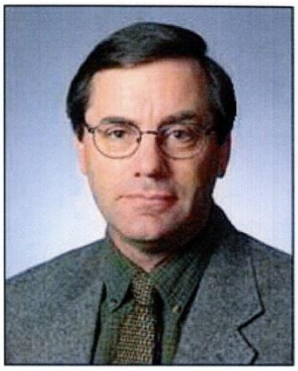
2016 Dairy Days

Maximizing Economic Returns to Fertilizer Expenses

Presentation Handout



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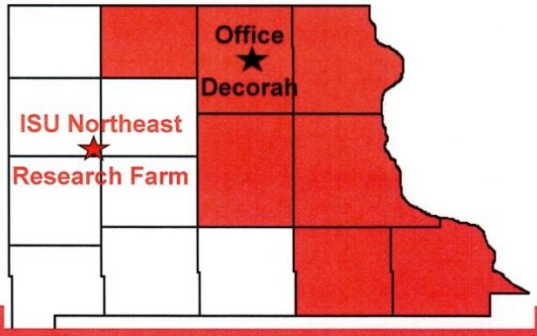

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Critical Factors in Soil Sampling, Tests and Interpretations

1. **Soil sampling**
   - A sample should represent an area of a field under similar conditions: grid or zone sampling (yield maps, soil type, slope, drainage, crop history, manure, proximity to gravel road, etc.)
   - Minimum of 10 cores, prefer 15 cores per soil sample. This includes using grid-sampling.
2. **Soil samples are sent to a certified lab in accordance with IDALS**
   - The list of certified labs is at: www.iowaagriculture.gov/feedandfertilizer.asp
   - Lab procedure is standardized, and the labs are spot-checked by the state.
   - Results of each mineral (P, K, etc.) is provided in parts per million (ppm).
   - Select 1 of 2 methods to analyze soil samples: 1) Dried; 2) Field-Moist/Slurry
3. **Read the soil test & interpret recommendations using publication PM-1688**
   - There are 4 different P tests: Bray P1, Mehlich-3 P, Mehlich-3 ICP, Olsen P
   - There are 2 different K tests: Ammonium-acetate or Mehlich-3 (equally good tests for K)
   - ISU Soil Test Categories are "Very Low", "Low", "Optimum", "High", "Very High"
     - Certified labs are NOT required to use ISU soil test categories
   - Recommendations are provided as lb/ac of fertilizer i.e. phosphate (P_2O_5), potash (K_2O)
     - For soil testing 'Optimum', ISU recommendation is to fertilize for crop removal
     - Certified labs are NOT required to use ISU fertilizer recommendations

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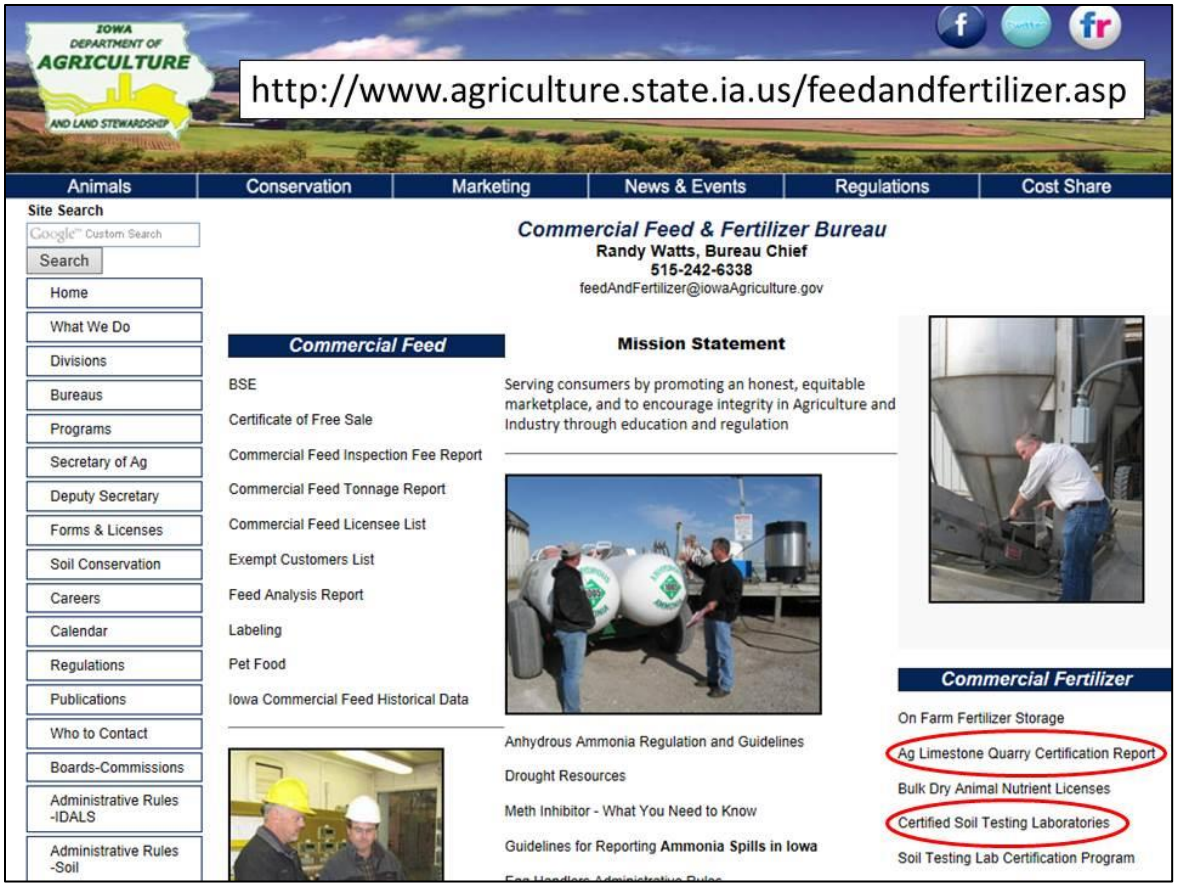


Soil Testing Labs Certified by IDALS

The soil test labs in a box offer the Field-Moist test for K

A&L Great Lakes Laboratories Inc.
Brian Thayer
3505 Conestoga Drive
Fort Wayne, IN
260-483-4759
bthayer@algreatlakes.com
www.algreatlakes.com

AgLab Express
Mike Barber
3600 S Minnesota Ave Ste 200
Sioux Falls, SD
605-271-9237
mikebarber@AGLABEXPRESS.COM
aglabexpress.com

AgSource-Ellsworth
Jim Friedericks
1532 DeWitt St
Ellsworth, IA
515-836-4444 Ext 102
jfriedericks@agsource.com
www.agsource.com

AgSource -Harris
Kevin Klink
300 Speedway Circle Ste 2
Lincoln, NE
402-476-0300 Ex 102
kklink@agsource.com
www.agsource.com

Brookside Labs Inc.
Mark A. Flock
200 White Mountain Dr.
New Bremen, OH
419-753-2448
mflock@blinc.com
www.blinc.com

Dairyland Laboratories
Dave Taysom
217 E. Main St.
Arcadia, WI
608-323-2123
dtaysom@dairylandlabs.com
www.dairylandlabs.com

Frontier Labs Inc.
Deann Morgan
3031 Hwy 122 E
Clear Lake, IA
641-357-7645
dmorgan@frontierlabs.net
www.frontierlabs.net

ISU Soil & Plant Analysis Lab
Kerry Culp
G-501 Agronomy Hall
Ames, IA
515-294-3076
soiltest@iastate.edu
www.agron.iastate.edu/soiltesting

Solum, Inc
Linda Bottorf
615 South Bell Avenue
Ames, IA
515-661-550
lbottorff@solumtech.com

Spectrum Analytic Inc.
Vernon Pabst
1087 Jamison Rd
Washington Court House, OH
740-335-1562
vernon@spectrumanalytic.com
www.spectrumanalytic.com

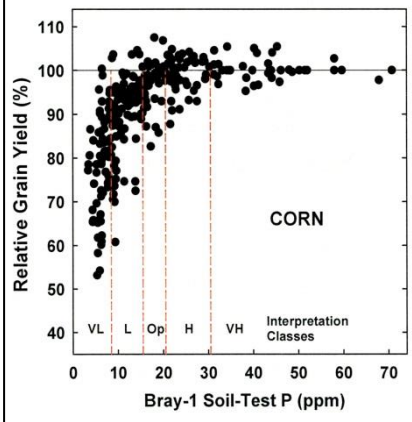
United Soils Inc
Corina Ardelean
108 S. Crystal Lane
Fairbury, IL
815-692-2626
ardeleanc@unitedsoilsinc.com
www.unitedsoilsinc.com

