Understanding Soil Fertility and Testing

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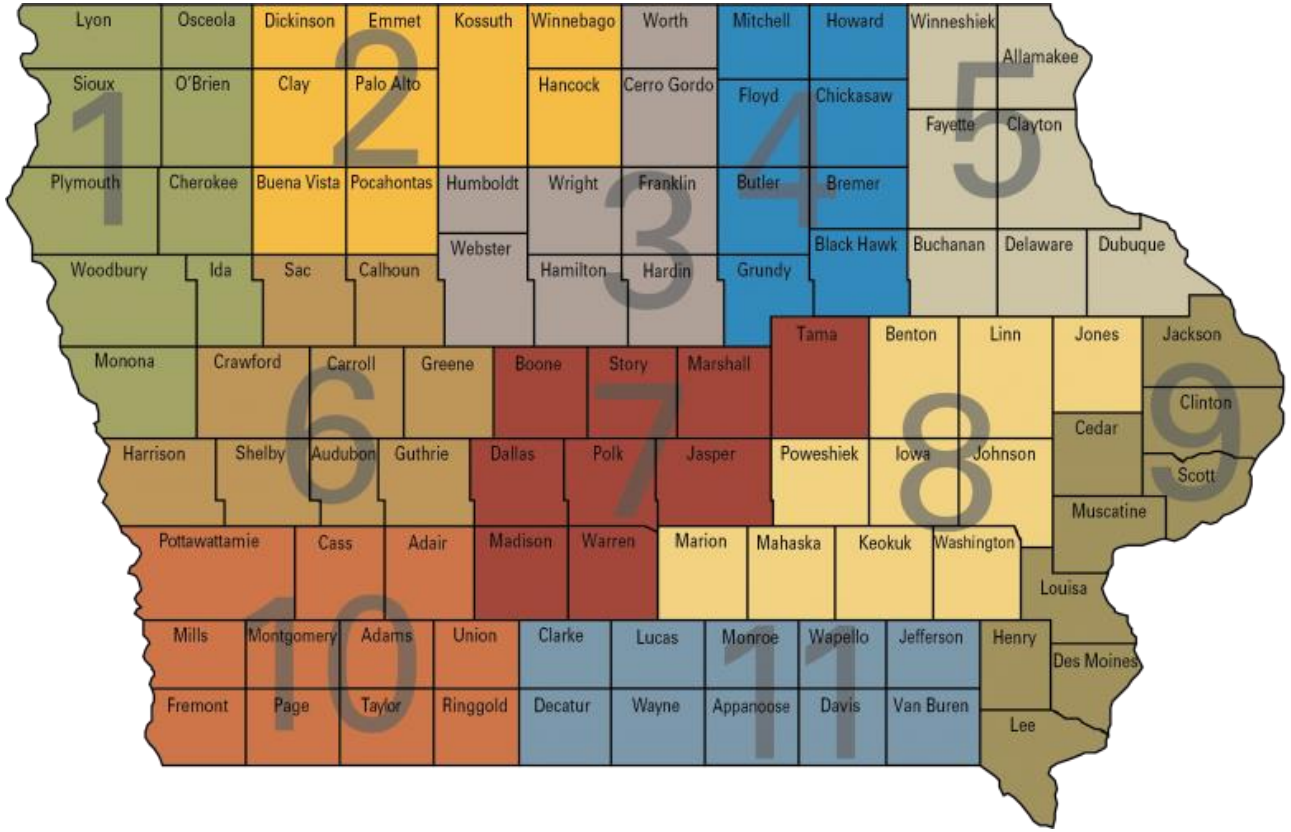
ISU Field Agronomists Across the State



https://www.extension.iastate.edu/ag/crops

Understanding Soil Fertility and Testing

Why is soil fertility important?

Why should we care about how much is being applied? Too Little vs Too Much

Why is testing important?

Soil Testing – identifying “what’s in the bank”

- Soil test results relate to the probability that adding fertilizer will increase yield
- Soil testing has been proven reliable for pH, P, K, and Zn, but not very reliable for the other nutrients
- Soil testing isn’t reliable for N; because of variable weather, biological and chemical processes that are constantly occurring in the soil.
- Ideally want to test at least once per crop rotation.

