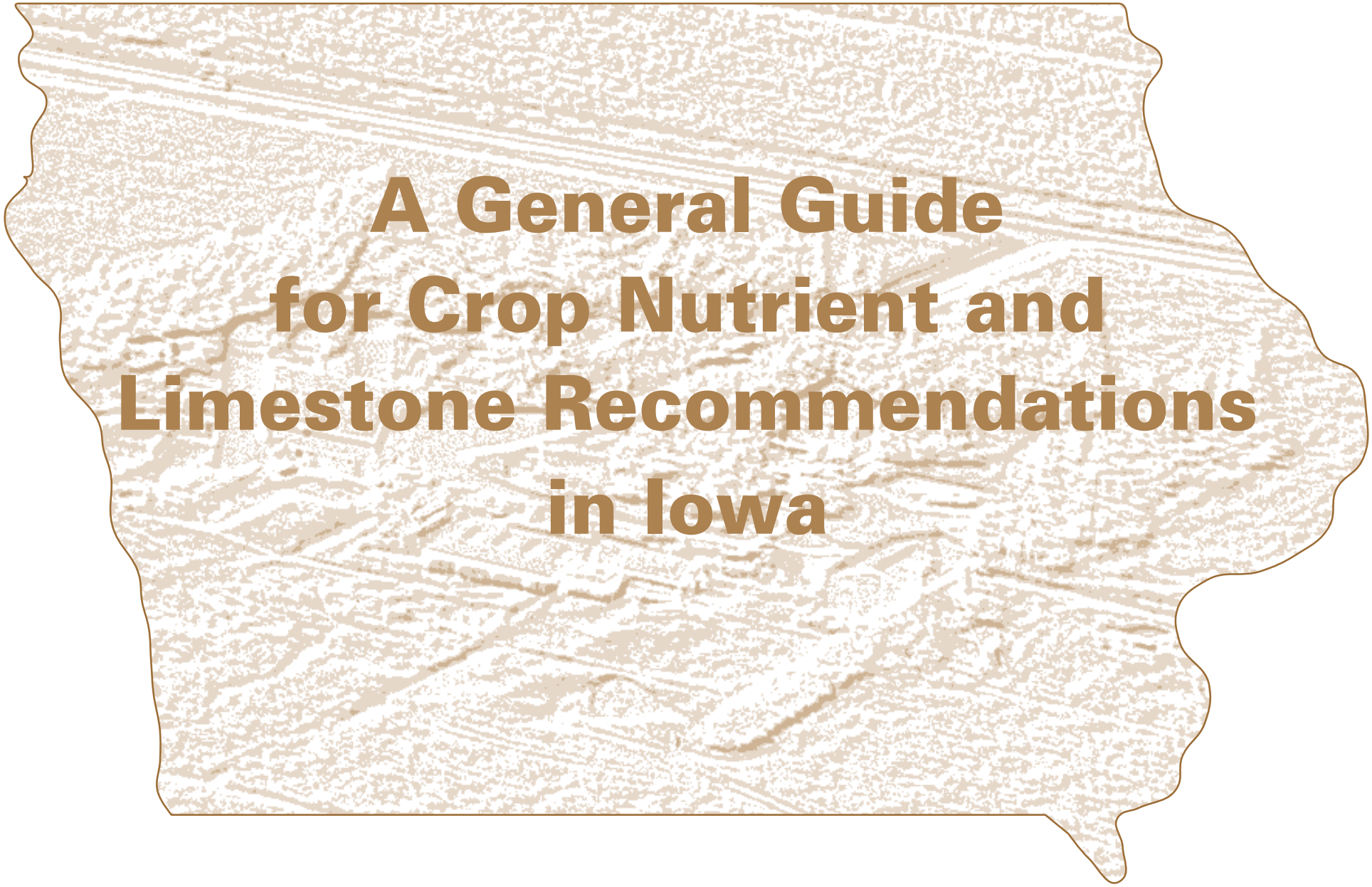

A General Guide for Crop Nutrient and Limestone Recommendations in Iowa

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University Extension

PM 1688 Reviewed and Reprinted September 2008

Contents

General Guide for Crop Nutrient and Limestone Recommendations in Iowa

Introduction

Phosphorus (P), potassium (K), zinc (Zn), and lime recommendations based on soil testing are provided in this publication for the major agronomic crops grown in Iowa. Interpretation of soil test values and nutrient recommendations are based on soil samples taken to a 6- to 7-inch depth. Research results from long-term and short-term field experiments have been used to determine the interpretation of soil test values and the nutrient recommendations.

Nutrients applied to meet the recommended amounts may be from inorganic sources, from manure, or both. Nutrient contents of manures are most accurately determined by laboratory analyses.

Soil Test Procedures

The soil tests for which interpretations are given in this publication are the Bray P_1, Mehlich-3, and the Olsen tests for P, the ammonium acetate and Mehlich-3 tests for K, the DTPA test for Zn, a water-soil slurry for soil pH, and the SMP buffer method for lime requirement. The Bray P_1 test is not recommended for soils with soil pH 7.4 or higher (calcareous) because it often underestimates plant-available P in those soils and can return false low values. Soil test P interpretations in this publication apply when a colorimetric method is used to measure the P extracted by the Bray P_1, Mehlich-3, and Olsen P tests. These tests, and those for soil pH and buffer pH, are among the tests recommended for the North Central Region by the NCR-13 Regional Committee on Soil Testing and Plant Analysis. These and other tests are described in the North Central Regional Publication 221 (Revised 1998), *Recommended Chemical Soil Test Procedures for the North Central Region*. In addition, soil test P interpretations are provided when an ICP (inductively coupled plasma) analytical method is used to measure the P extracted by the Mehlich-3 P test (Mehlich-3 ICP). All laboratory procedures have some inherent variability and thus soil test results should be viewed as a potential range in values. The ranges in variation for routine soil test results produced within a laboratory are expected to be on the order of ±10% for soil test P and K, and ±0.1 pH unit.

Soil Test Categories

Soil test numerical values are reported as parts per million (ppm). Soil test values for P and K have been classified into interpretive categories designated very low (VL), low (L), optimum (Opt), high (H), and very high (VH). These categories represent a decreasing probability of an economic yield response to applied nutrients. The percentage of P and K applications expected on average to produce a yield response within each soil test category is 80% for very low, 65% for low, 25% for optimum, 5% for high, and <1% for very high. Based on input costs and expected yield increases, the optimum category is the most profitable category to maintain over time. The very high category indicates that the nutrient concentration exceeds crop needs, and further additions of that nutrient very seldom produce a profitable yield response. Recommended applications are structured so that over time soil tests will move to the optimum category.

