SF882 (Revised October 2023)

North Dakota Fertilizer Recommendation Tables

D.W. Franzen
NDSU Extension Soil Specialist

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. For some crops, data from the literature were used to supplement state and regional data.

This publication contains major changes from previous publications. Please dispose of older editions.

Changes to tables from previous editions are based on new or re-evaluated data. The recommendations in this publication, and all NDSU fertilizer recommendations in all individual NDSU crop fertility publications, while based on field research are not to be considered absolute. Fertilizer application and soil management in general should also be guided by common sense and individual grower history of crop nutrient use and resulting successful crop production. These table values are not intended to be used as a basis for law and regulation.

Recommendation Tables

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

Trying to predict a future yield is a poor fertilization strategy. 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 greatest yield regardless of the maximum yield in any one experiment. In other words, the rate of nutrient resulting in the greatest yield in a low-yield environment is similar to the rate that resulted in the greatest yield in a high-yield environment.

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 growing season.

Several of the nitrogen (N) recommendations are “capped” at a maximum rate. In years that support higher yields, 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 rate limits. In addition, sunflower and flax N recommendations are capped due to greater lodging risk as the N rate increases.

NDSU | EXTENSION

North Dakota State Universtiy
Fargo, North Dakota

Nitrogen

Nitrogen (N) recommendations for most crops, except some legumes, include consideration of the amount of nitrate N (NO_3-N) in the top 2 feet of soil. Omission of the 2-foot NO_3-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.**

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 rate 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 the crop.

Spring wheat, durum, corn, sunflower and 2-row malting barley N recommendations include economic modifiers to rate based on an economic production function that combines yield and quality increases or 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 5** indicates a recommendation of 150 pounds N per acre total requirement. The amount of N to apply would be 150 – 55 = 95 pounds N per 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, thus the need for the expected N contribution of the previous crop based on rotational studies.

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 (sugarbeet, 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.

Credits Previous crop	Credit
Soybean	40 lb N/acre
Dry edible bean	40 lb N/acre
Other grain legume crops (field pea, lentil, chickpea)	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
Sugarbeet	
Yellow leaves	0 lb N/acre
Yellow/green leaves	30 lb N/acre
Dark green leaves	80 lb N/acre

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) in North Dakota was based on soil samples taken to a depth of 5 feet. Sampling beyond 2 feet improved N fertilizer recommendations a little, but in the late 1960s, researchers decided that the extra effort to sample to a depth of 3 and 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.

Sugarbeet is the most likely crop to be sampled to the 4-foot depth, but adjustments are not necessary in N calculations. Sugarbeet N recommendations for 2- and 4-foot samplings are provided in **Table 23**. 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 per 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% of the amount greater than 30 pounds/acre. 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% 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-half to one-third depending on the crop when banding with or near the seed. The resulting yields will be similar to the yield using the full rate of broadcast fertilizer.

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. Consult individual soil fertility publications for each crop. For information regarding fertilizer rate limits with the seed in small grains, refer to NDSU Extension publication SF1751, "Fertilizer Application with Small-grain Seed at Planting," available online at *www.ndsu.edu/agriculture/extension/publications/fertilizer-application-small-grain-seed-planting*.

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

SSulfur (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%. 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 non-saline soil in a wet season.

Current S soil tests characterize 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 per acre for small grains and corn, regardless of landscape position, soil texture or organic matter, may be prudent. Since 2014, serious S deficiency has appeared in many small grain and corn fields. 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 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 the malting industry. 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% 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 are also 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% organic matter in deep sandy soils, such as an eroded Arvilla loamy sand found in Red River Valley beach-ridge 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 that tests 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. 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

The supply of soluble iron (Fe) to plants from soil in the region is related to the soil carbonate level. 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) in soybean.

Most North Dakota crops are not sensitive to low available soil iron and are adapted to regional high pH, free soil carbonate conditions. However, IDC has been seen in flax, field pea and dry bean, and IDC 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. Recent studies in North Dakota have been conducted using FeHBED chelate, and positive results using this chelate have been noted.

Other Fe fertilizers, including ortho-para-FeEDDHA, are far less effective. Yield increases with ortho-ortho-FeEDDHA also have been seen in sugarbeet 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. NDSU researchers 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. Manganese is much more soluble at pH less than 5. Manganese toxicity in canola in pH about 4.5 has been observed in the state.

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% 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	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				
		pounds per acre				
Nitrogen (N)	H_2O Extract	See tables				
Sulfur (S), lb/a-2 feet‡	Monocalcium phosphate	no categories				
Chloride (Cl), lb/a-2 feet¶	H_2O Extract	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 sugarbeet. 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%. Response to copper is not common. Responses have been found only in 15% 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, five soil-test calibration categories 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%.

Low (L) - Crops growing on fields in this category will respond to applied nutrient 50% to 80% of the time.

Medium (M) - The probability of getting a response to applied nutrient is 20% to 50%.

High (H) - In this category, crops will respond to applied nutrient about 10% to 20% of the time.

Very High (VH) - The probability of getting a response to applied nutrient is less than 10%.

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	12-15	16+
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 removed.

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 3-1. Barley, feed, under conventional till management.

	Olsen Soil Test P, ppm					Soil Test K, ppm				
Total available N*, pounds per acre	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 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 3-2. Barley, feed, in no-till systems.

	Soil Test P, ppm					Soil Test K, ppm				
Total available N*, pounds per acre	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 151+
	Pounds P_2O_5 per acre					Pounds K_2O per acre				
120	78	60	52	26	0	90	60	45	30	0

Table 3-3. Barley, malting grade, P and K recommendations in North Dakota*.

Soil Test P, ppm					Soil Test K, 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 151+
Pounds P_2O_5 per acre					Pounds K_2O per acre				
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 3-4. Malting 2-row barley, western region, conventional tillage, economic N rates with N cost and barley price. Subtract 50 pounds N per acre if the field is long-term no-till.

