of the project to include more farms, an economic assessment of the farms and an evaluation of practical management options that could improve mass balances over time.

Websites:

1. Chesapeake Bay Program: http://www.chesapeakebay.net/.
2. Upper Susquehanna Coalition: http://www.u-s-c.org/html/CBP.htm.

3. Nutrient Management Spear Program: http://nmsp.css.cornell.edu/.

References:

1. Dou, Z., R.A. Kohn, J.D. Ferguson, R.C. Boston, and J.D. Newbold (1996). Managing nitrogen on dairy farms: an integrated approach 1. Model description. Journal of Dairy Science 79:2071-2080.
2. 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.
3. Klausner, S.D. (1992). Nutrient management on livestock farms. Department of Soil, Crop and Atmospheric Sciences Extension Series No E92-4. Cornell Univ., Ithaca, NY.
4. Klausner, S.D. (1993). Mass nutrient balances on dairy farms. In: Cornell Nutrition Conference for Feed Manufacturers Proceedings, Rochester, NY. Cornell University, Ithaca, NY. Pages 126-129.
5. Klausner, S.D., D.G. Fox, C.N. Rasmussen, R.E. Pitt, T.P. Tylutki, P.E. Wright, L.E. Chase and W.C. Stone (1998). Improving dairy farm sustainability I: An approach to animal and crop nutrient management planning. Journal of Production Agriculture 11:225-233.
6. Wang, S.J., D.G. Fox, D.J.R. Cherney, S.D. Klausner, and D.R. Bouldin. 1999. Impact of dairy farming on well water nitrate level and soil content of phosphorus and potassium. J. Dairy Sci. 82:2164-2169.

Appendix A: Farm survey forms.

Cornell Nutrient Management Spear Program
Mass Balance Nutrient Accumulation Calculator

Producer Name	
Farm Name	
Address	
City, State, Zip	
Phone	
E-Mail	

Balance Year	
Crop and Tillable Pasture Acres	

	Animal Group	#	Weight
Average Number of Animals			

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

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

IMPORTS

Feeds (purchased)	**Tons/year**	**% DM**	**CP (% DM)**	**P (% DM)**	**K (% DM)**	**% Grain**
Grain						
Milk replacer						
Forages						

Purchased Feeds Inventory	Beginning Year (tons)	Ending Year (tons)
Grain		
Milk Replacer		
Forages		

Fertilizer	Tons	% N	% P_2O_5	% K_2O	Comment
Corn Starter					
Urea					

Animals (purchased)	Number	Weight (lbs)	Comment
Calves			
Heifers			
Cows			

Bedding & Miscelaneous	Tons/year	% DM	N (%DM)	P (%DM)	K (%DM)	Comment
N Fixation-Legume Crops, Pasture	**% Legume**	**Acres**	**Dry Matter**	**Yield (t/a)**	**CP (%DM)**	**Comment**

EXPORTS

Milk	lbs/year	Milk Protein (%)	Comments
Animals (sold)	**Number**	**Weight (lbs)**	**Comments**
Calves			
Heifers			
Cows			

Crops (sold)	Tons/year	% DM	CP (%DM)	P (%DM)	K (%DM)
Other (sold)	**Tons/year**	**% DM**	**N (%DM)**	**P (%DM)**	**K (%DM)**

FARM PRODUCED FEED - Enter the type of feed, tons (as fed), average dry matter, percent grain, beginning and ending inventory balances.

This input is optional and is used to compute nutrient management diagnostics.

Item	Tons/year	% DM	% Grain	Beginning Inventory	End Inventory

Appendix B: Mass Nutrient Balance Help File

WHOLE FARM NUTRIENT BALANCE SPREADSHEET INSTRUCTIONS

November 19, 2004

INTRODUCTION

This Microsoft Excel program is design to assist in developing a mass nutrient balance. This software can be used to develop a mass nutrient balance for any type of livestock operation (dairy, swine, poultry, etc), or for non-livestock farms. For non-livestock farms, ignore all questions concerning animals. If the title screen box is not centered in the screen, use the "zoom" control on the toolbar menu to center the title box. Adjust all other worksheets to the same size with the "zoom" control. The screen size will be saved when the file is saved.

CONCEPT

Nutrients have three basic fates: 1) they are imported to the farm in purchased products; 2) they are exported from the farm in products sold; and 3) they remain on the farm to be recycled and some nutrient loss is likely. The mass nutrient balance will improve the understanding of nutrient movement onto, within, and away from the farm. A well managed nutrient management plan may reduce purchased inputs, improve nutrient cycling, and reduce the potential for nutrient loss.

FARM CHARACTERISTICS

Contact Information:
Record the producer contact information, year, crop and tillable pasture acres, and the average total animals units on the farm during the year. An animal unit is equal to 1,000 lbs of live weight.

Farm produced feeds:
Record the type of feed, tons produced per year, the percentages of dry matter, percentage grain, and beginning and ending inventories. This information is optional and used in the diagnostic report.

