New Nouveau Brunswick
CANADA

Agriculture, Fisheries and Aquaculture

Agriculture, Pêches et Aquaculture

CROP FERTILIZATION GUIDE

Prepared by

The Land Development Branch

- March 2001 -

PREFACE

This soil fertility guide is intended to help crop production specialists and producers better understand, interpret and use the field soil test report produced by the Agricultural Laboratory of the New Brunswick Department of Agriculture, Fisheries and Aquaculture. It is specific to field and garden soils and does not cover greenhouse growing media. This first edition does not include fertilizer recommendations for new crops such as blueberries and cranberries.

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I. SOIL SAMPLING METHODS

Your soil analysis report is only as good as the sample submitted to the lab for analysis. For this reason, it is worthwhile to begin by reviewing soil sampling procedures. Additional information is available on the factsheet produced by the New Brunswick Department of Agriculture, Fisheries and Aquaculture (1994).

Soil is sampled in order to diagnose a possible fertility problem in the field or to monitor soil nutrient levels so as to determine how much fertilizer and lime is required to grow a certain crop.

When to take a soil sample ?

Soil samples can be taken at any time, but fall is often the most convenient. Taking samples in the fall after harvest ensures that results are available to plan for the upcoming season. Soil chemical properties vary over the growing season so it is recommended to take soil samples at the same time each year. This allows you to compare the results over time. A sampling frequency of once every three years is often sufficient but more frequent analyses may be required for coarse textured soils, areas having production problems, or for high nutrient using crops.

How to take a soil sample ?

It is very important that the sample sent to the laboratory for analysis represents the field from which it was taken so that the lab results will reflect the fertility of the field. There are various ways to sample a field including composite sampling and grid sampling methods. So far, the Department of Agriculture, Fisheries and Aquaculture has recommended to farmers to take composite soil samples from similar areas of each field. Individual samples should be taken at a 15-cm depth throughout the field following a zigzag pattern that covers the entire area (Fig. 1).

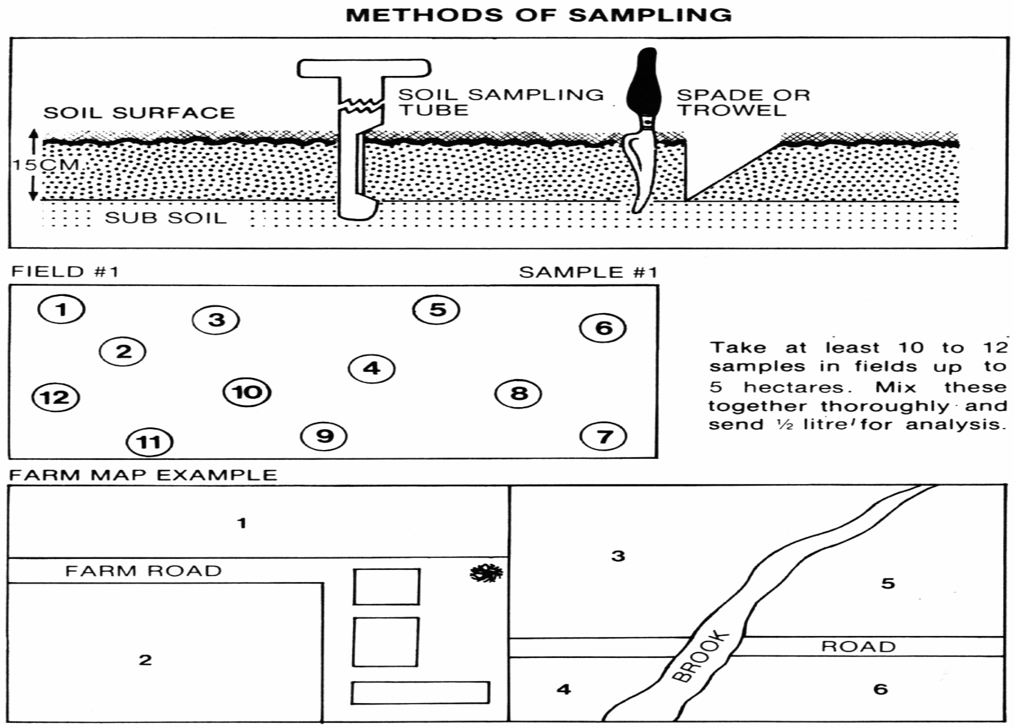


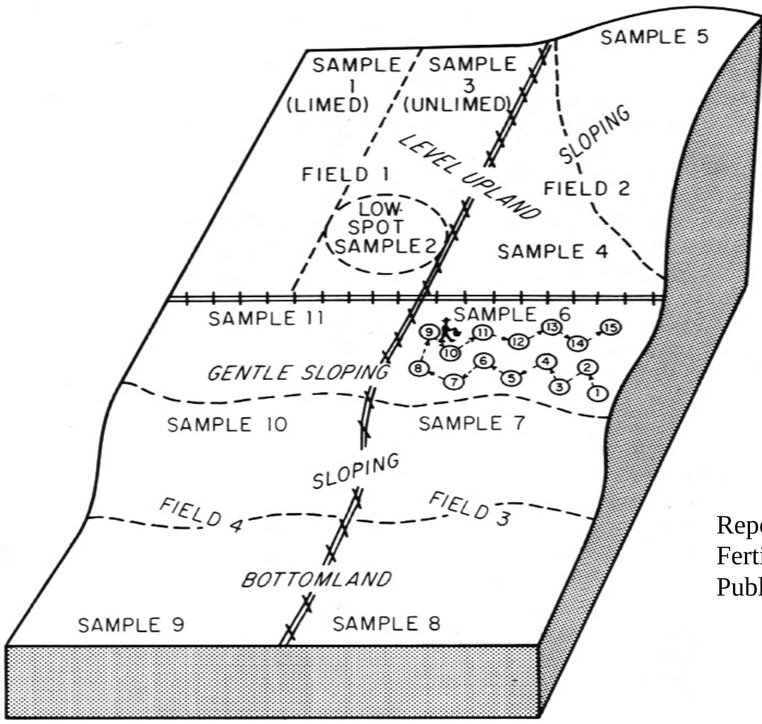
Fig. 1. Soil sampling using the composite method (check the soil sampling depth)

Composite Sample

Fields growing different crops should be sampled separately, as should different areas within a field (Fig. 2). Small areas that do not represent the majority of the field should be avoided or also sampled separately. These might include poorly drained areas, highly eroded areas, and areas of the field where lime or manure was piled.