Soil test categories for the numerical soil test values of P and K are given in Table 1. The interpretation of P and K soil test values into categories depends on the nutrient demand of the crop to be grown, the subsoil concentrations of P and K, and the soil test value. The interpretation of P soil test values for wheat and alfalfa is different than for the other agronomic crops indicating that these two crops require a higher soil P level in the surface soil for profitable production. The interpretation of P soil test values for all crops other than wheat and alfalfa, and K soil test values for all agronomic crops, differs according to subsoil P and K levels of the soil series.

Subsoil P and K levels are determined at the depth that provides the greatest range of soil test values for each nutrient. Subsoil P is determined by the Bray P_1 soil test for samples taken from the 30- to 42-inch depth. Subsoil K is determined by the ammonium acetate soil test for samples taken from the 12- to 24-inch depth. Subsoil P is designated low for subsoil test values of 8 ppm or less and high for values of 9 ppm or more. Subsoil K is designated low for subsoil test values of 50 ppm or less and high for values of 51 ppm or more. The effect of a high subsoil level of P or K is to require a lower concentration of that nutrient in the surface soil for optimum crop production.

Subsoil P and K levels for soil series with more than 5,000 acres and a corn suitability rating (CSR) greater than 30 are given in Table 15 for each of the major soil areas in Iowa that contain the principal soil associations shown in Figure 1. Subsoil levels do vary by soil series but not by soil mapping units within a soil series.

Table 1. Interpretation of soil test values for phosphorus (P) determined by Bray P_1, Mehlich-3, or Olsen extractants and potassium (K) determined by ammonium acetate or Mehlich-3 extractants for surface soil samples (6- to 7-inch deep cores).

	Wheat, alfalfa	All crops except wheat, alfalfa		All crops	
		Subsoil P		Subsoil K	
		Low	High	Low	High
	ppm				
Relative level	Bray P_1 or Mehlich-3 P			Ammonium Acetate or Mehlich-3 K	
Very low (VL)	0–15	0–8	0–5	0–90	0–70
Low (L)	16–20	9–15	6–10	91–130	71–110
Optimum (Opt)	21–25	16–20	11–15	131–170	111–150
High (H)	26–30	21–30	16–20	171–200	151–180
Very high (VH)	31+	31+	21+	201+	181+
	Olsen P				
Very low (VL)	0–10	0–5	0–3		
Low (L)	11–14	6–10	4–7		
Optimum (Opt)	15–17	11–14	8–11		
High (H)	18–20	15–20	12–15		
Very high (VH)	21+	21+	16+		
	Mehlich-3 ICP				
Very low (VL)	0–20	0–15	0–10		
Low (L)	21–30	16–25	11–20		
Optimum (Opt)	31–40	26–35	21–30		
High (H)	41–50	36–45	31–40		
Very high (VH)	51+	46+	41+		

Phosphorus and Potassium Recommendations

The recommended amounts of P_2O_5 and K_2O are based on research conducted in Iowa during many years. Applying the recommended rates for the very low and low soil test categories will result in profitable crop responses in that year and at the same time increase soil test values after crop harvest because of significant residual effects from the applied P and K.

The recommended P and K rates for the optimum soil test category are based on average nutrient removal in harvested crop parts (grain, silage, straw, and hay). The fertilization amounts shown in the tables for the optimum soil test category use default yield levels. These can be adjusted to a field-specific yield. The nutrient content per unit of yield for Iowa agronomic crops is given in Table 2.

Table 2. The nutrient content of harvested crops used to calculate nutrient removal and recommended amounts of P_2O_5 and K_2O for optimum soil test category.

		Pounds per unit of yield	
Crop	Unit of Yield	P_2O_5	K_2O
Corn	bu	0.375	0.30
Corn silage	bu grain equivalent	0.55	1.25
Corn silage	ton, 65% H_2O	3.50	8.0
Corn stover*	ton	5.9	25.0
Soybean	bu	0.80	1.5
Soybean stover*	ton	2.8	9.9
Oat and straw	bu	0.40	1.0
Oat straw	ton	5.0	33.0
Wheat	bu	0.60	0.30
Wheat straw	ton	4.0	25.0
Sunflower	100 lb	0.80	0.70
Alfalfa	ton	12.50	40.0
Red clover	ton	12.0	35.0
Trefoil	ton	12.0	35.0
Vetch	ton	12.0	47.0
Smooth bromegrass	ton	9.0	47.0
Orchardgrass	ton	14.0	68.0
Tall fescue	ton	12.0	66.0
Timothy	ton	9.0	32.0
Perennial ryegrass	ton	12.0	34.0
Sorghum-sudan	ton	12.0	38.0
Switchgrass	ton	12.0	66.0
Reed canarygrass	ton	9.0	47.0

*Nutrients in corn and soybean stover reflect content at plant maturity (dry matter based), and will therefore be more representative of stover harvested immediately after grain harvest. Corn stover is an average content of all aboveground plant components except grain. Soybean stover is nutrient content only of stems.

The recommendation tables provide suggested P and K applications intended for a single crop grown after soil sampling. Economic considerations suggest that a new soil test should be planned every two to four years for most crops. For P and K applications after the initial crop year and between soil testing years, and for multi-year applications planned for consecutive grain crops (for example, multi-year application for corn-soybean and corn-corn rotations), adjustment should be made to the recommended annual amounts. Available research data suggest that when recommended P and K amounts are applied to soils that test in the very low category, recommended amounts for the low category can be applied to subsequent crops until the next planned soil testing, but not for more than three years. When the recommended P and K amounts are applied to soils that test in the low category, recommended amounts for the optimum category can be applied to subsequent crops until the next planned soil testing, but not for more than three years. When soil tests are in the optimum category, the crop removal amount can be applied each year. For grain crops, an amount equivalent to the sum over two crop years can be applied in one application. Annual P and K applications are recommended for silage or forage crops to minimize excessive nutrient removal when large nutrient rates are applied at one time.

