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

The major changes from previous versions of this publication are in sunflower fertility recommendations.

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, and the nutrient needs of the crop to be grown, and knowing the historic productivity of the soil. The yield potential must be based on historical yield productivity for a field or the immediate area.

Recent research has shown that more productive areas of fields require less fertilizer, particularly nitrogen (N), than less productive areas of the field because they tend to be higher in organic matter, have greater seasonal moisture content, and tend to use existing and applied nutrients more efficiently. The exception to this would be saline areas that are commonly high in residual N.

Several of our N recommendations are "capped" at a maximum rate. In years that support higher yields than our N recommendation formulas indicate, our data show that greater N release from the soil 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 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.**

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 NO_3 N in the soil 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 130 pounds N per acre total requirement. The amount of N to apply would be 130 less 55, or 75 pounds N per acre.

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Adjusting N Recommendations

In a preplant NO_3 N soil testing program, certain adjustments need to be made for the expected but unseen from a fall or spring soil test NO_3-N analysis contribution of N from some previous crops.

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) may accelerate the normal N mineralization rate from organic matter.

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.

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

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 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.

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-foot 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 lb NO_3 N/acre, do not adjust the recommendation.

If the amount of NO_3 N in the 2- to 4-foot depth is more than 30 lb NO_3 N/acre, reduce the N recommendation by 80 percent of the amount greater than 30 lb/A. For example, if 50 lb of NO_3 N/acre are present at the 2- to 4-foot depth, reduce the N recommendation by 16 lb N/acre, or 80 percent X (50 lb N/acre less 30 lb N/acre, or 20 pounds).

Phosphorus and Potassium

The 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 still result in similar yield to 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, such as 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 SF1751, available online at *www.ag.ndsu.edu/pubs/plantsci/soilfert/sf1751.pdf*.

Under no-till and ridge-till systems, corn has responded to banded K even when soil test levels for K are high.

Broadcast recommendations of P or K for low- and very-low-testing soils include buildup P and K rates. When rates are reduced, soil test levels are not increased through time.

A long-term P and K strategy should include buildup to high (critical) soil test levels at some future date. Near maximum yield potential is achieved only when these soil test levels are reached. Application of less than maintenance rates will result in a decline in P and K levels through time and an accompanying decline in the productivity of most crops.

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 seen on clay soils with an 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 often is a better predictor of S need than soil testing.

In a year following a high rainfall/snowfall year, applying some 10 to 20 pounds S/acre regardless of landscape position, soil texture or organic matter may be prudent. Since 2014, serious S deficiency appeared in many fields that we used to think would be adequate in 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 Cl recommendation is determined by subtracting the amount of Cl found in the top 2 feet of soil from 40 lb/acre, although most of the yield response is the result of the first 10 to 15 lb/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 the crops known to respond positively to Zn application in the state, which are corn, potato, flax and dry edible bean (not soybean), and 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 soil.

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 lb/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 are also 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.

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 is over 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 of 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 that are more tolerant, and avoiding soybean cultivation on soils with high IDC potential and that are 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 copper 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) copper 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 copper levels, but expect a success rate of about 15 percent. 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:

YP = yield potential
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	Ammonium acetate	0-40	41-80	81-129	121-160	161+
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+

* 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 grain.

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. Alfalfa.

Alfalfa

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
ton/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
2	0		34	24	15	6	0	96	66	35	5	0
4	0		67	49	30	12	0	192	132	71	10	0
5	0		84	61	38	15	0	241	165	89	13	0
6	0		101	73	45	17	0	289	197	106	15	0

Inoculation is necessary using proper rhizobium culture.

(Annual rates of P_2O_5 and K_2O)

Bray-I P recommendation = (18.57-0.93 STP)YP
Olsen P recommendation = (18.57-1.16 STP)YP
Potassium recommendation = (55.71-0.38 STK)YP

Table 3. Barley, feed.