Crops don’t care where the fertilizer comes from…

- Fertilizer
- Soil
- Manure
- Organic sources
- Sewage sludge

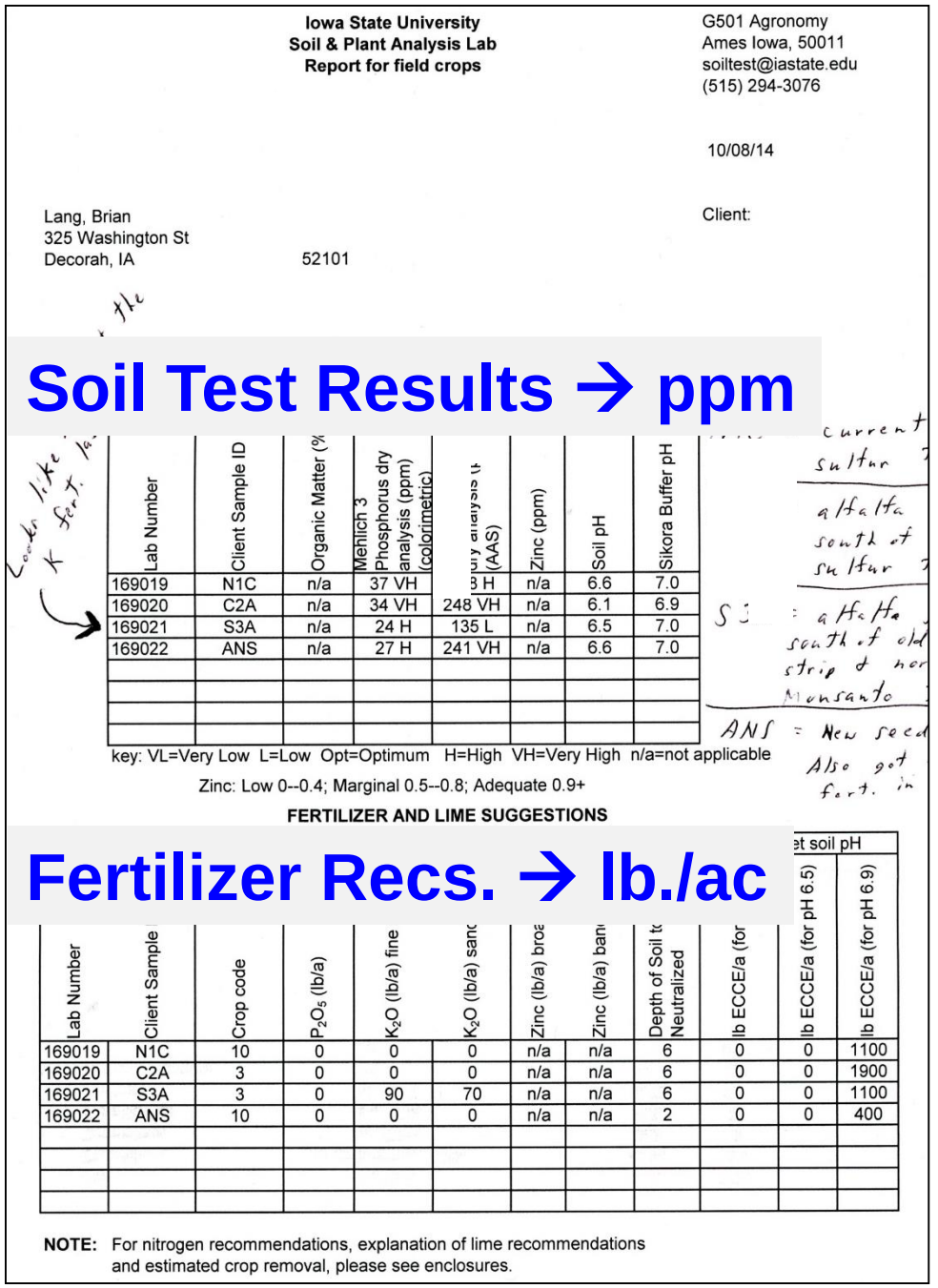
…as long as they get what they need when they need it.

