SF882 (Revised)

North Dakota Fertilizer Recommendation Tables and Equations

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The following soil test recommendation tables are based on field research data obtained in North Dakota, South Dakota, western Minnesota and the Canadian Prairie Provinces. In the case of some crops, data in the literature also were used to supplement data available from this area.

This publication contains major changes from previous publications. Please dispose of older editions. Changes to tables were based on new or re-evaluated data.

This publication contains several major changes from previous versions, including revised potassium recommendations for alfalfa, corn and sugar beet, and the elimination of yield-based nutrient recommendation formulas.

Recommendation Tables

Fertilizer needs should be determined after evaluating the current fertility level of the soil through soil testing, preferably using a site-specific zone sampling approach, as well as the nutrient needs of the crop to be grown, and knowing the historic productivity of the soil.

The most important reason for abandoning yield goal as a consideration in fertility recommendations is that the data from modern fertilizer rate trials indicate that a similar rate of nutrient results in the highest yield regardless of the maximum yield in any experiment. In other words, the rate of nutrient resulting in the highest yield in a low-yield environment was similar to the rate that resulted in the highest yield in a high-yield environment.

A logical way to explain this is that in a low-yield environment resulting from too wet or too dry conditions, nutrient use efficiency is quite low, so a greater rate of nutrient is required to produce a unit of yield. In a high-yield environment, nutrient use efficiency is quite high because release from the soil is maximized, root growth is maximized and the movement of nutrient to the root is maximized, so a lower rate of nutrient is required to produce a unit of yield. Therefore, the recommended N-rate table values should be utilized regardless of what yield a grower believes will result from the barley cultivation.

Several of our N recommendations are "capped" at a maximum rate. In years that support higher yields, our data indicate that greater N release from the soil and greater ability of crops to capture available soil N will support these higher yields without requiring supplemental N fertilizer greater than capped rates. In addition, sunflower N recommendations are capped due to greater lodging risk as the N rate increases.

Nitrogen

Nitrogen (N) recommendations for most crops except some legumes are based on the amount of nitrate N (NO_3-N) in the top 2 feet of soil and the yield potential. Omission of the 2-foot nitrate-N analysis results in random numbers for the N recommendation.

The 2-foot nitrate-N soil test is extremely important in this region for optimal N recommendations and to promote N-use efficiency, greater farm profitability and environmental stewardship.

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Nitrogen fertilizer recommendations are not adjusted based on method of placement, but they are adjusted for previous crop and depth of sampling. To determine the amount of recommended fertilizer N, subtract the amount of soil NO_3 N as determined by soil test and N-credit from the previous crop, if applicable, from the total amount of available N needed for a particular yield goal and crop.

Spring wheat, durum, corn and sunflower N recommendations include economic modifiers to rate based on an economic production function that combines yield/quality increases/decreases with nutrient rate and the cost of nutrient input to indicate the N rate that will provide the grower with the greatest net economic return.

Example of the use of soil test N in canola:

The soil test indicates that 55 pounds of NO_3 N are present in the soil to 2 feet. The chart in **Table 6** indicates a recommendation of 150 pounds of N per acre total requirement. The amount of N to apply would be 150-55 = 95 lb N/acre.

Credits

Previous crop	Credit
Soybean	40 lb N/acre
Dry edible bean	40 lb N/acre
Other grain legume crops (field pea, lentil, chickpea, fababean, lupin)	40 lb N/acre
Harvested sweet clover	40 lb N/acre
Alfalfa that was harvested and unharvested sweet clover:	
>5 plants/sq. ft.	150 lb N/acre
3-4 plants/sq. ft.	100 lb N/acre
1-2 plants/sq. ft.	50 lb N/acre
<1 plant /sq. ft.	0 lb N/acre
Sugar beet	
Yellow leaves	0 lb N/acre
Yellow/green leaves	30 lb N/acre
Dark green leaves	80 lb N/acre

Adjusting N Recommendations

In a preplant NO_3 N soil testing program, adjustments need to be made for the expected contribution of N following some previous crops. This expected N will not be seen in a fall or spring soil test NO_3-N analysis

Previous Crop N Credits

Some crop residues have a lower carbon-to-nitrogen (C/N) ratio than others, which results in a release of plant-available N through rapid decomposition. Also, the mass of residue of some crops is less than others (dry bean compared with wheat or corn, for example). Evidence also indicates that some crops (soybeans, other annual legumes) may accelerate the normal N mineralization rate from organic matter during their growing season, extending to the early growing season of the next crop.

Nitrogen availability is greater following crops with a lower C/N ratio (sugar beet, alfalfa) and crops having a lower mass of residue (soybean, dry bean) with less ability to tie up N during decomposition. The following N credits should be subtracted from crop N recommendations based on comparative subsequent crop N rate response. The values in the Credits table come from North Dakota and Minnesota experiments.

Second-year N Credits

Half of the N credit indicated for the first year for sweet clover and alfalfa is recommended, but no N credit is recommended after the second year for other crops.

Depth Adjustments

The original data for calibration of the NO_3-N test (1950s) was based on soil samples taken to a depth of 5 feet. Sampling beyond 2 feet improved nitrogen recommendations somewhat, but in the late 1960s, researchers decided that the extra effort to sample to a depth of 3 or 4 feet was not practical or necessary for most crops.

Drought and application of excess N, however, may result in a buildup of available N below 2 feet. When fields are tested for N each year and only the recommended amount of N is applied, an accumulation of nitrogen below 2 feet is unlikely unless N is not utilized by the crop due to drought or is leached in medium and coarser soils due to excessive early growing season rainfall.

Sugar beet is the most likely crop to be sampled to the 4-foot depth, but adjustments are not necessary in N calculations. Sugar beet N recommendations for 2- and 4-foot samplings are provided in **Table 24**.

If deeper sampling is conducted to refine recommendations or screen for problems in malting barley, sunflower or safflower, the following adjustments would apply:

- If the amount of NO_3 N in the 2- to 4-foot depth is less than 30 pounds of NO_3 N/acre, do not adjust the N recommendation.
- If the amount of NO_3 N in the 2- to 4-foot depth is more than 30 pounds of NO_3 N/acre, reduce the N recommendation by 80 percent of the amount greater than 30 pounds/A. For example, if 50 pounds of NO_3 N/acre are present at the 2- to 4-foot depth, reduce the N recommendation by 16 pounds of N/acre (80 percent X (50 pounds of N/acre less 30 pounds of N/acre, or 20 pounds)) = 16.

Phosphorus and Potassium

The rate of phosphorus (P) and potassium (K) recommended in these tables is the amount to be applied as a broadcast application. Because banded fertilizer generally is used more efficiently in the year of application, the amount of P_2O_5 and K_2O in the tables can be reduced by one-third when banding and the result will be similar to the yield with the full broadcast fertilizer rate.

Data from field trials in drier or cooler years indicate that small grains, corn and canola will respond to seed-placed or side-banded P fertilizer, even on soils testing medium to high in phosphorus.

Some crops are very sensitive to fertilizer salt injury. No fertilizer is recommended with the seed for these crops in 15-inch rows or wider. Fertilizer-sensitive crops include all legumes, including soybean, pea and dry bean. Consult individual soil fertility publications for each crop for more information. For information regarding fertilizer rate limits with the seed in small grains, refer to NDSU Extension publication EB62, "Fertilizer Application With Small-grain Seed at Planting," available online at *www.ag.ndsu.edu/pubs/plantsci/soilfert/sf1751.pdf*.

Broadcast recommendations of P and K for low- and very low-testing soils may include buildup P and K rates. When rates are reduced, soil test levels are not increased through time. Corn recommendations include K tables related to clay chemistry and K application economics.

Sulfur

Sulfur (S) deficiency most likely will occur on sandy soils throughout North Dakota and on well drained, medium textured soils. However, in wet seasons, S deficiency has been recorded on clay soils with organic matter content greater than 5 percent. Sulfur deficiencies appear most often on higher landscape positions with a thin-surface organic-matter layer ("A" horizon) and coarse soil texture (loam to sand and gravel), but having S deficiency is possible on almost any nonsaline soil should the seasons be wet.

Our current S soil test characterizes the S status of the soil very poorly. The test commonly underestimates or overestimates the available S in soil for a variety of reasons. Noting the texture, organic matter content, landscape position and rainfall in the past year is almost always a better predictor of S need than soil testing.

