CONSIDERATIONS FOR MANURE USE FOR SOYBEAN AND PERENNIAL LEGUME PRODUCTION IN NEW YORK

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Executive Summary

- Manure contains all seventeen essential nutrients for plant growth and as a result, when applied at the right rate, right method, and right timing, manure can significantly reduce reliance on commercial fertilizer.
- There is growing evidence that fields that receive manure cycle soil nutrients better because they tend to have greater water infiltration and holding capacity, tend to be better structured, and have a greater cation exchange capacity. As a result, manured soils are typically healthier soils that can supply more nutrients, sustain greater yields and enhance climate resiliency. Manure history improves not just soil health and yield stability, but it also enhances the economic efficiency of dairy farms.
- Non-legume crops like corn and grass as well as mixed legume-grass stands with more than 50% grass are prime targets for manure application, as these crops can make better use of the nitrogen (N) in the manure than legumes such as alfalfa and soybeans, which can fix their own N. Yet, legume fields can still be good places to apply manure to offset needs for phosphorus (P), potassium (K), sulfur (S), and other essential macro- and micro-nutrients, and to enhance soil productivity over time.
- There are considerations for use of manure for legume crops such as soybeans and alfalfa, as over-application of manure can have negative impacts on water and air quality, in addition to impacting the crop directly.
- This document contains management strategies for the use of manure on soybean and perennial legume fields in New York.

Acknowledgments

This document builds on a guidance document published in 2008: "Ketterings, Q.M., J.H. Cherney, K.J. Czymmek, E. Frenay, S.D. Klausner, L.E. Chase, and Y.H. Schukken. 2008. Manure Use for Alfalfa-Grass Production. Department of Animal Science Mimeo 231. Cornell University", and guidance described in a series of Agronomy Fact Sheets. We thank all co-authors for these documents. We are grateful to New York Agricultural Environmental Management (AEM) Certified Planners, Certified Crop Advisers (CCAs), Cornell Cooperative Extension (CCE) staff, Soil and Water Conservation District staff (SWCD), NRCS staff, and farmers for their valuable feedback as this guidance document was developed.

Acronyms

- AEM: Agricultural Environmental Management
- NRCS: Natural Resources Conservation Service
- NYSAGM: New York State Department of Agriculture and Markets
- NYSDEC: New York State Department of Environmental Conservation
- SWCD: Soil and Water Conservation District
- SMG: Soil Management Group
- YI: Yield Index

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1. Introduction

From a nitrogen (N) use efficiency standpoint, corn and grass fields are the preferred fields for manure application on dairy farms. Alfalfa and soybeans typically meet their own N requirement through biological N fixation, so N from other sources is unnecessary if conditions for N fixation are satisfactory. Yet, legume stands can still benefit from receiving manure when applied at the right rate, the right time, and using the right method, as it contains all the essential plant nutrients and has additional yield enhancing properties beyond its N supply to the crop. Manure application to soybeans and alfalfa-grass fields represents additional flexibility for dairies, livestock producers and crop farmers that utilize manure. Understanding the potential impact of manure management decisions before application can help farmers make better choices when applying manure. Here we describe the nutrient value of manure and give guidance on use of manure for soybeans and alfalfa-grass.

2. Value of Manure

Manure contains all 17 essential nutrients for plant growth. Manure analysis is needed to determine the exact nutrient content. Manure analysis reports should, at a minimum, include organic N, ammonium or inorganic N (NH_4-N), total N (organic + inorganic N, sometimes referred to as total Kjeldahl nitrogen or TKN), total phosphorus, and total potassium. The distinction in N forms is important because organic and inorganic N behave differently in soil and contribute differently to crop growth (for additional information, see Agronomy Fact Sheet #4). Most laboratories offer additional tests including magnesium (Mg), calcium (Ca), sulfur (S) and for micronutrients like zinc (Zn) and manganese (Mn). See Recommended Methods of Manure Analysis for standardized methods of sampling, processing, and analysis of manure samples.

Manure can be categorized as a solid, slurry, or liquid based on the proportion of solids versus liquid in the manure. Manure analysis reports will report either percent solids or percent moisture. A manure sample with 12% solids has 88% moisture, and vice versa. The terms “as-received”, “wet basis”, and “as is” all refer to manure as it was received by the laboratory. The nutrient content of manure can be reported as a percentage (%), pounds per ton (lbs/ton), pounds per 1000 gallons (lbs/kgal), or parts per million (ppm). Pounds per 1000 gallons is used for liquid and slurry manure (less than 10% solids). Pounds per ton is used for semi-solid and solid manure (more than 10% solids). Parts per million is commonly used to report micronutrient content of a manure source.

Some laboratories report phosphorus as P and as P_2O_5, and potassium as K and as K_2O. Use the P_2O_5 and K_2O values when deriving a manure application rate to meet all or a portion of crop nutrient needs. Table 1 shows useful conversions between different ways that manure analyses are reported.

While most standard manure analyses packages include only percent solids (or moisture), inorganic N, organic N, P, and K, it should be recognized that manure contains substantial amounts of other essential nutrients, including S. Sulfur is important for plant growth, crop yield, and crop quality as well. Given its role in N fixation, supplying legume fields with sufficient S is essential. Fields that are not able to meet plant S needs are increasingly more common in New York as atmospheric deposition of S has decreased over the past several decades. Currently S deposition is estimated to be 1 to 2 pounds per acre annually, well below S uptake for most field crops. Deficiencies are more common in coarse textured soils with low organic matter, as these soils have a limited soil S supply. For more information on the sulfur fertilizer value of liquid dairy manure, see Agronomy Fact Sheet #120.