VH Consulting Inc
Richard Vanden Heuvel
805 Lund St., N.
Hudson, WI
715-222-3366
vhconsul@msn.com

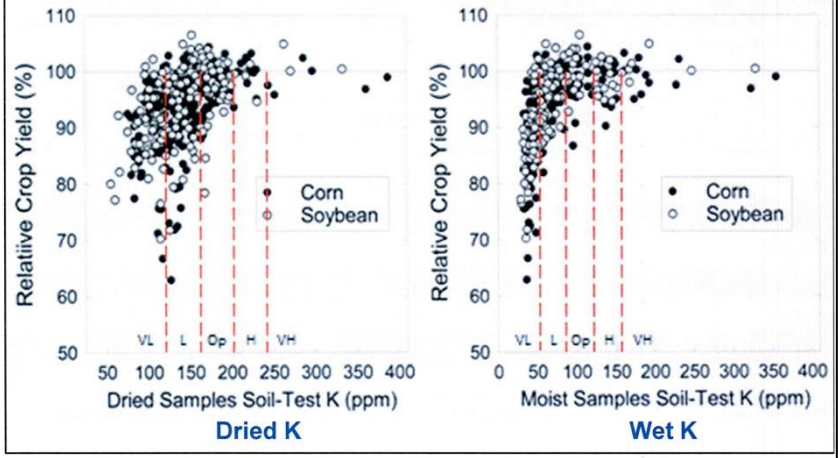
Waypoint Analytical Iowa, Inc.

Oven Dried or Field Moist-Slurry (wet)

Many years of Calibrations for P



Many years of Calibrations for K



6-inch sampling depth

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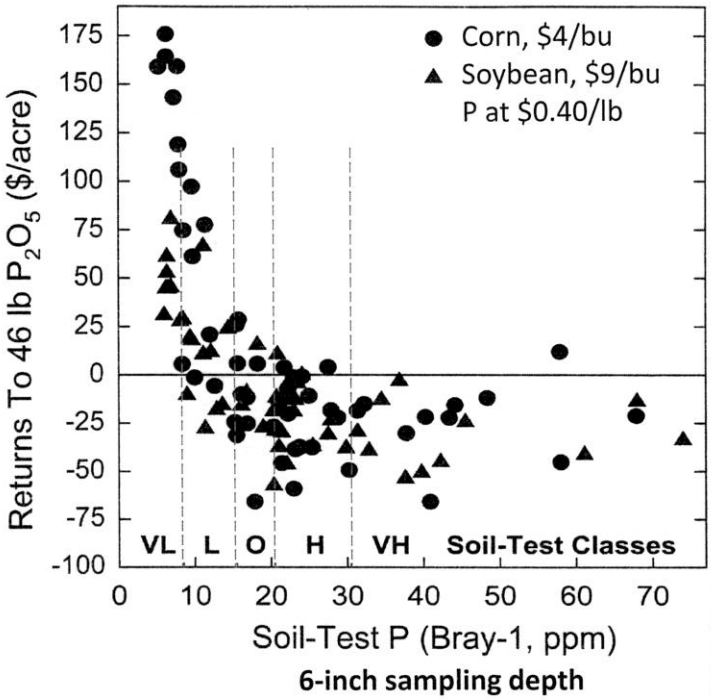
Returns to Cost of Fertilizer



6-inch sampling depth

Percent of P and K fertilizer applications expected to produce a yield response with soil test levels that are:

Very Low	80%
Low	65%
Optimum	25%
High	5%
Very High	<1%

For long-term profitable crop production, maintain in the optimum category.

For soil test levels in the optimum category, fertilize for crop removal.

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Soil Sample Information Sheet for Field Crops

The original will not be returned to you, so keep a copy for your records. Send to:
ISU Soil and Plant Analysis Laboratory, G501 Agronomy, Ames, Iowa 50011-1010.

Date_____

Submitter _____

Address _____

_____
City State Zip Code

Phone _____

Email address (please print clearly) _____

Client name _____ Farm is in _____ County.

Lab Space—Do Not Use

$ _____ Moist OR Dry

Check # _____ Co # _____

ACC # _____ Adj. _____

Note: Recommendations are computer generated. Please use numbers in the boxes below to help speed sample processing.

Lab no. Do not use	Sample number	Will lime be incorporated (Yes/No)	Crop Code (Select code from the table. Use one per sample)	Test series code (Use one per sample)

Test Series Codes (Moist samples)

Test code	Tests	Cost/sample
M1	Moist K and P and dry pH and lime	$12.00
M2	Moist K and P and dry pH, lime and OM	$15.00
M3	Moist K and P and dry pH, lime and Zn	$16.00
M4	Moist K and P and dry pH, lime, OM and Zn	$18.00

Test Series Codes (Dry samples)

Test code	Tests	Cost/sample
1	Dry K and P and dry pH and lime	$9.00
2	Dry K and P and dry pH, lime and OM	$12.00
3	Dry K and P and dry pH, lime and Zn	$13.00
4	Dry K and P and dry pH, lime, OM and Zn	$15.00
5	pH and lime only	$8.00

Crop codes (Use one per sample)

Crop code	Crop names	Table number in PM 1688
3	Corn or sorghum grain	3
4	Soybeans	4
5	Corn/soybean grain sequence (two year rotation, applied before either corn or soybean	5
6	Oat grain	6
7	Wheat	7
8	Sunflowers	8
9	Corn or sorghum silage	9
10	Alfalfa and alfalfa grass hay and pastures	10
11	Clover- and –trefoil-grass hay and pastures	11
12	Tall and cool season grasses, warm season grasses and sorghum-sudan hay and pastures	12
13	Bluegrass	13

What you need:

P for all crops

K for all crops

pH for all crops and useful in some herbicide selection and rates

OM correlates to S and useful in some herbicide selection and rates

Zn for corn on mainly on calcareous soils

B for alfalfa on low OM soils

Ca, Mg, S, Fe, Cu, Mn, CEC is all largely hype or unreliable poorly correlated tests. Refer to Dr. Rehm article *"Some Soil Test Information is Important; Some isn't"*

Table 1. Interpret soil test values for P & K.

Soil samples tested either:

- **Dried, or**
- **Field-Moist & Slurry**

Four soil P tests:

- **Bray1** (not a recommended soil P test on calcareous soil)
- **Mehlich-3 P**
- **Mehlich-3 ICP**
- **Olsen P**

P soil test values differ for:

- **Alfalfa and wheat, vs.**
- **All other crops**

Two K tests (equally good)**:**

- **Ammonium-Acetate**
- **Mehlich-3**

Table 1. Interpretation of soil-test values for phosphorus (P) and potassium (K) determined using recommended sample handling procedures and analysis methods (6-inch deep soil samples). Samples analyzed either field-moist or in a slurry (not dried), or after drying at 95 to 105° F.

	PHOSPHORUS		POTASSIUM
	Alfalfa or Wheat	All Other Crops	All Crops
Relative Level	Bray P_1 or Mehlich-3 P		Ammonium-Acetate or Mehlich-3
	Field-Moist and Slurry or Dried Samples		Field-Moist or Slurry Samples
Very low (VL)	0–15	0–8	0–50
Low (L)	16–20	9–15	51–85
Optimum (Opt)	21–25	16–20	86–120
High (H)	26–35	21–30	121–155
Very high (VH)	36+	31+	156+
	Mehlich-3 ICP		Ammonium-Acetate or Mehlich-3
	Field-Moist and Slurry or Dried Samples		Dried Samples
Very low (VL)	0–20	0–15	0–120
Low (L)	21–30	16–25	121–160
Optimum (Opt)	31–40	26–35	161–200
High (H)	41–50	36–45	201–240
Very high (VH)	51+	46+	241+
	Olsen P		
	Field-Moist and Slurry or Dried Samples		
Very low (VL)	0–9	0–5	
Low (L)	10–13	6–9	
Optimum (Opt)	14–16	10–13	
High (H)	17–19	14–18	
Very high (VH)	20+	19+	

Table 2. Crop Nutrient Removal

Table 2. Nutrient concentrations to calculate removal amounts of P_2O_5 and K_2O in the optimum soil-test category.

