Soil Test Interpretations and Fertilizer Recommendations

Kansas State University
Department of Agronomy MF-2586 Nutrient Management

Development of sound nutrient management programs involves knowledge of a wide range of information. Soil test records are an important piece of required information, but other factors such as soil moisture conditions, land ownership/tenure, crop and cropping sequence, pest management, cultural practices, environmental issues, and other management items are vital for developing sound nutrient management programs. It is beyond the scope of this publication to detail the ramifications of all these factors, but they should not be overlooked when finalizing nutrient application programs.

The following tables, equations and accompanying information are the most recent soil test interpretations for major crops for the most commonly deficient plant nutrients in Kansas. These interpretations are valid for interpreting soil test values from the KSU Soil Testing Laboratory and other laboratories utilizing the same soil testing procedures.

Yield Goals

Suggested recommended application rates are tied to yield goals for several nutrients. Yield records should be used to set individual realistic, but progressive, yield goals for each field. Appropriate yield goals for a specific field should be high enough to take advantage of high production years when they occur, but not so high as to jeopardize environmental stewardship and/or profitability when environmental conditions are not as favorable. Appropriate yield goals fall between the average yield obtained in a field over the past 3 to 5 years and the highest yield ever obtained in a particular field.

Soil Sampling Depth.

Interpretations for the nitrate-N, sulfate-S and chloride-Cl soil tests are based on a 0-24 inch soil profile sampling depth. All other nutrient interpretations are based on surface soil samples collected to a depth of six inches. We suggest collecting a sample from the 0 to 24 inch depth for N, S and Cl recommendations and a separate 0- to 6-inch sample for pH, P, K, Zn, Fe and B soil test determinations.

For lime, the recommended lime rate should be adjusted to reflect the depth of lime incorporation, while no-till and perennial crops should assume a depth of 2 inches.

A downloadable version of these recommendations is available at www.oznet.ksu.edu/agronomy/soiltesting/

Appropriate Soil Test Procedures

The KSU soil test interpretations are based on the following soil test procedures:

Soil pH – 1:1 Water pH

Buffer pH – SMP Buffer (determines lime requirement)

Nitrogen – Available Nitrate-N

Phosphorus:

Bray P1 Extractable P
Mehlich III Extractable P (ICP) – interpreted the same as Bray P1
Olsen P – multiply by 1.6 and interpret similarly to Bray P1

Potassium – Ammonium Acetate Extractable

Zinc, Iron and Boron – DTPA Extractable

Sulfur – Calcium Phosphate Extractable Sulfate

Chloride – Mercury (II) Thiocyanate Extractable (Colorimetric)

Nitrogen Interpretations

The nitrogen requirement for a specific crop and yield goal is adjusted by taking into account many field specific factors. The K-State nitrogen recommendation guidelines for all crops are directly adjusted for soil organic matter content. Twenty pounds of available N per acre is expected to be mineralized during the crop year for each 1.0 percent soil organic matter in the surface six inches for warm season crops (e.g. corn, grain sorghum), while 10 pounds nitrogen per acre is expected to be mineralized for each 1.0 percent soil organic matter for cool season crops (e.g. wheat). In addition, the previous crop, residual profile N, manure applications, irrigation water N content, grazing N removal and the tillage system utilized are additional factors used to refine suggested N application rates for specific crop situations. Detailed information for major crops is provided. Since nitrate (NO_3^--N) is mobile, we encourage use of a 0- to 24-inch soil sample to assess the profile N content (also for sulfate and chloride as they are mobile in soils as well).

How and when N is applied can have a dramatic effect on how efficiently it will be utilized by the crop. For example, using delayed or split N applications on irrigated fields, particularly on sandy soils, often improves N use efficiency by reducing the potential for loss. Also, for high residue systems such as no-till, placing fertilizer N below the residue or dribbling N solution in concentrated bands on the soil surface offers the potential for improved N use efficiency for summer crops. Many factors other than application rate influence N use efficiency and should be taken into account when developing the overall nutrient management plan.

Soil pH and Liming Interpretations

A buffer pH will be determined and reported on all soils having a pH of less then 6.4. Options are provided for liming to various target pH's and information is provided for various areas of the state to aid in selection of an appropriate target pH, based on subsoil acidity and crops to be grown.

Phosphorus and Potassium Interpretations.

Kansas State University phosphorus and potassium recommendations provide two main options for producers, depending on circumstances for specific producers, fields and situations.

'Sufficiency' fertility programs are intended to estimate the long-term average amount of fertilizer phosphorus required to, on the average, provide optimum economic return in the year of nutrient application while achieving about 90 to 95 percent of maximum yield. In some years greater amounts of nutrient are required for optimum yield and economic return, while in other years less than recommended amounts of nutrient would suffice. There is little consideration of future soil test values and soil test values will likely stabilize in the 'low', crop responsive range.

'Build-maintenance' recommendations are intended to apply enough phosphorus or potassium to build soil test values to a target soil test value over a planned timeframe (typically 4 to 8 years) and then maintain soil test values in a target range in future years. If soil test values exceed the target range, no phosphorus or potassium is recommended with the exception of low starter applied rates if desired. Build-maintenance fertility programs are not intended to provide optimum economic returns in a given year, but rather attempt to minimize the probability of phosphorus or potassium limiting crop yields while providing for near maximum yield potential.

Secondary/Micronutrient Interpretations

The KSU Soil Testing Lab offers soil tests and interpretations for sulfur, zinc, chloride, iron and boron. Detailed information is provided for interpreting soil test values for these nutrients and for recommending rates of application if they are deficient. To date in Kansas, we have not documented deficiencies of manganese (Mn), copper (Cu), or molybdenum (Mo) and do not offer interpretations for these micronutrients.

Nitrogen Rate Recommendation Adjustments for Cool Season Crops

Soil Organic Matter (SOM) Adjustment
Lb N/A Adjustment = % SOM x 10

Manure N

Inorganic N	100%of Manure Worksheet value[2]
Organic N	50%of Manure Worksheet value[2]

Profile N Test (2 foot sampling depth , if possible)

Default	30 Lb N/A if Profile N Sample Not Collected

Lb N/A = 0.3 x Sampling Depth (inches) x ppm Profile Nitrate-N

Tillage Adjustment

Conventional Tillage	0 Lb N/A
No-Tillage	+ 20 Lb N/A

Grazing Adjustment
40 Lb N per 100 Lb beef weight gain per acre

Previous Crop Adjustment

Corn, Wheat	0 Lb N/A
Sorghum, Sunflowers,	+ 30 Lb N/A
Soybeans	0 Lb N/A
Fallow	
Without Profile N Test	- 20 Lb N/A
With Profile N Test	0 Lb N/A

	With Stand Destruction Tillage[1]
Alfalfa	
Excellent Stand (> 5 plants/ft2)	- 60 Lb N/A
Good Stand (2 –5 plants/ft2)	- 40 Lb N/A
Fair Stand (1-2 plants/ft2)	- 20 Lb N/A
Poor Stand (< 1 plant/ft2)	0 Lb N/A
Red Clover	
Excellent Stand	- 40 Lb N/A
Good Stand	- 20 Lb N/A
Poor Stand	0 Lb N/A
Sweet Clover	
Excellent Stand	- 55 Lb N/A
Good Stand	- 30 Lb N/A
Poor Stand	0 Lb N/A

[1] *For no-till production, reduce nitrogen credit adjustment by 50 percent*
[2] *"Estimating Manure Nutrient Availability," MF-2562*

Nitrogen Rate Recommendation Adjustments for Warm Season Crops

Soil Organic Matter (SOM) Adjustment
Lb N/A Adjustment = % SOM x 20

Manure N

Inorganic N	100% of Manure Worksheet value[2]
Organic N	100% of Manure Worksheet value[2]

Profile N Test (2 foot sampling depth , if possible)

Default	30 Lb N/A if Profile N Sample Not Collected

Lb N/A = 0.3 x Sampling Depth (inches) x ppm Profile Nitrate-N

Irrigation Water Nitrate N
Lb N/A = ppm Nitrate-N in Water x 0.226 x Inches Irrigation Water Applied

Previous Crop Adjustment

Corn, Wheat	0 Lb N/A
Sorghum, Sunflowers	0 Lb N/A
Soybeans	- 40 Lb N/A
Fallow	
Without Profile N Test	- 20 Lb N/A
With Profile N Test	0 Lb N/A

	With Stand Destruction Tillage[1]
Alfalfa	
Excellent Stand (> 5 plants/ft2)	- 120 Lb N/A
Good Stand (2 –5 plants/ft2)	- 80 Lb N/A
Fair Stand (1-2 plants/ft2)	- 40 Lb N/A
Poor Stand (< 1 plant/ft2)	0 Lb N/A
Red Clover	
Excellent Stand	- 80 Lb N/A
Good Stand	- 40 Lb N/A
Poor Stand	0 Lb N/A
Sweet Clover	
Excellent Stand	- 110 Lb N/A
Good Stand	- 60 Lb N/A
Poor Stand	0 Lb N/A