In a year following a high rainfall/snowfall year, applying 10 to 20 pounds of S/acre regardless of landscape position, soil texture or organic matter may be prudent. Since 2014, serious S deficiency has appeared in many fields that we previously believed would provide adequate S. The sulfur source should be sulfate- or thiosulfate-based and not elemental S of any kind.

Chloride

The chloride (Cl) soil test is calibrated only for small grains, although a few responses also have been seen in corn within the U.S. In general, responses to Cl in small grains have been in the range of 1 to 6 bushels per acre on responsive sites.

The economics of Cl use is most favorable in barley because small-grain yield increase to Cl is due to increased kernel size. Increased kernel size in barley is the market-criteria "plump," which is a metric used to determine barley suitability to malters. The greater the plump score, the more likely the grain can be marketed as malting grade.

The Cl recommendation is determined by subtracting the amount of Cl found in the top 2 feet of soil from the critical value of 40 pounds/acre, although most of the yield response is the result of the first 10 to 15 pounds/acre of Cl applied. The most commercially available and cheapest source of Cl fertilizer is 0 0 60 (potassium chloride, muriate of potash), which contains approximately 50 percent Cl.

Other Nutrients

The DTPA (diethylenetriaminepentaacetic acid) soil test analysis is used in North Dakota to analyze soils for plant-available zinc (Zn), iron (Fe), manganese (Mn) and copper (Cu). Calibration data in North Dakota are available only for Zn on crops known to respond positively to Zn application in the state: corn, potato, flax and dry edible bean (not soybean). Calibration data also are available for Cu on wheat/durum and barley.

Micronutrient requirements are crop-specific. Additional crops would not be expected to respond to Zn or Cu if not listed above. The Cu soil test has been useful only in the state if the soils are less than 2.5 percent organic matter in deep sandy soils, such as an eroded Arvilla loamy sand found in Red River Valley beach soils and in numerous sandy glacial outwash-derived soils in eastern North Dakota.

Zinc

When corn, potato, flax or dry edible beans are to be grown on a field testing low to very low in Zn, the recommendation is to apply 10 pounds/acre of Zn as zinc sulfate in a broadcast application, or one-third of that rate in a seed-placed or near-seed band. Zinc is especially required in these crops if high levels of broadcast P or a starter P fertilizer is applied when soil Zn levels are low. The water solubility of the Zn fertilizer is important in efficient dispersion and uptake.

Also, the crop is more likely to achieve a first-year response to zinc sulfate if the fine granular formulation of the product is used instead of the MAP (mono-ammonium phosphate)- or DAP (diammonium phosphate)-sized granules usually available.

A fine granular application should be made using a fine-granular applicator similar to those used in the past to apply granular herbicide formulations. The distribution of large granules may not be adequate to supply all plants with Zn if low rates are applied.

A broadcast application of zinc sulfate should correct a Zn deficiency for four to five years. Zinc chelates at suggested manufacturer rates also may be used but are relatively expensive per pound of plant food and offer no residual soil buildup.

Banded chelates at 1 pint to 2 quarts/acre can be applied near or with the seed at planting. Foliar applications of zinc chelate and other soluble Zn fertilizers at low rates also are effective for correction of deficiencies for a single season. No Zn is recommended on fields testing medium or above or on fields testing very low, low or medium if the crop to be grown is not a Zn-sensitive crop. Ammoniated Zn complexes also are effective Zn fertilizer sources.

Iron

In general, the supply of soluble iron (Fe) to plants from soil is related to the soil carbonate level, which is important to determine if the field will be in soybean when the soil pH exceeds 7. If carbonates are present, soil wetness, cold soils, excessive tillage and high soluble salt levels influence the presence and severity of iron deficiency chlorosis (IDC).

Most North Dakota crops are not sensitive to low available iron and are adapted to regional conditions. However, IDC has been seen in flax, field pea and dry bean and is a particularly serious problem in soybean.

Seed treatment with ortho-ortho-FeEDDHA (iron-ethylenediaminedi (o-hydroxyphenylacetic) acid) has provided the most consistent soybean yield increases in IDC-susceptible soils. It should be seed-placed in a band as directed on the label for greatest effectiveness.

Other Fe fertilizers, including ortho-para-FeEDDHA, are far less effective. Yield increases to ortho-ortho-FeEDDHA also have been seen in sugar beet in the absence of IDC in multiple trials. Foliar applications have not been effective in correcting IDC and achieving similar yield to a seed-placed o-o-FeEDDHA band.

The best solution on fields with IDC is to plant varieties with greater regional IDC tolerance (not Iowa IDC ratings), and avoiding soybean cultivation on soils with high IDC potential and high in soluble salts. Researchers at NDSU have rated about 200 soybean varieties each year for the past 10 years for IDC tolerance.

Manganese

No field responses to manganese in North Dakota have been documented. Therefore, a recommendation is not made for any soil test level.

Copper

Yield increases due to soil-applied Cu were documented in North Dakota; however, the responses were on low-organic-matter, loamy sand soils with low (less than 0.3 parts per million) Cu levels. A number of companion trials on similar soils resulted in no yield increase.

At best, copper should be applied only to low organic matter, sandy soils with low soil test levels, but expect a success rate of about 15 percent positive yield responses in small grains. Copper fertilizers are expensive, and their use should be based on weighing the productivity of responsive soils with the low return of benefits if copper were applied.

Fertilization Recommendation Tables for Crops Commonly Grown in North Dakota

The following tables can be used for the yield potentials shown.

For other yield potentials, use the equations at the bottom of each table.

The abbreviations used in the tables are:

- STN = soil test nitrogen
- STP = soil test phosphorus
- STK = soil test potassium
- PCC = previous crop credit

Table 1. Soil test calibration levels used in North Dakota.

Nutrient Analysis	Test Method	Categories				
		Very Low	Low	Medium	High	Very High
		ppm				
Phosphorus (P), ppm	Olsen	0-3	4-7	8-11	12-15	16+
Potassium (K), ppm* low SI ratio	Ammonium	0-40	41-80	81-129	121-150	151+
Potassium, ppm high SI ratio	acetate	0-80	81-120	121-150	151-200	201+
Zinc (Zn)**, ppm	DTPA	0-0.25	0.26-0.50	0.51-0.75	0.76-1.00	1.01+
Iron (Fe), ppm	DTPA	no categories				
Copper (Cu)***	DTPA	0-0.10	0.10-0.20	0.20-0.30	0.30+	
Manganese (Mn), ppm †	DTPA	no categories				
Boron, ppm†	Hot water	no categories				
		lbs/acre				
Nitrogen (N)	H_2O Extract	see tables to follow				
Sulfur (S), lb/a-2 feet‡	Monocalcium phosphate	no categories				
Chloride (Cl), lb/a-2 feet¶	H_2O Extract	0-10	10-20	20-30	30-40	40+

* Potassium calibration depends on smectite-to-illite ratio within the clay fraction. Smectite-to-illite ratio is important for consideration in particularly K-responsive crops of alfalfa, corn and sugar beet. See specific crop for K recommendations.
** This calibration is only for corn, potato, flax and edible beans.
*** This calibration is only for wheat and barley in sandy loam or coarser soils with organic matter less than 2.5 percent. Response to copper is not common. Responses have been found only in 15 percent of medium- or lower-testing locations.
† Deficiencies of manganese and boron have not been confirmed in North Dakota.
‡ The sulfur soil test is not diagnostic and never should be used to formulate S recommendations for any crop.
¶ This calibration is only for small grains.

The amount of nutrient extracted by a particular soil extractant has little meaning or usefulness until it has been calibrated under field conditions. In North Dakota, we use five soil test calibration categories to give meaning to the soil test results. The categories from very low to very high are defined as follows, unless explained differently above:

- Very Low (VL) – In this category, the probability of getting a response to applied nutrient is greater than 80 percent.
- Low (L) – Crops growing on fields in this category will respond to applied nutrient 50 to 80 percent of the time.
- Medium (M) – The probability of getting a response to applied nutrient is 20 to 50 percent.
- High (H) – In this category, crops will respond to applied nutrient about 10 to 20 percent of the time.
- Very High (VH) – The probability of getting a response to applied nutrient is less than 10 percent.

Table 2-1. Alfalfa phosphorus recommendations.
Phosphorus recommendation for alfalfa establishment broadcast application rates of P_2O_5.
Growers should consider using replacement rates of P due to hay removal the previous year after first cutting at a rate of 10 pounds of P_2O_5 per ton removed.