	Cost of N, $/pound N																		
$/bu	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
3	140	130	120	112	103	94	84	74	65	55	46	38	28	19	10	0	0	0	0
4	144	137	131	124	117	110	102	96	89	82	75	68	61	54	47	40	32	26	19
5	147	142	136	131	125	120	114	108	102	97	92	86	81	75	69	64	58	53	47
6	149	144	140	135	131	126	121	117	112	109	103	98	94	89	84	80	75	70	65
7	150	146	143	138	135	131	127	123	119	115	111	107	103	99	95	91	87	83	79
8	151	148	144	141	137	135	132	127	124	120	117	113	110	106	103	99	96	92	89
9	152	149	146	143	140	137	134	131	127	124	121	118	115	112	109	106	103	100	97
10	153	150	147	144	142	139	136	133	131	128	125	123	119	119	114	111	108	106	103

Table 3-5. Malting 2-row barley, eastern region, conventional tillage, economic N rates with N cost and barley price. Subtract 50 pounds N per acre if the field is long-term no-till.

	Cost of N, $/pound N																		
$/bu	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
3	145	138	131	125	117	110	104	97	89	82	75	68	61	54	46	40	33	26	19
4	148	144	137	132	127	122	117	111	106	101	96	91	85	80	75	70	65	59	54
5	150	146	142	137	133	129	125	121	117	112	108	104	100	96	92	87	83	79	75
6	151	148	144	141	137	134	131	127	124	120	117	113	110	106	103	99	96	92	89
7	152	149	146	146	140	137	135	132	129	126	123	120	117	114	111	108	105	102	99
8	153	151	148	148	143	140	137	135	132	130	127	124	122	119	117	114	111	109	106
9	154	152	149	149	144	142	140	137	135	133	131	128	126	124	121	120	117	114	112
10	154	152	150	150	146	144	142	140	137	135	133	131	131	127	125	123	121	119	117

Table 3-6. Malting 2-row barley, Langdon area, conventional tillage, economic N rates with N cost and barley price. Subtract 50 pounds N per acre if the field is long-term no-till.

	Cost of N, $/pound N																		
$/bu	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
3	115	108	101	95	87	80	84	67	59	52	45	38	31	24	46	10	0	0	0
4	118	114	107	102	97	92	87	81	76	71	66	61	55	50	45	40	35	29	24
5	120	116	112	107	103	99	95	91	87	82	78	74	70	66	62	57	53	49	45
6	121	118	114	111	107	104	101	97	94	90	87	83	80	76	73	69	66	62	59
7	122	119	116	116	110	107	105	102	99	96	93	90	8/7	84	81	78	75	72	69
8	123	121	118	118	113	110	107	105	102	100	97	94	92	89	87	84	81	79	76
9	124	122	119	119	114	112	110	107	105	103	101	98	96	94	91	90	87	84	82
10	124	122	120	120	116	114	112	110	107	105	103	101	101	97	95	93	91	89	87

Table 4. Buckwheat.

	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+
N rate, lb/acre	lb P_2O_5/acre					lb K_2O/acre			
80*	40	30	20	10	0	60	40	30	10

*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 5. Canola. Nitrogen rates include soil test nitrate-N to 2 feet in depth and previous crop N credits. If long-term (6 years or more continuous), subtract 30 pounds N per acre.

	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
Soil N plus fertilizer	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+
N	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 Extension publication SF1122 for more details.

Table 6. Clover (Alsike, Red, Birdsfoot Trefoil or a grass-legume hay mix).

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

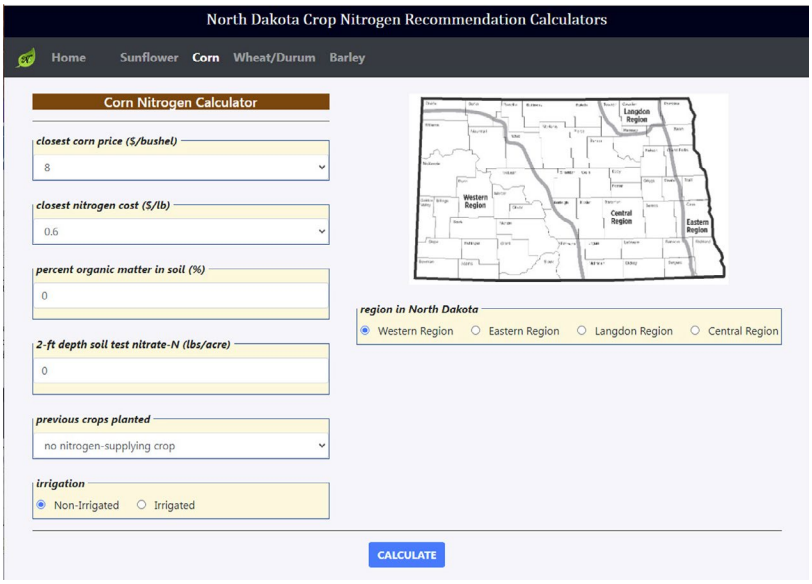
Inoculation is required at seeding with proper rhizobium culture.

Table 7. Corn for silage.

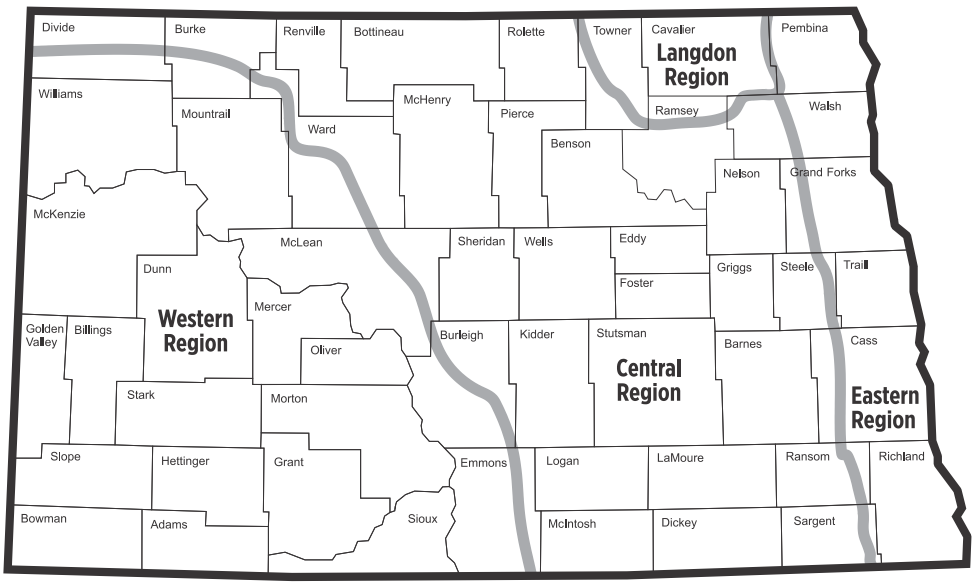
	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
	VL	L	M	H	VH	VL	L	M	H	VH
	0-3	4-7	8-11	12-15	16+	0-40	41-80	81-120	121-150	151+
N* recommended	lb P_2O_5/acre					lb/acre K_2O				
180	90	70	40	20	0	120	120	90	60	0

*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.