Barley, feed

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
bu/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
40	70		28	20	12	4	0	45	31	17	3	0
60	100		43	31	19	7	0	67	47	26	5	0
80	135		57	41	25	9	0	89	62	35	7	0
100	170		71	51	31	11	0	112	78	44	8	0

Nitrogen recommendation = 1.7 YP-STN-PCC
Bray-I P recommendation = (0.785-0.039 STP)YP
Olsen P recommendation = (0.785-0.050 STP)YP
Potassium recommendation = (1.2860-0.0085 STK)YP

Barley, malting grade

Table 4a. Barley, malting grade, in cooler, moister climates within North Dakota.

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
bu/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
40	60		28	20	12	4	0	45	31	17	3	0
60	90		43	31	19	7	0	67	47	26	5	0
80	120		57	41	25	9	0	89	62	35	7	0
100	150		71	51	31	11	0	112	78	44	8	0

Nitrogen recommendation = 1.5 YP-STN-PCC
Bray-I P recommendation = (0.785-0.039 STP)YP
Olsen P recommendation = (0.785-0.050 STP)YP
Potassium recommendation = (1.2860-0.0085 STK)YP

Early planting is critical for greatest success. Planting later than May 15 will require lower N rates. Applying potassium chloride (0-0-60) at 15-20 lb K_2O/acre can increase kernel plumpness on well-drained soils if a chloride test is not available.

Barley, malting grade

Table 4b. Barley, malting grade, in warmer, drier climates within North Dakota.*

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
bu/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
40	48		28	20	12	4	0	45	31	17	3	0
60	72		43	31	19	7	0	67	47	26	5	0
80	96		57	41	25	9	0	89	62	35	7	0
100	120		71	51	31	11	0	112	78	44	8	0

Nitrogen recommendation = 1.2 YP-STN-PCC
Bray-I P recommendation = (0.785-0.039 STP)YP
Olsen P recommendation = (0.785-0.050 STP)YP
Potassium recommendation = (1.2860-0.0085 STK)YP

Early planting is critical for greatest success. Planting later than May 15 will require lower N rates. Applying potassium chloride (0-0-60) at 15-20 lb K_2O/acre can increase kernel plumpness on well-drained soils if a chloride test is not available.

*This recommendation is most useful for the North Dakota region from north of Williston south and everything west of the Missouri River. In years with low soil moisture, growers further east may benefit from this formula. (See Figure 1, Page 20).

Buckwheat

Table 5. Buckwheat.

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
bu/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
25	55		30	22	13	5	0	41	29	18	6	0
30	65*		36	26	16	6	0	49	35	21	7	0
35	75*		42	30	19	7	0	57	41	25	8	0
40	90*		48	35	21	8	0	65	47	28	9	0

Nitrogen recommendation = 2.2 YP - STN - PCC
Bray-I P recommendation = (1.320-0.066 STP)YP
Olsen P recommendation = 1.320-0.083 STP)YP
Potassium recommendation = (1.8600-0.0116 STK)YP

* N fertilizer rates greater than 50 lb/acre can cause lodging in wet years.

Table 6. Canola.

Canola

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
lb/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
1,000	65		33	24	15	6	0	47	34	20	6	0
1,500	100		49	36	23	9	0	71	50	30	10	0
2,000	130*		65	48	30	13	0	94	67	40	13	0
2,300	150		75	55	35	15	0	108	77	46	15	0
2,500	150		82	60	38	16	0	118	84	50	16	0
3,000	150		98	72	46	18	0	142	100	60	20	0

Nitrogen recommendation = 0.065 YP-STN-PCC with a 150 lb max limit
Bray-I P recommendation = (0.036-0.0017 STP)YP
Olsen P recommendation = (0.036-0.0022 STP)YP
Potassium recommendation = (0.054-0.00034 STK)YP

Note: Canola has a high requirement for sulfur. Application of 20 to 30 lb/a S is recommended regardless of soil test results for this crop. Apply S as sulfate or thiosulfate form.

*Growers in warmer, drier areas should cap N rates at 120 lb N/a. (See Figure1).

Table 7. Clover (alsike, red, birdsfoot trefoil, grass-legume).