Olsen P, ppm				
0-3	**4-7**	**8-11**	**12-14**	**15+**
Rate P_2O_5, pounds per acre				
120	100	80	60	40

Table 2-2. Potassium recommended at alfalfa establishment in soils with a smectite-to-illite clay ratio >3.5 for broadcast application rates of K_2O (see Figure 1). Growers should consider using replacement rates of P due to hay removal the previous year after first cutting at a rate of 48 pounds of K_2O per ton hay removed.

K soil test, ppm				
0-50	**51-100***	**101-150**	**150-200**	**200+**
Rate K_2O, pounds per acre				
180	150	120	90	60

* Soils with estimated CEC (Table 2) 10 or less, apply 90 pounds per acre 0-0-60 at establishment regardless of soil test.

Table 2-3. Potassium recommended at alfalfa establishment in soils with a smectite-to-illite clay ratio <3.5 for broadcast application rates of K_2O (See Figure 1). Growers should consider using replacement rates of P due to hay removal the previous year after first cutting at a rate of 48 pounds of K_2O per ton hay.

K soil test, ppm			
0-50	**51-100***	**101-150**	**150+**
Rate K_2O, pounds per acre			
150	120	90	60

* Soils with estimated CEC (Table 2) 10 or less, apply 90 pounds per acre 0-0-60 at establishment regardless of soil test.

Table 3. Barley, feed.

Total available N*, pounds per acre	Olsen Soil Test P, ppm					Soil Test K, ppm				
	VL	L	M	H	VH	VL	L	M	H	VH
	0-3	4-7	8-11	12-15	16+	0-40	41-80	81-120	121-150	151+
	Pounds P_2O_5 per acre					Pounds K_2O per acre				
150	78	60	52	26	0	90	60	45	30	0

*Total available N includes residual soil nitrate-N to a 2-foot depth, previous crop N credit, and supplemental N from fertilizers, manures or other sources. N rate is 120 pounds/acre in long-term (six years or more continuous) no-till systems.

Table 4-1. Barley, malting grade, in cooler, moister climates in North Dakota*.

Total available N**, pounds per acre	Soil Test P, ppm					Soil Test K, ppm				
	VL	L	M	H	VH	VL	L	M	H	VH
	0-3	4-7	8-11	12-15	16+	0-40	41-80	81-120	121-150	151+
	Pounds P_2O_5 per acre					Pounds K_2O per acre				
150	78	60	52	26	0	90	60	45	30	0

* Generally west and south of the Missouri River, see Figure 1.

**Total available N includes residual soil nitrate-N to a 2-foot depth, previous crop N credit, and supplemental N from fertilizers, manures or other sources. N rate is 120 pounds/acre in long-term (six years or more continuous) no-till systems.

Table 4-2. Barley, malting grade, in warmer, drier climates in North Dakota.*

Total available N**, pounds per acre	Soil Test P, ppm					Soil Test K, ppm				
	VL	L	M	H	VH	VL	L	M	H	VH
	0-3	4-7	8-11	12-15	16+	0-40	41-80	81-120	121-150	151+
	Pounds P_2O_5 per acre					Pounds K_2O per acre				
100	78	60	52	26	0	90	60	45	30	0

* Generally west and south of the Missouri River, see Figure 1.

**Total available N includes residual soil nitrate-N to a 2-foot depth, previous crop N credit, and supplemental N from fertilizers, manures or other sources. In long-term (six years or more continuous no-till) systems, N rate is 70 pounds of N/acre.

Table 5. Buckwheat.

Recommended N	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm			
	VL	L	M	H	VH	VL	L	M	H
	0-3	4-7	8-11	12-15	16+	0-40	41-80	81-120	121+
lb/acre-2′	lb P_2O_5/acre					lb K_2O/acre			
80*	40	30	20	10	0	60	40	30	0

*N rate includes soil test nitrate-N to 2 feet in depth, previous crop N credit, and a 30-pound N credit for long-term (six years or more continuous no-till) no-till systems.

Table 6. Canola.

Soil N plus fertilizer N required	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
	VL	L	M	H	VH	VL	L	M	H	VH
	0-3	4-7	8-11	12-15	16+	0-40	41-80	81-120	121-160	161+
	lb P_2O_5/acre					lb K_2O/acre				
120*	60	44	28	12	0	90	60	40	20	0
150**	60	44	28	12	0	90	60	40	20	0

* Indicates N rate for warmer and drier areas in North Dakota (Figure 1).

** Indicates N rate for cooler and moister areas in North Dakota (Figure 1).

A sulfate or thiosulfate form of S always should be used when growing canola at a rate of about 20 pounds of S per acre. See SF1122 for more details.

Table 7. Clover (Alsike, Red, Birdsfoot Trefoil, grass-legume).

Olsen Soil Test Phosphorus, ppm		Soil Test Potassium, ppm	
L	H	L	H
0-9	10+	0-150	151+
----------lb P_2O_5/acre ----------		---- lb K_2O/acre --------	
60	0	60	0

Inoculation is required at seeding with proper rhizobium culture.

Table 8. Corn for silage.

N* recommended	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
	0-3	4-7	8-11	12-15	16+	0-40	41-80	81-120	121-150	151+
	lb/acre P_2O_5					lb/acre K_2O				
180	90	70	40	20	0	120	120	90	60	0

* Recommended N includes soil test nitrate-N to 2 feet in depth, previous crop N credits and 50 pounds of N credit for long-term (six years or more continuous no-till) systems.

Tables 9-1 through 9-14. Corn for grain.

For a simpler method to determine N rates for corn, see the North Dakota Corn N calculator at www.ndsu.edu/pubweb/soils/corn/. The calculator also can be downloaded on an IPhone or Android smartphone. Search for North Dakota N calculator on the phone app store and download for free.

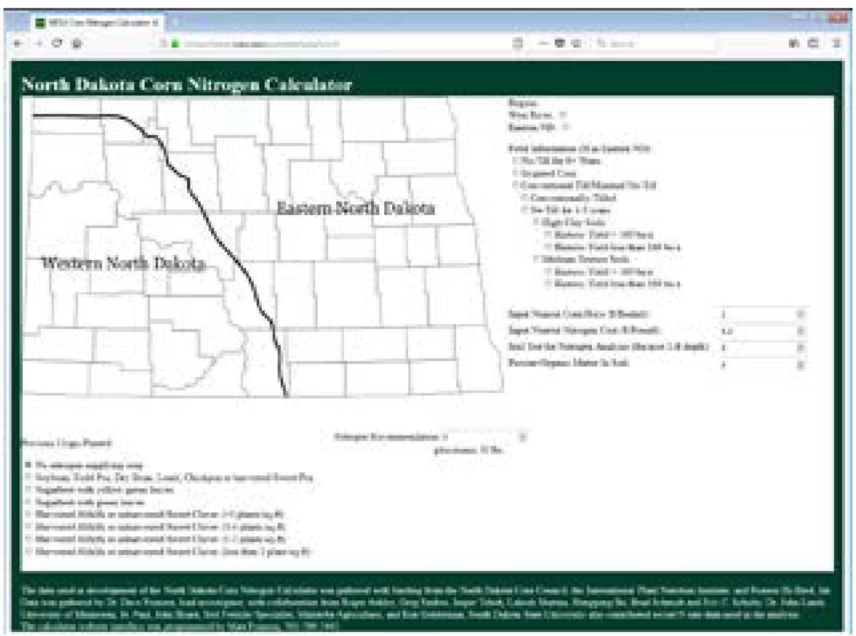

Table 9-1. Corn N recommendations for West River soils, considering maximum return to N using corn N price and N cost.

Corn Price, $/bushel	N cost, $/ pound N								
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
2	150	120	37	0	0	0	0	0	0
3	150	150	149	94	38	0	0	0	0
4	150	150	150	150	121	79	38	0	0
5	150	150	150	150	150	138	105	71	38
6	150	150	150	150	150	150	149	121	94
7	150	150	150	150	150	150	150	150	133
8	150	150	150	150	150	150	150	150	150
9	150	150	150	150	150	150	150	150	150
10	150	150	150	150	150	150	150	150	150

Table 9-2. Corn N recommendations for eastern long-term no-till soils, considering maximum return to N using corn N price and N cost.