For a simpler method to determine N rates for corn, see the North Dakota Corn N calculator at www.ndsu.edu/pubweb/soils/N_calculators/. 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.



Map of North Dakota relating to N recommendations by region.



Tables 8-1 through 8-14. Corn for grain.

Table 8-1. Corn N recommendations for West River soils, considering maximum return to N using corn N price and N cost. Assumes long-term no-till.

Corn $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
2	150	125	100	80	60	30	16	0	0	0	0	0	0	0	0	0	0	0	0
3	182	159	135	111	87	63	40	16	0	0	0	0	0	0	0	0	0	0	0
4	195	176	159	139	124	106	87	70	51	33	16	0	0	0	0	0	0	0	0
5	201	187	173	159	144	130	116	101	87	73	60	44	30	16	0	0	0	0	0
6	206	194	182	170	159	147	135	123	111	99	87	75	63	51	40	28	16	0	0
7	210	199	189	179	169	159	148	138	128	118	107	97	87	77	67	57	46	36	26
8	212	203	194	186	176	167	159	150	141	132	123	114	105	96	87	78	69	60	51
9	214	206	198	191	182	174	166	159	151	143	135	127	119	111	103	95	87	79	71
10	216	209	201	194	187	180	173	166	159	151	144	137	130	123	116	109	101	94	87
11	217	210	204	197	191	184	178	172	165	158	152	145	139	133	126	120	113	107	100
12	218	212	206	200	194	188	184	176	170	164	159	153	147	141	135	129	123	117	111

Table 8-2. Corn N recommendations for eastern and central region long-term no-till soils, considering maximum return to N using corn N price and N cost.

Corn $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
2	173	147	121	95	70	42	17	0	0	0	0	0	0	0	0	0	0	0	0
3	190	172	155	136	120	102	85	68	50	33	16	0	0	0	0	0	0	0	0
4	200	187	173	161	148	134	121	108	95	82	69	55	44	31	17	0	0	0	0
5	205	197	184	173	162	152	142	135	122	110	100	90	79	69	58	48	37	27	18
6	210	202	191	184	173	163	156	147	138	131	121	112	103	96	87	78	70	61	52
7	212	204	197	190	182	173	165	158	151	143	136	128	121	113	106	99	91	84	77
8	214	206	201	194	188	181	174	167	161	154	147	141	135	127	121	114	108	102	95
9	215	209	203	195	192	183	181	173	167	162	157	151	145	138	133	128	122	116	110
10	217	210	205	198	195	188	184	179	174	169	163	158	152	147	142	137	131	126	121
11	218	212	207	203	198	193	189	184	178	174	169	164	160	154	149	144	140	135	130
12	218	213	209	204	201	196	191	187	183	179	173	169	164	161	156	151	147	143	138

Table 8-3. Corn N recommendation table for the central region of North Dakota, considering maximum return to N using corn N price and N cost.

Corn $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
2	214	179	147	114	79	46	13	0	0	0	0	0	0	0	0	0	0	0	0
3	238	214	192	170	148	125	103	81	62	37	14	0	0	0	0	0	0	0	0
4	248	232	213	197	180	163	147	130	113	97	80	63	47	30	13	0	0	0	0
5	250	241	226	213	200	186	173	160	146	133	119	106	94	81	67	53	40	26	13
6	250	248	237	224	213	202	191	180	169	158	147	136	124	113	192	91	80	69	58
7	250	250	243	233	223	212	203	194	185	175	166	157	146	137	128	118	109	99	90
8	250	250	248	239	231	222	213	207	197	188	180	172	163	155	147	138	130	122	113
9	250	250	250	244	237	229	221	213	206	198	191	184	176	169	161	154	146	139	132
10	250	250	250	248	241	234	228	222	213	207	201	193	187	182	173	167	160	153	147
11	250	250	250	250	245	239	232	225	219	213	207	201	195	189	183	177	171	165	159
12	250	250	250	250	248	242	237	213	224	219	213	208	202	197	191	186	180	174	169

Table 8-4. Corn N recommendation table for the Langdon region of North Dakota, considering maximum return to N using corn N price and N cost.

Corn $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
2	184	149	117	84	49	16	0	0	0	0	0	0	0	0	0	0	0	0	0
3	208	184	162	130	118	95	73	51	32	0	0	0	0	0	0	0	0	0	0
4	218	202	183	167	150	133	117	100	83	67	50	33	17	0	0	0	0	0	0
5	220	211	196	183	170	156	143	130	116	103	89	76	64	51	37	23	10	0	0
6	220	218	207	194	183	172	161	150	139	128	117	106	94	83	72	61	50	39	28
7	220	220	213	203	193	182	173	164	155	145	136	127	116	107	98	88	79	69	60
8	220	220	218	209	201	192	183	177	167	158	150	142	133	125	117	108	100	92	83
9	220	220	220	214	207	199	191	183	176	168	161	154	146	139	131	124	116	109	102
10	220	220	220	218	211	204	198	192	183	177	171	163	157	152	143	137	130	123	117
11	220	220	220	220	215	209	202	195	189	183	177	171	165	159	153	147	141	135	129
12	220	220	220	220	220	212	207	201	194	189	183	178	172	167	161	156	150	144	139

Table 8-5. Corn N recommendation table for long-term no-till fields in the Langdon region of North Dakota, considering maximum return to N using corn N price and N cost.