Clover

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
ton/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
2	0		36	25	13	2	0	87	60	34	7	0
3	0		54	37	20	3	0	130	90	50	11	0
4	0		72	49	27	4	0	173	120	67	14	0
5	0		90	62	34	6	0	217	150	84	18	0

Inoculation is required at seeding with proper rhizobium culture.

Bray-I P recommendation = (20-STP)YP
Olsen P recommendation = (20-1.4 STP)YP
Potassium recommendation = (50.000-0.332 STK)YP

Table 8. Corn for silage.

Corn for silage

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
ton/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
10	105		51	37	23	9	0	83	59	35	11	0
14	145		71	52	32	13	0	116	83	49	15	0
18	185		92	67	41	16	0	149	106	63	20	0
22	230		112	81	50	20	0	183	130	77	24	0

Nitrogen recommendation = 10.4 YP-STN-PCC
Bray-I P recommendation = (5.62-0.28 STP)YP
Olsen P recommendation = (5.62-0.35 STP)YP
Potassium recommendation = (9.50-0.06 STK)YP

Tables 9-1 through 9-10. 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/.

Corn for West River soils

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

	N cost, $/ pound N								
Corn Price	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$/bushel									
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

Corn for eastern long-term no-till soils

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.

	N cost, $/ pound N								
Corn Price	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$/bushel									
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

Corn for eastern high-clay soils

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.

	N cost, $/ pound N								
Corn Price	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$/bushel									
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 for eastern high-clay soils

	N cost, $/ pound N								
Corn Price	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$/bushel									
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 for eastern medium-textured soils

	N cost, $/ pound N								
Corn Price	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$/bushel									
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 for eastern medium-textured soils

	N cost, $/ pound N								
Corn Price	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$/bushel									
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

Corn for irrigated soils

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.

	N cost, $/ pound N								
Corn Price	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	1.00
$/bushel									
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

Corn, West River, nonirrigated

Table 9-8. Corn P and K recommendations, West River, nonirrigated, pounds P_2O_5 or K_2O per acre.

Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, dry method				
VL	L	M	H	VH	VL	L	M	H	VH
0-3	4-7	8-11	23-15	16+	0-40	41-80	81-120	121-160	161+
78	52	39	26	10	120	90	60	30	0

Table 9-9. Corn P and K recommendations, East River, nonirrigated, pounds P_2O_5 or K_2O per acre.

Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, dry method				
VL	L	M	H	VH	VL	L	M	H	VH
0-3	4-7	8-11	23-15	16+	0-40	41-80	81-120	121-160	161+
104	78	52	39	10	120	90	60	60	60*

*rate in conventional till is 0. Use the 60-lb K2O rate for no-till/ridge till.

Corn, East River nonirrigated

Table 9-10. Corn P and K recommendations, irrigation, pounds P_2O_5 or K_2O per acre.

Olsen Soil Test Phosphorus, ppm					Soil Test Potassium, dry method				
VL	L	M	H	VH	VL	L	M	H	VH
0-3	4-7	8-11	23-15	16+	0-40	41-80	81-120	121-160	161+
156	104	78	52	26	120	90	60	60	0

Sweet corn

Table 10. Sweet corn P and K recommendations, pounds P_2O_5 or K_2O per acre.

			Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
ton/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
4	70		40	29	17	6	0	78	57	36	15	0
6	110		60	43	26	9	0	116	85	54	23	0
8	145		80	57	35	12	0	155	114	72	30	0
10	180		100	72	44	16	0	194	142	90	38	0

Nitrogen recommendation = 18 YP - STN - PCC
Bray-I P recommendation = (11.000-0.533 STP)YP
Olsen P recommendation = (11.0-0.7 STP)YP
Potassium recommendation = (22.00-0.13 STK)YP

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

Dry bean

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
lb/a	lb/acre-2'		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 YP) – STN – PCC
Dryland –
Inoculated 40 lb N/acre – STN-PCC
Noninoculated 70 lb 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.

Flax

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
lb/a	lb/acre-2'		lb K_2O/acre				
20	60		38	27	16	5	0
30	80		58	41	24	7	0
40	80		77	54	32	10	0
50	80		96	68	40	12	0

Nitrogen recommendation = 3 YP - STN – PCC, with limit of 80 lb/N.