Corn Price, $/bushel	N cost, $/ pound N								
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
2	200	168	137	106	75	43	12	0	0
3	220	200	179	158	137	116	95	75	55
4	232	216	199	185	169	154	137	119	107
5	239	226	213	200	187	176	163	150	137
6	243	232	220	211	201	190	179	169	158
7	246	237	226	217	209	200	191	183	173
8	247	241	232	223	215	207	200	192	184
9	249	243	235	228	220	213	207	200	194
10	252	244	239	232	225	218	212	206	200

Table 9-3. Corn N recommendations for eastern high-clay soils with historic yields greater than 160 bushels per acre, considering maximum return to N using corn N price and N cost.

Corn Price, $/bushel	N cost, $/ pound N								
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
2	242	214	186	159	131	103	75	47	19
3	260	242	222	205	186	169	149	131	113
4	270	257	243	229	213	200	186	172	158
5	276	265	254	243	232	220	208	196	184
6	280	270	260	250	240	230	220	210	200
7	285	274	263	252	243	235	226	218	212
8	285	277	270	264	257	251	243	236	229
9	286	280	274	267	261	255	249	243	237
10	287	283	276	270	266	260	254	248	242

Table 9-4. Corn N recommendations for eastern high-clay soils with historic yields less than 160 bushels per acre, considering maximum return to N using corn N price and N cost. The values in the table are the maximum to include in a preplant N application, followed by a side-dress N application based on the difference between the values in this table and the corresponding N cost/corn price value in Table 9-3. The use of an active-optical sensor to direct side-dress N rate instead of the difference between the Table 9-3 rate and preplant rate from this table is encouraged.

Corn Price, $/bushel	N cost, $/ pound N								
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
2	150	150	150	117	67	17	0	0	0
3	150	150	150	150	150	133	100	67	34
4	150	150	150	150	150	150	150	143	118
5	150	150	150	150	150	150	150	150	150
6	150	150	150	150	150	150	150	150	150
7	150	150	150	150	150	150	150	150	150
8	150	150	150	150	150	150	150	150	150
9	150	150	150	150	150	150	150	150	150
10	150	150	150	150	150	150	150	150	150

Table 9-5. Corn N recommendations for eastern medium-textured soils with historic yield greater than 160 bushels per acre, considering maximum return to N using corn N price and N cost.

Corn Price, $/bushel	N cost, $/ pound N								
	0.20	**0.30**	**0.40**	**0.50**	**0.60**	**0.70**	**0.80**	**0.90**	**1.00**
2	222	201	180	160	139	118	97	76	55
3	235	222	208	194	180	166	152	138	124
4	236	234	223	213	202	192	181	171	161
5	249	241	243	223	215	206	198	190	182
6	252	245	238	231	223	216	209	202	195
7	254	248	242	236	230	222	217	211	205
8	255	250	245	240	234	229	223	218	213
9	256	252	247	243	238	233	229	223	218
10	257	253	248	244	239	234	230	224	219

Table 9-6. Corn N recommendations for eastern medium-textured soils with historic yields less than 160 bushels per acre, considering maximum return to N using corn N price and N cost. The values in the table are the maximum to include in a preplant N application, followed by a side-dress N application, based on the difference between the values in this table and the corresponding N cost/corn price value in Table 9-5. The use of an active-optical sensor to direct side-dress N rate instead of the difference between the Table 9-5 rate and preplant rate from this table is encouraged.

Corn Price, $/bushel	N cost, $/ pound N								
	0.20	**0.30**	**0.40**	**0.50**	**0.60**	**0.70**	**0.80**	**0.90**	**1.00**
2	150	150	124	0	0	0	0	0	0
3	150	150	150	150	124	41	0	0	0
4	150	150	150	150	150	150	124	62	0
5	150	150	150	150	150	150	150	150	124
6	150	150	150	150	150	150	150	150	150
7	150	150	150	150	150	150	150	150	150
8	150	150	150	150	150	150	150	150	150
9	150	150	150	150	150	150	150	150	150
10	150	150	150	150	150	150	150	150	150

Table 9-7. Corn N recommendations for irrigated soils, considering maximum return to N using corn N price and N cost. This is the total amount for the season, which includes several split-N applications.

Corn Price, $/bushel	N cost, $/ pound N								
	0.20	**0.30**	**0.40**	**0.50**	**0.60**	**0.70**	**0.80**	**0.90**	**1.00**
2	255	241	228	215	201	188	175	162	149
3	263	254	245	237	228	219	210	201	194
4	268	262	256	250	244	238	232	226	220
5	272	267	262	257	252	247	242	237	232
6	273	268	263	258	253	248	243	238	233
7	274	269	264	259	254	249	244	239	234
8	275	270	265	260	255	250	245	240	235
9	276	271	266	261	256	251	246	241	236
10	277	272	267	262	257	252	247	242	237

Table 9-8. Corn recommendations, West River, nonirrigated, pounds P_2O_5.

Olsen Soil Test Phosphorus, ppm				
VL	L	M	H	VH
0-3	4-7	8-11	12-15	16+
78	52	39	26	10

Table 9-9. Corn P recommendations, East River, nonirrigated, pounds P_2O_5 per acre.

Olsen Soil Test Phosphorus, ppm				
VL	L	M	H	VH
0-3	4-7	8-11	12-15	16+
104	78	52	39	10

*Rate in conventional till is 0. Use the 60-lb K_2O rate for no-till/ridge till.

Table 9-10. Corn P recommendations, irrigated, pounds P_2O_5 per acre.

Olsen Soil Test Phosphorus, ppm				
VL	L	M	H	VH
0-3	4-7	8-11	12-15	16+
104	78	52	39	10

Table 9-11. Potassium recommendations for corn in soils with clay chemistry having a smectite-to-illite ratio greater than 3:5 and soil test K levels 150 ppm or less.

Corn price, $ per bushel	Price per pound K_2O, $ per pound									
	0.125	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
	Recommended pounds K_2O per acre									
2	90	90	90	90	60	60	0	0	0	0
3	90	90	90	90	60	60	60	60	60	0
4	90	90	90	90	90	90	90	90	90	60
5	90	90	90	90	90	90	90	90	90	90
6	120	120	120	120	90	90	90	90	90	90
7	120	120	120	120	120	120	120	120	120	90
8	120	120	120	120	120	120	120	120	120	120
9	120	120	120	120	120	120	120	120	120	120
10	120	120	120	120	120	120	120	120	120	120

Table 9-12. Potassium recommendations for corn in soils with clay chemistry having a smectite-to-illite ratio greater than 3:5 and soil test K levels from 151 to 199 ppm.

Corn price, $ per bushel	Price per pound K_2O, $ per pound									
	0.125	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
	Recommended pounds K_2O per acre									
2	90	90	60	60	60	0	0	0	0	0
3	90	90	90	90	60	60	60	0	0	0
4	90	90	90	90	90	90	90	60	60	0
5	90	90	90	90	90	90	90	90	90	60
6	120	120	120	120	90	90	90	90	90	90
7	120	120	120	120	120	120	120	120	120	90
8	120	120	120	120	120	120	120	120	120	120
9	120	120	120	120	120	120	120	120	120	120
10	120	120	120	120	120	120	120	120	120	120

Table 9-13. Potassium recommendations for corn in soils with clay chemistry having a smectite-to-illite ratio less than 3:5 and soil test K levels 100 ppm or less.

Corn price, $ per bushel	Price per pound K_2O, $ per pound									
	0.125	**0.20**	**0.30**	**0.40**	**0.50**	**0.60**	**0.70**	**0.80**	**0.90**	**1.00**
	Recommended pounds K_2O per acre									
2	90	90	90	90	60	60	0	0	0	0
3	90	90	90	90	60	60	60	60	60	0
4	90	90	90	90	90	90	90	90	90	60
5	90	90	90	90	90	90	90	90	90	90
6	120	120	120	120	90	90	90	90	90	90
7	120	120	120	120	120	120	120	120	120	90
8	120	120	120	120	120	120	120	120	120	120
9	120	120	120	120	120	120	120	120	120	120
10	120	120	120	120	120	120	120	120	120	120

Table 9-14. Potassium recommendations for corn in soils with clay chemistry having a smectite-to-illite ratio less than 3:5 and soil test K levels from 101 to 149 ppm.