Table 1. Common conversions (adapted from *Recommended Methods of Manure Analysis*).

Conversion	**Converting back**
percent (%) x 83.40 = lbs/1000 gal	lbs/1000 gal ÷ 83.40 = percent (%)
percent (%) x 20 = lbs/ton	lbs/ton ÷ 20.00 = percent (%)
percent (%) x 10,000 = ppm	ppm ÷ 10,000 = percent (%)
ppm x 0.00834 = lbs/1000 gal	lbs/1000 gal ÷ 0.00834 = ppm
ppm x 0.002 = lbs/1000 gal*	lbs/1000 gal ÷ 0.002 = ppm
US ton x 2000.00 = lbs	lbs ÷ 2000.00 = US ton
Nitrate-N x 4.43 = nitrate	nitrate ÷ 4.43 = nitrate-N
ammonia N x 1.22 = ammonia	ammonia ÷ 1.22 = ammonia N
phosphorus (P) x 2.29 = P_2O_5	P_2O_5 ÷ 2.29 = phosphorus (P)
potassium (K) x 1.20 = K_2O	K_2O ÷ 1.20 = potassium (K)

*assuming an average density of 8.34 lbs/gal

3. Considerations for Soybeans

Harvesting soybeans will remove P, K, and S nutrients in sizeable quantities (Table 2). However, not all of this N comes from N fixation. A significant portion of the N taken up by the legume roots comes from nitrate supplied by mineralization of organic N sources in the soil. In addition, as with other legume crops, when manure is applied to a field prior to soybean planting, N fixation is reduced but not eliminated. As a result, not all the N applied with manure will be taken up by a soybean crop.

Table 2: Estimates of soybean nitrogen (N), phosphorus (P_2O_5), potassium (K_2O), magnesium (Mg), and sulfur (S) removal (estimates assume 52.2 lbs/bu test weight).

			Soybean yield in bu/acre				
	Nutrient content		30	45	60	75	90
	% of DM	lbs/bu	Pounds of nutrient removed/acre				
N	6.41	3.35	101	151	201	251	302
P_2O_5	1.53	0.80	24	36	48	60	72
K_2O	2.24	1.17	35	53	70	88	105
Mg	0.25	0.13	4	6	8	10	12
S	0.31	0.16	5	7	10	12	14

Nitrogen losses from manure or fertilizer through leaching or denitrification and risk of lodging could increase substantially if N applied exceeds 50% of total N removed by soybean harvest. Thus, assuming estimated crop removal shown in Table 2, available N credits from manure should not exceed 50, 75, 100, 125, or 150 lbs of N per acre for estimated soybean yields of 30, 45, 60, 75 or 90 bu/acre, respectively. Because manure can vary quite a bit in nutrient content, actual manure analyses will be needed to set rate limits.

It should also be noted that application of a readily available N source to legumes will negatively impact nodulation and hence N fixation. This could cause a soybean stand to show poor nodulation which may, depending on growing conditions, cause an inability of the plant to fix N later in the season during critical crop stages such as pod fill.

In corn grain-soybean rotations, fall application of manure into corn stubble can help break down the corn crop residue. However, surface applications of liquid manure without incorporation into the soil will increase N volatilization and risk of runoff losses. Fall manure application in low residue row crop systems (especially if there is no cover crop in place) can also contribute to nitrate leaching over the winter and early spring.

Another consideration with the use of manure is the potential to overapply P compared to crop P removal with harvest (Table 2). Manure applications that add P beyond crop removal to soils with already very high soil test P are not encouraged as such applications will further build soil test P levels over time. As an example, a 60 bu soybean crop removes about 50 lbs P_2O_5/acre, the equivalent of about 6,000 gallons of untreated slurry manure using average slurry manure analyses (see Agronomy Factsheet #122). In addition, the NY PI 2.0 may prohibit or limit P applications (see Agronomy Factsheet #110). Similar concerns exist when intentionally growing low K forages, as depending on the rate of application and K content of the manure, its application can increase forage K content. It is recommended to use soil test P and K results, and to evaluate forage K levels, to make more informed decisions about where to apply manure.

Disease pressure is an additional consideration when using manure on soybeans; fields with a history of diseases like *Pythium* and white mold are at higher risk of increased disease pressure when manure is applied. Therefore, manure application to such fields is not recommended.

4. Considerations for Perennial Legumes

Established perennial legumes such as alfalfa have a deeper rooting system than grasses and/or corn, and the flexibility to reduce N fixation when a readily available N form is present in the soil. Established perennials also have a relatively high P and K demand (see alfalfa yield estimates and typical P contents in Agronomy Factsheet #28 and Appendix A). These characteristics make perennial legumes a more appropriate alternative for manure application than corn or grass fields for which N needs have already been met, or for legume row crops like soybeans.

If manure is applied in the spring of the establishment year of an alfalfa stand, the application should be limited to stands seeded with a companion crop that requires N and rates not exceeding the recommended amount for the companion crop (see Nitrogen Guidelines for Field Crops in New York). Higher applications increase the chance of lodging of the companion crop in addition to increasing soil N loss.