The optimum soil test category is the most profitable to maintain. Phosphorus and K application in the high category seldom produces a profitable yield increase, and no recommendation is made for annual (one crop-year) application. However, if the soil test is in the lower part of the high range, a multi-year application is planned for grain crops (for example, consecutive corn and soybean crops), and it will be two to four years until the next soil sampling, consider applying a partial crop removal rate during that period to ensure adequate nutrients for subsequent crops and to moderate soil test decline. The very high soil test category indicates that the nutrient concentration exceeds crop needs, and further additions of that nutrient very seldom produce a yield response. Therefore, no application is recommended for the very high category.

Method of Application

The recommended amounts for P and K are based on yield responses to applications in many tillage systems—from conventional-tillage to reduced-tillage and no-tillage systems. Research has shown that in most reduced-tillage systems equivalent crop responses are expected for broadcast, 2×2 band, and deep band P and K applications. The exceptions are for K in ridge-tillage corn and soybean where bands placed into the ridge provide higher yields than broadcast, and K in no-tillage corn where deep banding can produce greater yield response than broadcast or 2×2 band placement. However, on average the no-tillage corn yield increase from deep K banding is not large and may often not pay for the increased application costs.

Application of banded NP or NPK starter fertilizer for corn in the high soil test category may be advantageous under conditions of limited soil drainage, cool soil, crop residues on the soil surface, or late planting dates with full-season hybrids. Placement of starter fertilizer with corn seed should be limited to 10 pounds or less of N + K_2O per acre to reduce the risk of decreased plant stand. If soils are sandy or dry, reduce the amount of N + K_2O by one-half. It is recommended that no fertilizer be placed in contact with soybean seed.

Table 3. Phosphorus and potassium recommendations for corn grain production.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
			P_2O_5 to apply (lb/acre)		
	100	75	55	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
Fine Textured	130	90	45	0	0
Sandy Textured	110	70	45	0	0

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on 150 bu corn grain per acre. Nutrient removal amounts can be adjusted higher or lower for other yield levels. At the high soil test category, banded NP or NPK starter fertilizer may be advantageous under conditions of limited soil drainage, cool soil, crop residues on the soil surface, or late planting dates with full-season hybrids. None is recommended for the very high soil test category. Recommendations for soils with a corn suitability rating (CSR) of 30 or less should be based on expected crop yield and nutrient removal for soil test categories of optimum or lower.

Table 4. Phosphorus and potassium recommendations for soybean production.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
			P_2O_5 to apply (lb/acre)		
	80	60	40	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
Fine Textured	120	90	75	0	0
Sandy Textured	100	85	75	0	0

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on 50 bu soybean grain per acre. Nutrient removal amounts can be adjusted higher or lower for other yield levels. Recommendations for soils with a corn suitability rating (CSR) of 30 or less should be based on expected crop yield and nutrient removal for soil test categories of optimum or lower.

Table 5. Phosphorus and potassium recommendations for oat grain and straw production.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
	P_2O_5 to apply (lb/acre)				
	50	40	30	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
	K_2O to apply (lb/acre)				
All Soil Textures	100	90	80	0	0

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on 80 bu oat grain per acre and straw. Nutrient removal amounts can be adjusted higher or lower for other yield levels.

Table 6. Phosphorus and potassium recommendations for wheat production.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
All Subsoil P Levels	0–15	16–20	21–25	26–30	31+
Olsen P:					
All Subsoil P Levels	0–10	11–14	15–17	18–20	21+
Mehlich-3 ICP:					
All Subsoil P Levels	0–20	21–30	31–40	41–50	51+
	P_2O_5 to apply (lb/acre)				
	60	50	30	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
	K_2O to apply (lb/acre)				
All Soil Textures	70	40	15	0	0

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on 50 bu wheat grain per acre. Nutrient removal amounts can be adjusted higher or lower for other yield levels.

Table 7. Phosphorus and potassium recommendations for sunflower production.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
			P_2O_5 to apply (lb/acre)		
	70	50	15	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
All Soil Textures	90	50	15	0	0

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on 2,000 lb sunflower seed per acre. Nutrient removal amounts can be adjusted higher or lower for other yield levels.

Table 8. Phosphorus and potassium recommendations for corn silage or sorghum silage production.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
			P_2O_5 to apply (lb/acre)		
	105	90	75	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
Fine Textured	240	210	175	0	0
Sandy Textured	220	200	175	0	0

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on approximately 22 tons corn silage per acre. Nutrient removal amounts can be adjusted higher or lower for other yield levels. At the high soil test category, banded NP or NPK starter fertilizer may be advantageous under conditions of limited soil drainage, cool soil, crop residues on the soil surface, or late planting dates with full-season hybrids. None is recommended for the very high soil test category. Recommendations for soils with a corn suitability rating (CSR) of 30 or less should be based on expected crop yield and nutrient removal for soil test categories of optimum or lower.

Table 9. Phosphorus and potassium recommendations for alfalfa and alfalfa-grass hay and pastures.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
All Subsoil P Levels	0–15	16–20	21–25	26–30	31+
Olsen P:					
All Subsoil P Levels	0–10	11–14	15–17	18–20	21+
Mehlich-3 ICP:					
All Subsoil P Levels	0–20	21–30	31–40	41–50	51+
			P_2O_5 to apply (lb/acre)		
	110	80	60	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
All Soil Textures	280	240	200	0	0

*For soils that test in the high soil test P category, 30 lb P_2O_5 per acre is recommended at seeding time. The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on 5 ton per acre of harvested hay. Nutrient removal amounts can be adjusted higher or lower for other yield levels. For pastures, reduce the amount in all soil test categories for phosphorus to two-thirds and for potassium to one-half of the amount indicated for hay because more nutrients are returned to the soil when grazing.

Table 10. Phosphorus and potassium recommendations for clover- and trefoil-grass hay and pastures.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
			P_2O_5 to apply (lb/acre)		
	80	60	40	0	0

Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
All Soil Textures	180	140	100	0	0

*The recommended amounts of P_2O_5 and K_2O in the optimum test category are based on 3 ton per acre of harvested hay. Nutrient removal amounts can be adjusted higher or lower for other yield levels. For pastures, reduce the amount in all soil test categories for phosphorus to two-thirds and for potassium to one-half of the amount indicated for hay because more nutrients are returned to the soil when grazing.