Corn price, $ per bushel	Price per pound K_2O, $ per pound									
	0.125	**0.20**	**0.30**	**0.40**	**0.50**	**0.60**	**0.70**	**0.80**	**0.90**	**1.00**
	Recommended pounds K_2O per acre									
2	90	90	60	60	60	0	0	0	0	0
3	90	90	90	90	60	60	60	0	0	0
4	90	90	90	90	90	90	90	60	60	0
5	90	90	90	90	90	90	90	90	90	60
6	120	120	120	120	90	90	90	90	90	90
7	120	120	120	120	120	120	120	120	120	90
8	120	120	120	120	120	120	120	120	120	120
9	120	120	120	120	120	120	120	120	120	120
10	120	120	120	120	120	120	120	120	120	120

Table 10-1. Sweet corn P and K recommendations, pounds P_2O_5 and K_2O per acre. Smectite-to-illite ratio less than 3.5 (see Figure 3).

Total available N**, pounds per acre	Soil Test P, ppm					Soil Test K, ppm				
	VL	**L**	**M**	**H**	**VH**	**VL**	**L**	**M**	**H**	**VH**
	0-3	**4-7**	**8-11**	**12-15**	**16+**	**0-40**	**41-80**	**81-120**	**121-150**	**151+**
	Pounds P_2O_5 per acre					**Pounds K_2O per acre**				
150	78	60	52	26	0	120	120	90	60	0

Table 10-2. Sweet corn P and K recommendations, pounds P_2O_5 and K_2O per acre. Smectite-to-illite ratio greater than 3.5 (see Figure 3).

Total available N**, pounds per acre	Soil Test P, ppm					Soil Test K, ppm				
	VL	**L**	**M**	**H**	**VH**	**VL**	**L**	**M**	**H**	**VH**
	0-3	**4-7**	**8-11**	**12-15**	**16+**	**0-80**	**80-120**	**121-150**	**151-200**	**201+**
	Pounds P_2O_5 per acre					**Pounds K_2O per acre**				
150	78	60	52	26	0	120	120	90	60	0

Table 11. Dry bean (pinto, navy, other).

Soil N plus fertilizer N required lb/a -2'	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
	---------- lb P_2O_5/acre ----------					---------- lb K_2O/acre ----------				
See below	45	30	20	10	0	50	20	0	0	0

Nitrogen recommendation =
Irrigated sands (0.05 x cultivar yield expected) - STN – PCC
Dryland - Inoculated 40 pounds of N/acre – STN - PCC
Non-inoculated 70 pounds of N/acre – STN - PCC

Phosphorus and potassium responses are not yield potential-based but are related to soil test levels for any yield potential.

Table 12. Flax.

Total N * recommended	Soil Test Potassium, ppm				
	VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
	---------- K_2O, lb/acre ----------				
80	77	54	32	10	0

* Total N includes soil test nitrate-N to 2 feet in depth, previous crop N credits, long-term no-till N credit of 30 pounds of N/acre if field has been in no-till continuously for six years or more, and supplemental fertilizer N. Fertilizer P application will not result in economic benefit for flax growers.

Table 13. Forage/hay grasses, established grass, irrigated hay grasses, new seedings.

Total N* Recommended	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 150+
50	40	26	12	0	0	60	60	30	0	0

* Total N includes soil test N to 2 feet in depth, previous crop N credits and supplemental fertilizer N.

Table 14. Millet.

Total N* Recommended	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 150+
80	40	30	20	20	0	60	60	30	30	0

* Total N includes soil test N to 2 feet in depth, previous crop N credits and supplemental fertilizer N, and a 30-pound N/acre N credit for fields in six years or more continuous no-till systems.

Table 15. Mustard.

Total N* Recommended	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 150+
	---------- lb P_2O_5/acre ----------					---------- lb K_2O/acre ----------				
150	60	40	25	15	0	60	45	30	15	0

* Total N includes soil test N to 2 feet in depth, previous crop N credits and supplemental fertilizer N, and a 30-pound N/acre N credit for fields in six years or more continuous no-till systems.

Table 16. Oat.

Total N* Recommended	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 150+
120	60	45	30	20	0	90	60	45	15	0

* Total N includes soil test N to 2 feet in depth, previous crop N credits and supplemental fertilizer N, and a 30-pound N/acre N credit for fields in six years or more continuous no-till systems.

Table 17. Pea, field, lentil and chickpea.

Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
VL	L	M	H	VH	VL	L	M	H	VH
0-3	4-7	8-11	12-15	16+	0-40	41-80	81-120	121-150	150+
40	30	20	15	0	60	45	30	15	0

Inoculation is necessary with proper Rhizobium bacteria.

Table 18-1. Full-season Harvest Potato, Dryland.

Total N* Recommended lb N/acre
Reds 140±20
Russets and whites 170 ± 20

* Total N includes soil test N to 2 feet in depth, previous crop N credits and supplemental fertilizer N, and a 30-pound N/acre N credit for fields in six years or more continuous no-till systems.

Table 18.2. Irrigated potato N, requirements based on variety and date of vine-kill.

Vine kill dates	Varieties	N, lb/a *
Early season fresh market Vine kill before July 25, less than 90 days after planting	Norland, Red Norland, Dark Red Norland, Yukon Gold	160 ± 10
Midseason fresh market Vine kill between July 25 and Aug. 26, 90-120 days after planting	Midseason fresh market and processing varieties include Norkotah Russet, Gold Rush, Ranger Russet, Ivory Russet, Snowden, Atlantic, Dakota Pearl and Ivory Crisp. Also Alturas (N efficient variety)	200 ± 10
Late-season, fresh market and processing, Vine kill after Aug. 26, more than 120 days after planting	Russet Burbank and Umatilla	240 ± 10

* Total of soil test N to 2 feet in depth, previous crop credits if any and fertilizer N applied.

Table 18.3. Recommended P_2O_5 to apply for potato production in North Dakota.

Vine kill dates	Olsen Soil Test P, ppm							
	0-3	4-7	8-11	12-15	16-18	19-22	23-41	42+
Irrigated	P_2O_5 to apply, lb/acre							
Before July 25, less than 90 days after planting*	125	100	75	50	50	50	50	50
Between July 25 and Aug. 26, 90-120 days after planting†	150	125	100	75	75	75	75	75
more than 120 days after planting	175	150	125	100	100	100	100	100
Dryland Reds	150	125	100	75	75	75	75	75
Dryland Russets and Whites	175	150	125	100	100	100	100	100

*Early fresh market varieties include Norland, Red Norland, Dark Red Norland and Yukon Gold.

†Midseason fresh market and processing varieties include Norkotah Russet, Gold Rush, Ranger Russet, Ivory Russet, Snowden, Atlantic, Dakota Pearl and Ivory Crisp.

‡Late-season irrigated varieties included Russet Burbank and Umatilla and Alturas.

Table 18.4. Recommended K_2O to apply for potato production in North Dakota.

Vine kill dates, Production category		K Soil Test, ppm					
		0-40	41-80	81-120	121-150	151-200	200+
Irrigated		K_2O to apply, lb/acre					
Before July 25, less than 90 days after planting*		200	100	75	50	25	20
Between July 25 and Aug. 26, 90-120 days after planting†		300	200	100	75	50	25
more than120 days after planting‡		400	300	200	100	75	50
Dryland	Clay ¶Ratio	K_2O to apply, lb/acre					
Reds	S/I Ratio > 3.5	400	300	200	100	75	50
	S/I Ratio < 3.5	300	200	100	75	50	25
Russets and Whites	S/I Ratio > 3.5	400	300	200	100	75	50
	S/I Ratio < 3.5	300	200	100	75	50	25

*Early fresh market varieties include Norland, Red Norland, Dark Red Norland and Yukon Gold.
†Midseason fresh market and processing varieties include Norkotah Russet, Ivory Russet, Snowden, Atlantic, Gold Rush, Ranger Russet, Dakota Pearl and Ivory Crisp.
‡Late-season irrigated varieties included Russet Burbank, Umatilla and Alturas.
¶Clay ratio is smectite-to-illite clay ratio greater than or less than 3.5

Table 19. Rye.

Nitrogen rates

Areas of low productivity (yields below 40 bushels/acre) - Total available N = 100 pounds/acre
Areas of medium productivity (yields 40 to 60 bushels/acre) - Total available N = 150 pounds/acre
Areas of high productivity (yields greater than 60 bushels/acre - Total available N = 200 pounds/acre
(Total available N = soil test nitrate 2 feet + previous crop credit + fertilizer N)

Phosphorus

Low productivity - apply 25 pounds of P_2O_5/acre at seeding with the seed up to an Olsen soil test of 15 ppm.
Medium and high productivity - apply 40 pounds of P_2O_5 at seeding with the seed up to an Olsen soil test of 15 ppm.