Established mixed legume-grass stands with more than 50% grass are better alternatives for manure application than fields rotating into a perennial legume seeding or more legume-rich mixed stands. When legumes represent more than 50% of the established stand, it is recommended to limit total application rates to no greater than 150 lbs of crop available N per acre or 85% of the estimated N removal per acre with harvest. While established stands could receive higher rates of manure, depending on the actual manure analysis, applications that exceed 4,000 gallon per acre per cutting could lead to burn, smothering, and/or salt injury to the stand, especially when applications are delayed beyond 3-4 days after cutting. See Applying Manure to Established Alfalfa-Grass Stands, for a literature summary on manure use for alfalfa).

If manure is being applied in the last production years of a legume-grass stand to address declining P, K, S or other nutrient levels, apply the manure while the crop is still actively growing to enhance N uptake by the stand and thus reduce N losses during the fall/winter/spring.

If P buildup is to be avoided, manure application rates should be limited to no more than crop P removal. For information on crop P removal for field crops including perennial legumes (see Agronomy Factsheet #28). A practical approach could be to apply manure at 4,000 gallons/cutting for 2-3 cuts in the final years of the stand, rebuilding P levels to optimal after drawdown in the first couple of years. Note that the NY PI 2.0 may prohibit or limit P applications (see Agronomy Factsheet #110).

Manured fields should be checked for forage K content when the forage is being considered for feeding to non-lactating cows. Manure application rates should be set based on actual manure analyses, as K levels in manure can vary depending on the type of storage.

Wheel traffic damage due to manure spreaders can be minimized by planting traffic-tolerant varieties, avoiding unnecessary trips across the field, utilizing drag line manure systems, lowering tire pressures on equipment that travels in the field and driving on fields as soon after cutting as possible.

Application of manure from animals infected with pathogens, particularly Johne's disease, is a potential method of spreading these infections. In the case of Johne's disease, exposure of young animals (<1 year old) to contaminated pastures or to feed coming from these fields should be prevented.

References

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- Wilson, M.L., S. Cortus, R. Brimmer, J. Floren, L. Gunderson, K. Hicks, T. Hoerner, J. Lessl, R.J. Meinen, R.O. Miller, J. Mowrer, J. Porter, J.T. Spargo, B. Thayer, F. Vocasek (2022). *Recommended Methods of Manure Analysis*, 2nd Edition. University Digital Conservancy. https://conservancy.umn.edu/handle/11299/227650.

Relevant Cornell Agronomy Fact Sheets:

- # 61: Valuing Manure N, P, and K Applications http://nmsp.cals.cornell.edu/publications/factsheets/factsheet61.pdf

- # 4: Nitrogen Credits from Manure (8/19/2005)
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet4.pdf
- # 16: Application of Manure to Established Alfalfa
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet16.pdf
- # 18: Manure Spreader Calibrations (1/19/2007)
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet18.pdf
- #28: Removal of Phosphorus by Field Crops (7/21/2007; updated 2/3/2020)
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet28.pdf
- # 38: Manure Sampling, Handling and Analysis (2/5/2008 updated 7/8/2011)
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet38.pdf
- # 42: Manure Use for Alfalfa-Grass Establishment (9/12/2008)
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet42.pdf
- # 61: Valuing Manure N, P, and K Applications (7/15/2011)
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet61.pdf
- # 76: Manure Use for Soybeans (12/13/2012)
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet76.pdf
- # 87: Liquid Manure Injection (12/16/2015)
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet87.pdf
- # 101: Importance of Sulfur for Soybeans (12/15/2018)
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet101.pdf
- # 118: Groundwater Protection Guidelines for Agriculture (1/21/2022)
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet118.pdf
- # 120: Sulfur Fertilizer Value of Liquid Dairy Manure (10/5/2022)
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet120.pdf
- # 122: Reading and Interpreting Dairy Manure Analyses (10/31/2022)
  http://nmsp.cals.cornell.edu/publications/factsheets/factsheet122.pdf

Appendix

Appendix A: Soil management group and alfalfa yield index for undrained and artificially drained New York soils.

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Acton	4	M	5.5	4.0
Adams	5	W	4.5	4.5
Adirondack	4	W	4.0	4.0
Adjidaumo	1	P	3.5	2.5
Adrian	6	V	4.0	2.5
Agawam	4	W	6.0	6.0
Albia	3	S	4.5	3.5
Albrights	2	M	5.0	4.5
Alden	3	V	3.5	2.0
Allagash	5	W	5.0	5.0
Allard	3	W	6.0	6.0
Allendale	3	P	3.5	2.5
Allis	3	P	4.5	2.5
Alluvial land	3	S	4.0	3.0
Almond	3	S	3.0	2.5
Alps	3	M	5.0	4.5
Altmar	5	M	5.0	4.5
Alton	5	W	5.5	5.5
Amboy	4	W	5.5	5.5
Amenia	4	M	5.5	5.0
Angola	2	S	4.5	3.0
Appleton	2	S	4.5	4.0
Arkport	4	W	5.5	5.5
Armagh	2	P	4.0	2.5
Arnot	3	W	4.0	4.0
Ashville	3	V	3.5	3.0
Atherton	3	P	4.0	2.5
Atkins	3	V	3.5	2.0
Atsion	5	P	4.5	3.0
Au gres	5	S	4.5	3.0
Aurelie	3	P	2.5	2.0
Aurora	2	M	4.5	4.5
Barbour	3	W	6.0	6.0
Barcelona	3	S	4.5	3.5
Barre	1	P	4.0	2.5