Corn $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
2	144	109	77	44	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	168	144	122	90	78	55	33	11	0	0	0	0	0	0	0	0	0	0	0
4	178	162	143	127	110	93	77	60	43	27	10	0	0	0	0	0	0	0	0
5	180	171	156	143	120	116	103	90	76	63	49	36	24	11	0	0	0	0	0
6	180	178	167	154	143	132	121	110	99	88	77	66	54	43	32	21	10	0	0
7	180	180	173	163	153	142	133	124	115	105	96	87	76	67	58	48	39	29	20
8	180	180	178	169	161	152	143	137	127	118	110	102	93	85	77	68	60	52	43
9	180	180	180	174	167	159	151	143	136	128	121	114	106	99	91	84	76	69	62
10	180	180	180	178	171	164	158	152	143	137	131	123	117	112	103	97	90	83	77
11	180	180	180	180	175	169	162	155	149	143	137	131	125	119	113	107	101	95	89
12	180	180	180	180	180	172	167	161	154	149	143	138	132	127	121	116	110	104	99

Table 8-6. Corn N recommendation table for eastern high-clay soils with low risk of early-season N loss, considering maximum return to N using corn N price and N cost.

Corn $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
2	250	223	196	168	140	124	85	57	29	0	0	0	0	0	0	0	0	0	0
3	250	234	206	187	169	150	132	113	95	75	58	39	21	0	0	0	0	0	0
4	250	250	226	211	197	183	169	155	141	127	113	99	86	72	58	44	30	16	0
5	250	250	250	224	213	202	191	180	169	158	147	136	124	113	102	91	80	69	58
6	250	250	250	235	224	215	206	197	187	178	169	160	150	141	132	124	113	104	95
7	250	250	250	241	233	224	217	209	201	193	185	177	169	161	153	145	137	129	121
8	250	250	250	246	239	232	224	217	210	204	197	190	183	176	169	162	155	148	141
9	250	250	250	250	244	238	232	224	218	212	206	200	194	187	181	175	169	163	157
10	250	250	250	250	250	242	237	231	224	219	213	208	202	197	191	186	180	174	169
11	250	250	250	250	250	246	241	236	230	224	219	214	209	204	199	194	189	184	179
12	250	250	250	250	250	250	244	239	235	230	224	220	215	211	206	201	197	192	187

Table 8-7. Corn N recommendation table for eastern high-clay soils with high risk of early-season N loss, considering maximum return to N using corn N price and N cost.

Corn $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
2	150*	150	150	150	140	124	85	57	29	0	0	0	0	0	0	0	0	0	0
3	150	150	150	150	150	150	132	113	95	75	58	39	21	0	0	0	0	0	0
4	150	150	150	150	150	150	150	150	141	127	113	99	86	72	58	44	30	16	0
5	150	150	150	150	150	150	150	150	150	150	150	136	124	113	102	91	80	69	58
6	150	150	150	150	150	150	150	150	150	150	150	150	150	141	132	124	113	104	95
7	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	145	137	129	121
8	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	148	141
9	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
10	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
11	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
12	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150

* The 150 pound N per acre limit on N rate recognizes that increasing rate is not the way to achieve higher yields in these soils. When a split N application is used (side-dress), use Table 8-6 for the total rate of preplant plus side-dress.

Table 8-8. Corn N recommendation table for eastern medium-textured soils with low risk of early season N loss, considering maximum return to N using corn N price and N cost.

Corn $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
2	231	226	161	126	92	57	22	0	0	0	0	0	0	0	0	0	0	0	0
3	250	232	207	184	161	138	115	92	68	45	22	0	0	0	0	0	0	0	0
4	250	250	232	213	196	178	161	144	126	111	92	74	57	41	22	0	0	0	0
5	250	250	245	232	216	203	189	175	161	147	133	119	106	92	78	64	50	36	22
6	250	250	250	243	232	219	207	196	184	173	161	150	138	126	115	103	92	80	69
7	250	250	250	250	241	232	221	211	201	191	181	171	161	151	141	131	121	111	102
8	250	250	250	250	250	241	232	222	213	204	196	187	178	170	161	152	144	135	126
9	250	250	250	250	250	250	239	232	223	215	207	200	192	184	176	169	161	153	146
10	250	250	250	250	250	250	245	238	232	226	217	210	203	196	189	182	175	168	161
11	250	250	250	250	250	250	250	244	238	232	226	218	212	207	199	193	186	180	174
12	250	250	250	250	250	250	250	250	243	237	232	226	219	213	207	202	196	190	184

Table 8-9. Corn N recommendation table for eastern medium-textured soils with high risk for early season N loss, considering maximum return to N using corn N price and N cost.

Corn $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
2	150*	150	150	126	92	57	22	0	0	0	0	0	0	0	0	0	0	0	0
3	150	150	150	150	150	138	115	92	68	45	22	0	0	0	0	0	0	0	0
4	150	150	150	150	150	150	150	144	126	111	92	74	57	41	22	0	0	0	0
5	150	150	150	150	150	150	150	150	150	147	133	119	106	92	78	64	50	36	22
6	150	150	150	150	150	150	150	150	150	150	150	150	138	126	115	103	92	80	69
7	150	150	150	150	150	150	150	150	150	150	150	150	150	150	141	131	121	111	102
8	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	144	135	126
9	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	146
10	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
11	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
12	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150

* The 150 pound N per acre limit on N rate recognizes that increasing rate is not the way to achieve higher yields in these soils. When a split N application is used (side-dress), use Table 8-8 for the total rate of preplant plus side-dress.

Table 8-10. Corn N recommendation table for irrigated soils, considering maximum return to N using corn N price and N cost. This is the total N rate for the season, which includes several split-N applications.

Corn $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
2	255	241	228	215	201	188	175	162	149	136	123	109	96	83	70	57	44	30	17
3	263	254	245	237	228	219	210	201	194	184	175	166	158	149	140	131	123	114	105
4	268	262	256	250	244	238	232	226	220	208	201	195	188	183	175	169	162	155	149
5	272	267	262	257	252	247	242	237	232	223	217	212	207	201	196	191	186	180	175
6	273	268	263	258	253	248	243	238	233	230	226	223	219	215	210	206	201	197	193
7	274	269	264	259	254	249	244	239	234	231	227	225	223	221	218	216	213	209	205
8	275	270	265	260	255	250	245	240	235	232	228	226	224	222	219	217	214	210	206
9	276	271	266	261	256	251	246	241	236	233	229	227	225	223	220	218	215	211	207
10	277	272	267	262	257	252	247	242	237	234	230	228	226	224	221	219	216	212	208
11	278	273	268	263	258	253	248	243	238	235	231	229	227	225	222	220	217	213	209
12	279	274	269	264	259	254	249	244	239	236	232	230	228	226	223	221	218	214	210

Table 8-8. Corn P recommendations, West River, non-irrigated, pounds P_2O_5.