Potassium

All productive ranges - apply 50 pounds/acre 0-0-60 (30 pounds/acre K_2O) if soil test K is less than 100 ppm.

Table 20. Safflower.

Total N* Recommended	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 150+
80	40	30	20	20	0	60	60	30	30	0

* Total N includes soil test N to 2 feet in depth, previous crop N credits and supplemental fertilizer N, and a 30-pound N/acre N credit for fields in six years or more continuous no-till systems.

Table 21. Sorghum, forage and sudangrass.

Total N* Recommended	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 150+
	lbs/acre P_2O_5					lbs/acre K_2O				
120	70	50	30	11	0	120	120	90	60	0

* Total N includes soil test N to 2 feet in depth, previous crop N credits and supplemental fertilizer N, and a 30-pound N/acre N credit for fields in six years or more continuous no-till systems.

Table 22. Sorghum, grain.

Total N* Recommended	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 150+
	lbs/acre P_2O_5					lbs/acre K_2O				
120	65	52	39	26	0	120	90	60	30	0

* Total N includes soil test N to 2 feet in depth, previous crop N credits and supplemental fertilizer N, and a 30-pound N/acre N credit for fields in six years or more continuous no-till systems.

Table 23. Soybean.

Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
VL	L	M	H	VH	VL	L	M	H	VH
0-3	4-7	8-11	12-15	16+	0-40	41-80	81-120	121-150	150+
-------------------- lbs/acre P_2O_5--------------------					-------------------- lbs/acre K_2O --------------------				
78	52	52	26	0	90	90	60	30	0

Table 24. Sugar beet

Soil N plus supplemental N	Olsen Phosphorus Soil Test 0-6 inch core, ppm					Potassium Soil Test soil test, 0-6 inch core, ppm				
	VL	L	M	H	VH	VL	L	M*	H**	VH
100 lb N, 2 foot core	0-3	4-7	8-11	12-15	16+	0-40	41-80	81-120	121-160	161+
	Broadcast rate P_2O_5, lb/a					**K_2O, lb/a**				
130 lb N, 4 foot core	80	55	35	10	0	120	90/120†	50/90	0/60	0

* 120 ppm is critical K value for soils with smectite-to-illite ratio 3.5 or less (Figure 3).
** 160 ppm is critical K value for soils with smectite-to-illite ratio greater than 3.5.
†In divided K rate, small number is for soils with smectite-to-illite ratio 3.5 or less; larger number is rate for soils with smectite-to-illite ratio greater than 3.5.

Tables 25-1 through 25-3. Sunflower.
See Figure 2 for map of regions. Also, see web-based N calculator at *www.ndsu.edu/pubweb/soils/sunflower/*, or download the N calculator app for iPhones and Androids. Search for North Dakota N calculator and follow the download instructions.

Table 25-1. Eastern conventional till oil-seed sunflower N recommendations based on N cost and sunflower price. For confection sunflower N rate, add 10 pounds N per acre to these values except to zero values.

Sunflower Seed Price	N cost, $ per pound								
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$ per pound	Total Known Available N, pounds per acre*								
0.09	150	135	124	111	96	84	72	59	47
0.12	150	145	135	125	116	106	96	87	78
0.15	150	150	143	135	127	119	112	104	96
0.18	150	150	148	141	135	128	126	115	109
0.21	150	150	150	146	141	135	129	124	118
0.24	150	150	150	150	145	140	135	130	125
0.27	150	150	150	150	148	144	139	135	131
0.30	150	150	150	150	150	147	143	139	135

* Total known available N includes soil test N to 2 feet, previous crop credit and fertilizer amendment N rate.

Table 25-2. Eastern long-term no-till oil-seed sunflower N recommendations based on N cost and sunflower price. For confection sunflower N rate, add 10 pounds N per acre to these values, except to zero values.

Sunflower Seed Price	N cost, $ per pound								
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$ per pound	Total Known Available N, pounds per acre*								
0.09	84	22	0	0	0	0	0	0	0
0.12	117	68	24	0	0	0	0	0	0
0.15	137	97	61	24	0	0	0	0	0
0.18	150	117	86	55	24	0	0	0	0
0.21	150	132	105	77	50	24	0	0	0
0.24	150	142	119	95	71	47	24	0	0
0.27	150	150	130	108	87	65	44	24	0
0.30	150	150	139	118	99	80	61	42	24

* Total known available N includes soil test N to 2 feet, previous crop credit and fertilizer amendment N rate.

Table 25-3. Western long-term no-till oil-seed and western conventional oil-seed sunflower N recommendations based on N cost and sunflower price. For confection sunflower rate, add 10 pounds N per acre to these values, except to zero values.

Sunflower Seed Price $ per pound	N cost, $ per pound 0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
	Total Known Available N, pounds per acre*								
0.09	126	77	31	0	0	0	0	0	0
0.12	150	115	77	43	0	0	0	0	0
0.15	150	135	106	77	50	22	0	0	0
0.18	150	150	126	101	78	54	31	9	0
0.21	150	150	140	119	98	78	58	38	19
0.24	150	150	150	132	113	95	78	60	43
0.27	150	150	150	142	125	109	93	78	62
0.30	150	150	150	150	135	121	106	92	78

* Total known available N includes soil test N to 2 feet, previous crop credit and fertilizer amendment N rate.

Sunflower - Langdon Area N - Use Table 25-1 and Table 25-2, depending on tillage, and subtract 50 pounds N per acre from the eastern North Dakota N recommendation**.**

Sunflower Phosphorus (P) - No P is required for sunflowers. Adding P will not decrease yield, but neither will it increase yield.

Sunflower Potassium (K) - Apply 100 pounds per acre 0-0-60 potassium fertilizer or equivalent if soil test K is less than 150 ppm.

Sunflower response to S is low, but application after a wet fall/winter/early spring in deep sandy, low-organic-matter soils might be beneficial**.** Sunflower is not responsive to zinc, iron, boron or any other micronutrient in North Dakota.

Tables 26-1 through 26-9. Spring Wheat and Durum Nitrogen Recommendations.
To determine recommended N rate:

1. Find the region of the farm and look up the gross optimal available-N from the appropriate region/productivity table (Tables 27-1 through 27-9).
2. Subtract the soil test nitrate-N from the 0- to 2-foot depth.
3. Subtract any previous crop N credits.
4. Consider whether the field has been in a no-till or one-pass tillage system.
   - If the field has been in no-till less than five continuous years, add 20 pounds of N/acre.
   - If the field has been in no-till five or more continuous years, subtract 50 pounds of N/acre.
5. Make an organic-matter adjustment for soils with greater than 5.9 percent organic matter.
   - For each full percent of organic matter greater than 5 percent, subtract 50 pounds of N/acre.

For easier N rate determination, see the North Dakota Spring Wheat and Durum N Calculator at *www.ndsu.edu/pubweb/soils/wheat/* or download the N calculator app for iPhones and Androids. Search for North Dakota N calculator. Follow download instructions.

The final N rate may be adjusted plus or minus 30 pounds of N/acre due to a host of factors, including varietal protein traits, soil that tends to favor denitrification or leaching losses, excessive straw from the previous year or less than ideal application methods.

Within each region, the productivity is defined.
Productivity category definitions:

Langdon Region
- Low = less than 40 bushels/acre
- Medium = 41 to 60 bushels/acre
- High = greater than 60 bushels/acre

Eastern Region
- Low = less than 40 bushels/acre
- Medium = 41 to 60 bushels/acre
- High = greater than 60 bushels/acre

Western Region
- Low = less than 30 bushels/acre
- Medium = 31 to 50 bushels/acre
- High = greater than 50 bushels/acre

Table 26-1. Spring wheat/durum N recommendations, Langdon region, low productivity.

	Costs cents per pound N								
	20	30	40	50	60	70	80	90	100
Wheat price	-------------------------------------Gross Optimal N--								
$3	100	90	80	70	60	50	40	30	20
$4	110	100	90	80	70	60	50	40	30
$5	120	110	100	90	80	70	60	50	40
$6	120	115	110	100	90	80	75	65	60
$7	120	115	110	100	95	90	80	75	70
$8	120	115	110	105	95	90	85	80	75
$9	120	115	110	105	100	95	90	85	80
$10	120	115	110	110	105	100	95	90	85

Table 26-2. Spring wheat/durum N recommendations, Langdon region, medium productivity.