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Bash	3	S	5.5	5.0
Basher	3	M	6.0	5.5
Bath	3	W	5.0	5.0
Becket	4	W	4.5	4.5
Becraft	3	M	6.0	5.5
Belgrade	3	M	6.0	5.5
Benson	4	E	4.0	4.0
Bergen	6	V	6.0	2.0
Berkshire	5	W	5.5	5.5
Bernardston	4	W	5.5	5.5
Berrien	5	M	5.0	4.5
Berryland	5	V	3.5	2.0
Beseman	6	V	3.5	2.5
Bice	5	W	5.0	5.0
Biddeford	2	V	3.5	2.0
Birdsall	3	V	3.5	2.5
Blasdell	3	W	5.5	5.5
Bombay	4	M	5.5	5.0
Bonaparte	4	E	4.5	4.5
Bono	1	V	4.0	3.0
Boots	6	V	3.5	2.5
Borosaprists	6	V	3.5	2.0
Boynton	3	P	4.0	2.5
Braceville	4	M	5.0	4.0
Brayton	4	S	4.5	3.0
Bridgehampton	3	W	6.0	6.0
Bridport	2	S	4.5	3.5
Briggs	4	W	5.0	5.0
Brinkerton	2	P	4.0	2.5
Broadalbin	4	M	5.5	5.5
Brockport	1	S	4.5	4.0
Brookfield	3	W	5.0	5.0
Buchanan	3	M	4.5	4.5
Buckland	3	W	4.0	0.0
Bucksport	6	V	3.5	2.0
Budd	4	W	5.5	5.5
Burdett	2	S	4.5	4.0
Burnham	3	P	3.5	2.0
Burnt Vly	6	V	3.5	2.5
Busti	3	S	4.0	3.5

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Buxton	2	M	5.5	5.0
Cambria	2	P	3.5	2.5
Cambridge	3	M	5.5	5.0
Camillus	3	W	5.0	5.0
Camroden	3	S	4.5	4.0
Canaan	4	E	4.5	4.5
Canaan rock outcrop	4	E	4.5	4.5
Canadice	2	P	4.0	3.0
Canandaigua	3	P	4.0	2.5
Canaseraga	3	M	5.5	5.0
Canastota	2	M	5.0	4.5
Caneadea	2	S	4.5	4.0
Canfield	3	M	5.0	4.5
Canton	4	W	5.5	5.5
Carbondale	6	V	3.5	2.0
Cardigan	4	W	5.0	4.0
Carlisle	6	V	3.5	2.0
Carrollton	3	W	3.5	3.5
Carver	5	E	4.0	4.0
Carver-Plymouth	5	E	4.0	4.0
Castile	4	W	5.5	5.5
Cathro	6	V	3.5	2.5
Cathro-Greenwood	6	V	3.5	2.5
Cattaraugus	3	W	5.5	5.5
Cavode	2	S	4.5	3.5
Cayuga	2	W	5.5	5.5
Cazenovia	2	M	5.5	5.5
Ceres	3	W	3.5	3.5
Ceresco	3	M	6.0	6.0
Chadakoin	3	W	5.5	5.5
Chagrin	3	W	6.0	6.0
Champlain	5	E	3.5	3.5
Charles	3	P	3.0	2.0
Charlton	4	W	5.5	5.5
Chatfield (E)	4	E	4.5	4.5
Chatfield (WE)	4	W	4.5	4.5
Chaumont	1	S	4.0	3.0
Chautauqua	3	M	5.0	5.0
Cheektowaga	5	P	4.0	3.0
Chenango	3	W	5.5	5.5

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Cheshire	4	W	5.0	5.0
Chippeny	6	V	3.5	2.0
Chippewa	3	P	4.0	2.5
Churchville	2	S	4.5	3.0
Cicero	2	S	4.5	3.5
Clarkson	2	M	6.0	5.5
Claverack	4	M	5.5	5.5
Clymer	4	W	5.0	5.0
Cohoctah	4	P	3.5	2.5
Collamer	3	M	6.0	5.5
Colonie	5	W	4.5	4.5
Colosse	4	E	4.5	4.5
Colrain	4	W	5.5	5.5
Colton	5	E	4.5	4.5
Colwood	3	P	4.0	2.5
Conesus	2	M	5.5	5.0
Conotton	3	W	5.5	5.5
Constable	5	W	4.5	4.5
Cook	5	V	3.5	2.5
Copake	4	W	6.0	6.0
Cornish	3	S	4.5	3.5
Cosad	4	S	5.0	4.0
Cossayuna	4	W	5.5	5.5
Covert	4	M	5.5	5.0
Covertfalls	4	M	5.5	5.0
Coveytown	4	S	4.5	3.0
Covington	1	P	3.5	2.5
Crary	4	M	4.5	4.0
Croghan	5	M	4.5	4.5
Culvers	3	M	5.0	4.5
Dalbo	3	M	4.5	4.5
Dalton	3	S	4.0	3.0
Danley	2	M	5.0	4.5
Dannemora	4	P	3.5	2.5
Darien	2	S	4.5	3.5
Dawson	6	V	3.5	2.5
Deerfield	5	M	4.5	4.5
Deford	4	P	4.0	4.0
Deinache	5	V	3.5	2.5
Dekalb	4	W	5.0	5.0