[1] *For no-till production, reduce nitrogen credit adjustment by 50 percent*
[2] *"Estimating Manure Nutrient Availability," MF-2562*

Nitrogen Recommendations

Corn Nitrogen Recommendations

Fertilizer N Required At Various Yield and Soil Organic Matter Levels Assuming Profile N Test Is Not Used (includes 30 Lb N/A residual default) [1]

Yield Goal	Soil Organic Matter Content (%)						
	1.0	1.5	2.0	2.5	3.0	3.5	4.0
(Bu/A)	- - - - - - - Lb N/A - - - - - - - -						
60	46	36	26	16	6	0	0
100	110	100	90	80	70	60	50
140	174	164	154	144	134	124	114
180	238	228	218	208	198	188	178
220	300	292	282	272	262	252	242

N Rec [2, 3] = (Yield Goal × 1.6) – (% SOM × 20) – Profile N – Manure N – Other N Adjustments + Previous Crop Adjustments

[1] *Total N requirements presented include only Yield Goal and Soil Organic Matter Adjustments assuming profile N test not used. N rate should also be adjusted for Previous Crop, Manure and Other Appropriate N Rate Adjustments (see N rate adjustments for warm-season crops).*

[2] *Maximum fertilizer N recommendations are 230 Lb N/A for Dryland Corn production and 300 Lb N/A for Irrigated Corn production.*

[3] *A minimum fertilizer N application of 30 Lb N/A may be appropriate for early crop growth and development.*

Grain Sorghum Nitrogen Recommendations

Fertilizer N Required At Various Yield and Soil Organic Matter Levels Assuming Profile N Test Is Not Used (includes 30 Lb N/A residual default) [1]

Yield Goal	Soil Organic Matter Content (%)						
	1.0	1.5	2.0	2.5	3.0	3.5	4.0
(Bu/A)	- - - - - - - Lb N/A - - - - - - - -						
40	14	4	0	0	0	0	0
80	78	68	58	48	38	28	18
120	142	132	122	112	102	92	82
160	206	196	186	176	166	156	146
200	270	260	250	240	230	220	210

N Rec[2] = (Yield Goal × 1.6) – (% SOM × 20) – Profile N – Manure N – Other N Adjustments + Previous Crop Adjustments

[1] *Total N requirements presented include only Yield Goal and Soil Organic Matter Adjustments assuming profile N test not used. N rate should also be adjusted for Previous Crop, Manure and Other Appropriate N Rate Adjustments (see N rate adjustments for warm-season crops).*

[2] *A minimum fertilizer N application of 30 Lb N/A may be appropriate for early crop growth and development.*

Wheat Nitrogen Recommendations

Fertilizer N Required At Various Yield and Soil Organic Matter Levels Assuming Profile N Test Is Not Used (includes 30 Lb N/A residual default) [1]

Yield Goal	Soil Organic Matter Content (%)						
	1.0	1.5	2.0	2.5	3.0	3.5	4.0
(Bu/A)	- - - - - - - Lb N/A - - - - - - - -						
30	32	27	22	17	12	7	2
40	56	51	46	41	36	31	26
50	80	75	70	65	60	55	50
60	104	99	94	89	84	79	74
70	128	123	118	113	108	103	98

N Rec[2] = (Yield Goal × 2.4) – (% SOM × 10) – Profile N – Other N Adjustments + Previous Crop Adjustments + Tillage Adjustments + Grazing Adjustments

[1] *Total N requirements presented include only Yield Goal and Soil Organic Matter Adjustments assuming profile N test not used. N rate should also be adjusted for Previous Crop, Tillage, Grazing and Other Appropriate N Rate Adjustments (see N rate adjustments for cool-season crops).*

[2] *A minimum fertilizer N application of 30 Lb N/A may be appropriate for early crop growth and development.*

Sunflower Nitrogen Recommendations

Fertilizer N Required At Various Yield and Soil Organic Matter Levels Assuming Profile N Test Is Not Used (includes 30 Lb N/A residual default)[1]

Yield Goal	Soil Organic Matter Content (%)						
	1.0	1.5	2.0	2.5	3.0	3.5	4.0
(Lb/A)	– – – – – – – Lb N/A – – – – – – –						
1,000	25	15	5	0	0	0	0
1,500	63	53	43	33	23	13	3
2,000	100	90	80	70	60	50	40
2,500	138	128	118	108	98	88	78
3,000	175	165	155	145	135	125	115

N Rec [2] = (Yield Goal × 0.075) – (% SOM × 20) – Profile N – Manure N – Other N Adjustments + Previous Crop Adjustments

[1] *Total N requirements presented include only Yield Goal and Soil Organic Matter Adjustments assuming profile N test not used. N rate should also be adjusted for Previous Crop, Manure and Other Appropriate N Rate Adjustments (see N rate adjustments for warm-season crops).*

[2] *A minimum fertilizer N application of 30 Lb N/A may be appropriate for early crop growth and development.*

Oats Nitrogen Recommendations

Fertilizer N Required At Various Yield and Soil Organic Matter Levels Assuming Profile N Test Is Not Used (includes 30 Lb N/A residual default)[1]

Yield Goal	Soil Organic Matter Content (%)						
	1.0	1.5	2.0	2.5	3.0	3.5	4.0
(Bu/A)	– – – – – – – Lb N/A – – – – – – –						
60	38	33	28	23	18	13	8
80	64	59	54	49	44	39	34
100	90	85	80	75	70	65	60
120	116	111	106	101	96	91	86
140	142	137	132	127	122	117	112

N Rec[2] = (Yield Goal × 1.3) – (% SOM × 10) – Profile N – Other N Adjustments + Previous Crop Adjustments + Tillage Adj

[1] *Total N requirements presented include only Yield Goal and Soil Organic Matter Adjustments assuming profile N test not used. N rate should also be adjusted for Previous Crop, Tillage, Grazing and Other Appropriate N Rate Adjustments (see N rate adjustments for cool-season crops).*

[2] *A minimum fertilizer N application of 30 Lb N/A may be appropriate for early crop growth and development.*

Corn/Sorghum Silage Nitrogen Recommendations

Fertilizer N Required At Various Yield and Soil Organic Matter Levels Assuming Profile N Test Is Not Used (includes 30 Lb N/A residual default)[1]

Yield Goal	Soil Organic Matter Content (%)						
	1.0	1.5	2.0	2.5	3.0	3.5	4.0
(Ton/A)	– – – – – – – Lb N/A – – – – – – –						
10	57	47	37	27	17	7	0
15	110	100	90	80	70	60	50
20	163	153	143	133	123	113	103
25	217	207	197	187	177	167	157
30	270	260	250	240	230	220	210

N Rec[2, 3] = (Yield Goal × 10.67) – (% SOM × 20) – Profile N – Manure N – Other N Adjustments + Previous Crop Adjustments

[1] *Total N requirements presented include only Yield Goal and Soil Organic Matter Adjustments assuming profile N test not used. N rate should also be adjusted for Previous Crop, Manure and Other Appropriate N Rate Adjustments (see N rate adjustments for warm-season crops).*

[2] *Maximum fertilizer N recommendations are 230 Lb N/A for Dryland Corn production and 300 Lb N/A for Irrigated Corn production.*

[3] *A minimum fertilizer N application of 30 Lb N/A may be appropriate for early crop growth and development.*

Brome, Fescue and Bermuda Grass Nitrogen Recommendations

N Required At Various Yield Goals[1]

Yield Goal (Ton/A)	Production (Lb N/A)	New Seeding (Lb N/A)
2	80	20
4	160	20
6	240	20
8	320	20
10	400	20

[1] *Total N requirements presented only include Yield Goal Adjustments. These Total N requirements should be modified for other appropriate adjustments.*

Liming Recommendations

Lime Recommendations (Lb ECC/A)[1]

	Target pH = 6.8	Target pH = 6.0	Target pH = 5.5
Buffer pH	- – – – – – lb ECC/acre – – – – –		
7.4	0	0	0
7.2	750	375	250
7.0	1,750	875	500
6.8	3,000	1,500	750
6.6	4,500	2,250	1,125
6.4	6,250	3,125	1,625
6.2	8,250	4,125	2,000
6.0	10,250 [2]	5,125	2,625
5.8	12,500 [2]	6,250	3,125
5.6	15,250 [2]	7,625	3,750
5.4	18,000 [2]	9,000	4,500
5.2	20,000 [2]	10,375 [2]	5,250

[1] *Based on 6.67 inch soil depth. Soil Depth is the depth of incorporation through rotation. For No-Till systems, alfalfa and grass –assume 2 inch depth of incorporation (≈1/3 of rate for 6-7 inch depth).*

[2] *When lime recommendation exceeds 10,000 lb ECC/A, we suggest applying one-half rate, incorporate, wait 12 to 18 months and then retest.*

Target pH of 6.8 = [25,620 –(6,360 × Buffer pH) + (Buffer pH × Buffer pH × 391)] × Depth (inches)

All crops in Southeast Kansas –east of Flinthills & south of Highway 56
Alfalfa and clover in Northeast Kansas
Lime Rec if pH < 6.4