Stainless steel (not galvanized) or plastic containers should be used to collect the sample and prevent it from contamination, especially if you are interested in micronutrient testing. The number of subsamples needed to make a composite sample depends on the size of the area being sampled. A minimum of 10-12 subsamples should be taken per composite sample on areas up to 5 ha as shown on Fig. 1. Larger fields should be divided or a larger number of subsamples taken. One composite sample should never represent more than 10 ha.

The composite sample should be thoroughly mixed and a subsample taken and sent to the soil laboratory for analysis. Fill the soil sample bag to the fill line so that the lab has enough soil to complete the analyses.



Reported from Tisdale *et al.* 1985. Soil Fertility and Fertilizers. MacMillan Publ. 4th Edit. 754p.

Fig. 2. Field portions of similar characteristics are determined for soil sampling purposes

Be sure to provide the following information: name, address, farmer identification number, phone number, fax number (if applicable), field identification label, crop to be grown, the previous crop grown, and the sampling date.

II. SOIL TESTING AND RATINGS

The most common soil analysis package performed by the Agricultural Lab is the Standard Soil Package. This package includes pH, cation exchange capacity (CEC), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), trace elements, buffer pH (total or potential acidity), as well as required applications of N, P_2O_5 and K_2O, and base saturation percentages. Soil aluminum content is also routinely tested but the result is not given on the analysis report, yet. Additional analyses, available upon request, include organic matter, soil salinity, NO_3-N and particle size.

Soil Organic Matter

Soil organic matter comes from the decomposition of dead plants, animals and microorganisms. Although it is not used directly to determine the fertilizer or lime recommendations, soil organic matter is a general indicator of soil quality as it plays important roles in soil chemical and physical properties. First, soil organic matter contributes to the mineral nutrition of plants by increasing the soil's ability to provide and retain water and nutrients. Second, it provides exchange sites for soil cations thereby improving cation exchange capacity and buffering capacity of a soil. Third, soil organic matter also acts like "glue", binding soil particles together into aggregates which resist soil erosion and help balance aeration, moisture retention, and drainage.

Soil organic matter is expressed as a percentage (%). In general, organic matter varies from 1 to 5% in mineral soils. In New Brunswick, the soil organic matter is distributed in agricultural lands as shown on Fig. 3. Soils with greater than 30 % organic matter by weight are classified as Organic soils (Canadian System of Soil Classification, 1998).

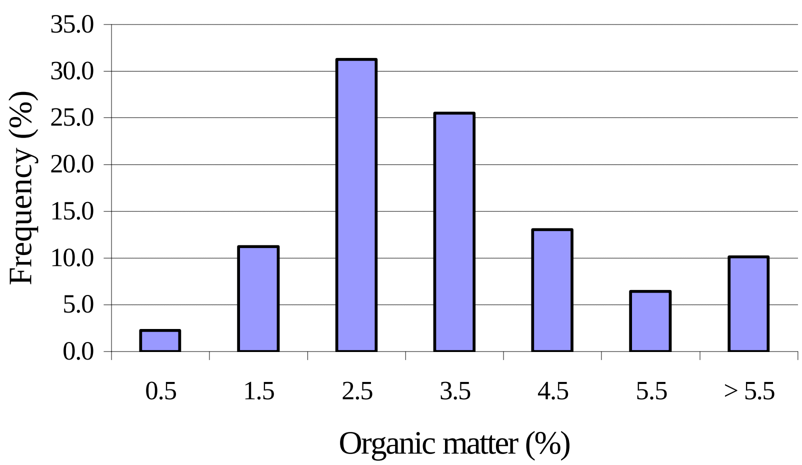


Fig. 3. Distribution of Organic Matter Levels in Soils of New Brunswick

Soil organic matter analysis is available at the Agricultural Laboratory upon request. It is analyzed using the modified Walkley Black Method (1934).

Cation Exchange Capacity

The soil's ability to hold onto and exchange certain nutrients (cations) for plant growth is known as the cation exchange capacity (CEC). The cations are the positively charged nutrients (K^+, Ca^{2+}, Mg^{2+}, NH_4^+ and Na^+) and exchangeable acidity (Al^{3+} and H^+). They are adsorbed (held) on negatively charged soil surfaces which are largely determined by the clay and organic matter fractions of the soil.

Cation exchange capacity is an indicator of soil fertility and is expressed in milliequivalents per 100g of soil (meq/100g). Although it can be measured in the Department Soil Laboratory, the method of analysis is costly and time consuming. As a result, the Agricultural Laboratory calculates rather than measures CEC, as follows:

CEC (meq/100g) = Ca (ppm)/200 + Mg (ppm)/120 + K (ppm)/390 + [9(7.5 - Buffer pH)]*.

The CEC can vary from a few milliequivalents in sandy soils to above 200 meq/100g in organic soils. Because CEC is highly dependent on soil texture, CEC values from 10 to 15 meq /100g would be very high for a sandy soil but very low for a clayey soil (Table 1). Figure 4 shows the distribution of CEC values estimated for New Brunswick soils.

Table 1. Cation Exchange Capacity Ranges for Different Soil Types

Soil Type	Cation Exchange Capacity (meq/100g)				
	very low	low	medium	high	very high
Light (sandy)	< 4	4 to 6	6 to 8	8 to 10	> 10
Loamy	< 10	10 to 15	15 to 20	20 to 25	> 25
Heavy (clayey)	< 25	25 to 30	30 to 35	35 to 40	> 40
Organic	< 50	50 to 100	100 to 150	150 to 200	> 200

Adapted from Doucet R. 1992. La science agricole. Climats sols et productions végétales du Québec.