Understanding Soil Fertility and Testing

1. **Definitions & crop nutrient removal**
2. Soil sampling and Why it's important
3. Send soil samples to a certified lab
4. Reading the soil test & interpret recommendations
5. Secondary and micronutrients
6. Soil pH and lime recommendations

Definitions

- Soil test results for nutrients are provided in **ppm**
  - ppm P, where P = phosphorous
  - ppm K, where K = potassium
- Fertilizer recommendations are provided as **lb/ac**
  - lb/ac P_2O_5 , where P_2O_5 = phosphate
  - lb/ac K_2O , where K_2O = potash
- Fertilizer is sold as phosphate and potash



Iowa State University
Soil & Plant Analysis Lab
Report for field crops

G501 Agronomy
Ames Iowa, 50011
soiltest@iastate.edu
(515) 294-3076

10/08/14

Client:

Lang, Brian
325 Washington St
Decorah, IA 52101

Soil Test Results → ppm

Lab Number	Client Sample ID	Organic Matter (%)	Mehlich 3 Phosphorus dry analysis (ppm) (colorimetric)	[illegible] (AAS)	Zinc (ppm)	Soil pH	Sikora Buffer pH
169019	N1C	n/a	37 VH	H	n/a	6.6	7.0
169020	C2A	n/a	34 VH	248 VH	n/a	6.1	6.9
169021	S3A	n/a	24 H	135 L	n/a	6.5	7.0
169022	ANS	n/a	27 H	241 VH	n/a	6.6	7.0

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 Recs. → lb./ac

Lab Number	Client Sample	Crop code	P_2O_5 (lb/a)	K_2O (lb/a) fine	K_2O (lb/a) sand	Zinc (lb/a) broa	Zinc (lb/a) ban	Depth of Soil t Neutralized	lb ECCE/a (for	lb ECCE/a (for pH 6.5)	lb ECCE/a (for pH 6.9)
169019	N1C	10	0	0	0	n/a	n/a	6	0	0	1100
169020	C2A	3	0	0	0	n/a	n/a	6	0	0	1900
169021	S3A	3	0	90	70	n/a	n/a	6	0	0	1100
169022	ANS	10	0	0	0	n/a	n/a	2	0	0	400

NOTE: For nitrogen recommendations, explanation of lime recommendations and estimated crop removal, please see enclosures.

Definitions

- Fertilizer analysis is a % of each nutrient
  - %N - $\%P_2O_5$ - $\%K_2O$
  - If more #'s, the 4th is sulfate, the 5th is zinc
    - Often include an abbreviation of the nutrient
    - i.e. S = sulfur and Zn = zinc
  - Cannot add up to more than 100%

Definitions

- Common forms of phosphorus fertilizer:
  - MAP = Monoammonium Phosphorus = 11-52-0
  - DAP = Diammonium Phosphorus = 18-46-0

- Most common form of potassium fertilizer:
  - KCL = Potassium Chloride (Potash) = 0-0-60

Definitions

- Pounds of fertilizer per acre = # of pounds of the complete product applied per acre
- Units of fertilizer = used more frequently to describe the # of pounds of the nutrient (i.e. phosphate, potash) applied per acre.

Example:
I wanted to apply 60 units of potash (K_2O) per acre. To get that I needed to apply 100 pounds of 0-0-60 fertilizer.