Table 11. Phosphorus and potassium recommendations for tall cool-season grasses, warm-season perennial grasses, and sorghum-sudan hay and pastures.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
Low Subsoil P	0–8	9–15	16–20	21–30	31+
High Subsoil P	0–5	6–10	11–15	16–20	21+
Olsen P:					
Low Subsoil P	0–5	6–10	11–14	15–20	21+
High Subsoil P	0–3	4–7	8–11	12–15	16+
Mehlich-3 ICP:					
Low Subsoil P	0–15	16–25	26–35	36–45	46+
High Subsoil P	0–10	11–20	21–30	31–40	41+
			P_2O_5 to apply (lb/acre)		
	90	60	30	0	0
Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
Low Subsoil K	0–90	91–130	131–170	171–200	201+
High Subsoil K	0–70	71–110	111–150	151–180	181+
			K_2O to apply (lb/acre)		
All Soil Textures	160	120	80	0	0

*The amounts of P_2O_5 and K_2O for the optimum category can be adjusted for approximate nutrient removal for the harvested yield. For pastures, reduce the amount in all soil test categories for phosphorus to two-thirds and for potassium to one-half of the amount indicated for hay because more nutrients are returned to the soil when grazing.

Table 12. Phosphorus and potassium recommendations for bluegrass dominant pasture.

Phosphorus Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum**	**High**	**Very High**
Bray P_1 and Mehlich-3 P:					
All Subsoil P Levels	0–8	9–15	16–20	21–30	31+
Olsen P:					
All Subsoil P Levels	0–5	6–10	11–14	15–20	21+
Mehlich-3 ICP:					
All Subsoil P Levels	0–15	16–25	26–35	36–45	46+
			P_2O_5 to apply (lb/acre)		
	40	30	0	0	0
Potassium Soil Test (ppm)					
Soil Test Category:	**Very Low**	**Low**	**Optimum**	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K:					
All Subsoil K	0–90	91–130	131–170	171–200	201+
			K_2O to apply (lb/acre)		
All Soil Textures	40	30	0	0	0

Micronutrients Recommendations

Iowa State University recommends only zinc (Zn) for corn and sorghum based on soil testing. The Zn soil test has been calibrated on Iowa soils. Zinc recommendations for corn and sorghum are given in Table 13.

Soil test procedures for the other micronutrients have not been calibrated because of either lack of or inconsistency of occurrence of deficiencies with the exception of iron deficiency on soybean. Iron deficiency on soybean occurs on high pH (calcareous) soils in central and north central Iowa and can be predicted by soil occurrence as shown in soil survey reports. Development of soybean varieties tolerant to low iron availability in calcareous soils has been an acceptable solution to the problem.

Table 13. Zinc recommendations for corn and sorghum production.

	Zinc Soil Test (ppm)		
Soil Test Category:	**Low**	**Marginal**	**Adequate**
DTPA Extractable Zn:	0–0.4	0.5–0.8	0.9+
	Zn to apply broadcast (lb/acre)		
	10	5	0
	Zn to apply in band (lb/acre)*		
	2	1	0

*Recommendation for amount to apply in band is based on other states' information.

Limestone Recommendations

Limestone recommendations (Table 14) are given in pounds of pure fine calcium carbonate ($CaCO_3$). The recommended amounts listed in Table 14 are for different soil Buffer pH, intended soil pH, and depth of soil to be neutralized. Actual rates of limestone to apply are calculated from the recommended $CaCO_3$ rate (Table 14) and the effective calcium carbonate equivalent (ECCE) of the limestone product to be applied (ECCE is determined for all agricultural limestone sources in Iowa). Soil pH is used to determine whether or not to lime the soil. The SMP Buffer (also termed the Ohio Buffer) solution has been calibrated to determine the amount of lime required to increase soil pH to a specific pH.

Recommendations are given to increase soil pH to 6.5 or to 6.9. Soil pH 6.0 is considered to be sufficient for grass pastures and grass haylands. Soil pH 6.9 is recommended for alfalfa. Soil pH 6.5 is considered to be sufficient for corn and soybean. Because of high pH (pH > 7.4) in the subsoil of the Clarion-Nicollet-Webster, Galva-Primghar-Sac, Moody, Ida-Monona, Marshall, and Luton-Onawa-Salix soil associations, soil pH 6.0 is considered sufficient for corn and soybean grown in these soil associations, but when liming is required, lime is recommended to raise soil pH to 6.5.

The amount of limestone recommended is adjusted for the incorporation depth from tillage, which determines the volume of soil to be neutralized. The equivalent depth for no-till is considered to be 2 to 3 inches.

Table 14. Lime recommendations, based on SMP Buffer Test, are given in pounds of pure fine calcium carbonate ($CaCO_3$) to increase soil pH from its present level to pH 6.5 or 6.9 for the depth of soil to be neutralized.

	Depth of soil to be neutralized*							
Buffer	**2 inch**		**3 inch**		**6 inch**		**8 inch**	
pH	**pH 6.5**	**pH 6.9**	**pH 6.5**	**pH 6.9**	**pH 6.5**	**pH 6.9**	**pH 6.5**	**pH 6.9**
	- $CaCO_3$ to apply (lb/acre) -							
7.0	0	400	0	600	0	1,100	0	1,500
6.9	0	600	0	1,000	0	1,900	0	2,500
6.8	200	900	300	1,400	600	2,700	800	3,600
6.7	400	1,200	700	1,800	1,300	3,500	1,700	4,700
6.6	700	1,500	1,100	2,200	2,100	4,400	2,800	5,900
6.5	900	1,700	1,400	2,600	2,800	5,200	3,700	6,900
6.4	1,200	2,000	1,800	3,000	3,500	6,000	4,700	8,000
6.3	1,400	2,300	2,100	3,400	4,200	6,800	5,600	9,100
6.2	1,700	2,600	2,500	3,900	5,000	7,700	6,700	10,300
6.1	1,900	2,800	2,900	4,300	5,700	8,500	7,600	11,400
6.0	2,200	3,100	3,200	4,700	6,400	9,300	8,600	12,400
5.9	2,400	3,400	3,600	5,100	7,100	10,100	9,500	13,500
5.8	2,600	3,700	4,000	5,500	7,900	11,000	10,600	14,700
5.7	2,900	3,900	4,300	5,900	8,600	11,800	11,500	15,900

*Soil pH 6.9 is recommended for alfalfa. Soil pH 6.5 is considered to be sufficient for corn and soybean. Because of high pH subsoils in the Clarion-Nicollet-Webster, Galva-Primghar-Sac, Moody, Ida-Monona, Marshall, and Luton-Onawa-Salix soil associations, soil pH 6.0 is considered sufficient for corn and soybean grown in these soil associations, but when liming is required, lime to soil pH 6.5. Soil pH 6.0 is sufficient for grass pastures and grass hayland.