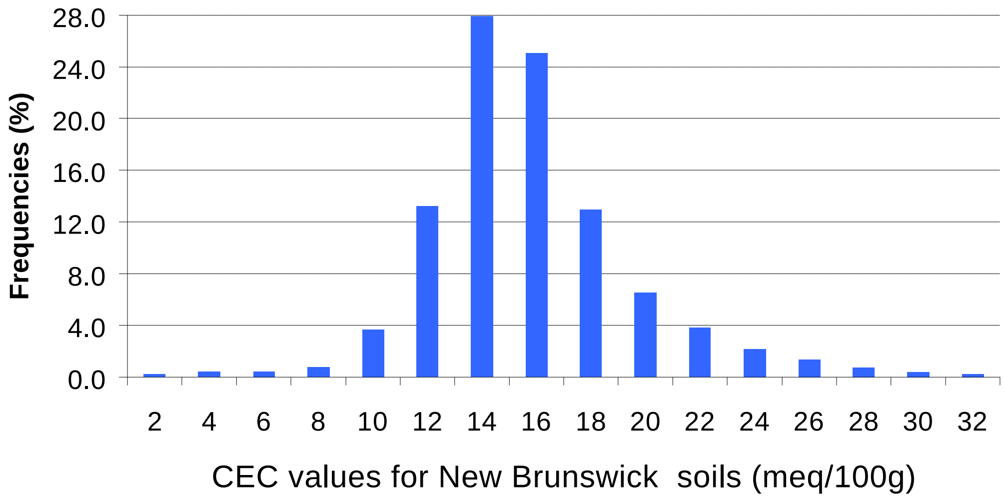


Fig. 4. Distribution of CEC in Soils of New Brunswick

Percent Base Saturation ratios

The soil test report gives the percentage of the CEC occupied by each of the base cations (K^+, Mg^{2+}, Ca^{2+}, and Na^+) and the total % of the CEC occupied by base cations. The remainder of the CEC is occupied by acid cations (H^+, Al^{3+} and Al-hydroxyl ions).

The percent base saturation values are helpful in identifying extremes in the ratios between cations. A very high level of one of the base cations (Ca, Mg or K) may reduce the availability to plants of one of the other nutrients. For example, K can interfere with Mg uptake in soils that test very high in K and low in Mg; however, these antagonistic interactions between nutrients are only important when one of the nutrients is approaching deficiency (OMAFRA 1998).

Soil pH

Soil pH is a measure of the concentration of hydrogen ions (H^+) in the soil solution. The concentration of H^+ ions in the soil solution determines whether the soil is acid, neutral or alkaline (basic). The pH scale is logarithmic and runs from 1 to 14. A pH of 7 is neutral, below 7 is acid and above 7 is alkaline (or basic). Soil pH is measured in a 1:1 soil:water ratio. It is also known as soil water pH. Soil pH plays an important role in the availability of nutrients to plants. The soil's pH affects the solubility of elements including plant nutrients as is shown on Fig. 5.

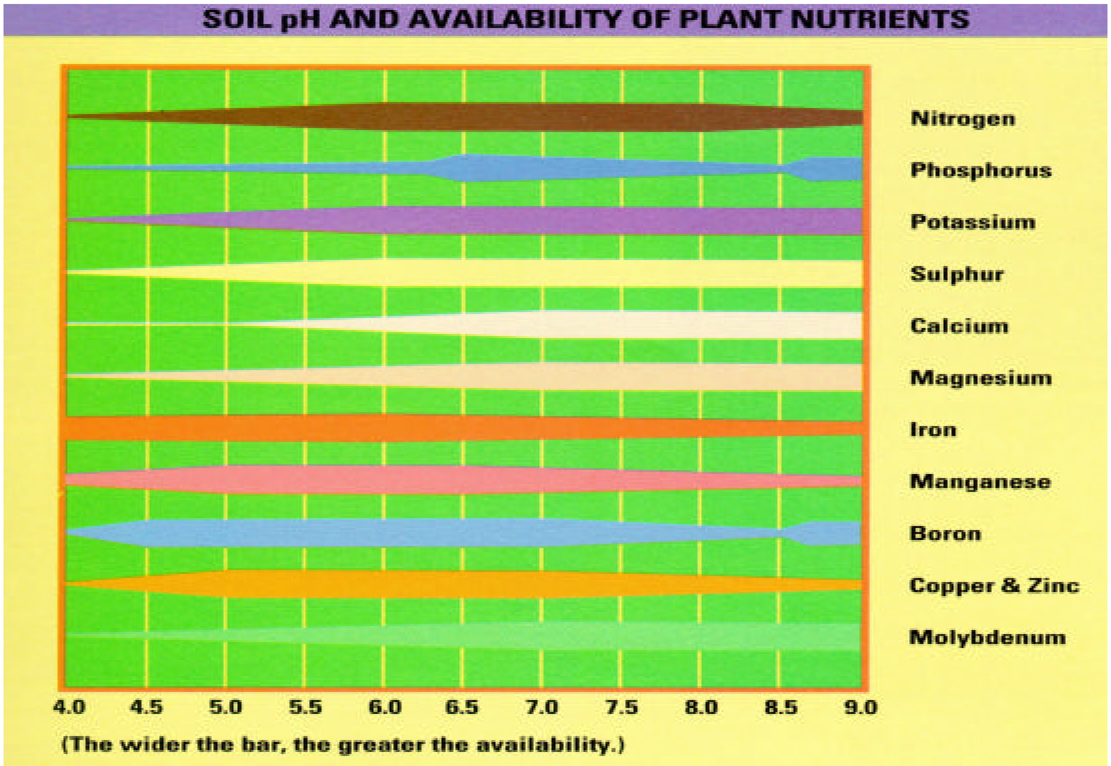


Fig. 5. Nutrient availability as a function of soil pH (Adopted from Ontario's Best Management Practices Booklet for Nutrient Management, 1994)

Plant nutrients are most available at a pH varying from 5.5 to 7.0. However, different crops have different requirements and tolerance of soil conditions that result from various pH regimes. It is very important to adjust the soil pH to the optimum range for the crop you are growing (Table 2)

Soil Nutrient Levels

Plant available soil nutrients are determined from a Mehlich III extractant and the results are expressed in parts per million (ppm) on the soil test report. Often soil test values are expressed in mg /kg. These two units are equivalent and can be used interchangeably.