Target pH of 6.0 = [12,810 –(3,180 × Buffer pH) + (Buffer pH × Buffer pH × 196)] × Depth (inches)

All crops in Northeast Kansas except alfalfa and clover
All crops in Central and Western Kansas
Lime Rec if pH < 5.8

Target pH of 5.5 = [6,405 –(1,590 × Buffer pH) + (Buffer pH × Buffer pH × 98)] × Depth (inches)

Cash flow/lime availability problem areas in Central and Western Kansas

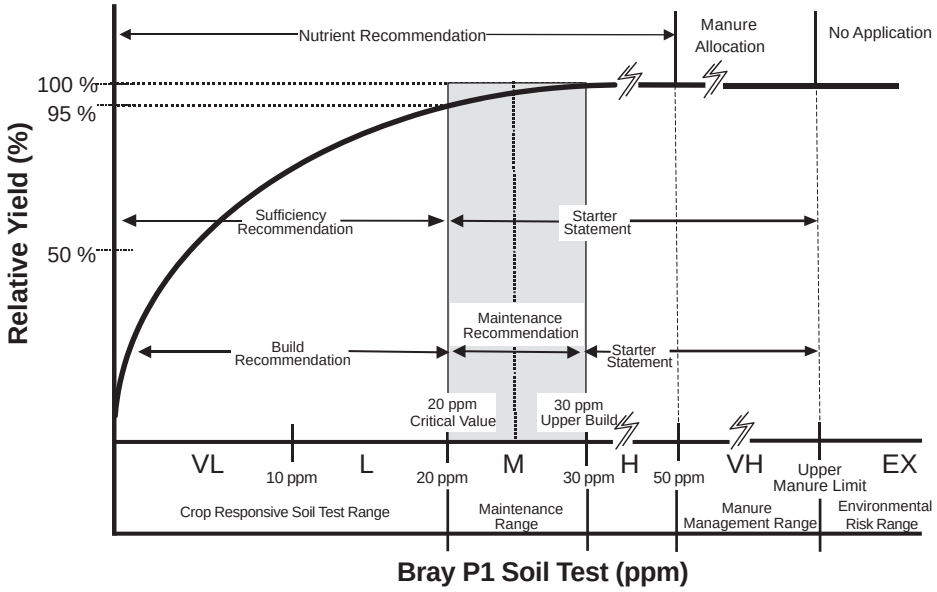
Lime Rec if pH < 5.5

Phosphorus and Potassium Recomendations

Phosphorus and Potassium Crop Removal Values

Crop	Unit	P_2O_5	K_2O
Alfalfa & Clover	ton	12	60
Bermudagrass	ton	12	40
Bromegrass	ton	12	40
Fescue, tall	ton	12	40
Corn	bushel	0.33	0.26
Corn silage	ton	3.20	8.70
Grain sorghum	bushel	0.40	0.26
Sorghum silage	ton	3.20	8.70
Wheat	bushel	0.50	0.30
Sunflowers	pound	0.015	0.006
Oats	bushel	0.25	0.20
Soybeans	bushel	0.80	1.40
Native grass	ton	5.40	30

Phosphorus Managment Model for Kansas Crop Production and Manure Management



Corn P and K Recommendations

Phosphorus Sufficiency Recommendations for Corn[1]

Bray P1 Soil Test	Yield Goal (Bu/A)				
	60	100	140	180	220
(ppm)	Lb P_2O_5/A				
0-5	55	60	70	75	80
5-10	40	45	50	55	60
10-15	25	25	30	30	35
15-20	15	15	15	15	15
20+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]
Crop Removal[3]	20	33	46	59	73

Potassium Sufficiency Recommendations for Corn[1]

Exch. K	Yield Goal (Bu/A)				
	60	100	140	180	220
(ppm)	Lb K_2O/A				
0-40	70	80	85	95	100
40-80	45	50	55	60	65
80-120	20	20	25	25	30
120-130	15	15	15	15	15
130+	0	0	0	0	0
Crop Removal[3]	16	26	36	47	57

Corn Sufficiency P Rec = [50 + (Exp Yield × 0.2) + (Bray P × -2.5) + (Exp Yield × Bray P × -0.01)]

If Bray P is greater than 20 ppm, then only a NP or NPKS starter fertilizer suggested
If Bray P is less than 20 ppm, then the minimum P Recommendation = 15 Lb P_2O_5/A

Corn Sufficiency K Rec = [73 + (Exp. Yield × 0.21) + (Exch K × -0.565) + (Exp Yield × Exch K × -0.0016)]

If Exch K is greater than 130 ppm then only a NPK or NPKS starter fertilizer is suggested
If Exch K is less than 130 ppm then the minimum K Recommendation = 15 Lb K_2O/A

Phosphorus Build-Maintenance Corn Recommendations[5]

Bray P1 Soil Test	4-Year Build Time Frame Yield (Bu/A)			6-Year Build Time Frame Yield (Bu/A)			8-Year Build Time Frame Yield (Bu/A)		
	60	140	220	60	140	220	60	140	220
(ppm)	Lb P_2O_5/A			Lb P_2O_5/A			Lb P_2O_5/A		
0-5	99	125	151	72	99	125	59	86	112
5-10	76	102	129	57	84	110	48	74	101
10-15	54	80	106	42	69	95	37	63	89
15-20	31	57	84	27	54	80	25	52	78
20-30 [4]	20	46	73	20	46	73	20	46	73
30+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]

Potassium Build-Maintenance Corn Recommendations[5]

Exch. K Soil Test	4-Year Build Time Frame Yield (Bu/A)			6-Year Build Time Frame Yield (Bu/A)			8-Year Build Time Frame Yield (Bu/A)		
	60	140	220	60	140	220	60	140	220
(ppm)	Lb K_2O/A			Lb K_2O/A			Lb K_2O/A		
0-40	263	284	305	181	201	222	139	160	181
40-80	173	194	215	121	141	162	94	115	136
80-130	72	93	113	53	74	95	44	65	85
130-160 [4]	16	36	57	16	36	57	16	36	57
160+	0	0	0	0	0	0	0	0	0

Phosphorus Build-Maintenance Rec = $\frac{\{(20 - \text{Current P Soil Test}) \times 18\}}{\text{Years To Build}}$ + P_2O_5 Removal In Crop

Potassium Build-Maintenance Rec = $\frac{\{(130 - \text{Current K Soil Test}) \times 9\}}{\text{Years To Build}}$ + K_2O Removal In Crop

1 *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied. At low to very low soil test levels applying at least 25 to 50% of total as a band is recommended.*

2 *Application of a NP, NPK or NPKS starter fertilizer may be beneficial regardless of P or K soil test level, especially for cold/wet soil conditions and/or high surface crop residues. Do not exceed N + K_2O guidelines for fertilizer placed in direct seed contact.*

3 *Crop removal numbers provided for comparitive purpose only -0.33 lb P_2O_5 and 0.26 lb K_2O per bushel of harvested corn. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

4 *Recommended amounts of P_2O_5 and K_2O are based on crop nutrient removal at the indicated yields (0.33 lb P_2O_5 /bu and 0.26 lb K_2O/bu).*

5 *Four, six and eight year timeframes below are examples only. Build programs can be over longer timeframe, however, build-maintenance recommendations should not be less than crop sufficiency based fertility programs.*

Wheat P and K Recommendations

Phosphorus Sufficiency Recommendations for Wheat[1]

Bray P1 Soil Test	Yield Goal (Bu/A)				
	30	40	50	60	70
(ppm)	Lb P_2O_5/A				
0-5	50	55	60	60	65
5-10	35	40	40	45	45
10-15	20	25	25	25	30
15-20	15	15	15	15	15
20+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]
Crop Removal[3]	15	20	25	30	35

Potassium Sufficiency Recommendations for Wheat[1]

Exch. K	Yield Goal (Bu/A)				
	30	40	50	60	70
(ppm)	Lb K_2O/A				
0-40	60	60	65	65	65
40-80	35	40	40	40	40
80-120	15	15	15	20	20
120-130	15	15	15	15	15
130+	0	0	0	0	0
Crop Removal[3]	9	12	15	18	21

Wheat Sufficiency P Rec = [46 + (Yield Goal × 0.42) + (Bray P × -2.3) + (Yield Goal × Bray P × -0.021)]

If Bray P is greater than 20 ppm, then only a NP or NPKS starter fertilizer suggested
If Bray P is less than 20 ppm, then the minimum P Recommendation = 15 Lb P_2O_5/A

Wheat Sufficiency K Rec = [62 + (Yield Goal × 0.24) + (Exch K × -0.48) + (Yield Goal × Exch K × -0.0018)]

If Exch K is greater than 130 ppm then only a NPK or NPKS starter fertilizer is suggested
If Exch K is less than 130 ppm then the minimum K Recommendation = 15 Lb K_2O/A

Phosphorus Build-Maintenance Wheat Recommendations[5]