Soils

Table 15. Subsoil phosphorus and potassium levels that are to be used to determine phosphorus and potassium nutrient recommendations for the major soil series in each of the 12 major soil areas in Iowa. Soil series of more than 5,000 acres and with a corn suitability rating of 30 or greater are listed. (Source: Iowa Soil Properties and Interpretations Database [ISPAID] 7.0, revised November 2002**)**

Abbreviations used in the subsections of this table are as indicated:
Str Sub: stratified subsoil
R: rock
S&G: sand and gravel

A. Major soil area 1 that includes the Downs, Fayette, and Fayette-Dubuque-Stonyland soil associations.

1. Loess-derived soils

Soil Name	Acres in Series	Sub P	Sub K
Arenzville	19,679	H	L
Arenzville-Chaseburg Complex	54,144	H	L
Bertrand	7,871	H	L
Caneek	9,223	H	L
Chaseburg	47,346	H	L
Chelsea-Lamont-Fayette	6,090	L	L
Colo-Ely Complex	10,234	H	L
Dinsdale	24,260	L	L
Dockery	5,430	H	L
Dorchester	22,927	H	L
Downs	545,763	H	L
Downs Benches	6,276	H	L
Downs-Tama Complex	40,208	H	H
Eitzen	9,480	L	L
Exette	27,685	H	L
Fayette	1,174,150	H	L
Fayette Benches	5,967	H	L
Huntsville	6,140	H	L
Ion	6,560	L	L
Newvienna	19,125	H	L
Orion	14,940	H	L

—continued

A. Major soil area 1 that includes the Downs, Fayette, and Fayette-Dubuque-Stonyland soil associations, continued**.**

1. Loess-derived soils

Soil Name	Acres in Series	Sub P	Sub K
Orwood	27,947	H	L
Ossian	6,250	H	L
Otter Overwash	6,180	H	H
Otter-Worthen Complex	24,968	H	L
Rozetta	14,800	H	L
Rozetta-Eleroy Complex	23,880	H	L
Sawmill	15,710	H	L
Tama	19,150	H	L
Worthen	11,167	H	L

2. Till-derived soils

Soil Name	Acres in Series	Sub P	Sub K
Jacwin	5,878	L	L
Lamont	14,374	H	L

B. Major soil area 2 that includes the Dinsdale-Tama and Tama-Muscatine soil associations.

Soil Name	Acres in Series	Sub P	Sub K
Ackmore	35,020	H	L
Ackmore-Colo Complex	48,635	H	L
Amana-Lawson-Perks	7,238	L	L
Ambraw	11,540	H	L
Atterberry	51,420	H	L
Atterberry Benches	9,754	H	L
Atterberry Sandy Subsoil	12,735	H	L
Bassett	7,722	H	L
Bolan	6,405	L	L
Bremer	30,630	H	H
Calco	7,094	H	L
Chelsea-Lamont-Fayette	15,046	L	L
Colo	207,339	H	L
Colo-Ely Complex	250,218	H	L

—continued

B. Major soil area 2 that includes the Dinsdale-Tama and Tama-Muscatine soil associations, continued.

Soil Name	Acres in Series	Sub P	Sub K
Dickinson	13,545	L	L
Dinsdale	358,010	H	L
Downs	70,560	H	L
Downs Sandy Subsoil	16,560	H	L
Ely	20,551	L	L
Fayette	34,295	H	L
Fayette Sandy Subsoil	5,000	H	L
Franklin	20,145	H	L
Fruitfield	7,760	L	L
Garwin	77,013	L	L
Garwin Sandy Subsoil	5,450	L	L
Judson	26,501	H	H
Kennebec	10,597	H	H
Kenyon	9,274	L	L
Killduff	110,635	H	L
Klinger	6,940	L	H
Klinger-Maxfield Complex	8,040	L	L
Koszta	8,056	H	L
Lawler 32–40″ To S&G	8,362	L	L
Lawson	14,426	H	L
Liscomb	10,375	L	L
Maxfield	35,141	L	L
Mt. Carroll	5,610	H	L
Muscatine	225,802	H	L
Muscatine Benches	7,856	H	L
Nevin	38,641	H	H
Nodaway	55,726	H	L
Nodaway-Arenzville Complex	13,160	H	L
Port Byron	9,335	H	L
Raddle	5,445	H	L
Radford	5,690	H	L
Richwood	7,272	H	L
Rowley	10,555	H	L
Saude	5,425	L	L
Sawmill	34,745	H	L
Sawmill-Garwin Complex	35,937	L	L

—continued

B. Major soil area 2 that includes the Dinsdale-Tama and Tama-Muscatine soil associations, continued.

Soil Name	Acres in Series	Sub P	Sub K
Shaffton	14,510	H	L
Shelby	11,590	H	L
Sparta	16,005	L	L
Tama	841,398	H	L
Tama Benches	18,759	H	L
Tama Sandy Subsoil	23,777	H	L
Tama-Dickinson Complex	8,895	L	L
Walford	24,465	H	L
Walford Benches	5,122	H	L
Waubeek	26,515	H	L
Waukee	5,225	H	L
Waukegan	22,137	H	L
Whittier	8,535	H	L
Wiota	24,783	H	H
Zook	16,691	H	L

C. Major soil area 3 that includes the Otley-Mahaska-Taintor and Clinton-Keswick-Lindley soil associations.

Soil Name	Acres in Series	Sub P	Sub K
Amana	16,568	H	L
Ambraw	8,405	H	L
Bremer	5,205	H	H
Clinton	377,687	H	L
Clinton Benches	24,697	H	L
Coland	5,095	H	L
Colo	38,379	H	L
Colo-Ely Complex	52,688	H	L
Colo-Zook Complex	8,070	H	L
Coppock	8,984	H	L
Ely	16,760	H	H
Fayette	7,790	H	L
Gara	51,687	H	L
Givin	43,369	H	L
Hedrick	47,455	H	L

—continued

C. Major soil area 3 that includes the Otley-Mahaska-Taintor and Clinton-Keswick-Lindley soil associations, continued**.**