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Depeyster	3	M	6.0	5.5
Deposit	3	M	5.5	5.0
Derb	3	S	4.0	3.5
Dixmont	5	M	5.0	4.5
Dorval	6	V	3.5	2.0
Dover	4	W	5.5	5.5
Duane	4	M	4.5	4.0
Dunkirk	3	W	5.5	5.5
Dutchess	4	W	5.5	5.5
Duxbury	4	W	5.0	5.0
Eldred	3	M	4.0	3.5
Edwards	6	V	3.5	2.5
Eel	2	M	5.5	4.5
Eelweir	4	M	5.5	5.0
Elka	4	W	4.5	4.5
Elko	3	M	4.0	3.5
Ellery	3	P	4.0	2.5
Elmridge	5	M	5.5	4.5
Elmwood	4	M	5.0	4.5
Elnora	5	M	5.0	4.5
Empeyville	4	M	4.5	3.5
Enfield	3	W	5.5	5.5
Ensley	3	P	3.5	3.0
Erie	3	S	4.0	3.0
Ernest	3	W	4.0	4.0
Essex	5	W	4.5	4.5
Factoryville	5	E	5.0	4.5
Fahey	5	M	4.5	4.0
Farmington	3	W	4.0	4.0
Farnham	4	M	5.5	5.0
Fernlake	4	E	3.0	3.0
Flackville	4	M	5.0	4.5
Fonda	2	V	3.5	2.0
Franklinville	4	W	5.0	5.0
Fredon	4	S	4.0	3.0
Freetown	6	V	3.5	2.5
Fremont	2	S	4.5	3.0
Frenchtown	3	P	4.0	2.5
Frewsburg	3	S	4.0	3.0
Fryeburg	3	W	4.0	4.0

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Fulton	1	P	3.0	2.5
Gage	3	P	4.0	3.0
Galen	4	M	5.5	5.0
Galestown	5	E	4.0	4.0
Galoo	4	W	3.5	3.5
Galoo rock outcrop	4	W	3.5	3.5
Galway	4	W	5.0	5.0
Genesee	2	W	6.5	6.5
Geneseo	2	W	6.5	5.5
Georgia	4	M	5.5	5.0
Getzville	3	P	3.5	3.0
Gilpen	3	W	4.0	4.0
Gilpin	3	W	4.0	4.0
Glebe	4	W	3.0	3.0
Glebe-Saddleback	4	W	3.0	3.0
Glendora	4	W	3.0	3.0
Glenfield	3	V	3.5	2.5
Gloucester	4	E	4.5	4.5
Glover	4	E	3.5	3.5
Gougeville	5	V	4.0	2.0
Granby	5	P	3.5	2.0
Grattan	5	E	4.5	4.5
Greene	3	S	4.0	3.0
Greenwood	6	V	3.0	2.0
Grenville	4	W	5.5	5.5
Gretor	3	S	3.0	2.5
Groton	4	M	5.0	4.5
Groveton	4	W	5.0	4.0
Guff	1	P	3.0	2.5
Guffin	1	P	3.5	2.5
Gulf	4	P	3.5	2.5
Guyanoga	3	M	5.5	5.0
Hadley	3	W	5.0	3.5
Haights	3	W	3.5	3.0
Haights-Gulf	3	P	5.0	3.0
Hailesboro	3	S	4.0	3.5
Halcott	2	W	3.5	3.0
Halsey	4	V	6.5	2.5
Hamlin	2	W	6.5	5.5
Hamplain	2	W	5.5	4.0

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Hannawa	4	P	6.0	3.0
Hartland	4	W	6.0	6.0
Haven	4	W	6.0	3.0
Hawksnest	3	W	6.0	2.5
Hemlock	2	M	4.5	3.5
Hempstead	4	W	6.0	3.5
Henniker	4	W	5.0	4.5
Henrietta	6	V	6.0	2.0
Herkimer	3	M	5.5	5.0
Hermon	4	W	6.0	5.0
Hero	4	M	5.5	5.5
Heuvelton	2	M	6.0	4.5
Highmarket	4	W	4.5	3.5
Hilton	2	M	5.5	4.5
Hinckley	5	E	5.5	4.5
Hinesburg	4	W	5.5	5.5
Hogansburg	4	M	5.0	4.0
Hogback	5	M	4.0	4.0
Hogback-ricker	5	M	4.5	4.0
Holderton	3	S	4.5	4.0
Hollis	4	S	3.5	3.5
Holly	2	P	4.0	2.5
Holyoke	3	W	4.0	4.0
Holyoke rock outcrop	3	W	5.0	4.0
Homer	2	S	5.5	4.0
Honeoye	2	W	5.5	5.0
Hoosic	4	W	5.0	4.0
Hornell	2	S	3.0	3.0
Hornellsville	3	S	4.5	2.5
Houghtonville	5	W	4.5	4.5
Houghtonville-Rawson	5	W	4.5	4.5
Houseville	2	S	5.5	4.0
Howard	3	W	5.5	5.5
Hudson	2	M	5.0	4.5
Hulberton	2	S	4.0	4.0
Ilion	2	P	3.0	2.5
Insula	4	W	3.5	3.0
Ipswich	6	V	5.0	2.5
Ira	4	M	4.5	4.5
Ischua	3	M	4.0	3.0