	Costs cents per pound N								
	20	30	40	50	60	70	80	90	100
Wheat price	-------------------------------------Gross Optimal N--								
$3	130	125	120	115	110	100	80	50	20
$4	135	130	125	120	115	100	90	80	70
$5	140	135	130	125	120	115	100	90	80
$6	140	135	130	125	120	115	105	95	85
$7	140	135	130	125	120	115	110	100	85
$8	140	135	130	130	125	120	115	105	85
$9	140	135	135	130	125	120	115	110	95
$10	140	135	135	130	125	120	115	110	100

Table 26-3. Spring wheat/durum N recommendations, Langdon region, high productivity.

	Costs cents per pound N								
Wheat price	20	30	40	50	60	70	80	90	100
	-------------------------------------Gross Optimal N--								
$3	160	145	130	125	110	100	90	75	40
$4	160	150	140	130	120	110	100	90	80
$5	160	155	150	140	130	120	115	105	100
$6	160	155	150	140	135	125	120	116	110
$7	160	155	150	145	135	130	125	120	115
$8	160	155	150	145	140	135	130	125	120
$9	160	155	150	145	140	135	130	130	125
$10	160	155	150	145	140	140	135	135	130

Table 26-4. Spring wheat/durum N recommendations, eastern, low productivity.

	Costs cents per pound N								
	20	30	40	50	60	70	80	90	100
Wheat price	------------------------------------Gross Optimal N--								
$3	100	90	75	60	0	0	0	0	0
$4	120	100	90	75	40	20	0	0	0
$5	160	140	120	100	90	75	40	20	0
$6	160	145	130	115	100	85	70	20	0
$7	160	150	135	120	105	90	75	40	20
$8	160	150	140	125	110	95	80	65	50
$9	160	150	145	125	115	105	95	85	75
$10	160	155	150	145	140	130	125	115	100

Table 26-5. Spring wheat/durum N recommendations, eastern, medium productivity.

	Costs cents per pound N								
	20	30	40	50	60	70	80	90	100
Wheat price	------------------------------------Gross Optimal N--								
$3	175	160	140	110	20	0	0	0	0
$4	180	165	145	125	100	40	0	0	0
$5	190	180	165	150	135	125	100	75	0
$6	200	190	185	175	160	150	100	75	20
$7	200	190	185	180	170	155	140	125	115
$8	200	190	185	180	175	160	145	130	120
$9	200	195	190	185	175	165	155	140	125
$10	200	200	195	190	180	170	160	145	130

Table 26-6. Spring wheat/durum N recommendations, eastern, high productivity.

	Costs cents per pound N								
	20	30	40	50	60	70	80	90	100
Wheat price	------------------------------------Gross Optimal N--								
$3	250	230	210	190	140	0	0	0	0
$4	250	250	250	240	175	160	100	0	0
$5	250	250	250	250	225	200	150	125	0
$6	250	250	250	250	240	225	160	150	150
$7	250	250	250	250	250	250	210	180	115
$8	250	250	250	250	250	250	250	225	200
$9	250	250	250	250	250	250	250	250	225
$10	250	250	250	250	250	250	250	250	250

Table 26-7. Spring wheat/durum N recommendations, western, low productivity.

	Costs cents per pound N								
	20	30	40	50	60	70	80	90	100
Wheat price	------------------------------------Gross Optimal N--								
$3	100	90	80	70	60	0	0	0	0
$4	120	110	100	90	80	65	50	0	0
$5	120	110	100	90	80	70	60	50	0
$6	120	115	110	105	100	95	90	85	80
$7	120	120	115	110	105	100	100	95	90
$8	120	120	115	115	110	105	105	100	100
$9	120	120	120	120	115	110	110	110	110
$10	120	120	120	120	120	120	120	120	120

Table 26-8. Spring wheat/durum N recommendations, western, medium productivity.

	Costs cents per pound N								
	20	30	40	50	60	70	80	90	100
Wheat price	--------Gross Optimal N--------								
$3	150	150	145	130	115	100	0	0	0
$4	150	150	150	140	125	110	100	0	0
$5	150	150	150	145	130	120	110	100	25
$6	150	150	150	150	140	130	120	110	100
$7	150	150	150	150	150	140	140	130	120
$8	150	150	150	150	150	150	150	145	140
$9	150	150	150	150	150	150	150	150	150
$10	150	150	150	150	150	150	150	150	150

Table 26-9. Spring wheat/durum N recommendations, western, high productivity.

	Costs cents per pound N								
	20	30	40	50	60	70	80	90	100
Wheat price	--------Gross Optimal N--------								
$3	200	190	175	150	135	120	100	0	0
$4	200	190	180	160	150	140	130	120	0
$5	200	195	185	180	175	165	155	140	130
$6	200	200	190	185	180	170	160	150	140
$7	200	200	195	190	185	175	165	155	150
$8	200	200	195	195	190	185	175	170	165
$9	200	200	200	200	190	190	190	190	180
$10	200	200	200	200	200	200	200	200	200

Table 26-10. Broadcast fertilizer phosphate recommendations for North Dakota for spring wheat and durum based on soil test (Olsen).

Soil Test Phosphorus, ppm				
VL	L	M	H	VH
0-3	4-7	8-11	12-15	16+
Pounds P_2O_5/acre				
90	60	35	20	15*

* Wheat seeding always should include a small amount of starter fertilizer in a band regardless of soil test. If starter fertilizer banding is not used, rates in H and VH categories should be zero.

Potassium recommendations for spring wheat and durum

Soils with smectite-to-illite ratio greater than 3.5 (Figure 3)

Soil test K > 150 ppm, no additional K required. KCl (0-0-60-50Cl) may be applied if Cl levels are low.

Soil test K 150 ppm or less, apply 50 pounds/acre KCl (30 pounds/acre K_2O)

Soils with smectite-to-illite ratio 3.5 or less (Figure 3)

Soil test K > 100 ppm, no additional K required. KCl (0-0-60-50Cl) may be applied if Cl levels are low.

Soil test K 100 ppm or less, apply 50 pounds/acre KCl (30 pounds/acre K_2O)

Table 27. Winter wheat.

Nitrogen rates

Areas of low productivity (yields below 40 bushels/acre) - Total available N = 100 pounds/acre
Areas of medium productivity (yields 40 to 60 bushels/acre) - Total available N = 150 pounds/acre
Areas of high productivity (yields greater than 60 bushels/acre - Total available N = 200 pounds/acre
(Total available N = soil test nitrate 2 feet + previous crop credit + fertilizer N)
Also, if growing winter wheat in Langdon Region (see Figure 2), subtract 40 pounds of N/acre.

Broadcast fertilizer phosphate recommendations for North Dakota winter wheat based on Olsen soil test P.

Soil Test Phosphorus, ppm				
VL	L	M	H	VH
0-3	4-7	8-11	12-15	16+
Pounds P_2O_5/acre				
75	50	30	15	15*

* Wheat seeding always should include a small amount of starter fertilizer in a band regardless of soil test.
If starter fertilizer banding is not used, rates in H and VH categories should be zero.

Potassium rates

Soils with smectite-to-illite ratio greater than 3.5 (Figure 3)

Soil test K > 150 ppm, no additional K required. KCl (0-0-60-50Cl) may be applied if Cl levels are low.

Soil test K 150 ppm or less, apply 50 pounds/acre KCl (30 pounds/acre K_2O)

Soils with smectite-to-illite ratio 3.5 or less (Figure 3)

Soil test K > 100 ppm, no additional K required. KCl (0-0-60-50Cl) may be applied if Cl levels are low.