Soil Name	Acres in Series	Sub P	Sub K
Inton	11,675	H	H
Kalona	23,015	L	L
Keomah	16,095	H	L
Klum	5,588	L	L
Ladoga	281,324	H	L
Ladoga Benches	14,194	H	L
Lawson	6,175	H	L
Lindley	44,305	H	L
Mahaska	212,911	H	H
Nevin	5,200	H	H
Nira	75,880	H	L
Nodaway	39,128	H	L
Nodaway-Cantril Complex	15,373	L	L
Nodaway-Martinsburg Complex	13,318	H	L
Nodaway-Vesser Complex	9,725	H	L
Nodaway-Vesser-Ackmore	7,210	L	L
Olmitz	6,124	L	H
Otley	295,300	H	L
Otley Benches	5,568	H	L
Otley-Nira Complex	5,670	H	L
Radford	5,504	H	L
Shelby	20,229	L	L
Sparta	11,476	L	L
Sperry	11,162	H	H
Taintor	161,872	L	L
Titus	5,340	H	L
Tuskeego	8,858	H	L
Vesser	7,911	H	L
Zook	24,622	H	L

D. Major soil area 4 that includes the Adair-Seymour, Grundy-Haig, Adair-Grundy-Haig, and Lindley-Keswick-Weller soil associations.

Soil Name	Acres in Series	Sub P	Sub K
Ackmore	5,015	H	L
Adair	47,502	L	L
Amana	6,125	H	L
Appanoose	8,353	H	L
Arispe	135,013	L	L
Armstrong	6,735	L	L
Beckwith	7,321	H	L
Belinda	31,906	H	L
Caleb	14,047	L	L
Cantril	8,156	L	L
Cantril-Coppock-Nodaway	58,539	L	L
Chequest	16,665	H	L
Clarinda	29,645	L	L
Clearfield	6,535	H	L
Clearfield-Arispe Complex	9,252	L	L
Colo	24,877	H	L
Colo-Ely Complex	13,800	H	L
Coppock	16,582	H	L
Downs	6,951	H	L
Edina	108,035	L	L
Fayette	5,362	H	L
Gara	226,070	H	L
Gara-Armstrong Complex	7,650	L	L
Grundy	160,303	H	L
Haig	121,765	H	L
Humeston	24,668	H	L
Kennebec	6,170	H	H
Kennebec-Amana Complex	11,905	H	L
Kniffin	66,856	H	L
Ladoga	6,225	H	L
Ladoga Benches	5,210	H	L
Lamoni	31,091	L	L
Landes	6,439	L	L
Lawson	13,393	H	L
Lindley	26,328	H	L
Lineville	17,597	L	L

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D. Major soil area 4 that includes the Adair-Seymour, Grundy-Haig, Adair-Grundy-Haig, and Lindley-Keswick-Weller soil associations, continued.

Soil Name	Acres in Series	Sub P	Sub K
Macksburg	8,385	H	H
Nira	19,600	H	L
Nodaway	36,717	H	L
Nodaway-Lawson-Ackmore	14,038	H	L
Nodaway-Lawson-Klum	12,710	L	L
Olmitz	20,020	L	H
Olmitz-Vesser-Colo	203,026	L	L
Pershing	218,817	H	L
Pershing Benches	29,905	H	L
Rathbun	8,328	H	L
Seymour	124,134	H	L
Sharpsburg	9,860	H	H
Shelby	116,359	L	L
Tuskeego	7,618	H	L
Vesser	35,935	H	L
Wabash	7,403	H	H
Weller	169,524	H	L
Zook	29,433	H	L
Zook-Ely Complex	11,475	H	L

E. Major soil area 5 that includes the Shelby-Sharpsburg-Macksburg soil association.

Soil Name	Acres in Series	Sub P	Sub K
Ackmore	9,380	H	L
Adair Thin Solum	30,255	L	L
Adair-Shelby Complex	10,931	L	L
Bremer	6,206	H	H
Clarinda	7,505	L	L
Clearfield	42,780	H	L
Clinton	26,697	H	L
Colo	67,442	H	L
Colo Overwash	9,364	H	L
Colo-Ackmore Complex	9,340	H	L
Colo-Ely Complex	146,672	H	L
Colo-Judson-Nodaway	36,528	H	L

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E. Major soil area 5 that includes the Shelby-Sharpsburg-Macksburg soil association, continued.

Soil Name	Acres in Series	Sub P	Sub K
Downs	14,100	H	L
Fayette	11,697	H	L
Gara	59,582	H	L
Humeston	5,400	H	L
Judson	14,752	H	H
Kennebec	8,808	H	H
Ladoga	160,886	H	L
Lamoni	30,780	L	L
Macksburg	87,651	H	H
Nevin	16,527	H	H
Nira	84,629	H	L
Nira-Sharpsburg Complex	25,248	H	L
Nodaway	55,004	H	L
Olmitz	12,275	L	H
Sharpsburg	639,674	H	H
Sharpsburg Benches	17,294	H	H
Shelby	234,586	L	L
Tama	19,626	H	L
Vesser	8,431	H	L
Wabash	38,287	H	H
Winterset	22,844	H	H
Zook	76,217	H	L
Zook-Colo-Ely	11,165	H	L

F. Major soil area 6 that includes the Marshall soil association.

Soil Name	Acres in Series	Sub P	Sub K
Ackmore	31,048	H	L
Burchard	6,030	H	H
Calco	6,994	H	L
Colo	69,125	H	L
Colo-Judson Complex	473,474	H	L
Ely	7,226	H	H
Exira	234,720	L	H
Judson	118,471	H	H
Kennebec	62,245	H	H
Kennebec-Ackmore Complex	6,420	H	L
Marshall	926,427	H	H
Marshall Benches	44,816	H	H
Minden	6,673	H	H
Monona	50,630	L	L
Napier-Kennebec-Nodaway	53,090	L	L
Nevin	5,515	H	H
Nodaway	98,318	H	L
Shelby	34,400	L	L
Zook	55,426	H	L

G. Major soil area 7 that includes the Monona-Ida-Hamburg soil association.

Soil Name	Acres in Series	Sub P	Sub K
Calco	5,230	H	L
Castana	16,086	L	L
Ida	402,531	L	L
Kennebec	72,505	H	H
Kennebec-McPaul Complex	8,015	H	H
McPaul	9,490	H	H
McPaul-Kennebec Complex	16,000	H	H
Monona	688,686	H	H
Monona Benches	15,393	H	L
Napier	270,672	L	H
Nodaway	8,940	H	H
Rawles	8,470	H	H