Crop †	Unit of Yield and Moisture Basis	Pounds per Unit of Yield ‡	
		P_2O_5	K_2O
Corn	bu, 15%	0.32	0.22
Corn silage	bu grain equiv., 15%	0.44	1.10
Corn silage	ton, 65%	3.5	9.0
Corn stover	ton, 15%	4.8	18
Soybean	bu, 13%	0.72	1.2
Soybean residue	ton, 10%	4.7	23
Oat	bu, 13%	0.29	0.19
Oat straw	ton, 10%	6.4	36
Wheat	bu, 12%	0.55	0.27
Wheat straw	ton, 10%	3.7	23
Sunflower	100 lb, 10%	0.75	0.65
Alfalfa, alfalfa-grass	ton, 15%	13	43
Red clover-grass	ton, 15%	11	31
Trefoil-grass	ton, 15%	11	31
Smooth bromegrass	ton, 15%	7.9	41
Orchardgrass	ton, 15%	12	60
Tall fescue	ton, 15%	11	58
Timothy	ton, 15%	7.9	28
Perennial ryegrass	ton, 15%	11	30
Sorghum-sudan	ton, 15%	11	33
Switchgrass	ton, 15%	11	58
Reed canarygrass	ton, 15%	7.9	41

Examples of Crop Removal Calculations using Table 2: When soil test levels are in the 'Optimum' range, fertilize for crop removal.

Corn grain, 15% moisture, crop removal/bu = 0.32 lb P_2O_5/bu and 0.22 lb K_2O/bu

For 200 bu/ac corn grain production:
200 x 0.32 = 64 lb P_2O_5
200 x 0.22 = 44 lb K_2O

Convert to lb/ac of 18-46-0 & 0-0-60 fertilizer:
64 / 0.46 = 139 lb/ac 18-46-0
44 / 0.60 = 73 lb/ac 0-0-60

Corn silage, 65% moisture, crop removal/ton = 3.5 lb P_2O_5/bu and 9.0 lb K_2O/bu

For 25 ton/ac corn silage production:
25 x 3.5 = 88 lb P_2O_5
25 x 9.0 = 225 lb K_2O

Convert to lb/ac of 18-46-0 & 0-0-60 fertilizer:
88 / 0.46 = 191 lb/ac 18-46-0
225 / 0.60 = 375 lb/ac 0-0-60

Alfalfa hay 15% moisture, crop removal/ton = 13 lb P_2O_5/bu and 43 lb K_2O/bu

For 6 ton/ac hay production:
6 x 13 = 78 lb P_2O_5
6 x 43 = 258 lb K_2O

Convert to lb/ac of 11-53-0 & 0-0-60 fertilizer:
78 / 0.53 = 147 lb/ac 11-53-0
258 / 0.60 = 430 lb/ac 0-0-60

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

	Phosphorus Dry or Field-Moist and Slurry Soil Tests (ppm)				
Soil Test Category	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P	0–15	16–20	21–25	26–35	36+
Olsen P	0–10	10–13	14–16	17–19	20+
Mehlich-3 ICP P	0–20	21–30	31–40	41–50	51+
	P_2O_5 to apply (lb/acre)				
	110	80	65	0	0
	Potassium Soil Tests (ppm)				
Soil Test Category	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K					
Dry	0–120	121–160	161–200	201–240	240+
Field-moist and Slurry	0–50	51–85	86–120	121–155	156+
	K_2O to apply (lb/acre)				
All Soil Types	280	240	215	0	0

Table 10. Fertilizer recommendations for 5 ton/ac alfalfa production.

SOIL TEST RESULTS AND INTERPRETATION

Lab Test Results

Soil testing lab results in % OM, ppm P, ppm K, Soil pH & Buffer pH

Lab Number	Client Sample ID	Organic Matter (%)	Mehlich 3 Phosphorus dry analysis (ppm) colorimetric	Mehlich 3 Potassium dry analysis (ppm) (AAS)	Zinc (ppm)	Soil pH	Sikora Buffer pH
149104	1	2.4	19 L	134 L	0.9	6.6	6.9
149105	2	1.8	12 VL	117 VL	1.2	7.1	7.0
149106	3	3.1	25 H	185 O	1.5	6.5	6.7
149107	4	2.1	37 VH	240 H	1.2	6.1	6.5
149108	5	2.8	15 L	165 O	0.7	5.8	6.6
149109	6	2.2	19 O	148 L	1.0	6.4	6.8

key: VL=Very Low L=Low Opt=Optimum H=High VH=Very High n/a=not applicable

Zinc: Low 0--0.4; Marginal 0.5--0.8; Adequate 0.9+

FERTILIZER AND LIME SUGGESTIONS

Fertilizer recommendation in lb/ac P_2O_5 and K_2O

Lime recommendation from Buffer pH in lb/ac ECCE

Client information		Crop Info	Fertilizer application suggestions						Target soil pH		
Lab Number	Client Sample ID	Crop code	P_2O_5 (lb/a)	K_2O (lb/a) fine soil	K_2O (lb/a) sandy soil	Zinc (lb/a) broadcast	Zinc (lb/a) banded	Depth of Soil to be Neutralized	lb ECCE/a (for pH 6.0)	lb ECCE/a (for pH 6.5)	lb ECCE/a (for pH 6.9)
149104	1	10	80	240	240	0	0	6	0	0	1900
149105	2	10	110	280	280	0	0	6	0	0	1100
149106	3	9	0	200	200	0	0	6	0	1300	3500
149107	4	3	0	0	0	0	0	6	200	2800	5200
149108	5	3	75	40	40	5	1	6	0	2100	4400
149109	6	4	40	90	85	0	0	6	0	600	2700

IOWA TESTING LABORATORIES, INC.
1101 North Iowa Avenu Highway #17 North
EAGLE GROVE, IOWA 50533-2701
e-mail: soils@iowatestinglabs.com website: www.iowatestinglabs.com

Dealer: ISU Extension - Winneshick Co.
911 S. Mill St.
Decorah IA 52101-

Grower Brian Lang
911 S Mill Street
Decorah IA 52101

6/7/2006
6/12/2006

CustomerNumber [redacted]

	SOIL ANALYSIS (PARTS PER MILLION)																		% SATURATION					
Samp Name	pH	BpH	OM	P-1	P-misc	K	Mg	Ca	Na	S	Zn	Mn	B	Cu	Fe	H sat	Na sat	K sat	Mg sat	Ca sat	CEC*
SH05	7.4		3.8 H	28 H		133 O	314	1908		1 VL	0.4	12.4 H	0.1 VL	0.4 L	3.5 VL	0.0		2.7	20.9	76.3	12.5
DS04	7.2		2.1 M	28 H		94 L	254	1432		3 VL	1.1	13.3 H	0.1 VL	0.5 L	4.4 VL	0.0		2.5	22.3	75.4	9.5
CH03	6.9		3.1 H	43 VH		220 VH	444	1926		7 M	0.7	17.9 H	0.9 M	0.9 M	8.5 L	3.5		3.9	25.7	66.9	14.4
WG02	6.9		3.3 H	13 VL		58 VL	170	1584		6 M	0.6	23.3 H	0.4 L	0.5 L	7.8 L	5.0		1.5	14.2	79.2	10.0
WZ01	6.4	6.8	2.6 M	71 VH		207 VH	176	1280		3 L	1.8	12.1 H	0.4 L	0.7 L	6.5 L	5.6		6.0	16.5	71.9	8.9

Certified labs test pH, OM, P, K and Zn according to certain standards and report the values in ppm.

They do not have to use ISU testing level categories (VL, L, O, H, VH).

RELATION TO TEXTURE (CEC): LIGHT 1-10 MEDIUM 11-20 HEAVY 21

			RECOMENDATIONS (POUNDS PER ACRE)													
Lab No.	Lime65	Lime69	CropYield	N	P2O5	K2O	CropYield	N	P2O5	K2O	CropYield	N	P2O5	K2O
6770			Al 6	36	25	195	Al 6	36	25	195	C 180	216	65	125
6771			Al 6	36	25	210	Al 6	36	25	210	C 180	216	65	140
6772			Al 6	36	20	160	Al 6	36	20	160	C 180	216	40	90
6773			Al 6	36	90	225	Al 6	36	90	225	C 180	216	110	155
6774	600	2,700	Al 6	36	20	165	Al 6	36	20	165	C 180	216	40	95

COMMENTS

They do not have to use ISU fertilizer recommendations.