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

Table 8-9. Corn P recommendations, East River, non-irrigated, pounds P_2O_5 per acre.

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

Table 8-10. Corn P recommendations, irrigated, pounds P_2O_5 per acre.

Olsen Soil Test Phosphorus, ppm				
VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+
156	104	78	52	26

Table 8-11. 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 8-12. 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 8-13. 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 8-14. 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 9-1. 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).

	Soil Test P, ppm					Soil Test K, ppm				
Total available N**, pounds per acre	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 151+
	Pounds P_2O_5 per acre					Pounds K_2O per acre				
150	78	60	52	26	0	120	120	90	60	0

Table 9-2. 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).

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

**includes nitrate-N to 2 feet in depth, previous crop N credits fertilizer N total and 50 lb N per acre no-till N credit. Subtract another 30 pounds per acre if grown in the Langdon region.

Table 10. Dry bean (pinto, navy, other).

	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
Soil N plus fertilizer N	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/acre K_2O				
See below	45	30	20	10	0	50	20	0	0	0

Nitrogen recommendation =
For irrigated sands - 0.05 X historic yield – STN -PCC
Dryland - Inoculated 40 pounds of N per acre – STN - PCC
Non-inoculated 70 pounds of N per acre – STN - PCC

P and K are related to soil test values and not to yield potential.

Table 11. Flax.

	Soil Test Potassium, ppm				
Total N * recommended	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 12. Forage/hay grasses, established grass, irrigated hay grasses, new seedings.

	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
Total N* Recommended	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+
	Pounds P_2O_5 per acre					Pounds K_2O per acre				
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 13. Millet.

Total N* Recommended	Olsen Soil Test Phosphorus, ppm				Soil Test Potassium, ppm				
	L 0-7	M 8-10	H 11-13	VH 13+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 150+
80	60	40	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 14. 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+
	Pounds P_2O_5 per acre					Pounds K_2O per 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. For long-term no-till (6 years or more continuous), subtract 30 pounds per acre from recommendation. In the Langdon area, subtract 30 pounds N from the recommendation.

Table 15. 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. For long-term no-till (6 years or more continuous), subtract 30 pounds per acre from recommendation. In the Langdon area, subtract 30 pounds N from the recommendation.

Table 16. Pea, field, lentil and chickpea.

Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm	
VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	<100	>100
40	30	20	15	0	30	0

Inoculation is necessary with proper Rhizobium bacteria.

Table 17-1. Full-season Harvest Potato, Dryland.

Total N* 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.

Table 17-2. 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 17-3. Recommended P_2O_5 to apply for potato production in North Dakota.

	Olsen Soil Test P, ppm							
	0-3	4-7	8-11	12-15	16-18	19-22	23-41	42+
Vine kill dates	P_2O_5 to apply, lb/acre							
Irrigated before July 25, less than 90 days after planting*	125	100	75	50	50	50	50	50
Irrigated between July 25 and Aug. 26, 90-120 days after planting†	150	125	100	75	75	75	75	75
Irrigated 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 17-4. Recommended K_2O to apply for potato production in North Dakota.

		K Soil Test, ppm					
		0-40	41-80	81-120	121-150	151-200	200+
Vine kill dates, Production category		K_2O to apply, lb/acre					
Irrigated							
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 than 120 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 18. 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

Apply 25 pounds of P_2O_5 per acre at seeding with the seed up to an Olsen value 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 19. Safflower. Apply P with or near the seed.

	Olsen Soil Test Phosphorus, ppm				Soil Test Potassium, ppm				
Total N* Recommended	VL 0-7	M 8-11	H 12-15	VH 16+	VL 0-40	L 41-80	M 81-120	H 121-150	VH 150+
80	40	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. For long-term no-till fields, subtract a 30-pound N per acre N credit.

Table 20. Sorghum, forage and sudangrass.

	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
Total N* Recommended	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, grain.

	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
Total N* Recommended	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 22. Soybean.

	Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, ppm					
Total N*	VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+	VL/VL 0-40	L/L 41-80	M/M 81-120	H/M 121-150	VH/H 151-200	VH/VH 201+
0	52	26	0	0	0	90/90†	60/90	60/60	30/60	0/60	0/0

† Split K recommendation, left is for soils with smectite-illite ratio < 3.5; right for soils with smectite-illite rate > 3.5

Table 23. Sugarbeet.

	Olsen Phosphorus Soil Test 0-6 inch core, ppm					Potassium Soil Test soil test, 0-6 inch core, ppm				
Total N* Recommended	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+
	Broadcast rate P_2O_5, lb/a					K_2O, lb/a				
100 lb N, 2 foot core	80	55	35	10	0	120	90/120†	50/90	0/60	0
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 24-1 through 24-3. Sunflower.

See Figure 2 for map of regions. Also, see web-based N calculator at https://www.ndsu.edu/pubweb/soils/N_calculators/# or download the N calculator app for iPhones and Androids. Search for North Dakota N calculator and follow the download instructions.

Table 24-1. Eastern conventional till oilseed 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 $ 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	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 24-2. Eastern long-term no-till oilseed 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 $ 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	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 24-3. Western long-term no-till oil-seed and western conventional oilseed 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 24-1 and Table 24-2, 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 25-1 through 25-9. 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 25-1 through 25-9).
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% organic matter.
   - For each full percent of organic matter greater than 5%, subtract 50 pounds of N/acre.

For easier N rate determination, see the North Dakota Spring Wheat and Durum N Calculator at https://www.ndsu.edu/pubweb/soils/N_calculators/#r 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 25-1. Langdon region conventional till low productivity (less than 40 bushels per acre).