Bray P1 Soil Test	4-Year Build Time Frame Yield (Bu/A)			6-Year Build Time Frame Yield (Bu/A)			8-Year Build Time Frame Yield (Bu/A)		
	30	50	70	30	50	70	30	50	70
(ppm)	Lb P_2O_5/A			Lb P_2O_5/A			Lb P_2O_5/A		
0-5	94	104	114	68	78	88	54	64	74
5-10	71	81	91	53	63	73	43	53	63
10-15	49	59	69	38	48	58	32	42	52
15-20	26	36	46	23	33	43	21	31	41
20-30[4]	15	25	35	15	25	35	15	25	35
30+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]

Potassium Build-Maintenance Wheat Recommendations[5]

Exch. K Soil Test	4-Year Build Time Frame Yield (Bu/A)			6-Year Build Time Frame Yield (Bu/A)			8-Year Build Time Frame Yield (Bu/A)		
	30	50	70	30	50	70	30	50	70
(ppm)	Lb K_2O/A			Lb K_2O/A			Lb K_2O/A		
0-40	257	263	269	174	180	186	133	139	145
40-80	167	173	179	114	120	126	88	94	100
80-130	65	71	77	47	53	59	37	43	49
130-160 [4]	9	15	21	9	15	21	9	15	21
160+	0	0	0	0	0	0	0	0	0

$$\text{Phosphorus Build-Maintenance Rec} = \frac{\{(20 - \text{Current P Soil Test}) \times 18\}}{\text{Years To Build}} + P_2O_5 \text{ Removal In Crop}$$

$$\text{Potassium Build-Maintenance Rec} = \frac{\{(130 - \text{Current K Soil Test}) \times 9\}}{\text{Years To Build}} + K_2O \text{ Removal In Crop}$$

1 *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied. At low to very low soil test levels applying at least 25 to 50% of total as a band is recommended.*

2 *Application of a NP, NPK or NPKS starter fertilizer may be beneficial regardless of P or K soil test level, especially for cold/wet soil conditions and/or high surface crop residues. Do not exceed N + K_2O guidelines for fertilizer placed in direct seed contact.*

3 *Crop removal numbers provided for comparitive purpose only -0.50 lb P_2O_5 and 0.30 lb K_2O per bushel of harvested wheat. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

4 *Recommended amounts of P_2O_5 and K_2O are based on crop nutrient removal at the indicated yields (0.50 lb P_2O_5/bu and 0.30 lb K_2O/bu).*

5 *Four, six and eight year timeframes below are examples only. Build programs can be over longer timeframe, however, build-maintenance recommendations should not be less than crop sufficiency based fertility programs.*

Grain Sorghum P and K Recommendations

Phosphorus Sufficiency Recommendations for Grain Sorghum[1]

Bray P1 Soil Test	Yield Goal (Bu/A) 40	80	120	160	200
(ppm)	Lb P_2O_5/A				
0-5	50	55	60	65	70
5-10	35	40	45	45	50
10-15	20	25	25	30	30
15-20	15	15	15	15	15
20+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]
Crop Removal[3]	16	32	48	64	80

Potassium Sufficiency Recommendations for Grain Sorghum[1]

Exch. K	Yield Goal (Bu/A) 40	80	120	160	200
(ppm)	Lb K_2O/A				
0-40	75	80	85	90	95
40-80	45	50	55	60	60
80-120	20	20	25	25	25
120-130	15	15	15	15	15
130+	0	0	0	0	0
Crop Removal[3]	10	21	31	42	52

G. Sorghum Sufficiency P Rec = [50 + (0.16 × Yield Goal) + (Bray P × –2.5) + (Yield Goal × Bray P × -0.008)]

If Bray P is greater than 20 ppm, then only a NP or NPKS starter fertilizer suggested
If Bray P is less than 20 ppm, then the minimum P Recommendation = 15 Lb P_2O_5/A

G. Sorghum Sufficiency K Rec = [80 + (0.17 × Yield Goal) + (Exch K × -0.616) + (Yield Goal × Exch K × -0.0013)]

If Exch K is greater than 130 ppm then only a NPK or NPKS starter fertilizer is suggested
If Exch K is less than 130 ppm then the minimum K Recommendation = 15 Lb K_2O/A

Phosphorus Build-Maintenance Grain Sorghum Recommendations[5]

Bray P1 Soil Test	4-Year Build Time Frame Yield (Bu/A) 40	120	200	6-Year Build Time Frame Yield (Bu/A) 40	120	200	8-Year Build Time Frame Yield (Bu/A) 40	120	200
(ppm)	Lb P_2O_5/A			Lb P_2O_5/A			Lb P_2O_5/A		
0-5	95	127	159	69	101	133	55	87	119
5-10	72	104	136	54	86	118	44	76	108
10-15	50	82	114	39	71	103	33	65	97
15-20	27	59	91	24	56	88	22	54	86
20-30 [4]	16	48	80	16	48	80	16	48	80
30+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]

Potassium Build-Maintenance Grain Sorghum Recommendations[5]

Exch. K Soil Test	4-Year Build Time Frame Yield (Bu/A) 40	120	200	6-Year Build Time Frame Yield (Bu/A) 40	120	200	8-Year Build Time Frame Yield (Bu/A) 40	120	200
(ppm)	Lb K_2O/A			Lb K_2O/A			Lb K_2O/A		
0-40	258	279	300	175	196	217	134	155	176
40-80	168	189	210	115	136	157	89	110	131
80-130	67	87	108	48	69	90	39	59	80
130-160 [4]	10	31	52	10	31	52	10	31	52
160+	0	0	0	0	0	0	0	0	0

Phosphorus Build-Maintenance Rec = $\frac{\{(20 - \text{Current P Soil Test}) \times 18\}}{\text{Years To Build}} + P_2O_5$ Removal In Crop

Potassium Build-Maintenance Rec = $\frac{\{(130 - \text{Current K Soil Test}) \times 9\}}{\text{Years To Build}} + K_2O$ Removal In Crop

1 *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied. At low to very low soil test levels applying at least 25 to 50% of total as a band is recommended.*

2 *Application of a NP, NPK or NPKS starter fertilizer may be beneficial regardless of P or K soil test level, especially for cold/wet soil conditions and/or high surface crop residues. Do not exceed N + K_2O guidelines for fertilizer placed in direct seed contact.*

3 *Crop removal numbers provided for comparitive purpose only –0.40 lb P_2O_5 and 0.26 lb K_2O per bushel of harvested grain sorghum. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

4 *Recommended amounts of P_2O_5 and K_2O are based on crop nutrient removal at the indicated yields (0.40 lb P_2O_5/bu and 0.26 lb K_2O /bu).*

5 *Four, six and eight year timeframes below are examples only. Build programs can be over longer timeframe, however, build-maintenance recommendations should not be less than crop sufficiency based fertility programs.*

Soybean P and K Recommendations

Phosphorus Sufficiency Recommendations for Soybeans[1]

Bray P1 Soil Test	Yield Goal (Bu/A) 30	40	50	60	70
(ppm)	– – – – – – – – – Lb P_2O_5/A – – – – – – – – –				
0-5	60	65	70	75	80
5-10	45	50	50	55	55
10-15	25	30	30	30	35
15-20	15	15	15	15	15
20+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]
Crop Removal [3]	24	32	40	48	56

Potassium Sufficiency Recommendations for Soybeans[1]

Exch. K	Yield Goal (Bu/A) 30	40	50	60	70
(ppm)	- – – – – – – Lb K_2O/A – – – – – – – –				
0-40	65	70	75	85	90
40-80	45	45	50	55	55
80-120	20	20	20	25	25
120-130	15	15	15	15	15
130+	0	0	0	0	0
Crop Removal [3]	42	56	70	84	98

Soybeans Sufficiency P Rec = [56 + (0.51 × Yield Goal) + (Bray P × -2.8) + (Yield Goal × Bray P × -0.0257)]

If Bray P is greater than 20 ppm, then only a NP or NPKS starter fertilizer suggested (not in direct seed contact)
If Bray P is less than 20 ppm, then the minimum P Recommendation = 15 Lb P_2O_5/A

Soybeans Sufficiency K Rec = [60 + (0.628 × Yield Goal) + (Exch K × -0.46) + (Yield Goal x Exch K × -0.0048)]

If Exch K is greater than 130 ppm then only a NPK or NPKS starter fertilizer is suggested (not in direct seed contact)
If Exch K is less than 130 ppm then the minimum K Recommendation = 15 Lb K_2O/A

Phosphorus Build-Maintenance Soybeans Recommendations[5]

Bray P1 Soil Test	4-Year Build Time Frame Yield (Bu/A) 30	50	70	6-Year Build Time Frame Yield (Bu/A) 30	50	70	8-Year Build Time Frame Yield (Bu/A) 30	50	70
(ppm)	- – Lb P_2O_5/A – –			- – Lb P_2O_5/A – –			- – Lb P_2O_5/A – –		
0-5	103	119	135	77	93	109	63	79	95
5-10	80	96	112	62	78	94	52	68	84
10-15	58	74	90	47	63	79	41	57	73
15-20	35	51	67	32	48	64	30	46	62
20-30 [4]	24	40	56	24	40	56	24	40	56
30+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]