The Mehlich III method is commonly used by soil testing laboratories in Quebec and Atlantic Canada. The Mehlich III extractant is popular because it is particularly well suited to soils with pH ranging from acid to neutral.

Table 2. Optimum pH ranges for common New Brunswick crops (adapted from Atlantic Agriculture Publications No. 100 and 1400).

Crops	Optimum pH	Crops	Optimum pH	Crops	Optimum pH
Fruits		*Forages*		*Vegetables ct'd*	
Apples	5.5-6.5	Pasture	6.0-6.5	Celery	6.5-6.8
Blueberries	4.5-5.5	Grass	6.0-6.4	Cole Crops	6.0-6.5
Strawberries	5.0-6.5	Alfalfa	6.2-7.0	Sweet Corn	6.0-6.8
		Clover	6.2-7.0	Cucumbers	6.0-6.8
		Silage Corn	6.0-6.5	Lettuce	6.0-6.8
		Lupins	6.0-7.0	Onions	6.5-6.8
		Soybeans	6.0-7.0	Parsnips	6.5-7.0
				Peas	6.0-6.5
Cereals		*Vegetables*		Potatoes	5.5-6.0
Wheat	6.0-7.0	Mixed Vegetables	6.0-6.5	Pumpkins	6.0-7.0
Barley	6.0-7.0	Asparagus	6.0-6.8	Radish	7.0
Oats	6.0-7.0	Beans	6.0-6.8	Rhubarb	6.0-6.8
Buckwheat	5.5-7.0	Beets	6.2-6.8	Spinach	6.5-6.8
Canola	6.0-7.0	Carrots	6.0-6.8	Tomatoes	6.0-6.5
				Turnips	6.0-7.0

The extractant is used for phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sodium (Na), manganese (Mn), zinc (Zn), copper (Cu), and boron (B).

Phosphorus (P) and potassium (K) are called macronutrients because crops require them in large quantities. Calcium (Ca) and magnesium (Mg) are considered to be secondary nutrients while boron (B), copper (Cu), zinc (Zn), sulphur (S), manganese (Mn) and iron (Fe) are called micronutrients because crops require them in very small quantities.

Soil test values for P, K, Ca and Mg are rated from very low (L-) to very high (H+). The P and K ratings are then used to establish the fertilizer recommendations (P_2O_5 and K_2O, respectively) for most crops of New Brunswick (Appendix A).

Soil Nitrates

Soil nitrate is not currently used to adjust the nitrogen fertilizer recommendations in New Brunswick. However, researches have been undertaken to determine if soil nitrate can be used to better determine the nitrogen recommendations for crops. Soil nitrate testing is currently only available from the Department Laboratory on request for research purposes.

Soil Salinity

Soil salinity is a measure of the soluble salt concentration in a soil. New Brunswick soils are naturally low in soluble salts, however, high soluble salts in soils can result from excessive applications of fertilizers and manure or from runoff of road salt. High concentrations of soluble salts can impede germination of seeds and damage established plants. They also interfere with the uptake of water by plants. High sodium (Na) levels destroy soil structure and impede soil porosity and aeration.

Soil salinity analysis is available from the Agricultural Lab on request. It is estimated by measuring the electrical conductivity of a 2 : 1 water: soil (v:v) paste and is expressed in millisiemens / cm (mS/cm). The method of analysis is extremely important when interpreting soil salinity values. For example, soil salinity values determined from a saturated paste will be very different from those determined from a 2 : 1 water: soil paste and should not be compared. Table 3 provides guidelines for interpreting soil salinity for field soils.

Table 3. Interpretation of Soil Salinity Readings from a 1:2 soil:water paste of Field Soils (taken from the Ontario Field Crop Recommendations, Publication 296)

Soil Salinity mS/cm	Rating	Plant Response
0-0.25	L	suitable for most plants if recommended amounts of fertilizer are used
0.26-0.45	M	suitable for most plants if recommended amounts of fertilizer are used
0.46-0.70	H	may reduce emergence and cause slight to severe damage to salt-sensitive plants
0.71-1.0	E	may prevent emergence and cause slight to severe damage to most plants
> 1.0	E	expected to cause severe damage to most plants

Soil Aluminum

The soil aluminum content has a significant effect on the availability of soil nutrients, especially on soil phosphorus availability. The Mehlich-III extractable phosphorus (P): Mehlich-III extractable aluminum (Al) ratio is currently being evaluated by the Department as an indicator for soil phosphorus availability to crops. This approach was developed (Khiari *et al*., 2000) and already integrated in the crop fertilization practices of Quebec (Simard *et al.*, 2001). The ratio (Mehlich III –P) / (Mehlich III – Al) could be used to improve phosphate fertilizer recommendations in the potato belt and environmentally sound management of livestock manures.

Soil Buffer pH

There are 2 types of acidity in soils, active acidity and reserve acidity. The active acidity is the same as soil pH. Soil pH is very important because it characterizes the environment in which the roots are immersed. The reserve acidity is the concentration of H^+ ions that are attached onto the soil's exchange sites. It is related to the type and amount of clay and the organic matter content of the soil. The greater the reserve acidity, the more lime will be required to bring the soil to the desired pH. As the lime neutralizes the H^+ in the soil solution, H^+ ions from the exchange sites go into solution to "buffer" the effect of the lime. The lime recommendation accounts for both the active and the reserve acidity. This is achieved through measurement of the buffer pH which is expressed as "Soil Index" on the soil test report. The soil index (buffer pH) is measured using the SMP (Shoemaker, McLean and Pratt, 1962) buffer solution and is used to determine the lime requirement of a soil.