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Ivory	2	S	4.0	2.5
Jebavy	5	P	4.0	3.0
Joliet	4	P	4.0	2.5
Junius	5	P	5.5	3.0
Kalurah	4	M	5.0	3.5
Kanona	2	S	5.5	2.5
Kars	4	W	5.5	3.0
Kearsarge	3	E	4.5	3.0
Kendaia	2	S	5.0	4.0
Kibbie	3	S	4.5	4.0
Kingsbury	1	S	4.5	3.5
Kinzua	3	W	4.5	4.5
Knickerbocker	5	E	5.5	4.5
Lackawanna	3	W	5.5	5.0
Lagross	3	W	5.0	5.0
Lagross-Haights	3	W	5.0	4.5
Lairdsville	2	M	4.5	3.5
Lakemont	1	P	4.0	2.5
Lakewood	5	E	4.0	4.0
Lamson	4	P	4.0	2.5
Lanesboro	3	W	5.0	4.0
Langford	3	W	5.5	4.5
Lansing	2	W	5.5	4.0
Leck kill	3	W	4.0	3.5
Leicester	4	P	4.5	2.5
Leon	5	P	4.5	3.0
Lewbath	3	W	5.5	4.5
Lewbeach	3	W	5.5	5.0
Leyden	2	M	5.5	4.5
Lima	2	M	5.0	4.5
Limerick	3	P	6.0	3.0
Linden	4	W	6.0	4.5
Linlithgo	3	S	3.5	3.0
Livingston	1	V	5.5	2.0
Lobdell	3	M	4.5	4.5
Lockport	2	S	4.5	4.0
Lorain	1	P	4.0	3.0
Lordstown	3	W	5.5	4.5
Lovewell	2	M	5.0	4.5
Lowville	4	W	5.0	3.5

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Loxley	6	V	5.5	2.5
Lucas	2	M	5.5	5.0
Ludlow	4	M	5.0	3.5
Lupton	6	V	4.0	2.5
Lyman	4	E	4.0	4.0
Lyman-Becket-Berkshire	4	E	4.0	4.0
Lyme	5	P	3.5	2.5
Lyonmounten	3	P	3.5	2.0
Lyons	2	P	5.0	2.5
Machias	4	M	4.5	3.5
Macomber	4	W	3.5	3.5
Macomber-Taconic	4	W	3.5	3.5
Madalin	1	P	5.0	2.5
Madawaska	5	M	5.5	4.5
Madrid	4	W	5.5	4.5
Malone	4	S	3.5	3.5
Manahawkin	6	V	4.0	2.5
Mandy	3	W	4.5	4.0
Manheim	2	S	4.5	3.5
Manhoning	2	S	4.5	3.0
Manlius	3	W	4.5	3.5
Mansfield	3	V	5.5	2.0
Maplecrest	2	W	5.5	4.0
Marcy	3	P	5.0	3.0
Mardin	3	M	4.5	4.5
Marilla	3	M	4.0	3.5
Markey	6	V	5.0	2.0
Marlow	4	W	5.0	3.5
Martisco	6	V	4.5	2.5
Massena	4	S	4.0	3.5
Matoon	1	S	3.0	3.0
Matunuck	6	V	3.5	2.5
Medihemists	6	V	2.5	2.0
Medina	3	W	5.0	5.0
Medomak	3	V	5.0	2.0
Melrose	4	W	5.0	3.5
Menlo	4	P	5.5	2.5
Mentor	4	W	5.5	5.0
Merrimac	4	W	5.0	4.5
Metacomet	3	M	4.5	4.0

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Middlebrook	3	M	4.5	4.0
Middlebrook-Mongaup	3	M	5.5	4.0
Middlebury	3	M	5.0	4.5
Millis	4	W	5.0	4.5
Millsite	4	W	5.5	4.5
Mineola	4	M	5.0	3.5
Miner	1	P	5.0	2.5
Mino	4	S	5.0	3.0
Minoa	4	S	5.5	3.0
Mohawk	2	W	5.5	5.0
Moira	4	M	4.0	3.5
Monadnock	4	W	4.5	3.5
Monarda	4	S	4.5	3.5
Mongaup	3	W	5.0	4.5
Montauk	4	W	5.0	3.5
Mooers	5	M	4.0	3.0
Morocco	4	P	4.5	3.0
Morris	3	S	4.5	3.5
Mosherville	4	S	3.5	3.5
Muck	6	V	3.5	2.0
Muck-peat	6	V	3.5	2.0
Mundal	4	W	4.5	3.5
Mundalite	3	W	4.5	4.5
Mundalite-Rawsonville	3	W	4.5	4.5
Munson	2	S	3.5	3.5
Munuscong	4	P	3.5	2.0
Muskego	6	V	4.5	2.0
Muskellunge	3	S	3.5	3.5
Naples Creek	3	S	4.0	4.0
Napoleon	6	V	3.5	2.0
Napoli	3	S	4.0	2.5
Nassau	4	E	4.5	4.0
Naumburg	5	S	5.0	3.0
Nehasne	4	W	5.5	5.0
Nellis	4	W	5.5	3.5
Neversink	4	P	5.5	2.0
Newfane	4	W	5.5	4.5
Newstead	4	S	3.5	3.5
Newton	5	V	5.0	2.0
Niagara	3	S	4.5	4.0