Comparison 1 of recommendations from a commercial soil testing lab and ISU

Corn

Soil test results in ppm P and K

Soil test fertilizer recs. in lb/ac P_2O_5 and K_2O for 180 bu/ac

SOIL ANALYSIS (PARTS PER MILLION)									
Samp Name	pH	BpH	OM		P-1		P-misc	K	
SH05	7.4		3.8	H	28	H		133	O
DS04	7.2		2.1	M	28	H		94	L
CH03	6.9		3.1	H	43	VH		220	VH
WG02	6.9		3.3	H	13	VL		58	VL
WZ01	6.4	6.8	2.6	M	71	VH		207	VH

RECOMENDATIONS (POUNDS PER ACRE)												
Lab No.	Lime65	Lime69	CropYield	N	P2O5	K2O	CropYield	N	P2O5	K2O		
6770			Al	6	36	25	195	C	180	216	65	125
6771			Al	6	36	25	210	C	180	216	65	140
6772			Al	6	36	20	160	C	180	216	40	90
6773			Al	6	36	90	225	C	180	216	110	155
6774	600	2,700	Al	6	36	20	165	C	180	216	40	95

ISU fertilizer recs. in PM-1688 page 5, table 3 in lb/ac P_2O_5 and K_2O for 180 bu/ac

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

Phosphorus Dry or Field-Moist and Slurry Soil Tests (ppm)					
Soil Test Category	Very Low	Low	Optimum*	High	Very High
Bray P_1 and Mehlich-3 P	0–8	9–15	16–20	21–30	31+
Olsen P	0–5	6–9	10–13	14–18	19+
Mehlich-3 ICP P	0–15	16–25	26–35	36–45	46+
P_2O_5 to apply (lb/acre)					
	100	75	58	0	0
Potassium Soil Tests (ppm)					
Soil Test Category	Very Low	Low	Optimum*	High	Very High
Ammonium Acetate and Mehlich-3 Extractable K					
Dry	0–120	121–160	161–200	201–240	240+
Field-moist and Slurry	0–50	51–85	86–120	121–155	156+
K_2O to apply (lb/acre)					
Fine Textured	130	90	40	0	0
Sandy Textured	110	70	40	0	0

Table 3 fertilizer recommendations are for 180 bu/ac corn grain production.

Comparison 2 of recommendations from a commercial soil testing lab and ISU

Alfalfa

Soil test results in ppm P and K

Soil test fertilizer recs. in lb/ac P_2O_5 and K_2O for 6 ton/ac

SOIL ANALYSIS (PARTS PER MILLION)									
Samp Name	pH	BpH	OM		P-1		P-misc	K	
SH05	7.4		3.8	H	28	H		133	O
DS04	7.2		2.1	M	28	H		94	L
CH03	6.9		3.1	H	43	VH		220	VH
WG02	6.9		3.3	H	13	VL		58	VL
WZ01	6.4	6.8	2.6	M	71	VH		207	VH

RECOMENDATIONS (POUNDS PER ACRE)												
Lab No.	Lime65	Lime69	CropYield		N	P2O5	K2O	CropYield		N	P2O5	K2O
6770			Al	6	36	25	195	C	180	216	65	125
6771			Al	6	36	25	210	C	180	216	65	140
6772			Al	6	36	20	160	C	180	216	40	90
6773			Al	6	36	90	225	C	180	216	110	155
6774	600	2,700	Al	6	36	20	165	C	180	216	40	95

ISU fertilizer recs. in PM-1688 page 5, table 10 in lb/ac P_2O_5 and K_2O for 5 ton/ac

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

Phosphorus Dry or Field-Moist and Slurry Soil Tests (ppm)					
Soil Test Category	Very Low	Low	Optimum*	High	Very High
Bray P_1 and Mehlich-3 P	0–15	16–20	21–25	26–35	36+
Olsen P	0–10	10–13	14–16	17–19	20+
Mehlich-3 ICP P	0–20	21–30	31–40	41–50	51+
P_2O_5 to apply (lb/acre)					
	110	80	65	0	0
Potassium Soil Tests (ppm)					
Soil Test Category	Very Low	Low	Optimum*	High	Very High
Ammonium Acetate and Mehlich-3 Extractable K					
Dry	0–120	121–160	161–200	201–240	240+
Field-moist and Slurry	0–50	51–85	86–120	121–155	156+
K_2O to apply (lb/acre)					
All Soil Types	280	240	215	0	0

Table 10 fertilizer recommendations are for 5 ton/ac of harvested hay production.

Comparison 3 of recommendations from a commercial soil testing lab and ISU

Alfalfa

Soil test results in ppm P and K

Soil test fertilizer recs. in lb/ac P_2O_5 and K_2O for 6 ton/ac

ISU fertilizer recs. in PM-1688 page 5, table 10 in lb/ac P_2O_5 and K_2O for 5 ton/ac

SOIL ANALYSIS (PARTS PER MILLION)

Samp Name	pH	BpH	OM		P-1		P-misc	K	
SH05	7.4		3.8	H	28	H		133	O
DS04	7.2		2.1	M	28	H		94	L
CH03	6.9		3.1	H	43	VH		220	VH
WG02	6.9		3.3	H	13	VL		58	VL
WZ01	6.4	6.8	2.6	M	71	VH		207	VH

RECOMENDATIONS (POUNDS PER ACRE)

Lab No.	Lime65	Lime69	CropYield		N	P2O5	K2O	CropYield		N	P2O5	K2O
6770			Al	6	36	25	195	C	180	216	65	125
6771			Al	6	36	25	210	C	180	216	65	140
6772			Al	6	36	20	160	C	180	216	40	90
6773			Al	6	36	90	225	C	180	216	110	155
6774	600	2,700	Al	6	36	20	165	C	180	216	40	95

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

Phosphorus Dry or Field-Moist and Slurry Soil Tests (ppm)					
Soil Test Category	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P	0–15	16–20	21–25	26–35	36+
Olsen P	0–10	10–13	14–16	17–19	20+
Mehlich-3 ICP P	0–20	21–30	31–40	41–50	51+
P_2O_5 to apply (lb/acre)					
	110	80	65	0	0
Potassium Soil Tests (ppm)					
Soil Test Category	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K					
Dry	0–120	121–160	161–200	201–240	240+
Field-moist and Slurry	0–50	51–85	86–120	121–155	156+
K_2O to apply (lb/acre)					
All Soil Types	280	240	215	0	0

Table 10 fertilizer recommendations are for 5 ton/ac of harvested hay production.

Corn Grain Example Using Soil Test Results to Calculate Fertilizer Cost Per Acre

Example 1: Soil test results in ppm:

20 ppm P, Bray1

148 ppm K, Dry test

ISU publication 1688, Table 3 for 180 bu/ac corn, recommends…

P_2O_5 lb/ac = 58

K_2O lb/ac = 90

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

Phosphorus Dry or Field-Moist and Slurry Soil Tests (ppm)					
Soil Test Category	Very Low	Low	Optimum*	High	Very High
Bray P_1 and Mehlich-3 P	0–8	9–15	16–20	21–30	31+
Olsen P	0–5	6–9	10–13	14–18	19+
Mehlich-3 ICP P	0–15	16–25	26–35	36–45	46+
P_2O_5 to apply (lb/acre)					
	100	75	58	0	0
Potassium Soil Tests (ppm)					
Soil Test Category	Very Low	Low	Optimum*	High	Very High
Ammonium Acetate and Mehlich-3 Extractable K					
Dry	0–120	121–160	161–200	201–240	240+
Field-moist and Slurry	0–50	51–85	86–120	121–155	156+
K_2O to apply (lb/acre)					
Fine Textured	130	90	40	0	0
Sandy Textured	110	70	40	0	0

Common fertilizer products	$N\text{-}P_2O_5\text{-}K_2O$	Price, $/ton
DAP (diammonium phosphate)	18-46-0	560
MAP (monoammonium phosphate)	11-53-0	570
KCl (potassium chloride)	0-0-60	420
AMS (ammonium sulfate)	21-0-0-24S	360
Gypsum (calcium sulfate)	0-0-0-18S-22Ca	220
Anhydrous ammonia	82-0-0	630
Urea	46-0-0	380

The analysis numbers represent the percent nutrient in the product.

For example: 1 lb of DAP has 0.18 lb of N and 0.46 lb of P_2O_5

Calculate fertilizer lb/ac using DAP and KCl

Recommendation of 58 lb/ac P_2O_5 / 0.46 = 126 lb/ac DAP

Recommendation of 90 lb/ac K_2O / 0.60 = 150 lb/ac KCl

Recommendation of 15 lb/ac sulfate-S divided by 0.24 = 63 lb/ac AMS

Fertilizer cost per acre

DAP = $560/ton, so 560/2,000 = $0.28/lb of DAP fertilizer

We need 126 lb/ac DAP, so 126 x $0.28 = $35.28/ac. This also includes 22.7 lb/ac N.