In New Brunswick calcitic ($CaCO_3$) and dolomitic $Ca.Mg(CO_3)_2$ limestone are the most common liming materials. It is the carbonate (CO_3^-) in limestone that neutralizes the H^+ in the soil solution to produce water and carbon dioxide gas.

$$CaCO_3 + 2H^+ \longrightarrow H_2O + Ca^{2+} + CO_2\ (gas)$$

Calcitic lime + hydrogen ⟶ water + calcium + carbon dioxide gas

Calcium and magnesium also play a role in pH adjustment. As the H^+ ions in the soil solution are neutralized, they are removed from the exchange sites and are replaced by the calcium (Ca^{2+}) and magnesium (Mg^{2+}) ions. In addition, calcium and magnesium are elements that contribute to the mineral nutrition of the crops. Calcitic lime supplies calcium to crops while dolomitic lime supplies both calcium and magnesium. Both liming materials improve the fertilizer use efficiency and the soil structure.

III. REQUIRED APPLICATIONS

Limestone

The soil test report provides the lime requirements for three target pHs: 5.5, 6.0 and 6.5. The quantity of lime required is determined by the dominant crop to be grown. For example, if the dominant crop is potatoes but the lime is to be applied to a barley crop in rotation, a target pH between 5.5-6.0 (for potatoes) should be chosen (Table 2). The required application of limestone is intended to raise the pH of the top 15 cm of soil through either incorporation or surface application. Surface application is allowed on perennial crops such as established forages, turf and strawberries. Splitting the application of lime is recommended on such perennial crops when the total lime requirement is greater than 4000 kg/ha. Liming materials take 6 months or more (when lime is surface-broadcast, for instance) to react and adjust the soil pH. It is advised to incorporate the lime in the fall and to repeat the application once in three or four years (upon soil test).

Lime requirements are given in kg/ha. To convert to tonnes per hectare, simply divide the required application by 1000. To convert to lbs /acre, multiply the required application by 0.893.

Nitrogen - Phosphate - Potash Recommendations

Required applications of fertilizer are given in kg/ha of nitrogen (N), phosphate (P_2O_5) or potash (K_2O). The required amounts have been converted to a fertilizer recipe at an accompanying fertilizer rate. The fertilizer recipe is given as the percentage of each N, P_2O_5, and K_2O.

> *For example, 5 - 10 - 15 recommended fertilizer contains 5 % N, 10 % P_2O_5 and 15 % K_2O, whereas 34 - 0 - 0 contains 34% N and no P_2O_5 or K_2O.*

To convert the fertilizer recommendations from kg/ha to lbs/acre, multiply the rate by 0.893.

Secondary and Micronutrient Recommendations

When soil magnesium (Mg) and calcium (Ca) levels are very low, supplement with Mg and Ca by using dolomitic limestone if limestone is required. If lime is not recommended and Mg level is very low, add 1-2% Mg to the fertilizer. If lime is not recommended and Ca level is very low, apply gypsum to supply the crop with calcium. Applications of 0.2 to 3.0% boron are often recommended on crops such as potatoes and alfalfa. For the other micronutrients, contact your regional Land Development Officer.

IV. THE PRINCIPLES BEHIND FERTILIZER RECOMMENDATIONS

There are various different approaches to developing fertilizer recommendations. These include the soil build-up and maintenance level, the sufficiency level and the base cation saturation ratio (Black, 1992).

Soil Build-Up and Maintenance Approach

The soil build-up and maintenance concept promotes the application of sufficiently high rates of P and K to raise soil test levels to a "theoretical optimum" in relatively short period of time such as 1 or 2 years. It has been commonly referred to as *fertilizing the soil*. Once the soil reaches its theoretical optimum, annual applications of fertilizer are based on the amount removed in the harvested portion of the crop. This is often referred to as crop removal. This approach does not consider nutrient losses through other processes than crop removal. It does not consider the fertilizer cost, either.

Sufficiency Level Approach

The sufficiency level concept (also referred to as the *sufficiency-level-of-available-nutrient*, or *SLAN* concept) is similar to the build-up and maintenance concept except that the rate of build-up is much slower and the soil is built to a lower level. The fertilization objective is to add enough nutrients to meet the economic or high yield goals. A modified version of the sufficiency level concept is the approach used by the Agricultural Lab to recommend phosphate (P_2O_5) and potash (K_2O) for many crops in New Brunswick. Nitrogen (N) fertilizer recommendations are currently independent of soil test values for N, assuming that soil N build-up is negligible.

Soil test results for P and K are classified from very low to very high (Appendix A) with associated probabilities of yield response to applied fertilizer. The recommendations at low soil test values will provide more fertilizer than the crop can remove, resulting in a build-up of the nutrient in soil. A medium soil test value should result in a recommendation of *roughly* the same amount of fertilizer as the crop removes. The high or very high category should be above the level of yield response and should receive low or no fertilizer. For many crops in New Brunswick grown on soils having high and very high P and K values, the recommended rates have been significantly reduced. However, significant amounts of phosphate (P_2O_5) and potash (K_2O) fertilizers are still recommended on some crops. This is particularly the case for some potato varieties for which yield responses to fertilizer have been measured at very high soil test values for phosphorus. The SLAN approach to fertilizing has also been referred to as *fertilizing the crop*.

Base Cation Saturation Ratio Approach

This approach proposes ideal proportions of the major exchangeable cations in soil (Ca, Mg, and K). The proposed ranges are 65 to 75 % Ca^{2+}, about 10 % Mg^{2+} and 2.5 to 5 % K^+. These ranges evolved from studies done in the 1940s and 1950s where infertile, acid soils were limed and fertilized to grow alfalfa. The authors of these studies suggested that the CEC should be occupied by 65 % Ca, 10 % Mg, 5 % K and 20 % H. However, because the alfalfa crop grew well at this ratio, does not mean that this ratio is required to grow a good crop of alfalfa. Interestingly, there has been little scientific evidence to support one ideal target ratio for Ca:Mg:K. There are, however, a number of studies that refute this approach. According to these studies (Westerman, 1990), various base cation saturation ratios had no effect on yields except at extremely wide ratios where a deficiency of one element was caused by excesses of others. They emphasized the need for assuring sufficient levels of each nutrient rather than attempting to adjust the soil to an ideal base saturation ratio that does not exist.