Wheat $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
3	112	100	90	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	124	100	100	87	62	37	0	0	0	0	0	0	0	0	0	0	0	0	0
5	132	116	100	100	85	66	47	42	0	0	0	0	0	0	0	0	0	0	0
6	137	123	110	100	99	84	69	52	47	30	14	0	0	0	0	0	0	0	0
7	141	129	117	106	100	97	84	71	57	47	41	22	0	0	0	0	0	0	0
8	143	133	123	113	103	100	94	83	72	60	47	47	16	0	0	0	0	0	0
9	145	136	127	118	109	100	100	93	83	73	63	52	47	40	17	13	0	0	0
10	145	139	131	123	115	107	100	100	91	83	74	65	56	47	35	34	23	11	0
11	145	141	134	126	119	112	104	100	98	90	82	74	66	58	50	47	39	30	20
12	145	145	134	127	125	114	107	100	98	95	89	80	73	65	58	50	45	42	33
13	145	145	136	130	125	117	111	105	98	98	93	87	82	73	66	60	53	47	46
14	145	145	138	132	127	121	115	109	103	98	98	92	86	80	74	67	61	55	48
15	145	145	140	134	129	123	118	112	104	101	98	97	91	86	80	74	68	62	56

Table 25-2. Langdon region conventional till medium productivity (41-60 bushels per acre).

Wheat $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
3	130	125	120	115	110	100	80	50	50	30	20	15	10	0	0	0	0	0	0
4	135	130	125	120	115	100	90	80	70	50	40	30	25	0	0	0	0	0	0
5	140	135	130	125	120	115	100	90	80	60	50	40	35	10	0	0	0	0	0
6	145	140	135	130	120	115	105	95	85	65	60	50	45	25	10	0	0	0	0
7	150	145	140	135	125	120	110	100	95	70	70	60	55	35	30	20	10	0	0
8	155	150	145	140	130	125	115	105	100	80	80	70	65	45	40	30	20	15	0
9	160	155	150	145	135	130	120	110	105	90	90	80	75	55	50	40	30	25	10
10	165	160	155	150	145	135	125	120	110	100	95	85	80	65	60	50	40	35	20
11	175	170	165	155	150	140	130	125	115	110	100	90	85	75	65	60	50	40	30
12	178	171	165	157	150	143	136	128	121	114	107	99	92	84	77	69	62	54	46
13	178	172	165	159	152	146	139	132	126	119	112	106	99	92	86	78	72	65	58
14	178	172	166	160	154	148	142	136	130	124	118	111	105	99	93	86	80	74	67
15	178	173	167	162	156	150	145	139	133	128	122	116	110	104	99	93	87	81	75

Table 25-3. Langdon Region, conventional tillage, high productivity (greater than 60 bushels per acre).

Wheat $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
3	167	165	163	160	155	148	135	120	101	77	35	20	0	0	0	0	0	0	0
4	172	168	165	162	156	150	141	131	121	110	98	84	50	30	20	0	0	0	0
5	177	170	168	164	157	151	144	137	130	122	114	105	96	86	76	65	52	30	10
6	178	172	170	168	158	152	146	140	134	128	122	116	109	102	95	88	80	72	50
7	178	174	172	170	160	152	147	143	139	133	128	121	117	112	106	101	95	89	83
8	178	175	173	171	161	152	147	144	142	136	131	127	123	118	114	109	104	99	94
9	178	176	174	172	162	154	149	146	142	138	133	131	127	123	119	115	111	107	103
10	178	176	174	172	162	154	149	146	142	138	134	133	130	126	123	119	116	112	109
11	178	176	174	172	162	154	149	146	142	138	134	133	130	129	126	123	120	117	113
12	178	176	174	172	162	154	149	146	142	138	134	133	130	129	127	126	123	120	117
13	178	176	174	172	162	154	149	146	142	138	134	133	130	129	127	126	126	123	121
14	178	176	174	172	162	154	149	146	142	138	134	133	130	129	127	126	126	125	123
15	178	176	174	172	162	154	149	146	142	138	134	133	130	129	127	126	126	125	124

Table 25-4. Spring wheat/durum N recommendations, Eastern Region, conventional tillage, low productivity (less than 40 bushels per acre).

Wheat $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
3	142	130	120	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	154	130	130	117	92	77	39	0	0	0	0	0	0	0	0	0	0	0	0
5	162	146	130	130	115	96	77	72	34	0	0	0	0	0	0	0	0	0	0
6	167	153	140	130	129	114	99	82	77	60	44	0	0	0	0	0	0	0	0
7	171	159	147	136	130	127	114	101	87	77	71	52	30	0	0	0	0	0	0
8	173	163	153	143	133	130	124	113	102	90	77	77	46	29	0	0	0	0	0
9	175	166	157	148	139	130	130	123	113	103	93	82	77	70	57	43	29	13	0
10	175	169	161	153	145	137	130	130	121	113	104	95	86	77	75	64	53	41	28
11	175	171	164	156	149	142	134	130	128	120	112	104	96	88	80	77	69	60	50
12	175	175	164	157	155	144	137	130	128	125	119	110	103	95	88	80	75	72	63
13	175	175	166	160	155	147	141	135	128	128	123	117	112	103	96	90	83	77	76
14	175	175	168	162	156	151	145	139	133	128	128	122	116	112	104	97	91	85	78
15	175	175	170	164	159	153	148	142	137	131	128	127	121	116	110	104	98	92	86

Table 25-5. Spring wheat/durum N recommendations Eastern Region, conventional tillage, medium productivity (41-60 bushels per acre).

Wheat $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
3	178	150	120	117	100	42	0	0	0	0	0	0	0	0	0	0	0	0	0
4	182	161	141	118	118	103	72	33	0	0	0	0	0	0	0	0	0	0	0
5	183	167	150	133	120	118	103	82	57	29	0	0	0	0	0	0	0	0	0
6	184	171	157	143	128	118	118	105	86	69	49	28	0	0	0	0	0	0	0
7	185	173	162	150	137	125	118	118	118	91	76	60	44	27	8	0	0	0	0
8	186	176	165	155	144	133	122	118	118	105	93	81	68	54	40	26	11	0	0
9	186	177	168	159	149	140	130	121	118	118	118	95	84	73	62	50	38	26	13
10	187	178	170	162	155	145	136	130	119	118	118	105	96	87	77	68	57	47	36
11	187	179	172	164	158	149	141	134	126	118	118	118	106	97	89	80	71	61	53
12	187	180	173	166	160	153	146	138	131	124	118	118	118	106	98	90	83	75	67
13	187	181	175	168	162	155	149	143	136	129	123	122	118	113	106	99	92	85	77
14	188	182	176	170	164	158	152	146	140	135	128	122	118	118	118	106	99	93	86
15	188	182	177	171	166	160	154	149	143	138	132	126	121	118	118	118	106	100	94

Table 25-6. Spring wheat/durum N recommendations, Eastern Region conventional tillage, high productivity (greater than 60 bushels per acre).