Potassium Build-Maintenance Soybeans Recommendations[5]

Exch. K Soil Test	4-Year Build Time Frame Yield (Bu/A) 30	50	70	6-Year Build Time Frame Yield (Bu/A) 30	50	70	8-Year Build Time Frame Yield (Bu/A) 30	50	70
(ppm)	- – Lb K_2O/A – –			- – Lb K_2O/A – –			- – Lb K_2O/A – –		
0-40	290	318	346	207	235	263	166	194	222
40-80	200	228	256	147	175	203	121	149	177
80-130	98	126	154	80	108	136	70	98	126
130-160 [4]	42	70	98	42	70	98	42	70	98
160+	0	0	0	0	0	0	0	0	0

Phosphorus Build-Maintenance Rec = $\frac{\{(20 - \text{Current P Soil Test}) \times 18\}}{\text{Years To Build}}$ + P_2O_5 Removal In Crop

Potassium Build-Maintenance Rec = $\frac{\{(130 - \text{Current K Soil Test}) \times 9\}}{\text{Years To Build}}$ + K_2O Removal In Crop

[1] *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied. At low to very low soil test levels applying at least 25 to 50% of total as a band is recommended.*

[2] *Application of a NP, NPK or NPKS starter fertilizer may be beneficial regardless of P or K soil test level, especially for cold/wet soil conditions and/or high surface crop residues.* ***Do not place fertilizer in direct seed contact.***

[3] *Crop removal numbers provided for comparitive purpose only -0.80 lb P_2O_5 and 1.4 lb K_2O per bushel of harvested soybeans. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

[4] *Recommended amounts of P_2O_5 and K_2O are based on crop nutrient removal at the indicated yields (0.80 lb P_2O_5 /bu and 1.4 lb K_2O/bu).*

[5] *Four, six and eight year timeframes below are examples only. Build programs can be over longer timeframe, however, build-maintenance recommendations should not be less than crop sufficiency based fertility programs.*

Sunflower P and K Recommendations

Phosphorus Sufficiency Recommendations for Sunflower[1]

Bray P1 Soil Test	Yield Goal (Lb/A) 1,000	1,500	2,000	2,500	3,000
(ppm)	– – – – – – – – Lb P_2O_5/A – – – – – – – – –
0-5	45	50	55	60	65
5-10	35	35	40	40	45
10-15	20	20	25	25	25
15-20	15	15	15	15	15
20+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]
Crop Removal [3]	15	22	30	38	45

Potassium Sufficiency Recommendations for Sunflower[1]

Exch. K	Yield Goal (Lb/A) 1,000	1,500	2,000	2,500	3,000
(ppm)	- – – – – – – Lb K_2O/A – – – – – – – –
0-40	75	80	80	85	90
40-80	45	50	50	55	55
80-120	20	20	20	25	25
120-130	15	15	15	15	15
130+	0	0	0	0	0
Crop Removal [3]	6	9	12	15	18

Sunflower Sufficiency P Rec = [42 + (Yield Goal × 0.01) + (Bray P × –2.1) + (Yield Goal × Bray P × -0.0005)]

If Bray P is greater than 20 ppm, then only a NP or NPKS starter fertilizer suggested (not in direct seed contact)
If Bray P is less than 20 ppm, then the minimum P Recommendation = 15 Lb P_2O_5/A

Sunflower Sufficiency K Rec = [80 + (Yield Goal × 0.008) + (Exch K × -0.622) + (Yield Goal × Exch K × -0.00006)]

If Exch K is greater than 130 ppm then only a NPK or NPKS starter fertilizer is suggested (not in direct seed contact)
If Exch K is less than 130 ppm then the minimum K Recommendation = 15 Lb K_2O/A

Phosphorus Build Sunflowers Recommendations[5]

Bray P1 Soil Test	4-Year Build Time Frame Yield (Lb/A) 1,000	2,000	3,000	6-Year Build Time Frame Yield (Lb/A) 1,000	2,000	3,000	8-Year Build Time Frame Yield (Lb/A) 1,000	2,000	3,000
(ppm)	- – Lb P_2O_5/A – –			- – Lb P_2O_5/A – –			- – Lb P_2O_5/A – –		
0-5	94	109	124	68	83	98	54	69	84
5-10	71	86	101	53	68	83	43	58	73
10-15	49	64	79	38	53	68	32	47	62
15-20	26	41	56	23	38	53	21	36	51
20-30 [4]	15	30	45	15	30	45	15	30	45
30+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]

Potassium Build-Maintenance Sunflowers Recommendations[5]

Exch. K Soil Test	4-Year Build Time Frame Yield (Lb/A) 1,000	2,000	3,000	6-Year Build Time Frame Yield (Lb/A) 1,000	2,000	3,000	8-Year Build Time Frame Yield (Lb/A) 1,000	2,000	3,000
(ppm)	- – Lb K_2O/A – –			- – Lb K_2O/A – –			- – Lb K_2O/A – –		
0-40	254	260	266	171	177	183	130	136	142
40-80	164	170	176	111	117	123	85	91	97
80-130	62	68	74	44	50	56	34	40	46
130-160 [4]	6	12	18	6	12	18	6	12	18
160+	0	0	0	0	0	0	0	0	0

Phosphorus Build-Maintenance Rec = $\frac{\{(20 - \text{Current P Soil Test}) \times 18\}}{\text{Years To Build}}$ + P_2O_5 Removal In Crop

Potassium Build-Maintenance Rec = $\frac{\{(130 - \text{Current K Soil Test}) \times 9\}}{\text{Years To Build}}$ + K_2O Removal In Crop

[1] *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied. At low to very low soil test levels applying at least 25 to 50% of total as a band is recommended.*

[2] *Application of a NP, NPK or NPKS starter fertilizer may be beneficial regardless of P or K soil test level, especially for cold/wet soil conditions and/or high surface crop residues.* ***Do not place fertilizer in direct seed contact.***

[3] *Crop removal numbers provided for comparitive purpose only –0.015 lb P_2O_5 and 0.006 lb K_2O per pound of harvested sunflower. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

[4] *Recommended amounts of P_2O_5 and K_2O are based on crop nutrient removal at the indicated yields (0.015 lb P_2O_5/lb and 0.006 lb K_2O/lb).*

[5] *Four, six and eight year timeframes below are examples only. Build programs can be over longer timeframe, however, build-maintenance recommendations should not be less than crop sufficiency based fertility programs.*

Oats P and K Recommendations

Phosphorus Sufficiency Recommendations for Oats[1]

Bray P1 Soil Test	Yield Goal (Bu/A) 60	80	100	120	140
(ppm)	Lb P_2O_5/A				
0-5	55	60	65	65	70
5-10	40	40	45	50	50
10-15	25	25	25	30	30
15-20	15	15	15	15	15
20+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]
Crop Removal[3]	15	20	25	30	35

Potassium Sufficiency Recommendations for Oats[1]

Exch. K	Yield Goal (Bu/A) 60	80	100	120	140
(ppm)	Lb K_2O/A				
0-40	65	65	70	75	80
40-80	40	45	45	45	50
80-120	15	20	20	20	20
120-130	15	15	15	15	15
130+	0	0	0	0	0
Crop Removal[3]	12	16	20	24	28

Oats Sufficiency P Rec = [47 + (Yield Goal × 0.25) + (Bray P × -2.3) + (Yield Goal × Bray P × -0.013)]

If Bray P is greater than 20 ppm, then only a NP or NPKS starter fertilizer suggested
If Bray P is less than 20 ppm, then the minimum P Recommendation = 15 Lb P_2O_5/A

Oats Sufficiency K Rec = [62 + (Yield Goal × 0.221) + (Exch K × -0.48) + (Yield Goal × Exch K × -0.0017)]

If Exch K is greater than 130 ppm then only a NPK or NPKS starter fertilizer is suggested
If Exch K is less than 130 ppm then the minimum K Recommendation = 15 Lb K_2O/A

Phosphorus Build Oats Recommendations[5]

Bray P1 Soil Test	4-Year Build Time Frame Yield (Bu/A) 60	100	140	6-Year Build Time Frame Yield (Bu/A) 60	100	140	8-Year Build Time Frame Yield (Bu/A) 60	100	140
(ppm)	Lb P_2O_5/A			Lb P_2O_5/A			Lb P_2O_5/A		
0-5	94	104	114	68	78	88	54	64	74
5-10	71	81	91	53	63	73	43	53	63
10-15	49	59	69	38	48	58	32	42	52
15-20	26	36	46	23	33	43	21	31	41
20-30 [4]	15	25	35	15	25	35	15	25	35
30+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]

Potassium Build-Maintenance Oats Recommendations[5]

Exch. K Soil Test	4-Year Build Time Frame Yield (Bu/A) 60	100	140	6-Year Build Time Frame Yield (Bu/A) 60	100	140	8-Year Build Time Frame Yield (Bu/A) 60	100	140
(ppm)	Lb K_2O/A			Lb K_2O/A			Lb K_2O/A		
0-40	260	268	276	177	185	193	136	144	152
40-80	170	178	186	117	125	133	91	99	107
80-130	68	76	84	50	58	66	40	48	56
130-160 [4]	12	20	28	12	20	28	12	20	28
160+	0	0	0	0	0	0	0	0	0