V. CREDITING ON-FARM NUTRIENT SOURCES

Livestock Manure

Manure is an excellent source of nitrogen, phosphorus, potassium, micronutrients and organic matter. The use of livestock manure reduces the requirement for chemical fertilizer. Unfortunately, the nutrients in manure are often underestimated. This may be due, in part, to the fact that the availability of the nutrients in manure is difficult to estimate and is greatly influenced by management practices.

Nutrient management planning estimates the nutrients available in manure by considering farm-specific management practices and reduces the chemical fertilizer requirement accordingly. Nutrient applications from all sources (organic and inorganic) are balanced to optimize crop yield and quality and minimize the impact on the environment.

The New Brunswick Department of Agriculture, Fisheries and Aquaculture has partnered with the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) to develop NMAN2000, nutrient management software for New Brunswick. This software will automate the calculations necessary to estimate the availability of manure nutrients to crops based on different management practices. It will also evaluate the risk of these practices to water quality.

Legumes

Grains are often underseeded with red clover. Red clover contains about 40 kg N /ha for every tonne per hectare of top growth and can supply a significant amount of N to the following crop. The quantity of available nitrogen to the following crop depends on the amount of growth, timing of legume kill and soil incorporation. Currently the recommendation is to reduce the N rate by 25 kg /ha if the previous crop was red clover.

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APPENDIX A

NEW BRUNSWICK
FERTILIZER RECOMMENDATIONS

POTATOES[1]

NITROGEN

Variety - end use	Rate (kg N /ha)	Variety - end use	Rate (kg N /ha)
Potatoes -general	135	Russet Burbank processing	185
Chieftain-seed	145	Russet Burbank -seed	165
Chieftain-table	145	Russet Norkota -seed	170
Green Mountain	145	Russet Norkota -table	195
Katahdin -seed	145	Sebago	145
Katahdin -table	145	Shepody -processing	150
Kennebec -seed	145	Shepody-seed	135
Krantz -processing	165	Snowden -processing	200
Krantz-seed	165	Snowden-seed	168
Krantz-table	165	Snowden-table	200
Norland-seed	135	Superior -processing	135
Norland-table	135	Superior-seed	135
Netted Gem	170	Superior table	135
Red Pontiac	145	Yukon Gold	145

If the end use has not been specified on the soil sample, the general recommendation to reduce the N rate by 10-20 kg/ha when growing seed potatoes is given.

PHOSPHORUS

Rating	**Soil P level**	**Soil P content** (ppm P)	**Recommendations** (kg P_2O_5 /ha)	
			Group I [(1)]	**Group II**
L-	Very low	< 10	280	335
L	Low	11–19	280	335
M	Medium	20–39	220	270
M+	Medium high	40–58	160	210
H	High	59–78	110	140
H+	Very High	> 78	97	114

Group I includes all varieties mentioned for nitrogen, except for Netted Gem Russet Burbank that belong to Group II.

[1] For some of the potato varieties grown in New Brunswick

POTASSIUM

Rating	Soil K level	Soil K content (ppm K)	Recommendations (kg K_2O /ha) Group I	Group II
L-	Very low	< 18	280	335
L	Low	19-37	280	335
M	Medium	38-74	220	270
M+	Medium high	75-112	160	210
H	High	113-148	110	140
H+	Very High	> 148	60	90

Group I includes all varieties mentioned for nitrogen, except for Netted Gem and Russet Burbank that belong to Group II.

Secondary and Micronutrient Applications to Potatoes

Soil test results may indicate that supplemental applications of Ca and Mg are required. Limestone is an excellent source of Ca and Mg, however, if no change in pH is required, gypsum ($CaSO_4$) can be used for Ca and supplemental fertilizer Mg can be used.

Boron (B) is often recommended for potatoes, particularly on sandy soils, however, recent research conducted in PEI showed no yield response to applications of boron (B) where deficiencies were not detected. However, care should be taken when supplementing with fertilizer B as there is a very narrow range between deficient and toxic levels.

BARLEY, SPRING WHEAT, OATS, GRAIN UNDERSEEDED, BUCKWHEAT

NITROGEN

Barley (kg N / ha)	**Spring Wheat** (kg N / ha)	**Oats** (kg N / ha)	**Any grain underseeded** (kg N / ha)	**Buckwheat** (kg N / ha)
60 (60 - 80)	60 (60 – 90)	45	48 (45 – 60)	25

To have high protein levels in milling wheat, adequate N must be supplied to the crop throughout the growing season. To achieve this, apply 60 kg N /ha at planting and an additional 30 kg N /ha in a second application at Zadoks growth stage 30-45. Care should be taken that excessive rates of N are not applied due to the risk of lodging. The nitrogen rates should be adjusted to account for cultivar type and residual nitrogen from the previous crop, incorporation of green manure or application of livestock manure. Contact the local Land Development Officer for more details.

PHOSPHORUS

Rating	**Soil P level**	**Soil P content** (ppm P)	**Recommendations** (kg P_2O_5/ha)				
			Barley	**Spring Wheat**	**Oats**	**Grain under-seeded**	**Buck-wheat**
L-	Very low	< 10	100	100	68	120	32
L	Low	11–19	100	100	46	100	32
M	Medium	20–39	60	60	32	68	16
M+	Medium high	40–58	25	25	15	50	8
H	High	59–78	20	20	0	30	8
H+	Very High	>78	20	20	0	30	8

POTASSIUM

Rating	**Soil K level**	**Soil K content** (ppm K)	**Recommendations** (kg K_2O /ha)				
			Barley	**Spring Wheat**	**Oat**	**Grain under-seeded**	**Buck-wheat**
L-	Very low	< 18	100	100	90	150	32
L	Low	19-37	100	100	90	150	32
M	Medium	38-74	80	80	68	100	24
M+	Medium high	75-112	60	60	50	68	16
H	High	113-148	60	60	20	50	16
H+	Very High	> 148	60	60	0	50	16

WINTER WHEAT AND FALL RYE

NITROGEN (kg/ha)

Winter Wheat			Fall Rye		
fall	spring	Zadoks 30-45	fall	spring	Zadoks 30-45
22	37	37	22	37	37

Care should be taken that excessive rates of N are not applied due to the risk of lodging. The nitrogen rates should be adjusted to account for cultivar type and residual nitrogen from the previous crop, incorporation of green manure or application of livestock manure. Contact your local Land development Officer for more precision.