Wheat $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
3	218	202	185	167	148	147	145	129	109	81	50	35	20	10	0	0	0	0	0
4	227	213	199	184	169	154	147	147	137	123	106	85	65	40	30	15	0	0	0
5	233	221	209	196	184	171	158	147	147	143	131	118	104	86	63	40	30	20	10
6	237	227	216	205	195	184	173	161	150	147	147	137	127	115	102	88	70	43	30
7	241	231	222	212	203	193	184	174	164	153	147	147	142	133	123	112	101	88	74
8	244	235	227	218	210	205	193	183	175	165	156	147	147	146	137	129	120	110	100
9	246	238	231	223	215	207	199	191	183	174	167	159	149	147	147	141	133	125	117
10	248	241	234	227	220	212	205	198	191	184	176	168	161	153	147	147	144	137	130
11	250	243	237	230	223	217	210	203	197	190	183	176	169	162	155	148	147	147	141
12	250	245	239	233	227	221	214	208	201	196	189	183	177	170	164	157	151	147	147
13	250	247	241	235	230	224	218	212	206	201	195	194	183	176	171	165	159	153	147
14	250	247	243	237	232	227	221	216	210	205	199	194	188	183	177	172	166	160	155
15	250	250	245	239	235	229	224	219	214	209	204	198	193	188	183	178	172	167	162

Table 25-7. Spring wheat/durum N recommendations, Western Region, conventional tillage, low productivity (less than 30 bushels per acre).

Wheat $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
3	99	95	93	76	59	55	30	0	0	0	0	0	0	0	0	0	0	0	0
4	102	97	95	85	68	60	54	42	0	0	0	0	0	0	0	0	0	0	0
5	105	99	97	90	71	64	60	52	33	0	0	0	0	0	0	0	0	0	0
6	108	103	98	93	78	68	66	60	52	50	45	28	9	0	0	0	0	0	0
7	111	107	100	96	86	74	72	65	58	58	52	51	39	26	11	0	0	0	0
8	114	110	103	99	90	82	77	70	64	66	57	55	45	35	25	13	0	0	0
9	117	112	106	100	93	86	82	77	72	73	64	60	52	46	35	41	13	11	10
10	120	114	109	103	96	92	88	84	80	77	68	62	59	54	45	44	23	20	15
11	120	116	110	105	100	95	93	90	86	84	79	74	68	63	56	47	42	38	20
12	120	118	112	107	102	98	96	94	92	88	83	79	74	69	64	59	48	45	40
13	120	120	114	108	104	101	98	96	94	92	86	83	78	73	69	65	60	56	50
14	120	120	120	111	107	104	100	97	96	95	90	86	82	78	74	70	65	61	58
15	120	120	120	120	112	108	101	98	97	96	93	89	85	82	78	74	70	66	62

Table 25-8. Spring wheat/durum N recommendations, Western Region, conventional tillage medium productivity (31-50 bushels per acre).

Wheat $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
3	148	139	139	138	121	102	102	101	60	50	30	15	0	0	0	0	0	0	0
4	162	139	139	139	139	138	115	102	102	101	80	60	40	20	0	0	0	0	0
5	172	153	139	139	139	138	117	102	102	101	80	65	55	45	30	10	0	0	0
6	178	162	146	139	139	138	134	102	102	102	101	90	70	50	40	30	20	0	0
7	182	169	155	141	139	139	138	113	113	102	102	101	96	65	50	40	30	20	0
8	186	174	162	149	139	139	139	127	127	113	102	102	101	98	76	48	35	25	15
9	188	178	167	156	145	139	139	136	136	124	113	102	102	101	100	83	63	38	20
10	190	181	171	162	151	142	139	137	137	135	124	112	102	102	101	101	87	71	53
11	192	183	174	165	157	148	139	139	139	138	132	122	112	102	102	101	101	90	77
12	194	186	177	169	161	153	145	139	139	139	138	130	121	112	103	102	101	101	92
13	194	187	180	172	165	157	150	142	139	139	138	138	129	121	112	103	102	101	102
14	196	189	183	176	168	162	154	147	140	139	139	138	135	127	119	112	105	102	102
15	196	190	184	177	171	164	158	151	145	139	139	139	138	133	126	119	111	104	102

Table 25-9. Spring wheat/durum N recommendations, Western Region conventional tillage high productivity (greater than 50 bushels per acre).

Wheat $ per bu	N cost $ per pound																		
	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00	1.10	1.20	1.30	1.40	1.50	1.60	1.70	1.80	1.90	2.00
	Nitrogen Recommended, pounds per acre																		
3	164	157	127	95	61	25	0	0	0	0	0	0	0	0	0	0	0	0	0
4	164	164	147	125	101	77	52	26	0	0	0	0	0	0	0	0	0	0	0
5	172	164	159	141	123	104	85	66	46	26	0	0	0	0	0	0	0	0	0
6	178	164	164	152	137	122	106	91	75	59	43	26	0	0	0	0	0	0	0
7	182	169	165	158	147	134	122	108	95	81	68	54	27	0	0	0	0	0	0
8	185	174	166	164	154	143	132	120	109	98	86	74	63	51	39	27	0	0	0
9	187	177	168	164	160	155	140	130	120	110	100	90	79	69	59	48	38	27	0
10	189	180	170	164	164	156	147	138	129	120	111	102	92	83	74	65	55	46	37
11	190	181	175	167	164	160	152	144	136	128	120	111	103	95	86	78	70	61	53
12	192	184	177	170	164	164	157	149	142	134	127	119	112	103	97	89	81	74	66
13	193	186	180	172	166	164	160	154	147	140	133	128	119	112	105	98	91	84	77
14	194	187	181	175	169	164	164	157	151	145	138	133	125	119	113	106	100	93	87
15	195	189	183	177	171	164	164	161	155	149	143	137	131	125	119	113	107	101	95

Table 25-10. Broadcast fertilizer phosphate recommendations for North Dakota for spring wheat and durum based on soil test (Olsen).

Soil Test Phosphorus, ppm				
VL 0-3	L 4-7	M 8-11	H 12-15	VH 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)

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)
When growing winter wheat in Langdon region (see Figure 2), subtract 40 pounds of N/acre.
Under long-term no-till management (6 years or more continuous), subtract 50 pounds N/acre.