KCl = $420/ton, so 420/2,000 = $0.21/lb of KCl fertilizer

We need 150 lb/ac, so 150 x $0.21 = $31.50/ac

AMS = $360/ton, so 360 / 2,000 = $0.18/lb of sulfur

We need 63 lb/ac, so 63 x $0.18= $11.34/ac. This also includes 13 lb/ac N.

Urea = $380/ton, so 380/2,000 = $0.19/lb of product that is 46% N, so $0.19/0.46 = $0.41/lb N

126 lb/ac DAP used for P recommendations provides (126 x 0.18 N) = 22.7 lb/ac N

63 lb/ac AMS used for S recommendations provides (63 x 0.21 N) = 13 lb/ac N

Credit the 22.7 from DAP & 13 from AMS towards the total N fertilizer recommendation.

Alfalfa Example Using Soil Test Results to Calculate Fertilizer Cost Per Acre

Example 3: Soil test results in ppm:

20 ppm P, Bray1

148 ppm K, Dry test

ISU publication 1688, Table 10 for 5 ton/ac alfalfa, recommends…

P_2O_5 lb/ac = 80

K_2O lb/ac = 240

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

Phosphorus Dry or Field-Moist and Slurry Soil Tests (ppm)					
Soil Test Category	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Bray P_1 and Mehlich-3 P	0–15	16–20	21–25	26–35	36+
Olsen P	0–10	10–13	14–16	17–19	20+
Mehlich-3 ICP P	0–20	21–30	31–40	41–50	51+
P_2O_5 to apply (lb/acre)					
	110	80	65	0	0
Potassium Soil Tests (ppm)					
Soil Test Category	**Very Low**	**Low**	**Optimum***	**High**	**Very High**
Ammonium Acetate and Mehlich-3 Extractable K					
Dry	0–120	121–160	161–200	201–240	240+
Field-moist and Slurry	0–50	51–85	86–120	121–155	156+
K_2O to apply (lb/acre)					
All Soil Types	280	240	215	0	0

Common fertilizer products	N-P_2O_5-K_2O	Price, $/ton
DAP (diammonium phosphate)	18-46-0	560
MAP (monoammonium phosphate)	11-53-0	570
KCl (potassium chloride)	0-0-60	420
AMS (ammonium sulfate)	21-0-0-24S	360
Gypsum (calcium sulfate)	0-0-0-18S-22Ca	220

The analysis numbers represent the percent nutrient in the product.

For example: 1 lb of DAP has 0.18 lb of N and 0.46 lb of P_2O_5

Calculate fertilizer lb/ac using MAP, KCl and Gypsum

Recommendation of 80 lb/ac P_2O_5 divided by 0.53 = 151 lb/ac MAP

Recommendation of 240 lb/ac K_2O divided by 0.60 = 400 lb/ac KCl

Recommendation of 25 lb/ac sulfate-S divided by 0.18 = 139 lb/ac Gypsum

Fertilizer cost per acre

MAP = $570/ton, so 570 / 2,000 = $0.285/lb of MAP fertilizer

We need 151 lb/ac MAP, so 151 x $0.285 = $43.04/ac

KCl = $420/ton, so 420 / 2,000 = $0.21/lb of KCl fertilizer

We need 400 lb/ac, so 400 x $0.21 = $84.00/ac

Gypsum = $220/ton, so 220 / 2,000 = $0.11/lb of Gypsum

We need 139 lb/ac, so 139 x $0.11= $15.29/ac

Sulfur Management for Iowa Crop Production

ISU Extension publication CROP 3072 is available as a free pdf at:
http://www.agronext.iastate.edu/soilfertility/info/CROP3072.pdf

Sulfur Fertilizer Recommendations in a Nutshell:

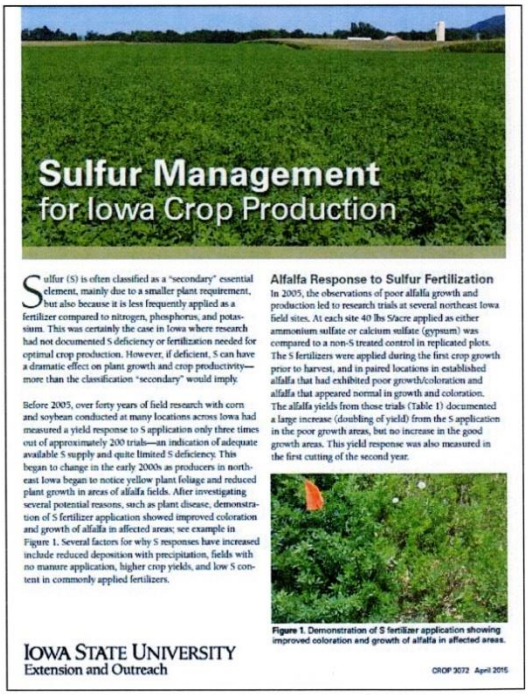
For corn:

- Soil and tissue tests are not reliable.
- Consider 15 lb/ac on most soils, but up to 30 lb/ac on sandy soils.

For soybeans: No recommendation.

For alfalfa:

- The soil test not reliable.
- The tissue test is okay
  - Clip the top 6-inches of ~35 stems at bud stage and send to a lab for %S plant analysis
  - If the test is lower than 0.23% S, fertilize with S
  - Consider 20-25 lb/ac on most soils but up to 35 lb/ac on sandy soils



Sulfur Management
for Iowa Crop Production

Sulfur (S) is often classified as a "secondary" essential element, mainly due to a smaller plant requirement, but also because it is less frequently applied as a fertilizer compared to nitrogen, phosphorus, and potassium. This was certainly the case in Iowa where research had not documented S deficiency or fertilization needed for optimal crop production. However, if deficient, S can have a dramatic effect on plant growth and crop productivity—more than the classification "secondary" would imply.

Before 2003, over forty years of field research with corn and soybean conducted at many locations across Iowa had measured a yield response to S application only three times out of approximately 200 trials—an indication of adequate available S supply and quite limited S deficiency. This began to change in the early 2000s as producers in northeast Iowa began to notice yellow plant foliage and reduced plant growth in areas of alfalfa fields. After investigating several potential reasons, such as plant disease, demonstration of S fertilizer application showed improved coloration and growth of alfalfa in affected areas; see example in Figure 1. Several factors for why S responses have increased include reduced deposition with precipitation, fields with no manure application, higher crop yields, and low S content in commonly applied fertilizers.

Alfalfa Response to Sulfur Fertilization

In 2005, the observations of poor alfalfa growth and production led to research trials at several northeast Iowa field sites. At each site 40 lbs S/acre applied as either ammonium sulfate or calcium sulfate (gypsum) was compared to a non-S treated control in replicated plots. The S fertilizers were applied during the first crop growth prior to harvest, and in paired locations in established alfalfa that had exhibited poor growth/coloration and alfalfa that appeared normal in growth and coloration. The alfalfa yields from those trials (Table 1) documented a large increase (doubling of yield) from the S application in the poor growth areas, but no increase in the good growth areas. This yield response was also measured in the first cutting of the second year.

Figure 1. Demonstration of S fertilizer application showing improved coloration and growth of alfalfa in affected areas.

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CROP 3072 April 2015

Commercial Fertilizer Sources of Sulfur

Sulfate-sulfur fertilizers are immediately available

Material name	Chemical formula	Fertilizer analysis	Sulfur %
Ammonium sulfate	$(NH_4)_2SO_4$	21 - 0 - 0 - 24	24
Ammonium thiosulfate	$(NH_4)_2SO_3$	12 - 0 - 0 - 26	26
Calcium sulfate (gypsum)	$CaSO_4$	0 - 0 - 0 - 16	16-18
Potassium sulfate	K_2SO_4	0 - 0 - 50 - 18	18-20
Potassium-Mg sulfate	$K_2SO{\cdot}2MgSO_4$	0 - 0 - 22 - 23	23
Elemental sulfur	S	0 - 0 - 0 - 90	90

Initially insoluble & unavailable. Requires months to become available. Requires oxidation by soil bacteria, influenced by soil incorporation, weathering, temperature & moisture.

Micronutrients

Table 15. 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.

ISU only provides micronutrient recommendations for Zn for corn and sorghum based on soil testing. Note that soil test procedures for the other micronutrients have not been calibrated because of either lack of or inconsistent occurrence of deficiencies.