N is limited to 80 lb/a due to the risk of lodging. If environment is favorable for higher yield, higher N release from organic matter will provide the added N in most situations.

Phosphorus application is not necessary for flax. Phosphorus can be applied, but no yield increase should be expected regardless of soil test level.

Potassium recommendation = (2.200-0.014 STK)YP

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

Forage/hay grasses

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
ton/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
2	50*		40	26	12	0	0	69	48	27	6	0

Nitrogen recommendation = 25 YP-STN
Bray-I P recommendation = 45.0-2.5 STP
Olsen P recommendation = 45.00-3.45 STP
Potassium recommendation = 80.00-0.53 STK

* Nitrogen application to **native grass** stands is discouraged due to selective pressures from less desirable plants with higher N nutrition. Native grass stands sometimes can benefit from P application.

Table 14. Millet.

Millet

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
lb/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
1,500	50		23	16	9	3	0	40	29	18	7	0
2,000	70		31	22	13	3	0	53	38	24	10	0
2,500	90		38	27	16	4	0	66	48	30	12	0
3,000	105		46	32	19	5	0	79	58	36	14	0

Nitrogen recommendation = 0.035 YP-STN-PCC
Bray-I P recommendation = (0.0171-0.00085 STP)YP
Olsen P recommendation = (0.0171-0.00114 STP)YP
Potassium recommendation = (0.03-0.00018 STK)YP

Mustard

Table 15. Mustard.

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm: VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm: VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
lb/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
1,000	65		33	24	15	6	0	47	34	20	6	0
1,500	100		49	36	23	9	0	71	50	30	10	0
2,000	130		65	48	30	13	0	94	67	40	13	0
2,500	150*		82	60	38	16	0	118	84	50	16	0

Nitrogen recommendation = 0.065 YP-STN-PCC
Bray-I P recommendation = (0.036-0.0017 STP)YP
Olsen P recommendation = (0.036-0.0022 STP)YP
Potassium recommendation = (0.054-0.00034 STK)YP

* There is a cap of 150 lb N regardless of yield potential.

Oat

Table 16. Oat.

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm: VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm: VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
bu/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
50	65		29	21	13	5	0	55	38	21	4	0
70	90		41	29	18	7	0	77	53	29	5	0
90	115		52	38	23	8	0	100	69	38	7	0
110	145		64	46	28	10	0	122	84	46	8	0

Nitrogen recommendation = 1.3 YP-STN-PCC
Bray-I P recommendation = (0.644-0.032 STP)YP
Olsen P recommendation = (0.644-0.041 STP)YP
Potassium recommendation = (1.2777-0.0086 STK)YP

Pea, field, lentil and chickpea

Table 17. Pea, field, lentil and chickpea (garbanzo bean).

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm: VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm: VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
lb/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
1,400	20		22	15	9	3	0	37	27	17	7	0
1,800	20		28	20	12	4	0	48	35	22	9	0
2,200	20		34	24	15	5	0	58	42	26	11	0
2,600	20		40	29	17	6	0	69	50	31	13	0

Bray-I P recommendation = (0.0171-0.00085 STP)YP
Olsen P recommendation = (0.0171-0.0011 STP)YP
Potassium recommendation = (0.03-0.00018 STK)YP

Inoculation is necessary with proper Rhizobium culture.

Potato

Table 18. Potato.

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm: VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm: VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
cwt/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
200	80		90	63	35	8	0	147	102	56	10	0
300	120		135	94	53	12	0	221	152	84	16	0
400	160		180	125	71	16	0	294	203	112	21	0
500	200		225	157	89	21	0	368	254	140	26	0

Nitrogen recommendation = 0.4 YP-STN-PCC
Bray-I P recommendation = (0.5-0.024 STP)YP
Olsen P recommendation = (0.5-0.034 STP)YP
Potassium recommendation = (0.85-0.0057 STK)YP

Under irrigation, N application should be split to reduce nitrate leaching risk. Supplemental N should be directed through the use of petiole/sap testing.