H. Major soil area 8 that includes the Luton-Onawa-Salix soil association.

Soil Name	Acres in Series	Sub P	Sub K
Albaton	54,983	L	H
Blake	20,158	L	H
Blencoe	16,117	L	H
Blend	7,267	L	H
Carr	5,920	L	H
Cooper	9,748	L	H
Forney	13,916	L	H
Grable	9,845	L	H
Haynie	39,041	L	H
Keg	20,553	L	H
Lakeport	14,131	L	H
Lossing	5,767	L	H
Luton	114,634	L	H
Luton Thin Surface	17,575	L	H
McPaul	66,426	H	H
McPaul-Kennebec Complex	13,410	H	H
Modale	10,424	L	H
Moville	8,085	L	H
Napier-Castana Complex	8,900	L	L
Napier-Nodaway-Colo	5,177	L	L
Onawa	31,497	L	H
Owego	6,207	L	H
Percival	8,195	L	H
Salix	26,372	L	H
Tieville	5,858	L	H
Woodbury	16,169	L	H

I. Major soil area 9 that includes the Galva-Primghar-Sac soil association.

Soil Name	Acres in Series	Sub P	Sub K
Ackmore	11,305	H	L
Afton	45,552	L	L
Allendorf	5,520	L	L
Bolan	6,302	L	L
Calco	28,242	H	L
Colo	97,943	H	L
Colo-Judson Complex	28,610	H	L
Davis	5,970	H	L
Ely	7,235	H	H
Everly	59,439	L	L
Galva	1,068,182	L	L
Galva Benches	67,332	L	L
Galva Str Sub	15,715	L	L
Ida	9,005	L	L
Judson	7,255	H	H
Kennebec	26,265	H	H
Letri Calcareous	5,445	L	L
Marcus	159,279	L	L
Nicollet	24,494	L	L
Ocheyedan	13,358	L	H
Primghar	366,779	L	L
Radford	59,045	H	L
Ransom	12,555	L	L
Sac	169,598	L	L
Spicer	7,195	L	L
Spillco	11,195	H	L
Spillville	7,960	L	L
Steinauer	5,561	L	L
Terril	9,280	L	L
Tripoli	17,241	L	L
Wadena 24–32″ To S&G	5,910	L	L
Wilmonton	23,815	L	L

J. Major soil area 10 that includes the Moody soil association.

Soil Name	Acres in Series	Sub P	Sub K
Crofton	5,700	L	L
Egan	17,620	L	L
Moody	153,555	L	L
Moody Loamy Subsoil	5,015	L	L
Trent	13,100	L	L

K. Major soil area 11 that includes the Clarion-Nicollet-Webster soil association.

Soil Name	Acres in Series	Sub P	Sub K
Biscay Deep	43,703	L	L
Blue Earth	16,208	L	L
Bode	56,321	L	L
Brownton	57,027	L	L
Calco	10,371	H	L
Canisteo	1,297,749	L	L
Clarion	1,629,066	L	L
Clarion Long Slopes	26,815	L	L
Clarion-Storden Complex	83,342	L	L
Coland	134,671	H	L
Coland-Spillville Complex	63,328	L	L
Collinwood	19,024	L	L
Colo	18,452	H	L
Crippin	40,208	L	L
Cylinder Deep	34,026	L	L
Cylinder Moderately Deep	14,270	L	L
Dickinson	8,072	L	L
Dickman	12,231	L	L
Estherville	9,746	L	L
Fieldon	11,369	L	L
Fostoria	8,731	L	L
Guckeen	11,452	L	L
Hanlon	8,280	L	L
Hanska	5,325	L	L
Harcot	20,750	L	L
Harps	255,122	L	L

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K. Major soil area 11 that includes the Clarion-Nicollet-Webster soil association, continued**.**

Soil Name	Acres in Series	Sub P	Sub K
Havelock	13,735	L	L
Hayden	37,778	H	L
Kilkenny	13,704	H	L
Knoke	24,276	L	L
Kossuth	76,968	L	L
Le Sueur	14,598	H	L
Lester	104,111	H	L
Lester Long Slopes	5,050	H	L
Linder	8,683	L	L
Luther	8,684	H	L
Marna	23,015	L	L
Mayer 24–32″ To S&G	6,662	L	L
Mayer 32–40″ To S&G	5,620	L	L
Nicollet	1,067,487	L	L
Okoboji	318,210	L	L
Okoboji-Harps Complex	40,776	L	L
Ottosen	72,172	L	L
Palms	35,517	H	L
Ridgeport	16,714	H	H
Rolfe	5,355	L	H
Spicer	5,882	L	L
Spillville	66,514	H	L
Storden	109,067	L	L
Talcot 32–40″ To S&G	45,340	L	L
Terril	29,781	L	L
Truman Str Sub	7,020	H	L
Vinje	6,836	L	L
Wacousta	20,232	L	L
Wadena 24–32″ To S&G	77,175	L	L
Wadena 32–40″ To S&G	31,082	L	L
Waldorf	24,575	L	L
Webster	918,520	L	L
Webster-Nicollet Complex	77,907	L	L
Zenor	15,938	H	L

L. Major soil area 12 that includes the Kenyon-Floyd-Clyde and Cresco-Lourdes-Clyde soil associations.

Soil Name	Acres in Series	Sub P	Sub K
Ansgar	9,495	H	L
Aredale	37,724	L	L
Ashdale	6,255	H	L
Atkinson	6,978	L	L
Bassett	140,498	H	L
Bolan	26,491	L	L
Burkhardt-Saude Complex	6,857	L	L
Chelsea	12,351	L	L
Clyde	381,543	L	L
Clyde-Floyd Complex	318,086	L	L
Coggon	7,078	H	L
Coland	25,785	H	L
Cresco	47,728	L	L
Dickinson	84,505	L	L
Dickinson Loamy Subsoil	15,850	L	L
Dickinson-Ostrander Complex	5,039	L	L
Dinsdale	44,033	H	L
Donnan	24,633	L	L
Downs	9,558	H	L
Finchford	10,170	H	L
Flagler	42,799	L	L
Floyd	256,708	L	L
Franklin	23,132	H	L
Hayfield 24–32″ To S&G	23,484	H	L
Hayfield 24–40″ To S&G	9,739	H	L
Hoopeston	7,317	L	L
Jameston	6,484	L	L
Kenyon	591,170	L	L
Klinger	139,349	L	H
Lamont	7,542	H	L
Lawler 24–32″ To S&G	37,772	L	L
Lawler 32–40″ To S&G	50,196	L	L
Lourdes	19,330	L	L