Phosphorus Build-Maintenance Rec = $\frac{\{(20 - \text{Current P Soil Test}) \times 18\}}{\text{Years To Build}} + P_2O_5$ Removal In Crop

Potassium Build-Maintenance Rec = $\frac{\{(130 - \text{Current K Soil Test}) \times 9\}}{\text{Years To Build}} + K_2O$ Removal In Crop

1 *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied. At low to very low soil test levels applying at least 25 to 50% of total as a band is recommended.*

2 *Application of a NP, NPK or NPKS starter fertilizer may be beneficial regardless of P or K soil test level, especially for cold/wet soil conditions and/or high surface crop residues. Do not exceed N + K_2O guidelines for fertilizer placed in direct seed contact.*

3 *Crop removal numbers provided for comparitive purpose only -0.25 lb P_2O_5 and 0.20 lb K_2O per bushel of harvested oats. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

4 *Recommended amounts of P_2O_5 and K_2O are based on crop nutrient removal at the indicated yields (0.25 lb P_2O_5/bu and 0.20 lb K_2O/bu).*

5 *Four, six and eight year timeframes below are examples only. Build programs can be over longer timeframe, however, build-maintenance recommendations should not be less than crop sufficiency based fertility programs.*

Corn Silage P and K Recommendations

Phosphorus Sufficiency Recommendations for Corn Silage[1]

Bray P1 Soil Test	Yield Goal (Ton/A) 10	15	20	25	30
(ppm)	- - - - - - - Lb P_2O_5/A - - - - - - - -
0-5	60	65	70	75	80
5-10	40	45	50	55	55
10-15	25	25	30	30	35
15-20	15	15	15	15	15
20+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]
Crop Removal [3]	32	48	64	80	96

Potassium Sufficiency Recommendations for Corn Silage[1]

Exch. K	Yield Goal (Ton/A) 10	15	20	25	30
(ppm)	- - - - - - - Lb K_2O/A - - - - - - - -
0-40	75	80	90	95	100
40-80	50	50	55	60	65
80-120	20	25	25	25	30
120-130	15	15	15	15	15
130+	0	0	0	0	0
Crop Removal [3]	87	131	174	218	261

Corn Silage Sufficiency P Rec = [56 + (Yield Goal × 1.12) + (Bray P × –2.8) + (Yield Goal × Bray P × -0.056)]

If Bray P is greater than 20 ppm, then only a NP or NPKS starter fertilizer suggested
If Bray P is less than 20 ppm, then the minimum P Recommendation = 15 Lb P_2O_5/A

Corn Silage Sufficiency K Rec = [74 + (Yield Goal × 1.50) + (Exch K × -0.567) + (Yield Goal × Exch K × -0.0115)]

If Exch K is greater than 130 ppm then only a NPK or NPKS starter fertilizer is suggested
If Exch K is less than 130 ppm then the minimum K Recommendation = 15 Lb K_2O/A

Phosphorus Build Corn Silage Recommendations[5]

Bray P1 Soil Test	4-Year Build Time Frame Yield (Ton/A) 10	20	30	6-Year Build Time Frame Yield (Ton/A) 10	20	30	8-Year Build Time Frame Yield (Ton/A) 10	20	30
(ppm)	- - Lb P_2O_5/A - -			- - Lb P_2O_5/A - -			- - Lb P_2O_5/A - -		
0-5	111	143	175	85	117	149	71	103	135
5-10	88	120	152	70	102	134	60	92	124
10-15	66	98	130	55	87	119	49	81	113
15-20	43	75	107	40	72	104	38	70	102
20-30 [4]	32	64	96	32	64	96	32	64	96
30+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]

Potassium Build-Maintenance Corn Silage Recommendations [5]

Exch. K Soil Test	4-Year Build Time Frame Yield (Ton/A) 10	20	30	6-Year Build Time Frame Yield (Ton/A) 10	20	30	8-Year Build Time Frame Yield (Ton/A) 10	20	30
(ppm)	- - Lb K_2O/A - -			- - Lb K_2O/A - -			- - Lb K_2O/A - -		
0-40	335	422	509	252	339	426	211	298	385
40-80	245	332	419	192	279	366	166	253	340
80-130	143	230	317	125	212	299	115	202	289
130-160 [4]	87	174	261	87	174	261	87	174	261
160+	0	0	0	0	0	0	0	0	0

Phosphorus Build-Maintenance Rec = $\frac{\{(20 - \text{Current P Soil Test}) \times 18\}}{\text{Years To Build}}$ + P_2O_5 Removal In Crop

Potassium Build-Maintenance Rec = $\frac{\{(130 - \text{Current K Soil Test}) \times 9\}}{\text{Years To Build}}$ + K_2O Removal In Crop

[1] *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied. At low to very low soil test levels applying at least 25 to 50% of total as a band is recommended.*

[2] *Application of a NP, NPK or NPKS starter fertilizer may be beneficial regardless of P or K soil test level, especially for cold/wet soil conditions and/or high surface crop residues. Do not exceed N + K_2O guidelines for fertilizer placed in direct seed contact.*

[3] *Crop removal numbers provided for comparitive purpose only –3.2 lb P_2O_5 and 8.7 lb K_2O per ton of harvested corn silage. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

[4] *Recommended amounts of P_2O_5 and K_2O are based on crop nutrient removal at the indicated yields (3.2 lb P_2O_5 /ton and 8.7 lb K_2O/ton).*

[5] *Four, six and eight year timeframes below are examples only. Build programs can be over longer timeframe, however, build-maintenance recommendations should not be less than crop sufficiency based fertility programs.*

Sorghum Silage P and K Recommendations

Phosphorus Sufficiency Recommendations for Sorghum Silage[1]

Bray P1 Soil Test	Yield Goal (Ton/A) 10	15	20	25	30
(ppm)	- - - - - - - Lb P_2O_5/A - - - - - - - -
0-5	50	60	65	70	75
5-10	40	40	45	50	50
10-15	25	25	25	30	30
15-20	15	15	15	15	15
20+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]
Crop Removal [3]	32	48	64	80	96

Potassium Sufficiency Recommendations for Sorghum Silage[1]

Exch. K	Yield Goal (Ton/A) 10	15	20	25	30
(ppm)	- - - - - - - Lb K_2O/A - - - - - - - -
0-40	75	85	90	100	105
40-80	50	55	60	65	70
80-120	20	25	25	25	30
120-130	15	15	15	15	15
130+	0	0	0	0	0
Crop Removal [3]	87	131	174	218	261

Sorghum Silage Sufficiency P Rec = [48 + (1.19 × Yield Goal) + (Bray P × -2.38) + (Yield Goal × Bray P × -0.0594)]

If Bray P is greater than 20 ppm, then only a NP or NPKS starter fertilizer suggested
If Bray P is less than 20 ppm, then the minimum P Recommendation = 15 Lb P_2O_5/A

Sorghum Silage Sufficiency K Rec = [73 + (1.8 × Yield Goal) + (Exch K × -0.56) + (Yield Goal × Exch K × -0.0139)]

If Exch K is greater than 130 ppm then only a NPK or NPKS starter fertilizer is suggested
If Exch K is less than 130 ppm then the minimum K Recommendation = 15 Lb K_2O/A

Phosphorus Build Sorghum Silage Recommendations[5]

Bray P1 Soil Test	4-Year Build Time Frame Yield (Ton/A) 10	20	30	6-Year Build Time Frame Yield (Ton/A) 10	20	30	8-Year Build Time Frame Yield (Ton/A) 10	20	30
(ppm)	- - Lb P_2O_5/A - -			- - Lb P_2O_5/A - -			- - Lb P_2O_5/A - -		
0-5	111	143	175	85	117	149	71	103	135
5-10	88	120	152	70	102	134	60	92	124
10-15	66	98	130	55	87	119	49	81	113
15-20	43	75	107	40	72	104	38	70	102
20-30 [4]	32	64	96	32	64	96	32	64	96
30+	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]	0 [2]

Potassium Build-Maintenance Sorghum Silage Recommendations[5]

Exch. K Soil Test	4-Year Build Time Frame Yield (Ton/A) 10	20	30	6-Year Build Time Frame Yield (Ton/A) 10	20	30	8-Year Build Time Frame Yield (Ton/A) 10	20	30
(ppm)	- - Lb K_2O/A - -			- - Lb K_2O/A - -			- - Lb K_2O/A - -		
0-40	335	422	509	252	339	426	211	298	385
40-80	245	332	419	192	279	366	166	253	340
80-130	143	230	317	125	212	299	115	202	289
130-160 [4]	87	174	261	87	174	261	87	174	261
160+	0	0	0	0	0	0	0	0	0

Phosphorus Build-Maintenance Rec = $\frac{\{(20 - \text{Current P Soil Test}) \times 18\}}{\text{Years To Build}}$ + P_2O_5 Removal In Crop