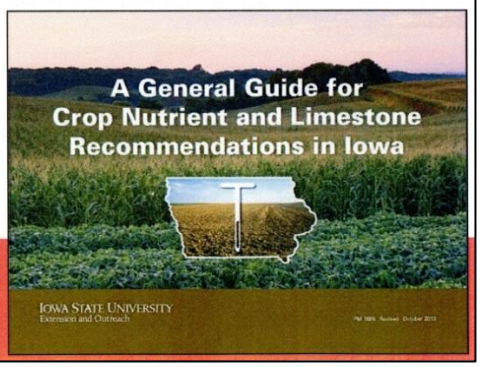

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Table 1. Traditional view of concerning likelihood of micronutrient deficiency

Micronutrient	Soil Conditions	Most Sensitive Crops
Boron (B)	Sandy or highly weathered soils low in organic matter, drought.	Alfalfa Clovers
Copper (Cu)	Very sandy soils. Acid organic soils.	Corn Oats Wheat
Iron (Fe)	Soil pH >7.0	Soybean
Manganese (Mn)	Organic soils with pH >5.8 Mineral soils with pH >7.0	Oats Soybean Sugar beets Wheat
Molybdenum (Mo)	Sandy or very acid soils (<5.5 pH)	Legumes
Zinc (Zn)	Sandy or organic soils. Low organic matter soils due to erosion. Soil pH >7.0	Corn

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Corn and Soybean Yield Responses to Micronutrient Fertilization

Antonio Mallarino, Professor, Iowa State University

Proceedings of the 26th Annual Integrated Crop Management Conference
Ames, IA, Dec.3-4, 2014

- 65 field trials with corn and soybeans on foliar fertilization with B, Cu, Mn and Zn, and soil fertilization of B, Mn and Zn did not increase grain yield at any trial.
- 25 foliar fertilization strip trials with a mixture of B, Mn and Zn showed a yield increase in one soybean field and a yield decrease in one corn field.
- In contrast to lack of grain yield response, fertilization sometimes increased micronutrient concentration of plant tissue and in grain. No yield response to the micronutrient applications suggest the previous nutrient supply was sufficient.
- Lack of grain yield responses in Iowa to fertilization of micronutrients do not allow for establishing reliable soil or tissue test interpretations.
- Decisions about micronutrient fertilization should follow traditional knowledge about conditions in which deficiencies are more likely, which were summarized in Table 1 above.

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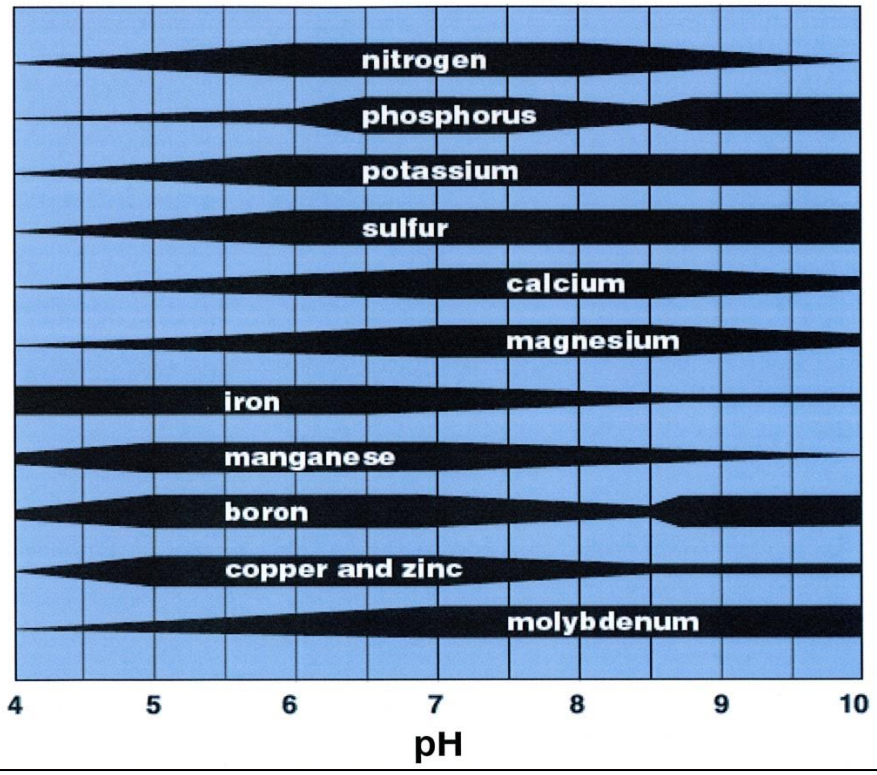
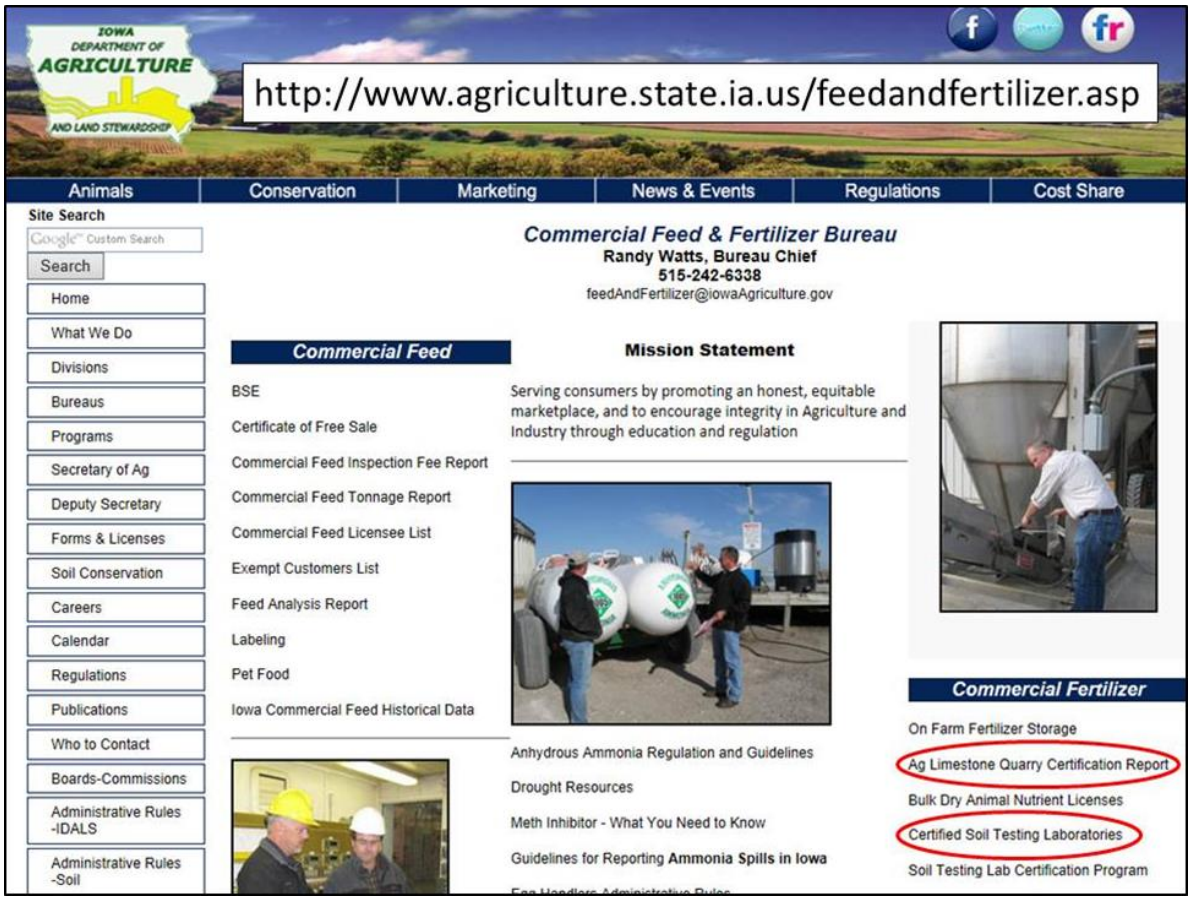
Available Nutrients in Relation to pH





RECAPITULATION
AGLIME ECCE QUARRY CERTIFICATION
IOWA DEPARTMENT OF AGRICULTURE AND LAND STEWARDSHIP
SECOND QUARTER 2014 REPORT