PHOSPHORUS

Rating	Soil P level	Soil P content (ppm P)	Recommendations (kg P_2O_5 /ha)	
			Winter Wheat	Fall Rye
L-	Very low	< 10	100	100
L	Low	11–19	100	100
M	Medium	20–39	60	60
M+	Medium high	40–58	25	25
H	High	59–78	20	20
H+	Very High	> 78	20	20

POTASSIUM

Rating	Soil K level	Soil K content (ppm K)	Recommendations (kg K_2O /ha)	
			Winter Wheat	Fall Rye
L-	Very low	< 18	100	100
L	Low	19-37	100	100
M	Medium	38-74	80	80
M+	Medium high	75-112	60	60
H	High	113-148	60	60
H+	Very High	> 148	60	60

ALFALFA, CLOVER, TREFOIL AND MIXED FORAGES WITH 50 % LEGUMES AND OVER

NITROGEN: 28kg N/ha at seeding and in the spring of the production year.

PHOSPHORUS

Rating	Soil P level	Soil P content (ppm P)	**Recommendations** (kg P_2O_5 / ha)	
			At seeding	Spring of Crop Year
L-	Very low	< 10	120	120
L	Low	11–19	100	100
M	Medium	20–39	68	68
M+	Medium high	40–58	50	50
H	High	59–78	30	30
H+	Very High	>78	30	30

POTASSIUM

Rating	Soil K level	Soil K content (ppm K)	**Recommendations** (kg K_2O /ha)	
			At Seeding	Spring of Crop Year
L-	Very low	< 18	150	150
L	Low	19-37	150	150
M	Medium	38-74	100	100
M+	Medium high	75-112	68	68
H	High	113-148	50	50
H+	Very High	> 148	50	50

It is recommended that all required nutrients and lime be applied at planting when incorporation is possible. When manure is to be applied, the fertilizer recommendations are reduced by as much nutrient amount as that supplied from manure. Contact your local Land Development Officer for information on manure nutrient management planning.

Secondary Nutrients and Micronutrient Applications

Boron (B) is very important for alfalfa production but may not be required on all soils. Deficiencies are more likely on high pH sandy soils. It is recommended that supplemental B be applied at a rate of 0.6 – 3.0 kg B/ ha at planting. Additional boron applications may be required during the subsequent production years.

PASTURE, GRASS FORAGE, HAY AND SILAGE, RYEGRASS, TIMOTHY, TRIPLE MIX AND MIXED FORAGE WITH LESS THAN 50 % LEGUMES

NITROGEN: 48kg N /ha at seeding and in the spring of the production year.

For optimal forage yield during the production year, additional 110-140 kg/ha ammonium nitrate (34-0-0) amount is recommended after each cut when more than one cuts are planned.

PHOSPHORUS

Rating	Soil P level	Soil P content (ppm P)	Recommendations (kg P_2O_5 /ha)	
			at seeding	spring of crop year
L-	Very low	< 10	90	90
L	Low	11–19	68	68
M	Medium	20–39	48	48
M+	Medium high	40–58	16	16
H	High	59–78	0	0
H+	Very High	> 78	0	0

POTASSIUM

Rating	Soil K level	Soil K content (ppm K)	Recommendations (kg K_2O /ha)	
			at seeding	spring of crop year
L-	Very low	< 18	90	90
L	Low	19-37	68	68
M	Medium	38-74	48	48
M+	Medium high	75-112	0	0
H	High	113-148	0	0
H+	Very High	> 148	0	0

It is recommended that all required nutrients and lime be applied at planting when incorporation is possible. The fertilizer recommendations can be significantly reduced when manure is used. Contact your local Land development Officer for information on manure nutrient management planning.

SILAGE CORN

NITROGEN: 140 kg N /ha

PHOSPHORUS

Rating	Soil P level	Soil P content (ppm P)	Recommendations (kg P_2O_5 /ha)
L-	Very low	< 10	100
L	Low	11–19	80
M	Medium	20–39	60
M+	Medium high	40–58	50
H	High	59–78	40
H+	Very High	> 78	30

POTASSIUM

Rating	Soil K level	Soil K content (ppm K)	Recommendations (kg K_2O/ha)
L-	Very low	< 18	175
L	Low	19-37	150
M	Medium	38-74	100
M+	Medium high	75-112	75
H	High	113-148	50
H+	Very High	> 148	30

It is recommended that 2/3 of the nitrogen, phosphate (P_2O_5) and potash (K_2O) be broadcast and incorporated before planting. The remaining 1/3 of nitrogen, phosphate, and potash is to be applied with the seed at planting. Mineral fertilizer applications are significantly reduced when manure is used. Contact your local Land Development Officer for information on manure nutrient management planning.

SWEET CORN

NITROGEN: 140 kg N / ha.

PHOSPHORUS

Rating	**Soil P level**	**Soil P content** (ppm P)	**Recommendations** (kg P_2O_5 /ha)
L-	Very low	< 10	400
L	Low	11–19	250
M	Medium	20–39	250
M+	Medium high	40–58	130
H	High	59–78	130
H+	Very High	> 78	70

POTASSIUM

Rating	**Soil K level**	**Soil K content** (ppm K)	**Recommendations** (kg K_2O /ha)
L-	Very low	< 18	400
L	Low	19-37	250
M	Medium	38-74	250
M+	Medium high	75-112	130
H	High	113-148	130
H+	Very High	> 148	70

It is recommended that 2/3 of the nitrogen, phosphate (P_2O_5) and potash (K_2O) be broadcast and incorporated before planting. The remaining 1/3 of nitrogen, phosphate, and potash is to be band-applied at planting. Mineral fertilizer applications are significantly reduced when manure is used. Contact your local Field Crop Specialist for information on manure nutrient management planning.