Potassium Build-Maintenance Rec = $\frac{\{(130 - \text{Current K Soil Test}) \times 9\}}{\text{Years To Build}}$ + K_2O Removal In Crop

[1] *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied. At low to very low soil test levels applying at least 25 to 50% of total as a band is recommended.*

[2] *Application of a NP, NPK or NPKS starter fertilizer may be beneficial regardless of P or K soil test level, especially for cold/wet soil conditions and/or high surface crop residues. Do not exceed N + K_2O guidelines for fertilizer placed in direct seed contact.*

[3] *Crop removal numbers provided for comparitive purpose only -3.2 lb P_2O_5 and 8.7 lb K_2O per ton of harvested sorghum silage. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

[4] *Recommended amounts of P_2O_5 and K_2O are based on crop nutrient removal at the indicated yields (3.2 lb P_2O_5 / ton and 8.7 lb K_2O / ton).*

[5] *Four, six and eight year timeframes below are examples only. Build programs can be over longer timeframe, however, build-maintenance recommendations should not be less than crop sufficiency based fertility programs.*

Brome and Fescue P and K Recommendations

Phosphorus Sufficiency Recommendations for Brome and Fescue[1]

Bray P1 Soil Test	Yield Goal (Ton/A) 2	3	4	5	6
(ppm)	Lb P_2O_5/A				
0-5	50	55	60	65	70
5-10	35	40	45	45	50
10-15	20	25	25	30	30
15-20	15	15	15	15	15
20+	0	0	0	0	0
Crop Removal[2]	24	36	48	60	72

Potassium Sufficiency Recommendations for Brome and Fescue[1]

Exch. K	Yield Goal (Ton/A) 2	3	4	5	6
(ppm)	Lb K_2O/A				
0-40	45	50	55	60	65
40-80	30	30	35	40	40
80-120	15	15	15	15	20
120-130	15	15	15	15	15
130+	0	0	0	0	0
Crop Removal[2]	80	120	160	200	240

Brome/Fescue Sufficiency P Rec = [44 + (6.3 × Yield Goal) + (Bray P × –2.2) + (Yield Goal × Bray P × -0.315)]

If Bray P > 20 ppm then basic P Recommendation = 0
If Bray P < 20 ppm then the minimum P Recommendation = 15 Lb P_2O_5/A

Brome/Fescue Sufficiency K Rec = [41 + (5.85 × Yield Goal) + (Exch K × -0.315) + (Yield Goal × Exch K × -0.045)]

If Exch K > 130 ppm then basic K Recommendation = 0
If Exch K < 130 ppm then the minimum K Recommendation = 15 Lb K_2O/A

[1] *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied. At low to very low soil test levels applying at least 25 to 50% of total as a band is recommended.*

[2] *Crop removal numbers provided for comparitive purpose only - 12 lb P_2O_5 and 40 lb K_2O per ton of harvested forage. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

New Brome and Fescue P and K Recommendations

Phosphorus Sufficiency Recommendations for Brome and Fescue[1]

Bray P1 Soil Test	Yield Goal (Ton/A) 2	2.5	3	3.5	4
(ppm)	Lb P_2O_5/A				
0-5	80	85	90	95	100
5-10	55	60	65	65	70
10-15	35	35	40	40	40
15-20	15	15	15	15	15
20+	0	0	0	0	0
Crop Removal[2]	24	30	36	42	48

Potassium Sufficiency Recommendations for Brome and Fescue[1]

Exch. K	Yield Goal (Ton/A) 2	2.5	3	3.5	4
(ppm)	Lb K_2O/A				
0-40	100	110	115	120	130
40-80	65	70	75	75	80
80-120	30	30	30	35	35
120-130	15	15	15	15	15
130+	0	0	0	0	0
Crop Removal[2]	80	100	120	140	160

New Brome/Fescue Sufficiency P Rec = [68 + (11.2 × Yield Goal) + (Bray P × -3.4) + (Yield Goal × Bray P × -0.56)]

If Bray P > 20 ppm then basic P Recommendation = 0
If Bray P < 20 ppm then the minimum P Recommendation = 15 Lb P_2O_5/A

New Brome/Fescue Sufficiency K Rec = [91 + (15 × Yield Goal) + (Exch K × -0.7) + (Yield Goal × Exch K × -0.116)]

If Exch K > 130 ppm then basic K Recommendation = 0
If Exch K < 130 ppm then the minimum K Recommendation = 15 Lb K_2O/A

[1] *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied. At low to very low soil test levels applying at least 25 to 50% of total as a band is recommended.*

[2] *Crop removal numbers provided for comparitive purpose only - 12 lb P_2O_5 and 40 lb K_2O per ton of harvested forage. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

Bermuda Grass P and K Recommendations

Phosphorus Sufficiency Recommendations for Bermuda[1]

Bray P1 Soil Test	Yield Goal (Ton/A) 2	4	6	8	10
(ppm)	– – – – – – – – – Lb P_2O_5/A – – – – – – – – –				
0-5	65	75	85	95	105
5-10	50	60	65	75	80
10-15	35	45	50	55	60
15-20	20	25	30	30	35
20-25	15	15	20	20	25
25+	0	0	0	0	0
Crop Removal[2]	24	48	72	96	120

Potassium Sufficiency Recommendations for Bermuda[1]

Exch. K Soil Test	Yield Goal (Ton/A) 2	4	6	8	10
(ppm)	- - - - - - - - Lb K_2O/A - - - - - - - -				
0-40	75	85	95	110	120
40-80	50	60	65	75	80
80-120	30	35	35	40	45
120-150	15	15	15	15	15
150+	0	0	0	0	0
Crop Removal[2]	80	160	240	320	400

Bermuda Sufficiency P Rec = [64 + (5.3 × Yield Goal) + (Bray P × -2.56) + (Yield Goal × Bray P × -0.21)]

If Bray P > 25 ppm then basic P Recommendation = 0
If Bray P < 25 ppm then the minimum P Recommendation = 15 Lb P_2O_5/A

Bermuda Sufficiency K Rec = [75 + (6. 25 × Yield Goal) + (Exch K × -0.5) + (Yield Goal × Exch K × -0.042)]

If Exch K > 150 ppm then basic K Recommendation = 0
If Exch K < 150 ppm then the minimum K Recommendation = 15 Lb K_2O/A

[1] *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied.*
[2] *Crop removal numbers provided for comparitive purpose only - 12 lb P_2O_5 and 40 lb K_2O per ton of harvested forage. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

New Bermuda Grass P and K Recommendations

Phosphorus Sufficiency Recommendations for Bermuda [1]

Bray P1 Soil Test	Yield Goal (Ton/A) 2	3	4	5	6
(ppm)	- - - - - - - - Lb P_2O_5/A - - - - - - - -				
0-5	75	80	90	100	105
5-10	60	65	70	75	85
10-15	40	45	50	55	60
15-20	25	25	30	35	35
20-25	15	15	20	20	25
25+	0	0	0	0	0
Crop Removal[2]	24	36	48	60	72

Potassium Sufficiency Recommendations for Bermuda[1]

Exch. K Soil Test	Yield Goal (Ton/A) 2	3	4	5	6
(ppm)	- - - - - - - - Lb K_2O/A - - - - - - - -				
0-40	115	130	145	155	170
40-80	80	90	100	110	115
80-120	45	50	55	60	65
120-150	15	15	15	20	20
150+	0	0	0	0	0
Crop Removal[2]	80	120	160	200	240

Bermuda Sufficiency P Rec = [64 + (9.1 × Yield Goal) + (Bray P × -2.56) + (Yield Goal × Bray P × -0.365)]

If Bray P > 25 ppm then basic P Recommendation = 0
If Bray P < 25 ppm then the minimum P Recommendation = 15 Lb P_2O_5/A

Bermuda Sufficiency K Rec = [105 + (15 × Yield Goal) + (Exch K × -0.7) + (Yield Goal × Exch K × -0.1)]

If Exch K > 150 ppm then basic K Recommendation = 0
If Exch K < 150 ppm then the minimum K Recommendation = 15 Lb K_2O/A

[1] *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied.*
[2] *Crop removal numbers provided for comparitive purpose only - 12 lb P_2O_5 and 40 lb K_2O per ton of harvested forage. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

Alfalfa and Clover P and K Recommendations

Phosphorus Sufficiency Recommendations for Alfalfa[1, 5]

Bray P1 Soil Test	Yield Goal (Ton/A) 2	4	6	8	10
(ppm)	- - - - - - - Lb P_2O_5/A - - - - - - - -				
0-5	75	80	90	100	105
5-10	60	65	70	75	85
10-15	40	45	50	55	60
15-20	25	30	30	35	35
20-25	15	15	15	15	15
25+	0	0	0	0	0
Crop Removal[2]	24	48	72	96	120

Potassium Sufficiency Recommendations for Alfalfa[1]