—continued

L. Major soil area 12 that includes the Kenyon-Floyd-Clyde and Cresco-Lourdes-Clyde soil associations, continued.

Soil Name	Acres in Series	Sub P	Sub K
Marshan 24–32″ To S&G	27,264	L	L
Marshan 32–40″ To S&G	88,781	L	L
Maxfield	63,479	L	L
Olin	63,200	L	L
Oran	83,395	L	L
Ostrander	94,518	L	L
Palms	10,864	L	L
Protivin	34,767	L	L
Racine	43,776	L	L
Readlyn	200,316	L	L
Riceville	13,283	L	L
Rockton 20–30″ To R	38,953	L	L
Rockton 30–40″ To R	22,146	L	L
Rossfield	8,075	H	L
Sattre	6,566	H	L
Saude	133,715	L	L
Schley	61,513	L	L
Seaton	6,008	H	L
Sparta	70,253	L	L
Spillville	34,753	L	L
Spillville-Coland Complex	29,291	L	L
Tama	5,850	H	L
Terril	22,225	L	L
Tripoli	102,559	L	L
Turlin	5,218	L	L
Udolpho	5,105	H	L
Wapsie	52,150	H	L
Waubeek	9,387	H	L
Waukee	61,392	H	L
Winneshiek	25,549	H	L

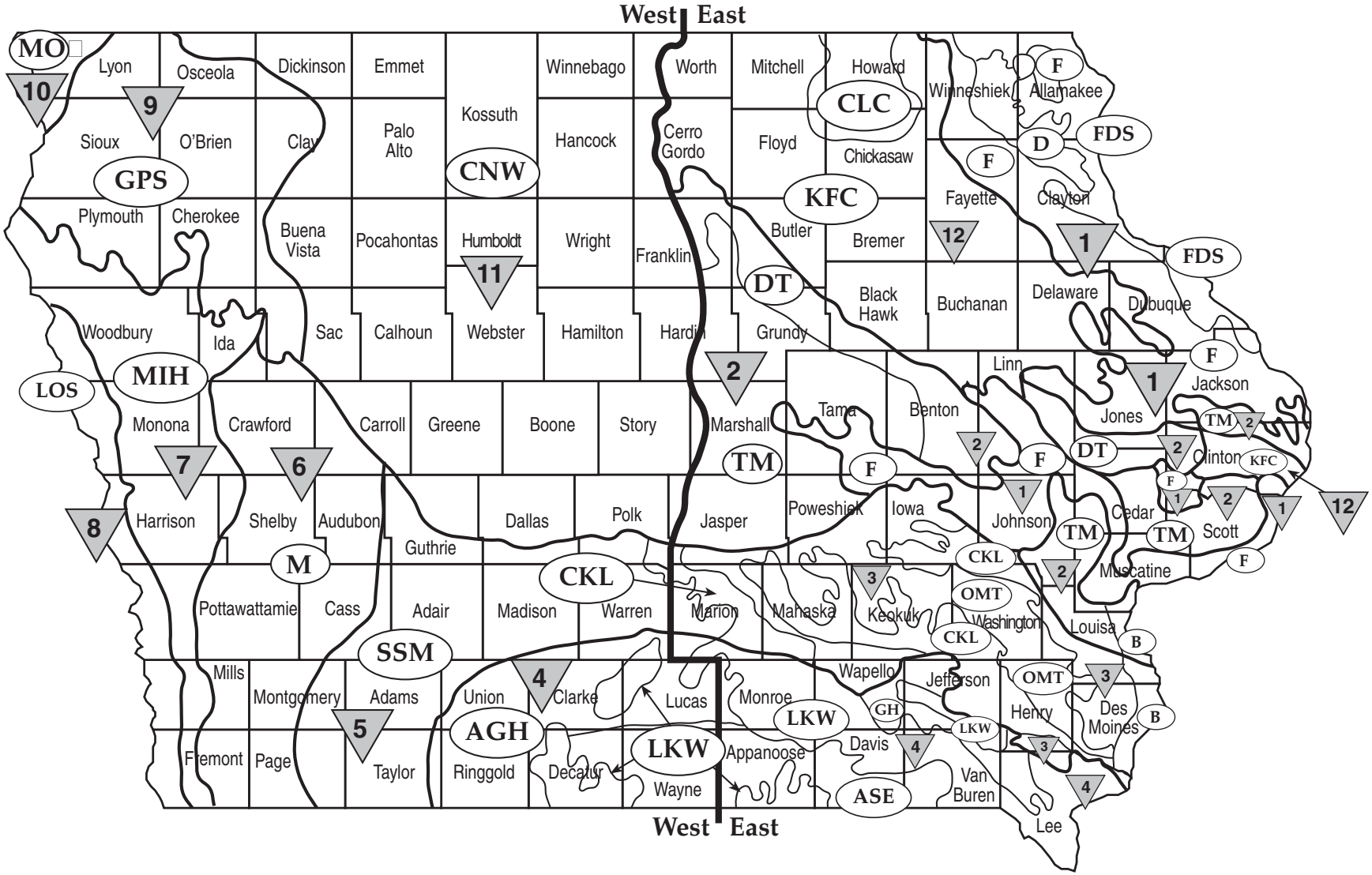

Figure 1. Map of Iowa delineating the 21 principal soil association areas (letters) and the 12 major soil areas (numbers). B designates the Mississippi bottomland.

AGH:	Adair-Grundy-Haig	D:	Downs	GH:	Grundy-Haig	MIH:	Monona-Ida-Hamburg
ASE:	Adair-Seymour-Edina	DT:	Dinsdale-Tama	KFC:	Kenyon-Floyd-Clyde	Mo:	Moody
CKL:	Clinton-Keswick-Lindley	F:	Fayette	LKW:	Lindley-Keswick-Weller	OMT:	Otley-Mahaska-Taintor
CLC:	Cresco-Lourdes-Clyde	FDS:	Fayette-Dubuque-Stonyland	LOS:	Luton-Onawa-Salix	SSM:	Shelby-Sharpsburg-Macksburg
CNW:	Clarion-Nicollet-Webster	GPS:	Galva-Primghar-Sac	M:	Marshall	TM:	Tama-Muscatine

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University Extension

File: Agronomy 8-2

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Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Jack M. Payne, director, Cooperative Extension Service, Iowa State University of Science and Technology, Ames, Iowa.