VEGETABLES

NITROGEN (kg N/ha)

Broccoli	Brussel Sprouts	Cabbage	Cauliflower	Cole Crops	Mixed Vegetables
150	150	150	150	150	120

For mixed vegetables, if peas, beans, beets and turnips are being grown, reduce the nitrogen rate 50%. If potatoes are being grown, increase the nitrogen rate by 50%.

PHOSPHORUS

Rating	Soil K level	Soil P content (ppm P)	**Recommendations** (kg P_2O_5 /ha)					
			Broccoli	**Brussel Sprouts**	**Cabbage**	**Cauliflower**	**Cole Crops**	**Mixed Vegetables**
L-	Very low	< 10	225	225	225	225	225	360
L	Low	11–19	225	225	225	225	225	240
M	Medium	20–39	160	160	160	160	160	120
M+	Med. high	40–58	90	90	90	90	90	120
H	High	59–78	90	90	90	90	90	120
H+	Very High	> 78	90	90	90	90	90	60

POTASSIUM

Rating	Soil K level	Soil K content (ppm K)	**Recommendations** (kg K_2O /ha)					
			Broccoli	**Brussel Sprouts**	**Cabbage**	**Cauliflower**	**Cole Crops**	**Mixed Vegetables**
L-	Very low	< 18	225	225	225	225	225	360
L	Low	19-37	225	225	225	225	225	240
M	Medium	38-74	160	160	160	160	160	120
M+	Med. high	75-112	90	90	90	90	90	120
H	High	113-148	90	90	90	90	90	120
H+	Very High	> 148	90	90	90	90	90	60

Secondary Nutrients and Micronutrient Applications

For mixed vegetables, if there are broccoli, cabbage, turnip, Brussels sprouts, cauliflower and beets, apply 28mg (1oz) of boron per 100sq meters. For Cole, broccoli, cauliflower, cabbage and Brussels sprouts crops, in addition to the nutrients recommended on the soil report, the addition of 0.2% B to the fertilizer should be required. If you are splitting the application, apply 2/3 at planting and 1/3 at the second application. If the soil pH is greater than 5.5 for the mixed vegetables, lime should not be applied to areas where potato are being grown.

RASPBERRIES

NITROGEN

New Raspberries	Established Raspberries
50 kg N /ha at planting	70 kg N/ha in spring

PHOSPHORUS

Ratings	Soil P level	Soil P content (ppm P)	Recommendations (kg P_2O_5 /ha)	
			New Raspberries	Established Raspberries
L-	Very low	0-40	270	140
L	Low	41-60	215	110
M	Medium	61-80	185	95
M+	Medium high	81-120	150	75
H	High	121-160	110	50
H+	Very High	> 160	55	20

POTASSIUM

Rating	Soil K level	Soil K content (ppm K)	Recommendations (kg K_2O/ ha)	
			New Raspberries	Established Raspberries
L-	Very low	0-80	270	95
L	Low	81-120	205	80
M	Medium	121-160	170	65
M+	Medium high	161-200	140	55
H	High	201-240	85	40
H+	Very High	>240	50	30

STRAWBERRIES

NITROGEN

New Strawberries	Established Strawberries
35 kg N /ha preplant	50 kg N /ha immediately after harvest
50 kg N /ha 4 to 6 weeks after planting	
50 kg /ha in mid-August	

PHOSPHORUS

Rating	Soil P level	Soil P content (ppm P)	**Recommendations** (kg P_2O_5/ha)	
			New Strawberries	**Established Strawberries**
L-	Very low	0-20	275	100
L	Low	21-40	215	100
M	Medium	41-60	140	75
M+	Medium high	61-80	110	50
H	High	81-120	75	50
H+	Very High	> 120	45	50

POTASSIUM

Rating	Soil K level	Soil K content (ppm K)	**Recommendations** (kg K_2O /ha)	
			New Strawberries	**Established Strawberries**
L-	Very low	0-40	135	100
L	Low	41-80	90	100
M	Medium	81-120	70	75
M+	Medium high	121-160	60	50
H	High	161-200	50	50
H+	Very High	> 200	40	50

Secondary and Micronutrient Applications

Boron (B) deficiency has been noted in some strawberry fields in Atlantic Canada (Strawberry Fertilizer Recommendations for the Atlantic Provinces, Factsheet No. ACC1015). Tissue analysis is recommended to verify B deficiency. Where soils are low in B, preplant fertilizer B can be applied at a rate of 1 kg B/ha.

TURFGRASS

NITROGEN

Home Lawns	Fairways, Athletic Fields, Nursery Sod
100 – 150kg /ha	150 kg /ha

PHOSPHORUS

Rating	Soil P level	Soil P content (ppm P)	Recommendations (kg P_2O_5 /ha) Home Lawns, Fairways, Athletic Fields, Nursery Sod
L-	Very low	< 10	280
L	Low	11–19	210
M	Medium	20–39	145
M+	Medium high	40–58	100
H	High	59–78	45
H+	Very High	> 78	0

POTASSIUM

Rating	Soil K level	Soil K content (ppm K)	Recommendations (kg K_2O /ha) Home Lawns, Fairways, Athletic Fields, Nursery Sod
L-	Very low	< 18	180
L	Low	19-37	135
M	Medium	38-74	90
M+	Medium high	75-112	60
H	High	113-148	45
H+	Very High	> 148	0

For new turf, phosphate and potash should be applied and incorporated in the spring or fall prior to crop establishment. Nitrogen should be split into multiple applications: one at planting and the remainder throughout the growing season, as required. For turf maintenance, the application rates and frequency will depend on turf type, soils and management intensity. Slow release nitrogen sources are recommended for turf maintenance.