Table 19. Rye.

Nitrogen rates

- Areas of low productivity (yields below 40 bu/acre) Total available N = 100 lb/acre
- Areas of medium productivity (yields 40 to 60 bu/acre) Total available N = 150 lb/acre
- Areas of high productivity (yields greater than 60 bu/acre Total available N = 200 lb/acre

(Total available N = soil test nitrate 2 feet + previous crop credit + fertilizer N)

Phosphorus

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

Potassium

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

Table 20. Safflower.

			Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
lb/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
800	40		20	14	9	3	0	34	24	14	5	0
1,200	60		29	21	13	5	0	50	36	22	7	0
1,600	80		39	28	17	6	0	67	48	29	10	0
2,000	100		49	35	22	8	0	84	60	36	12	0

Nitrogen recommendation = 0.05 YP-STN-PCC
Bray-I P recommendation = (0.027-0.0014 STP)YP
Olsen P recommendation = (0.027-0.0017 STP)YP
Potassium recommendation = (0.048-0.0003 STK)YP

Safflower will extract N from depths of more than 4 feet.
Excessive N will delay maturity and lower oil content.

Table 21. Sorghum, forage and sudangrass.

			Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
ton/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
3	75		30	21	13	5	0	111	75	39	3	0
5	125		50	36	22	8	0	185	125	65	5	0
7	175		70	50	30	11	0	259	175	91	7	0
9	225		90	64	39	14	0	333	225	117	9	0

Nitrogen recommendation = 25 YP-STN-PCC
Bray-I P recommendation = (11.000-0.533 STP)YP
Olsen P recommendation = (11.0-0.7 STP)YP
Potassium recommendation = (43.0-0.3 STK)YP

Table 22. Sorghum, grain.

			Soil Test Phosphorus, ppm					Soil Test Potassium, ppm				
Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
bu/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
60	66		36	26	17	7	0	46	32	18	4	0
80	88		48	35	22	9	0	61	42	24	5	0
100	110		60	44	28	11	0	76	53	30	6	0
120	132		72	53	33	14	0	91	63	35	8	0

Nitrogen recommendation = 1.1 YP-STN-PCC
Bray-I P recommendation = (0.666-0.033 STP)YP
Olsen P recommendation = (0.666-0.041 STP)YP
Potassium recommendation = (0.875-0.0058 STK)YP

Soybean

Table 23. Soybean.

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
bu/a	lb/acre-2'		lb P_2O_5/acre					lb K_2O/acre				
30	0		40	23	10	0	0	55	33	11	0	0
40	0		54	31	10	0	0	73	44	15	0	0
50	0		67	39	11	0	0	92	55	19	0	0
60	0		80	47	13	0	0	110	66	22	0	0

Bray-I P recommendation = (1.55-0.10 STP)YP
Olsen P recommendation = (1.55-0.14 STP)YP
Potassium recommendation = (2.2000-0.0183 STK)YP

Inoculation or rotation within four years of a well-nodulated soybean crop is necessary.

Sugar beet

Table 24. Sugar beet.

Yield potential	Soil N plus fertilizer N required	Bray-1 Olsen	Soil Test Phosphorus, ppm VL 0-5 0-3	L 6-10 4-7	M 11-15 8-11	H 16-20 12-15	VH 21+ 16+	Soil Test Potassium, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
ton/a	lb/acre-4'		lb P_2O_5/acre					lb K_2O/acre				
20	130		80	58	36	15	0	110	77	43	9	0

Bray-I P recommendation = (4.38-0.22 STP)YP
Olsen P recommendation = (4.38-0.27 STP)YP
Potassium recommendation = (6.350-0.042 STK)YP

A minimum of 65 lb N should be in the 0- to 2-foot depth.
Soil N plus fertilizer N required with a 0- to 2-foot core only is 100 lb/acre.

Tables 25-1 through 25-3. Sunflower. See Figure 2 (Page 20) for map of regions.

Eastern conventional till oil-seed sunflower

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 0 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.