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Nicholville	4	M	6.0	4.0
Ninigret	4	M	5.5	3.5
Norchip	3	P	4.5	2.5
Northway	5	S	5.5	2.5
Norwell	5	S	3.5	3.5
Norwich	3	V	5.5	2.5
Nunda	2	M	5.0	4.5
Oakville	5	W	5.5	4.5
Oatka	2	S	4.0	4.0
Occum	4	W	5.5	4.5
Occur	4	M	5.5	5.0
Odessa	2	S	4.5	4.0
Ogdensburg	4	S	6.0	3.5
Olean	2	M	6.0	5.5
Ondawa	4	W	6.0	4.5
Oneida	4	S	4.5	3.5
Onoville	3	M	6.0	4.0
Ontario	2	W	6.0	4.5
Onteora	3	S	4.5	3.5
Ontusia	3	S	4.5	3.5
Oquaga	3	W	5.5	4.5
Oramel	2	S	5.5	3.5
Organic	6	V	4.5	2.5
Orpark	2	S	4.5	3.5
Orwell	2	P	3.5	3.0
Ossipee	6	V	5.5	2.0
Otego	2	M	5.0	4.5
Otisville	4	E	5.0	4.5
Ottawa	5	W	5.0	4.5
Ovid	2	S	4.5	4.0
Palatine	2	W	4.5	3.5
Palms	6	V	5.5	2.5
Palmyra	3	W	5.5	4.5
Panton	1	P	3.5	3.5
Papakating	2	P	5.0	2.5
Parishville	4	M	4.0	3.5
Parsippany	1	P	3.5	2.5
Patchin	3	P	3.5	2.5
Pavilion	4	P	5.5	2.5
Pawcatuck	6	V	5.5	2.5

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Pawling	4	M	5.5	5.0
Paxton	4	W	5.0	3.0
Peacham	3	P	3.5	2.0
Peasleeville	4	S	5.0	3.0
Peat	6	V	3.5	2.5
Peat-muck	6	V	5.0	2.0
Peru	4	M	5.5	4.5
Petoskey	4	W	5.5	5.5
Phelps	3	M	6.0	5.0
Philo	3	M	5.5	4.0
Pillsbury	4	S	4.5	2.5
Pinckney	3	M	4.5	4.0
Pipestone	5	S	5.5	2.5
Pittsfield	4	W	5.5	5.5
Pittstown	4	M	5.0	3.0
Plainbo	5	E	4.5	3.0
Plainfield	5	E	4.5	4.0
Plessis	3	S	4.0	3.5
Plymouth	4	E	6.0	4.0
Podunk	4	M	5.5	5.5
Poland	2	W	5.5	5.0
Pompton	4	M	5.5	4.5
Pootatuck	4	M	5.5	5.0
Pope	4	W	5.5	5.0
Portville	3	S	5.0	3.5
Potsdam	4	W	5.0	3.0
Poygan	1	V	4.5	2.0
Punsit	3	S	5.5	3.0
Pyrities	4	W	5.5	3.0
Quetico	4	W	3.0	3.0
Quetico-rock outcrop	4	W	5.0	3.0
Raquette	4	S	4.0	4.0
Rawsonville	5	W	4.0	4.0
Rawsonville-Beseman	5	W	5.0	4.0
Rayne	3	W	5.0	4.5
Raynham	3	S	3.5	3.5
Raypol	3	P	4.5	2.5
Red hook	4	S	5.5	3.5
Redwater	3	S	4.5	4.5
Remsen	2	S	4.5	3.0

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Retsof	2	S	4.5	3.5
Rexford	4	S	4.5	3.0
Rhinebeck	2	S	4.0	4.0
Ricker	4	E	4.0	4.0
Ricker-Lyman	4	E	4.0	4.0
Ridgebury	4	P	3.5	3.0
Rifle	6	V	4.5	2.5
Riga	2	M	4.5	3.5
Rippowam	4	P	5.5	2.5
Riverhead	4	W	5.5	4.5
Rockaway	2	W	5.5	4.0
Romulus	2	P	6.0	3.0
Ross	2	W	6.0	4.0
Roundabout	3	S	4.0	3.5
Rumney	2	P	3.0	2.0
Runeberg	4	P	3.5	2.0
Ruse	4	P	5.0	2.5
Rushford	3	M	4.5	3.0
Saco	3	V	4.5	2.0
Salamanca	3	M	5.0	4.0
Salmon	4	W	5.0	3.5
Saprists	6	V	4.5	2.0
Saugatuck	5	S	4.5	3.0
Scantic	2	P	4.0	3.0
Scarboro	4	P	5.0	2.5
Schoharie	1	M	5.0	5.0
Schroon	5	M	5.0	5.0
Schuyler	3	M	5.5	4.5
Scio	3	M	5.0	4.5
Sciota	5	M	5.0	4.5
Scituate	4	M	4.5	4.5
Scriba	4	S	4.0	3.5
Searsport	4	P	4.5	2.5
Shaker	2	P	3.5	3.5
Sheddenbrook	5	M	4.5	4.0
Shongo	3	S	4.0	2.5
Shoreham	2	V	3.5	2.0
Sisk	4	V	4.5	2.0
Skerry	5	M	4.0	3.5
Sloan	3	V	5.0	2.0