NUTRIENT IMPORTS
(worksheet to determine N, P, K imports in feed, fertilizer, etc.)

Purchased feeds
Record the type of feed, tons purchased per year, and the percentages of dry matter, crude protein, P, and K. Entering the beginning and ending inventory will result in a more accurate annual mass balance. The "% grain" is used to determine the proportion of forage purchased. To convert percent N to crude protein multiply by 6.25. To convert percent crude protein to N divide by 6.25.

Purchased fertilizer
Record the fertilizer types, tons purchased per year, and the percentages of N, P_2O_5, and K_2O.

Purchased animals
Record the number of adults and young stock purchased, and the average weight for each group.

N fixation by legumes
Record the number of acres, dry matter yield, and crude protein for each crop. The nitrogen contribution of legume nitrogen fixation is calculated as 60% of the crude protein. Thirty-six (36) % of the N in mixed legume crops is considered to be contributed by N fixation.

NUTRIENT EXPORTS
(worksheet to estimate N, P, K exports in milk, meat, etc.)

Animal products
Enter the amount of milk sold, milk crude protein and the number of animals and their average weight.

Crop products
Enter the type of crop sold, its quantity, and the percentages of dry matter, crude protein, P and K. Refer to the section on purchased feed to convert crude protein to elemental N or visa versa.

Miscellaneous products
Record any other significant products that were sold or given away, such as manure, fertilizer, etc. Enter the quantity, and percentages of dry matter, crude protein, P, and K.

Mass Balance Calculations

NUTRIENT IMPORTS

Purchased Feed

- Nitrogen (Tons N/year) = Sum of ((tons as-fed purchased + beginning inventory - ending inventory)*%dry matter*crude protein concentration))/6.25 for each purchased feedstuff.
- Phosphorus (Tons P/year) = Sum of ((tons as-fed purchased + beginning inventory - ending inventory)*%dry matter * %P for each purchased feedstuff.
- Potassium (Tons K/year) = Sum of ((tons as-fed purchased + beginning inventory - ending inventory)*%dry matter*%K for each purchased feedstuff.

Fertilizer

- Nitrogen (Tons N/year) = Sum of (tons fertilizer purchased*%N) for each purchased fertilizer.
- Phosphorus (Tons P/year) = Sum of (tons fertilizer purchased*%P_2O_5*0.43) for each purchased fertilizer.
- Potassium (Tons K/year) = Sum of (tons fertilizer purchased*%K_2O*0.83) for each purchased fertilizer.

Nitrogen Fixation

Nitrogen (Tons N / year) = for each legume crop or pasture, sum of:

If legume % >90%: (0.6*acres produced*dry matter yield*crude protein content)/6.25

If legume % ≤90%: (0.36*acres produced*dry matter yield*crude protein content)/6.25

Animals Purchased

This version of the Mass Balance Calculator assumes that dairy livestock are the primary animals purchased and sold. If this is not the case, contact the authors for N, P and K coefficients for other livestock species. The N, P and K concentrations are from M. Van Amburgh (personal communication, 8/10/2004).

- Nitrogen (Tons N/year) = Sum of (number of animals*average weight in pounds*0.029)/2000
- Phosphorus (Tons P/year) = Sum of (number of animals*average weight in pounds*0.007)/2000
- Potassium (Tons K/year) = Sum of (number of animals*average weight in pounds*0.002)/2000

Miscellaneous Purchases

For each miscellaneous item imported:

- Nitrogen (Tons N/year) = Sum of (weight in tons*%dry matter*%N)
- Phosphorus (Tons P/year) = Sum of (weight in tons*%dry matter*%P)
- Potassium (Tons K/ year) = Sum of (weight in tons*%dry matter*%K)

NUTRIENT EXPORTS

Milk Sold

Phosphorus and Potassium coefficients are from the Fundamentals of Dairy Chemistry (Noble P. Wong, Editor, and Robert Jenness, Mark Keeney, Elmer H. Marth, Associate Editors, Gaithersburg, MD: Aspen Pub., 1999). Milk protein reported to the producer as true protein is converted to crude protein by multiplying by 1.075 (Cornell Animal Science Dept. Mimeo 213). The N content of milk crude protein is calculated by dividing by 6.25.

- Nitrogen (Tons N/year) = ((Pounds of milk sold*(milk true protein*1.075)/6.25)/2000
- Phosphorus (Tons P/year) = (Pounds of milk sold*0.00074)/2000
- Potassium (Tons K/year) = (Pounds of milk sold*0.0014)/2000

Animals Sold

This version of the Mass Balance Calculator assumes that dairy livestock are the primary animals purchased and sold. If this is not the case, contact the authors for N, P and K coefficients for other livestock species. Nitrogen, P and K concentrations are from M. Van Amburgh (personal communication, 8/10/2004).