Eastern long-term no-till oil-seed sunflower

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	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	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.

Western long-term no-till oil-seed and western conventional oil-seed sunflower

Sunflower – Langdon Area N – Use Table 26-1 and Table 26-2, 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 lb N/acre.
   – If the field has been in no-till five or more continuous years, subtract 50 lb 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 lb N/acre.

For easier N rate determination, see the North Dakota Spring Wheat and Durum N Calculator at *www.ndsu.edu/pubweb/soils/wheat/.*

The final N rate may be adjusted plus or minus 30 lb 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 bu/acre
- Medium = 41 to 60 bu/acre
- High = greater than 60 bu/acre

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

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

Spring wheat/durum, Langdon Region, low productivity

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

	Costs cents per pound N								
Wheat price	20	30	40	50	60	70	80	90	100
	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								
Wheat price	20	30	40	50	60	70	80	90	100
	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

Spring wheat/durum, Langdon Region, medium productivity

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

Spring wheat/durum, Langdon Region, high productivity

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

	Costs cents per pound N								
Wheat price	20	30	40	50	60	70	80	90	100
	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

Spring wheat/durum, eastern, low productivity

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

	Costs cents per pound N								
Wheat price	20	30	40	50	60	70	80	90	100
	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

Spring wheat/durum, eastern, medium productivity

Spring wheat/durum, eastern, high productivity

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

	Costs cents per pound N								
Wheat price	20	30	40	50	60	70	80	90	100
	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

Spring wheat/durum, western, low productivity

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

	Costs cents per pound N								
Wheat price	20	30	40	50	60	70	80	90	100
	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

Spring wheat/durum, western, medium productivity

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

	Costs cents per pound N								
Wheat price	20	30	40	50	60	70	80	90	100
	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

Spring wheat/durum, western, high productivity

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

	Costs cents per pound N								
Wheat price	20	30	40	50	60	70	80	90	100
	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) and historic yield potential.

Broadcast fertilizer phosphate recommendations for North Dakota for spring wheat and durum

Yield potential	Soil Test Phosphorus, ppm VL 0-40	L 41-80	M 81-120	H 121-160	VH 161+
bu/a	Pounds P_2O_5/acre				
40	39	28	17	15	15*
60	59	42	26	15	15
80	78	56	35	15	15
100	98	70	43	17	15

Olsen P recommendations = (1.071-0.067STP)YP, where STP is soil test P and YP is yield potential.

* 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

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 lb/acre KCl (30 lb/acre K_2O)

Table 27. Winter wheat.

Winter wheat

Nitrogen rates

- Areas of low productivity (yields below 40 bu/acre) — Total available N = 100 lb/acre
- Areas of medium productivity (yields 40 to 60 bu/acre) — Total available N = 150 lb/acre
- Areas of high productivity (yields greater than 60 bu/acre — Total available N = 200 lb/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, Page 20), subtract 40 lb N/acre.

Phosphorus rates

Productivity level	Soil Test Phosphorus, ppm VL 0-3	L 4-7	M 8-11	H 12-15	VH 16+
bu/acre	Pounds P_2O_5/acre				
<40	39	28	17	15	15*
40-70	60	40	25	15	15
>70	80	60	40	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

- 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 lb/acre KCl (30 lb/acre K_2O)