Producer	Quarry	Pile	Effective Date	Pile Type	Certified Pounds ECCE
00113	**A D M CORN PROCESSING -CLINTON** CLINTON, IA				
	001	A D M - CLINTON			
		ADM - CLINTON	12/14/2011	Water Treatment	589
00234	**AG CHOICE COIN** COIN, IA				
	001	AG CHOICE COIN			
			No Current Certification		
00093	**ANDERSON SAND & GRAVEL** DEWITT, IA				
	001	ANDERSON SAND & GRAVEL			
		ANDERSON SAND AND GRAVEL	01/09/2014	Quarry Lime	1257
00218	**AQUA AID INC** ROCKY MOUNT, NC				
	001	AQUA AID INC			
		VERDE CAL COARSE	04/20/2012	Quarry Lime	1668
00090	**ARCHER DANIELS MIDLAND CO** DECATUR, IL				
	001	ADM COGENERATION			
		ADM CONGENERATION WEST	No Current Certification		
		ADM CONGNRATN EAST PO #1581933	03/29/2011	Quarry Lime	942
		ADM CONGNRTN WEST PO#1581933	03/29/2011	Quarry Lime	814
		ADM EAST PO#1581933	03/29/2011	Quarry Lime	881
00214	**AVOCA SEED AND CHEMICAL** AVOCA, IA				
	001	AVOCA SEED AND CHEMICAL			
			No Current Certification		

Soil testing lab results in % OM, ppm P, ppm K, Soil pH & Buffer pH

SOIL TEST RESULTS AND INTERPRETATION

Lab Test Results

Lab Number	Client Sample ID	Organic Matter (%)	Mehlich 3 Phosphorus dry analysis (ppm) (colorimetric)	Mehlich 3 Potassium dry analysis (ppm) (AAS)	Zinc (ppm)	Soil pH	Sikora Buffer pH
149104	1	2.4	19 L	134 L	0.9	6.6	6.9
149105	2	1.8	12 VL	117 VL	1.2	7.1	7.0
149106	3	3.1	25 H	185 O	1.5	6.5	6.7
149107	4	2.1	37 VH	240 H	1.2	6.1	6.5
149108	5	2.8	15 L	165 O	0.7	5.8	6.6
149109	6	2.2	19 O	148 L	1.0	6.4	6.8

key: VL=Very Low L=Low Opt=Optimum H=High VH=Very High n/a=not applicable

Zinc: Low 0--0.4; Marginal 0.5--0.8; Adequate 0.9+

Fertilizer recommendation in lb/ac P_2O_5 and K_2O

Lime recommendation from Buffer pH in lb/ac ECCE

FERTILIZER AND LIME SUGGESTIONS

Client information		Crop Info	Fertilizer application suggestions						Target soil pH		
Lab Number	Client Sample ID	Crop code	P_2O_5 (lb/a)	K_2O (lb/a) fine soil	K_2O (lb/a) sandy soil	Zinc (lb/a) broadcast	Zinc (lb/a) banded	Depth of Soil to be Neutralized	lb ECCE/a (for pH 6.0)	lb ECCE/a (for pH 6.5)	lb ECCE/a (for pH 6.9)
149104	1	10	80	240	240	0	0	6	0	0	1900
149105	2	10	110	280	280	0	0	6	0	0	1100
149106	3	9	0	200	200	0	0	6	0	1300	3500
149107	4	3	0	0	0	0	0	6	200	2800	5200
149108	5	3	75	40	40	5	1	6	0	2100	4400
149109	6	4	40	90	85	0	0	6	0	600	2700

Table 16. Lime recommendations use Buffer pH to give lb/ac of ECCE

(effective calcium carbonate equivalent)

Target pH

alfalfa 6.9

other forages 6.0

corn & soybeans 6.5 (or 6.0 on calcareous soils)

Example:

Soil pH of 6.6, Buffer pH of 6.9, 6-inch depth, lime for alfalfa to 6.9

6.9 Buffer = 1,900 lb ECCE from table

East PO ECCE quarry certification = 942 lb/ton

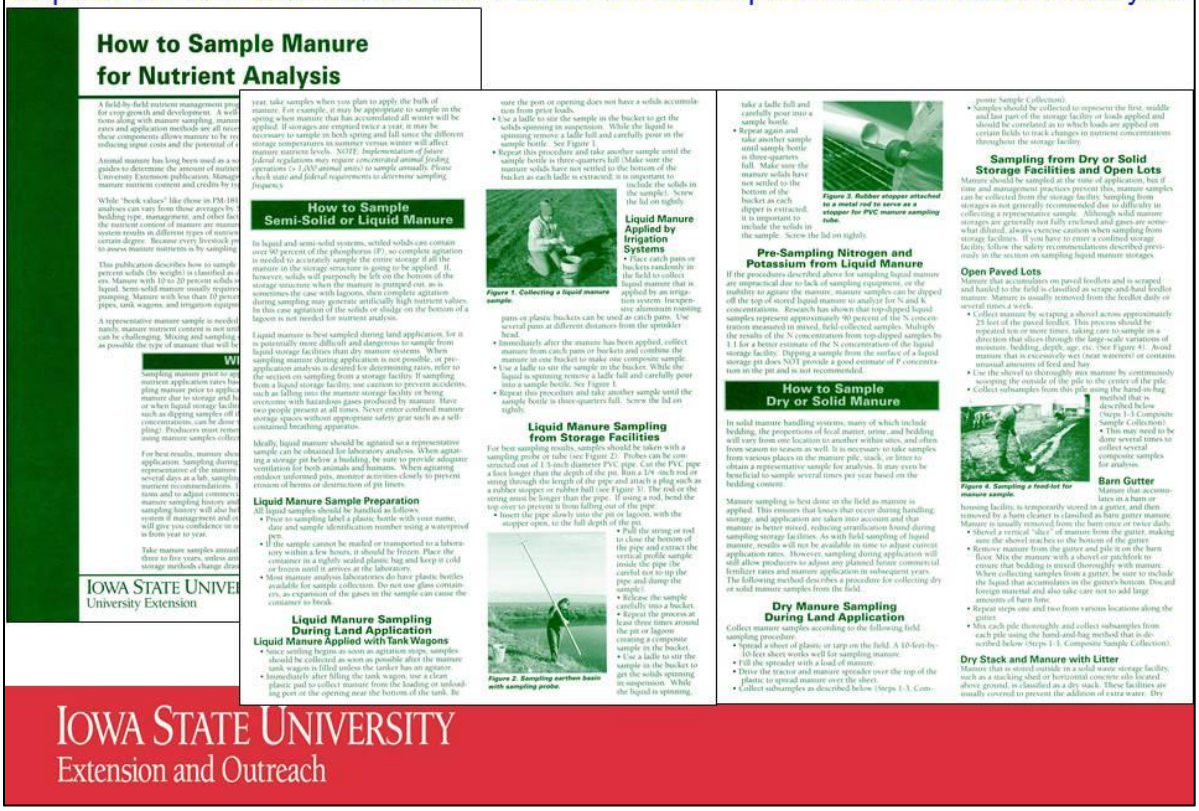
1,900 / 942 = 2 ton/ac of actual lime to apply

Table 16. Lime recommendations based on SMP or Sikora buffer pH methods, given in pounds per acre of finely ground pure calcium carbonate ($CaCO_3$) to increase soil pH from its present level to pH 6.0, 6.5, or 6.9 for the soil depth to be neutralized.†

	Depth of Soil to be Neutralized								
	2 inches			3 inches			6 inches		
	Target Soil pH								
Buffer pH	pH 6.0	pH 6.5	pH 6.9	pH 6.0	pH 6.5	pH 6.9	pH 6.0	pH 6.5	pH 6.9
	Amount of Calcium Carbonate to Apply (lb/acre) ‡								
7.0	0	0	400	0	0	600	0	0	1,100
6.9	0	0	600	0	0	1,000	0	0	1,900
6.8	0	200	900	0	300	1,400	0	600	2,700
6.7	0	400	1,200	0	700	1,800	0	1,300	3,500
6.6	0	700	1,500	0	1,100	2,200	0	2,100	4,400
6.5	100	900	1,700	100	1,400	2,600	200	2,800	5,200
6.4	300	1,200	2,000	400	1,800	3,000	800	3,500	6,000
6.3	500	1,400	2,300	700	2,100	3,400	1400	4,200	6,800
6.2	700	1,700	2,600	1000	2,500	3,900	2000	5,000	7,700
6.1	900	1,900	2,800	1300	2,900	4,300	2500	5,700	8,500
6.0	1000	2,200	3,100	1600	3,200	4,700	3100	6,400	9,300
5.9	1200	2,400	3,400	1900	3,600	5,100	3700	7,100	10,100
5.8	1400	2,600	3,700	2200	4,000	5,500	4300	7,900	11,000
5.7	1600	2,900	3,900	2500	4,300	5,900	4900	8,600	11,800