- Nitrogen (Tons N/year) = Sum of (number of animals*average weight in pounds *0.029)/2000

- Phosphorus (Tons P/year) = Sum of (number of animals*average weight in pounds *0.007)/2000
- Potassium (Tons K/year) = Sum of (number of animals*average weight in pounds *0.002)/2000

Crops Sold

- Nitrogen (Tons N/year) =Sum of (tons sold*dry matter%*crude protein concentration)/6.25
- Phosphorus (Tons P/year) = Sum of (tons sold*dry matter%*% phosphorus)
- Potassium (Tons K/year) = Sum of (tons sold*dry matter%*% potassium)

Miscellaneous Sales

- Nitrogen (Tons N/year) = Sum of (weight in tons*dry matter%*%N)
- Phosphorus (Tons P/year) = Sum of (weight in tons*dry matter%*%P)
- Potassium (Tons K/year) = Sum of (weight in tons*dry matter%*%K)

Diagnostics

- Animal Density = Crop and tillable pasture acres/animal units
- Animal units = sum of (number of animals*average weight in pounds)/1000 for each animal group.
- Milk Production Land Efficiency = milk sales in pounds/crop and tillable pasture acres.
- Farm Produced Feed (% of total feed dry matter) = total farm produced feed dry matter (total farm produced feed dry matter + total purchased feed dry matter)
- Farm Produced Forage (% of total feed dry matter) = total farm produced forage dry matter/(total farm produced forage dry matter + total purchased forage dry matter)

Fertilizer Value

- Lbs phosphorus remaining per acre is converted to P_2O_5 equivalent by multiplying the remaining value by 2.325.
- Lbs potassium remaining per acre is converted to K_2O equivalent by multiplying the remaining value by 1.2048.

Appendix C: Example of a Mass Nutrient Balance Analysis Report

MASS NUTRIENT BALANCE v. 2 OUTPUT **Sample Farm 2004**
6/21/2005 13:45

Category	N	P	K	N	P	K
Imports	-------- tons per year --------			------ lbs per acre per year ------		
Feed	9.95	2.13	3.51	33	7	12
Fertilizer	4.08	0.17	0.66	14	1	2
N Fixation (legumes)	2.16			7	-	-
Animals	0.17	0.04	0.01	1	0	0
Miscellaneous	0.34			1	-	-
Total Imports	16.70	2.34	4.18	56	8	14
Exports	-------- tons per year --------			------ lbs per acre per year ------		
Milk	5.16	0.65	1.23	17	2	4
Animals	0.30	0.07	0.03	1	0	0
Crops	0.27	0.05	0.34	1	0	1
Miscellaneous	0	0.00	0.00	0	0	0
Total Exports	5.73	0.78	1.59	19	3	5
Tons Remaining	10.97	1.57	2.59			
Lbs Remaining/acre	37	5	9			
Lbs Remaining/AU	58	8	14			
% Remaining	66%	67%	62%			

DISTRIBUTION OF IMPORTED NUTRIENTS

Source	N	P	K
	------------------- % ---------------------		
Feed	60	91	84
Fertilizer	24	7	15
N Fixation	13		
Animals	1	1	0
Miscellaneous	2	1	1

DISTRIBUTION OF EXPORTED NUTRIENTS

Source	N	P	K
	------------------- % ---------------------		
Milk	90	83	77
Animals	5	9	1
Crops	5	7	21
Miscellaneous	0	0	0

DIAGNOSTICS

Animal Density (au/acre)	0.64
Milk Production (lbs/acre)	2,917
Purchased Feed (% of total feed dry matter)	19%
Farm Produced Forage (% of total forage dry matter)	80%
Fertilizer Value	5 lbs P remaining/acre = 12 lbs P_2O_5/acre 9 lbs K remaining/acre = 10 lbs K_2O/acre

Itemized N, P, K imports

Import % from purchased feed	% N	% P	% K
Canola Meal	13%	18%	16%
Custom Mix	20%	13%	14%
Cottonseed	15%	21%	24%
Mineral Mix	0%	34%	24%
Corn Silage	12%	5%	6%
Import % from purchased fertilizers	% N	% P	% K
20-20-0	13%	7%	
Potash			15%
Urea	11%		
Import % from legume fixation	% N	% P	% K
Alfalfa	13%		
Import % from purchased animals	% N	% P	% K
Heifers Purchased	1%	1%	
Import % from misc. imports	% N	% P	% K
Paper sludge	1%	1%	1%
Kiln dry saw dust	1%		
Total import %	100%	100%	100%

Distribution of exported N,P,K

Export % from milk sales	% N	% P	% K
	90%	83%	77%
Export % from crop sales	% N	% P	% K
Dry Hay Bales	5%	7%	21%
Export % from animal sales	% N	% P	% K
Calves	1%	1%	
Cows	4%	8%	1%
Export % from misc. exports	% N	% P	% K
Total Export %	100%	100%	100%