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Sodus	4	W	5.0	4.6
Somerset	5	P	4.0	3.0
St johns	4	P	4.0	2.5
Staatsburg	3	W	4.5	4.0
Stafford	4	S	4.5	3.5
Steamburg	3	M	5.0	4.0
Stetson	5	W	5.0	4.0
Stissing	4	P	5.5	2.5
Stockbridge	3	W	5.5	4.0
Stockholm	5	P	4.5	3.0
Stowe	4	W	5.0	4.5
Sudbury	4	M	5.5	4.0
Suffield	2	M	5.0	3.0
Summerville	4	E	4.0	3.5
Sun	4	V	4.5	2.5
Sunapee	4	M	3.5	3.0
Suncook	5	E	3.4	3.0
Suny	4	P	3.5	2.0
Surplus	4	V	3.5	2.0
Surplus-Sisk	4	V	5.0	2.0
Sutton	4	M	5.0	4.5
Swanton	4	P	5.0	3.0
Swartswood	4	W	5.0	4.5
Swormville	1	S	3.5	3.0
Taconic	3	W	3.5	3.5
Taconic-Macomber	3	W	3.5	3.5
Tawas	6	V	5.5	2.5
Teel	2	M	4.5	3.5
Tioga	3	W	6.0	6.0
Toledo	2	V	4.5	2.0
Tonawanda	2	S	3.5	3.0
Tor	4	S	4.0	2.0
Torull	3	S	5.0	3.0
Towerville	3	M	5.5	4.5
Trestle	3	W	5.5	4.0
Trout river	5	E	5.5	4.0
Troy	3	M	5.0	3.5
Trumbull	1	P	3.5	2.5
Tughill	4	V	4.0	2.5
Tuller	3	S	4.5	3.5

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Tunbridge	4	W	4.5	4.5
Tunbridge-Adirondack	4	W	5.5	4.5
Tunkhannock	3	W	5.5	4.5
Turin	2	S	5.5	3.0
Tuscarora	4	M	6.0	5.5
Unadilla	3	W	6.0	5.5
Valois	3	W	5.5	3.5
Varick	2	P	5.5	2.5
Varysburg	2	W	5.5	4.5
Venango	3	S	5.0	3.5
Vergennes	1	M	4.5	4.0
Vly	3	W	4.5	4.0
Volusia	3	S	5.0	3.5
Waddington	4	W	5.0	4.5
Wainola	5	S	4.5	3.0
Wakeland	3	S	5.0	3.5
Wakeville	3	S	4.0	4.0
Wallace	5	E	4.5	4.0
Wallington	3	S	4.0	3.5
Wallkill	3	V	4.5	2.0
Walpole	4	P	5.5	3.0
Walton	3	W	5.5	5.5
Wampsville	3	W	6.0	5.5
Wappinger	3	W	6.0	4.5
Wareham	5	P	3.5	3.0
Warners	3	V	4.5	2.0
Wassaic	4	M	4.5	4.0
Watchaug	4	M	4.5	3.0
Waumbeck	4	M	3.5	3.0
Wayland	2	P	4.5	2.5
Weaver	3	M	4.0	3.5
Wegatchie	3	P	5.0	2.5
Wellsboro	3	M	5.0	4.5
Wenonah	4	W	5.0	4.5
Westbury	4	S	3.5	3.0
Westland	2	V	5.5	2.5
Wethersfield	4	W	5.5	5.0
Wharton	2	M	4.5	3.5
Whately	4	V	4.5	2.0
Whippany	2	S	5.5	3.5

Soil management group (SMG; 1 through 6), drainage class (D; V=very poorly drained; P=poorly drained; S=somewhat poorly drained; M=moderately drained; W=well-drained) and alfalfa yield indices for artificially drained (DR) and undrained (UD) fields.				
Name	SMG	D	YI_alfalfa (YI_a)	
			DR	UD
Whitelaw	4	W	5.5	3.5
Whitman	4	V	4.5	2.0
Wilbraham	4	S	5.0	3.0
Willdin	3	M	4.5	3.5
Willette	6	V	5.0	2.5
Williamson	4	M	5.0	4.5
Willowemoc	3	M	4.5	4.0
Wilmington	4	P	5.0	2.5
Wilpoint	1	M	4.5	4.0
Windsor	5	E	5.0	4.5
Winooski	4	M	5.0	3.5
Wiscoy	3	S	5.0	3.5
Wolcottsburg	1	P	3.5	2.5
Wonsqueak	6	V	5.0	2.0
Woodbridge	4	M	4.5	4.5
Woodlawn	4	W	4.5	4.0
Woodstock	4	E	4.0	4.0
Woodstock-rock outcrop	4	E	5.0	4.0
Wooster	3	W	5.5	5.0
Woostern	3	W	5.5	5.5
Woostern-Bath-Valois	3	W	5.5	3.5
Worden	4	S	4.5	2.0
Worth	4	W	4.5	4.5
Wurtsboro	4	M	4.0	4.0
Wyalusing	3	P	5.0	3.0
Yalesville	4	W	5.0	4.0
Yorkshire	3	M	4.0	3.5