Exch. K Soil Test	Yield Goal (Ton/A) 2	4	6	8	10
(ppm)	- - - - - - - Lb P_2O_5/A - - - - - - - -				
0-40	80	90	100	110	120
40-80	55	65	70	75	80
80-120	30	35	40	40	45
120-150	15	15	15	15	15
150+	0	0	0	0	0
Crop Removal[2]	120	240	360	480	600

Alfalfa/Clover Sufficiency P Rec = [73 + (4.56 × Yield Goal) + (Bray P × -2.92) + (Yield Goal × Bray P × -0.18)]

If Bray P > 25 ppm then P Recommendation = 0
If Bray P < 25 ppm then the minimum P Recommendation = 15 Lb P_2O_5/A

Alfalfa/Clover Sufficiency K Rec = [84 + (5.24 × Yield Goal) + (Exch K × -0.56) + (Yield Goal × Exch K × -0.035)]

If Exch K > 150 ppm then basic K Recommendation = 0
If Exch K < 150 ppm then the minimum K Recommendation = 15 Lb K_2O/A

Phosphorus Build Alfalfa Recommendations[1, 4, 5]

Bray P1	4-Year Build Time Frame Yield (Ton/A)			6-Year Build Time Frame Yield (Ton/A)			8-Year Build Time Frame Yield (Ton/A)		
Soil Test	2	6	10	2	6	10	2	6	10
(ppm)	- - Lb P_2O_5/A - -			- - Lb P_2O_5/A - -			- - Lb P_2O_5/A - -		
0-5	125	173	221	77	125	173	63	111	159
5-10	80	128	176	62	110	158	52	100	148
10-15	58	106	154	47	95	143	41	89	137
15-25	35	83	131	32	80	128	30	78	126
25-35[3]	24	72	120	24	72	120	24	72	120
35+	0	0	0	0	0	0	0	0	0

Potassium Build-Maintenance Alfalfa Recommendations[1,4]

Exch. K	4-Year Build Time Frame Yield (Ton/A)			6-Year Build Time Frame Yield (Ton/A)			8-Year Build Time Frame Yield (Ton/A)		
Soil Test	2	6	10	2	6	10	2	6	10
(ppm)	- - Lb K_2O/A - -			- - Lb K_2O/A - -			- - Lb K_2O/A - -		
0-40	413	653	893	315	555	795	266	506	746
40-80	323	563	803	255	495	735	221	461	701
80-120	233	473	713	195	435	675	176	416	656
120-150	154	394	634	143	383	623	137	377	617
150-180[3]	120	360	600	120	360	600	120	360	600
180+	0	0	0	0	0	0	0	0	0

Phosphorus Build-Maintenance Rec = $\frac{\{(25 - \text{Current P Soil Test}) \times 18\}}{\text{Years To Build}}$ + P_2O_5 Removal In Crop

Potassium Build-Maintenance Rec = $\frac{\{(150 - \text{Current K Soil Test}) \times 9\}}{\text{Years To Build}}$ + K_2O Removal In Crop

1 *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied*

2 *Crop removal numbers provided for comparitive purpose only - 12 lb P_2O_5 and 60 lb K_2O per ton of harvested alfalfa or clover. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

3 *Recommended amounts of P_2O_5 and K_2O are based on crop nutrient removal at the indicated yields (12 lb P_2O_5 / ton and 60 lb K_2O/ton).*

4 *Four, six, and eight year timeframes below are examples only. Build programs can be over longer timeframe, however, build-maintenance recommendations should not be less than crop sufficiency based fertility programs.*

5 *Nitrogen fertilizer is not recommended, however, the amount of N supplied by common P fertilizers is not detrimental to alfalfa production*

New Alfalfa and Clover P and K Recommendations

Phosphorus Sufficiency Recommendations for Brome and Fescue[1]

Bray P1 Soil Test	Yield Goal (Ton/A) 2	3	4	5	6
(ppm)	- - - - - - - Lb P_2O_5/A - - - - - - - -				
0-5	95	110	120	130	140
5-10	75	85	90	100	110
10-15	55	60	65	70	80
15-20	30	35	40	45	45
20-25	15	15	15	15	15
25+	0	0	0	0	0
Crop Removal [2]	24	36	48	60	72

Potassium Sufficiency Recommendations for Brome and Fescue[1]

Exch. K	Yield Goal (Ton/A) 2	3	4	5	6
(ppm)	- - - - - - - Lb K_2O/A - - - - - - - -				
0-40	115	130	145	155	170
40-80	80	90	100	110	115
80-120	45	50	55	60	65
120-150	15	15	15	20	20
150+	0	0	0	0	0
Crop Removal [2]	120	180	240	300	360

New Alfalfa/Clover Sufficiency P Rec = [84 + (12 × Yield Goal) + (Bray P × -3.37) + (Yield Goal × Bray P × -0.48)]

If Bray P > 25 ppm then basic P Recommendation = 0
If Bray P < 25 ppm then the minimum P Recommendation = 15 Lb P_2O_5/A

New Alfalfa/Clover Sufficiency K Rec = [105 + (15 × Yield Goal) + (Exch K × -0.7) + (Yield Goal × Exch K × -0.1)]

If Exch K > 150 ppm then basic K Recommendation = 0
If Exch K < 150 ppm then the minimum K Recommendation = 15 Lb K_2O/A

[1] *Crop P & K recommendations are for the total amount of broadcast and banded nutrients to be applied.*

[2] *Crop removal numbers provided for comparitive purpose only - 12 lb P_2O_5 and 60 lb K_2O per ton of harvested alfalfa or clover. If crop removal exceeds nutrient applications, soil test levels are expected to decline over time.*

For More Information

For additonal information about nutrient management, see the following publications , available from your local K-State Research and Extension office, or on the World Wide Web at www.oznet.ksu.edu.

Best Management Practices for Phosphorous, MF-2321
Chloride in Kansas: Plant, Soil, and Fertilizer Considerations, MF-2570
Estimating Manure Nutrient Availability, MF-2562
Phosphorus and Water Quality in Kansas, MF-2463
Sulphur in Kansas, MF-2264
Water Quality Protection: Best Management Practices for Cropland, MF-2462

Secondary and Micronutrients

Chloride

Wheat, Corn and Sorghum

Profile Soil Chloride		Chloride Recommendation
ppm	Lb/A	Lb Cl/A
< 4	< 30	20
4 – 6	30 – 45	10
> 6	> 45	0

Boron[1, 2]

Alfalfa, Corn, Sorghum and Soybeans Boron Recommendation

DTPA Extr. B	Boron Recommendation
ppm	Lb B/A
< 0.5	2
0.6 – 1.0	1
> 1.0	0

[1] *Recommendations are for southeast Kansas. Test is not well calibrated*
[2] *DO NOT BAND APPLY BORON*

Zinc

Corn, Sorghum and Soybeans Zinc Recommendation

Zn Rate[1, 2] = 11.5 – (11.25 × ppm DTPA Zn)

If DTPA Zn > 1.0 ppm then Zn Rec = 0

If DTPA Zn <= 1.0 ppm then Minimum Zn Rec = 1

Wheat, Sunflowers and Oats Zinc Recommendation

Zn Rate = 0[3]

[1] *Broadcast application intended to build Zn soil test level to non-responsive range and correct soil deficiency for several years*
[2] *If applied as banded starter at planting, application of about 0.5 – 1.0 lb Zn/A will correct crop deficiency for that crop year. Soil deficiency will likely remain.*
[3] *May desire to apply Zinc depending on incorporation opportunity in rotation*

Alfalfa, Brome, Fescue, Bermuda and Others Zn Recommendation

Zn Rate = 0

Sulfur[1]

Wheat Sulfur Recommendation (Lb/A) = (0.6 × Y Goal) – (2.5 × % OM) – Profile Sulfur – Other Sulfur Credits

Corn and Grain Sorghum Sulfur Recommendation (Lb/A) = (0.2 × Y Goal) – (2.5 × % OM) – Profile Sulfur – Other Sulfur Credits

Corn and Forage Sorhum Silage Sulfur Recommendation (Lb/A) = (1.33 × Y Goal) – (2.5 × % OM) – Profile Sulfur – Other Sulfur Credits

Sunflower Sulfur Recommendation (Lb/A) = (0.005 × Y Goal) – (2.5 × % OM) – Profile Sulfur – Other Sulfur Credits

Brome, Fescue & Bermuda Grass Sulfur Recommendation (Lb/A) = (5.0 × Y Goal) – (2.5 × % OM) – Profile Sulfur – Other Sulfur Credits

Alfalfa Sulfur Recommendation (Lb/A) = (6.0 × Y Goal) – (2.5 × % OM) – Profile Sulfur – Other Sulfur Credits

Soybean Sulfur Recommendation (Lb/A) = (0.4 × Y Goal) – (2.5 × % OM) – Profile Sulfur – Other Sulfur Credits

[1] *Default Profile Sulfur = 25 lb S/A*

Dale F. Leikam
Extension Specialist
Nutrient Management

Ray E. Lamond
Extension Specialist
Soil Fertility, Soil Testing

Dave B. Mengel
Head
Department of Agronomy

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

MF-2586 September 2003