Table 26. Winter wheat P recommendations.

Olsen soil test P soil test values, ppm				
VL 0-3	L 4-7	M 8-11	H 12-15	VH 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.

Winter wheat K 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)

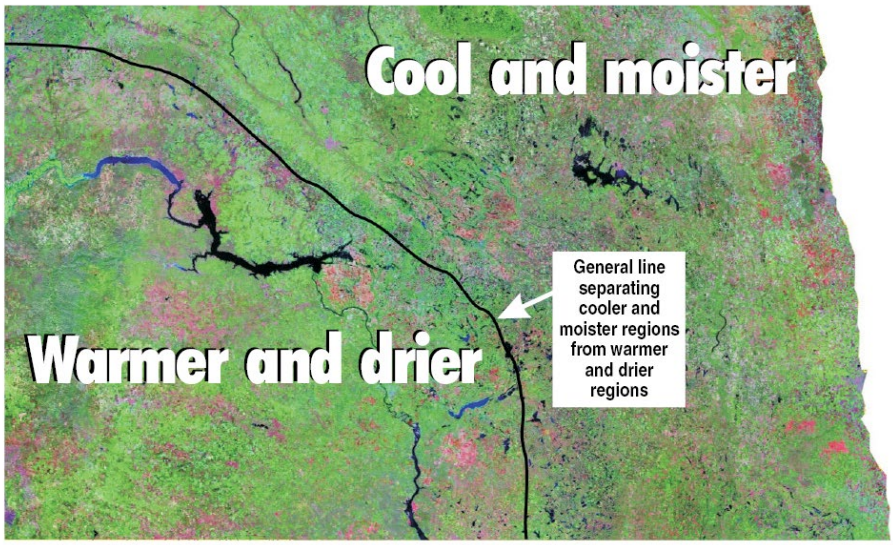


Figure 1. General climatic delineation between cooler and moister areas in North Dakota compared with warmer and drier areas. In a given year, the line separating the two regions may move considerably east or west.

For use with Tables 3-4, 3-5 and 5.

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

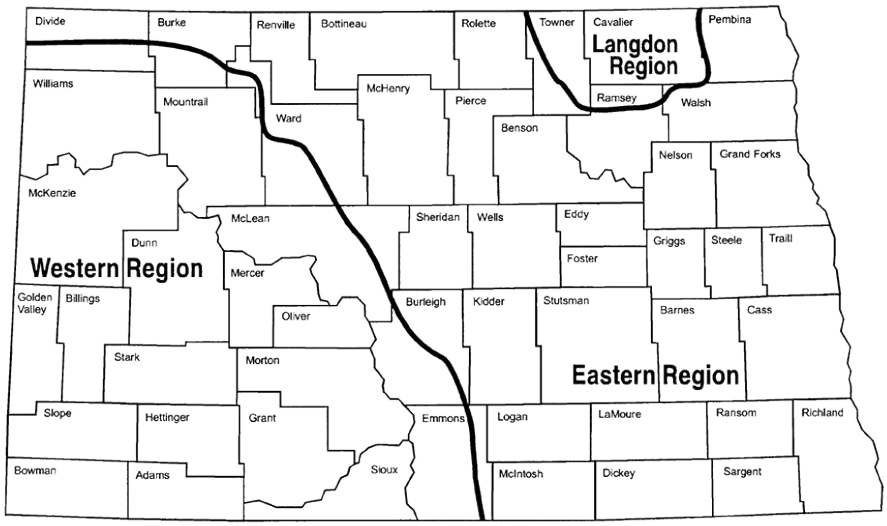


Figure 2. Agri-climatology regions for use in Tables 24-1 through 24-3 for sunflower and Tables 25-1 through 25-9 for spring wheat and durum N recommendations, and for winter wheat considerations.

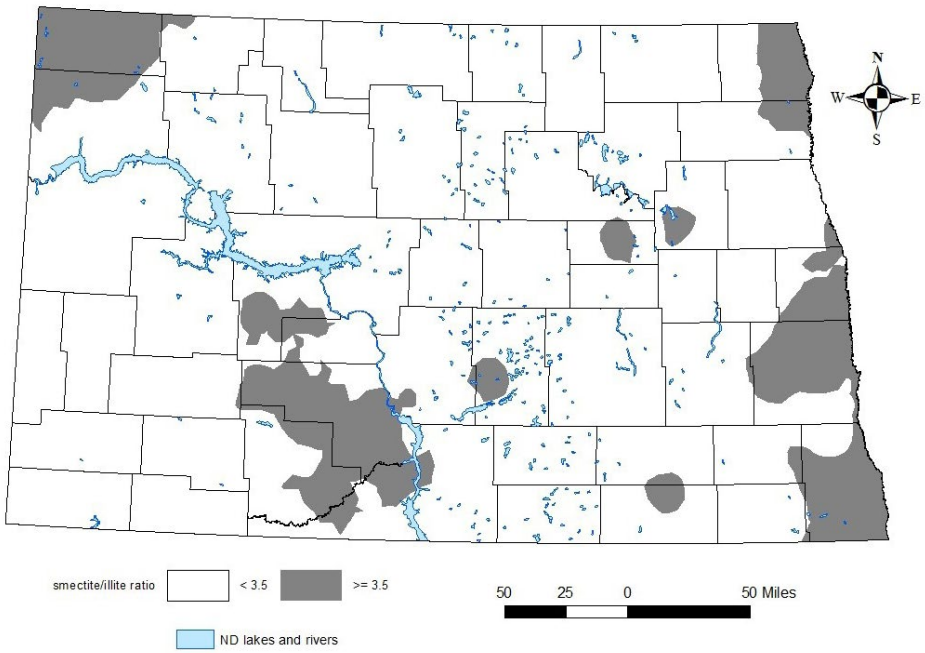


Figure 3. Smectite-to-illite ratios relevant to alfalfa, corn and sugarbeet potassium (K) recommendations in Figures 2-2 and 2-3 for alfalfa; 8-11 to 8-14 for corn, 9-1 to 9-2 for sweet corn; Table 17-4 for potato, Table 23 for sugarbeet and for spring wheat after Table 25-10 and winter wheat after Table 26.