PM 1558, How to Sample Manure for Nutrient Analysis

https://store.extension.iastate.edu/Product/How-to-Sample-Manure-for-Nutrient-Analysis



How to Sample Manure for Nutrient Analysis

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How to Sample Semi-Solid or Liquid Manure

Liquid Manure Sample Preparation

Liquid Manure Sampling During Land Application
Liquid Manure Applied with Tank Wagons

Liquid Manure Applied by Irrigation Systems

Liquid Manure Sampling from Storage Facilities

Pre-Sampling Nitrogen and Potassium from Liquid Manure

How to Sample Dry or Solid Manure

Dry Manure Sampling During Land Application

Sampling from Dry or Solid Storage Facilities and Open Lots

Open Paved Lots

Barn Gutter

Dry Stack and Manure with Litter

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Eg. Dairy Liquid Pit Manure

SAMPLE INFORMATION
LIQUID/SOLID: LIQUID
Livestock Type: DAIRY
Farmer Name: [redacted]
Sample Description: [redacted] DAIRY PIT

ANALYTE	ACTUAL ANALYSIS		TOTAL NUTRIENTS
Total Moisture	92.6	%	lbs/1000 GAL
Total Nitrogen	0.35	%	30
Phosphorus (P2O5)	0.22	%	19
Potassium (K2O)	0.28	%	24
Ammonia Nitrogen	0.18	%	

COMMENTS:
1. Availability of Nitrogen changes depending on application technique.

2. TOTAL NUTRIENTS FOR N,P,K CONVERSION FACTORS
lbs/1000 gallon = % x 85
lbs/ton = % x 20

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Eg. Dairy Solid Lot Manure

SAMPLE INFORMATION
LIQUID/SOLID: SOLID
Livestock Type: DAIRY
Farmer Name: [redacted]
Sample Description: [redacted]

ANALYTE	ACTUAL ANALYSIS	TOTAL NUTRIENTS
Total Moisture	76.3 %	lbs/TON
Total Nitrogen	0.68 %	14
Phosphorus (P205)	0.49 %	10
Potassium (K20)	0.53 %	11
Ammonia Nitrogen	0.12 %	

COMMENTS:
1. Availability of Nitrogen changes depending on application technique.

2. TOTAL NUTRIENTS FOR N,P,K CONVERSION FACTORS
lbs/1000 gallon = % x 85
lbs/ton = % x 20

111

Calculate Nutrient Availability

PMR-1003, Using Manure Nutrients for Crop Production

https://store.extension.iastate.edu/Product/Using-Manure-Nutrients-for-Crop-Production

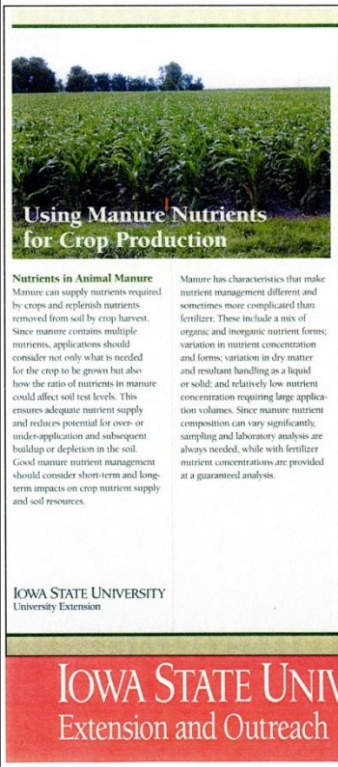

Table 1. First-Year Availability Estimates

First-Year Availability Estimates

Table 1. First-year nutrient availability for different animal manure sources.

Manure Source	Nitrogen[1]	Phosphorus[2]	Potassium[2]
	Percent of Total Nutrient Applied		
Beef cattle (solid or liquid)	30–40	60–100	90–100
Dairy (solid or liquid)	30–40	60–100	90–100
Liquid swine (anaerobic pit)	90–100	90–100	90–100
Liquid swine (anaerobic lagoon)	90–100[3]	90–100[3]	90–100
Poultry (all species)	50–60	90–100	90–100

[1]The estimates for N availability do not account for potential volatile N losses during and after land application. Correction factors for volatile loss are given in Table 2. The ranges are provided to account for variation in the proportion of ammonium N (and for poultry manure also uric acid), bedding type and amount, and both sampling and analysis.

Table 2. Correction for N Volatization with Application

Using Manure Nutrients for Crop Production

Table 2. Correction factors to account for N volatilization losses during and after land application of animal manure.[1]

Application Method	Incorporation	Volatilization Correction Factor[2]
Direct injection	—	0.98–1.00
Broadcast (liquid/solid)	Immediate incorporation	0.95–0.99
Broadcast (liquid)	No incorporation	0.75–0.90
Broadcast (solid)	No incorporation	0.70–0.85
Irrigation	No incorporation	0.60–0.75

[1]Adapted from Midwest Plan Service MWPS-18, Third Edition. Nitrogen losses during and within four days of application.
[2]Multiply the manure total N rate applied times the volatilization correction factor to determine the portion of total manure N remaining.

Soil Fertility http://www.agronext.iastate.edu/soilfertility/

Nutrient Topics

- Lime and soil pH
- Manure nutrients
- Nitrogen
- Nutrient deficiencies
- Site specific 4R nutrient management planning
- Nutrient management planning
- Nonconventional additives & byproducts
- Nutrients & water quality
- Phosphorus
- Potassium
- Secondary & micronutrients
- Soil sampling & testing
- Soil test interpretations & recommendations

Photo Gallery

Tools

Links

Weather/Climate

- ISU College of Agriculture and Life Sciences
- ISU Agronomy Extension
- ISU Agronomy
- ISU Extension and Outreach

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Soil Fertility Home Page

Welcome to the Iowa State University Agronomy Extension Soil Fertility Home Page. Nutrient topics are listed on the left side. Simply click on a topic of interest and you can find information about that topic, including Extension publications, newsletter articles, conference proceedings and reports, presentations, and links to other related sites. Links also provide access to soil fertility decision aid tools, a photo gallery, and the ISU Soil and Plant Analysis Laboratory.

Current Topic

NITROGEN LOSS?

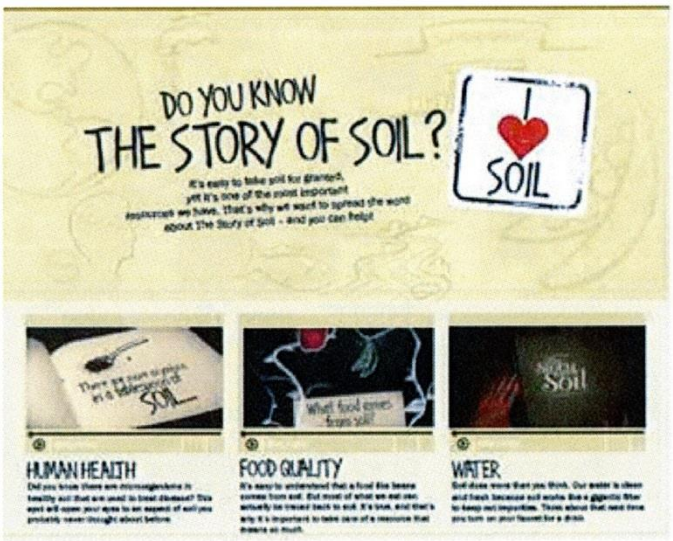
John Sawyer, Department of Agronomy, Iowa State University
December 18, 2015

Really, it just had to rain large amounts in December. Seems we can't get any relief from worrying about excess rain and impacts on nitrogen (N). The questions have already begun -- what about fall 2015 fertilizer and manure N applications? Read on.

Past Current Topics

DO YOU KNOW THE STORY OF SOIL?

Click here to view pdf file
Click on one of the three images below to view video:



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Iron chlorosis symptom - soybean.
Photo © John E. Sawyer

ISU Soil and Plant Analysis Laboratory

Corn N Rate Calculator

Compendium of Nontraditional Materials

North Central Extension-Industry Soil Fertility Conf. Proceedings

Crops Knowledgebase

Integrated Crop Management NEWS

Chicago Board of Trade

Ames, IA
28 °F / -2 °C
Overcast
at 06:05 AM
Click for Forecast

Did you know?
In 2010, the Iowa area harvested for oat grain was 0.07 million acres.