Soil test K 100 ppm or less, apply 50 pounds/acre KCl (30 pounds/acre K_2O)

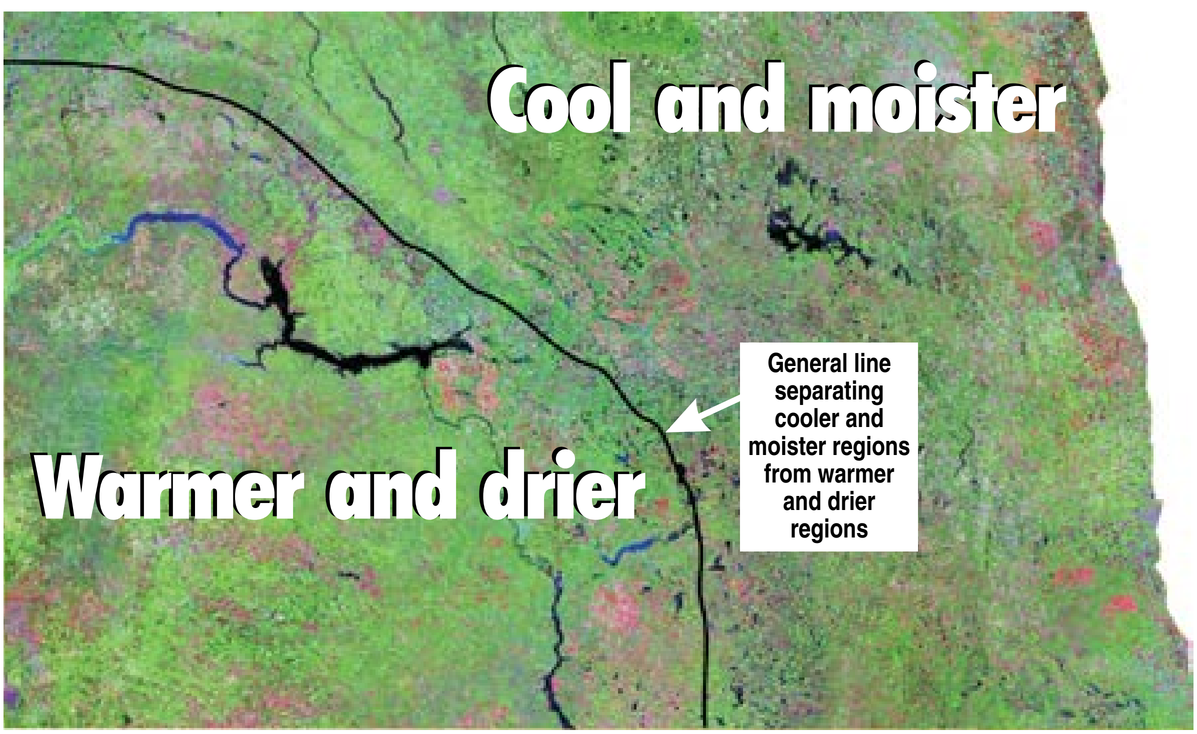

Figure 1.

General climatic delineation between cooler and moister areas in North Dakota compared with warmer and drier areas. In a given year, the line separating the two regions may move considerably east or west.

For use with Tables 1, 4-2 and 6.

(Image courtesy of NASA, Angela King – image compiler, and Hobart King/Geology.com, publisher).

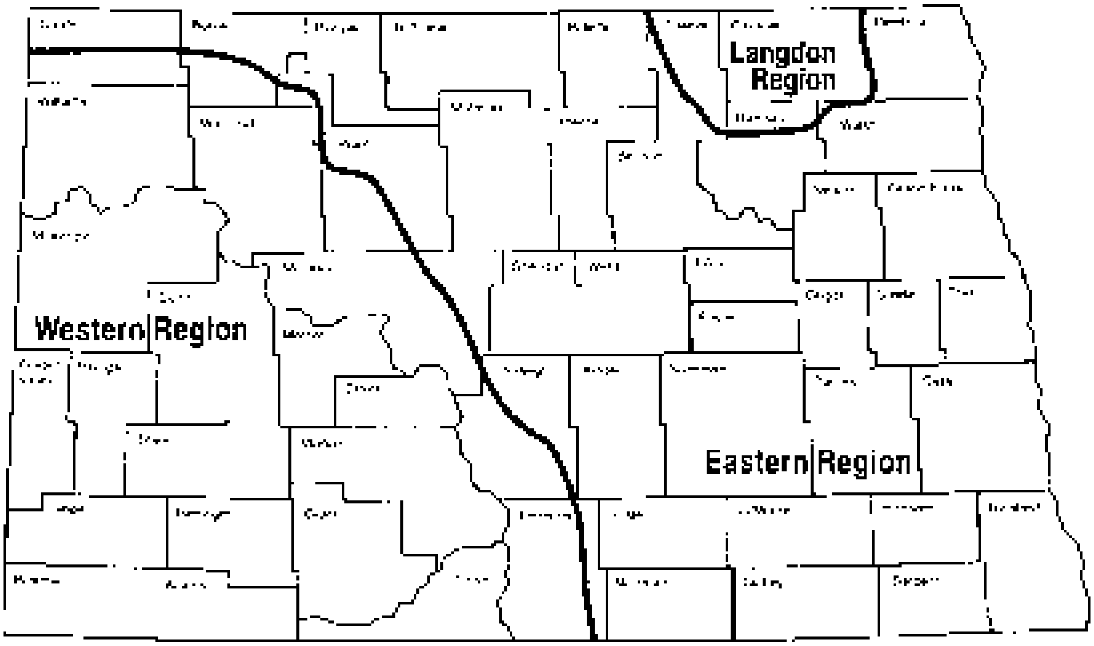

Figure 2.

Agri-climatology regions for use in Tables 25-1 through 25-3 for sunflower and Tables 26-1 through 26-9 for spring wheat and durum N recommendations, and Table 27 for winter wheat considerations.

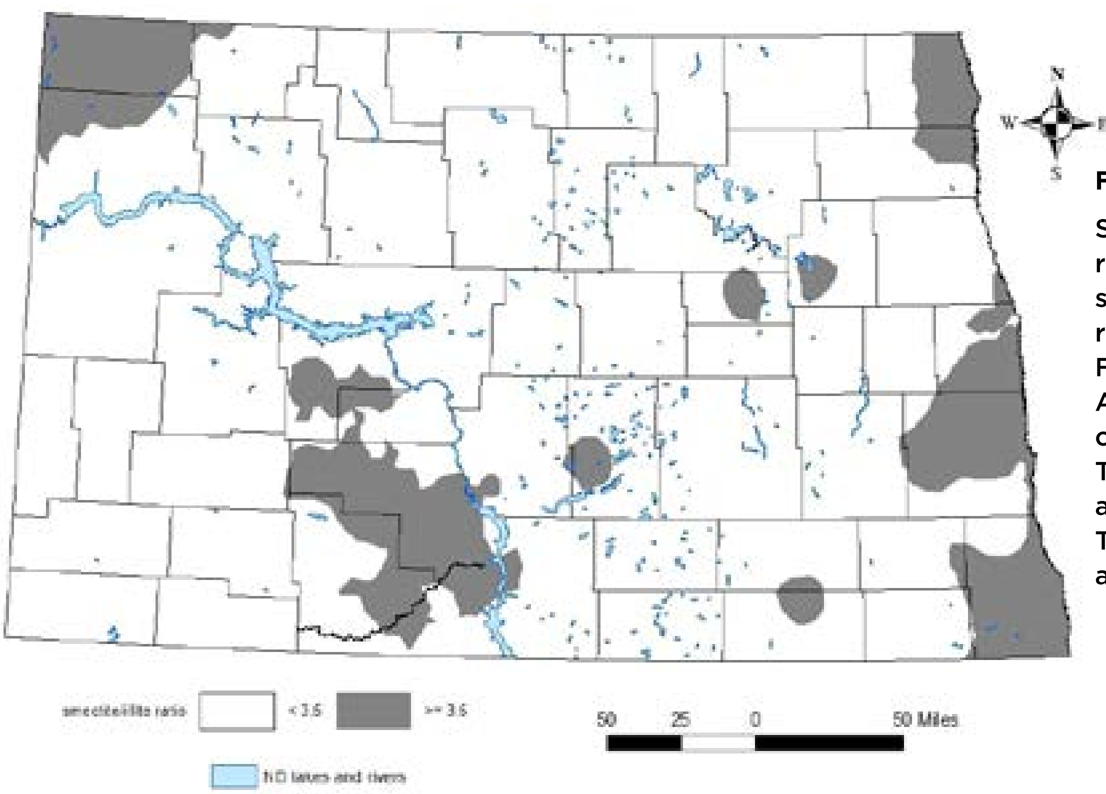

Figure 3.

Smectite-to-illite ratios relevant to alfalfa, corn and sugar beet potassium (K) recommendations in Figures 2-2 and 2-3 for Alfalfa; 9-11 to 9-14 for corn, Table 18.4 for potato, Table 24 for sugar beet and for spring wheat after Table 26-9 and winter wheat after Table 27.

2M-5-07; 2M-12-09; 2M-1-10; 1M-11-13; 500-5-16; web-1-18 web-2-18