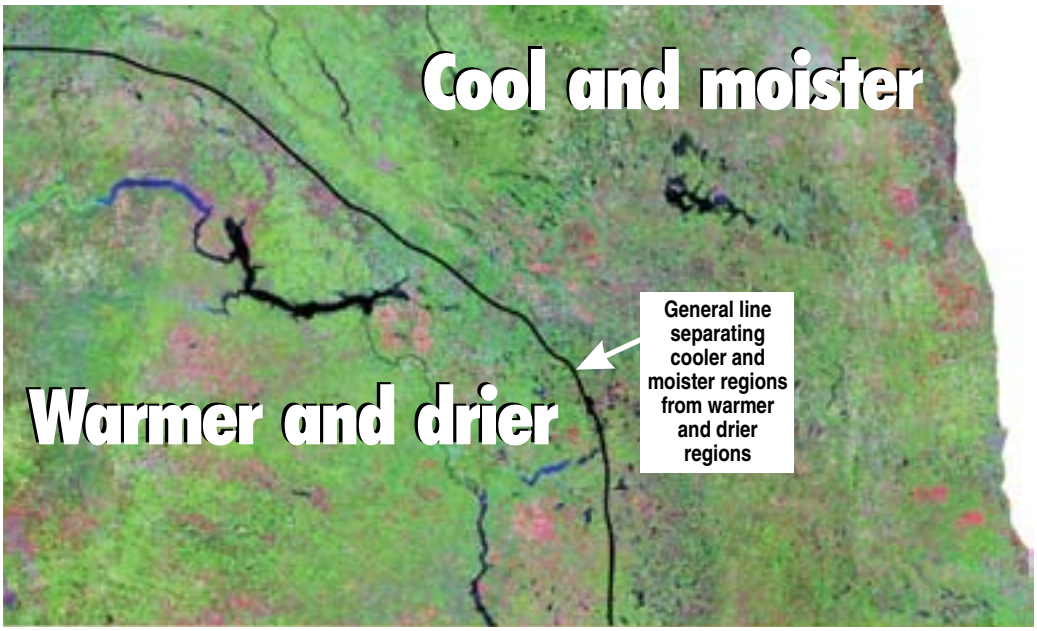

Figure 1.

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 4a, 4b and 6.

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

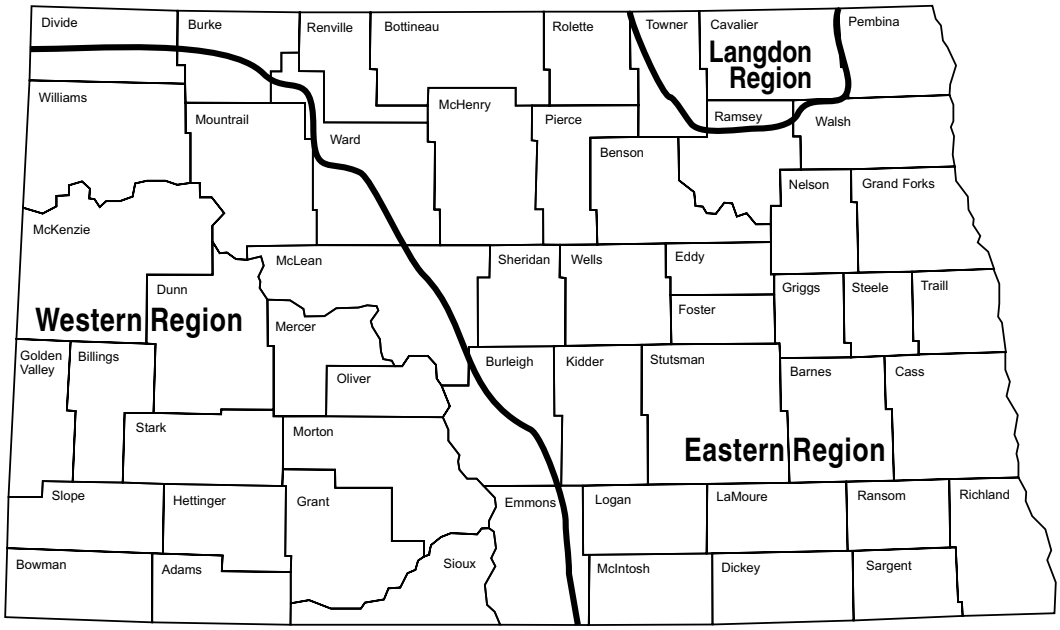

Figure 2.

Agri-climatology regions for use in Tables 26-1 through 26-3 for sunflower and Tables 27-1 through 27-9 for spring wheat and durum N recommendations, and Table 28 for winter wheat considerations.

For more information on this and other topics, see www.ag.ndsu.edu

County commissions, North Dakota State University and U.S. Department of Agriculture cooperating.

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