Applying definitions

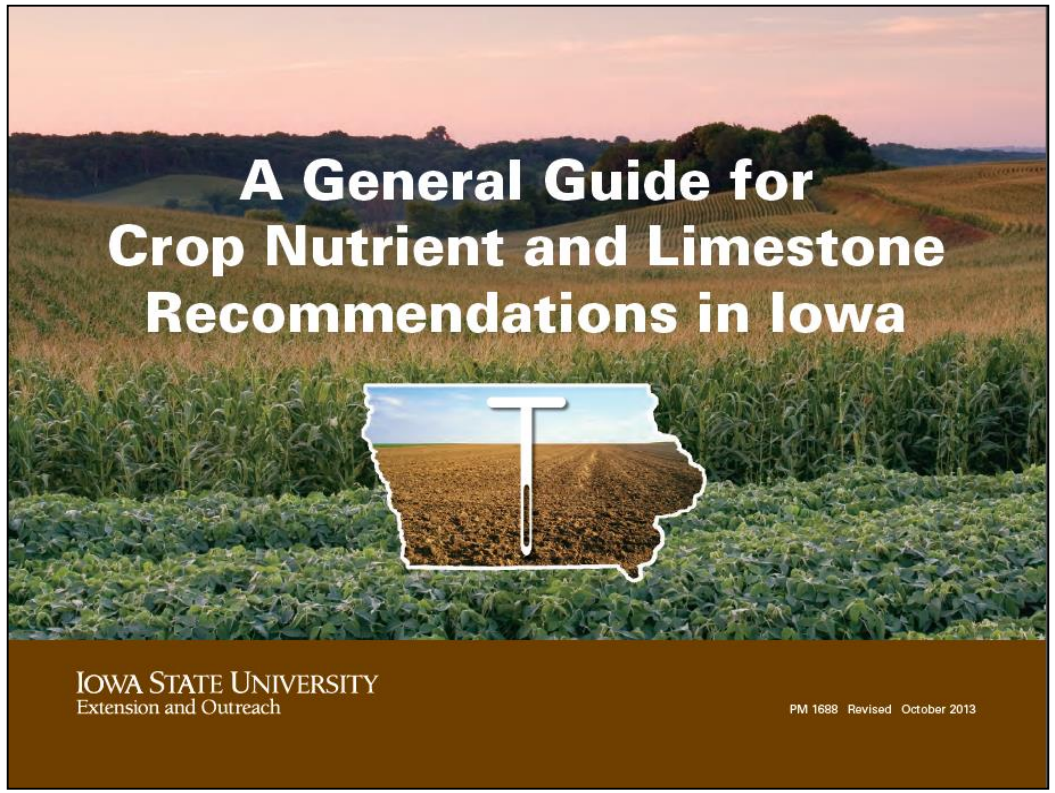
- You want to apply 15 lb/ac sulfur on your corn crop. Product choices include Ammonium sulfate (21-0-0-24), which is 24% sulfur; and Calcium sulfate (aka gypsum) (0-0-0-18) which is 18% sulfur. How much of each product would you use?

  ✓ **AMS:** 15 lb/ac ÷ 0.24 = 62 lb/ac AMS, which also provides 13 lb/ac N

  ✓ **Calcium sulfate:** 15 lb/ac ÷ 0.18 = 83 lb/ac CaS

Crop Removal

- Estimate crop nutrient removal with Table 2 in PM 1688



PM-1688

Table 2.

Page 4.

Google the publication or go to:
https://store.extension.iastate.edu/Product/5232

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
Perennial ryegrass	ton, 15%	11	30
Sorghum-sudan	ton, 15%	11	33

Example: Corn

- **200 bu/ac corn at 15% moisture would remove:**
  - **P_2O_5: 0.32 lb P_2O_5/bu x 200 bu/ac = 64 lb P_2O_5/ac**
  - **K_2O: 0.22 lb K_2O/bu x 200 bu/ac = 44 lb K_2O/ac**

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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
Perennial ryegrass	ton, 15%	11	30
Sorghum-sudan	ton, 15%	11	33

Example: Soybeans

- **50 bu/ac soybeans at 13% moisture would remove:**
  - **P_2O_5: 0.72 lb P_2O_5/bu x 50 bu/ac = 36 lb P_2O_5/ac**
  - **K_2O: 1.2 lb K_2O/bu x 50 bu/ac = 60 lb K_2O/ac**

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		P_2O_5	K_2O
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

Example: Alfalfa

- **2 tons/ac alfalfa at 15% moisture would remove:**
  - **P_2O_5: 13 lb P_2O_5/bu x 2 ton/ac = 26 lb P_2O_5/ac**
  - **K_2O: 43 lb K_2O/bu x 2 ton/ac = 86 lb K_2O/ac**

Looking at Crop Removal Rates

- 200 bu/ac corn removes 64 lbs P and 44 lbs K
- 50 bu/ac soybeans removes 36 lbs P and 60 lbs K
- 2 tons/ac alfalfa removes 26 lbs P and 86 lbs K
- Lots of “withdrawals from the bank”
- At a minimum we should be replacing these amounts

Maximize Economic Returns to Fertilizer Inputs

1. Definitions & crop nutrient removal
2. **Soil sampling**
3. Send soil samples to a certified lab
4. Reading the soil test & interpret recommendations
5. Secondary and micronutrients
6. Soil pH and lime recommendations

2. Soil sampling

- A sample should represent an area of a field under similar conditions:
  - grid or zone sampling
  - make use of yield maps
  - soil map units (SMU), slope, drainage, crop history, manure, proximity to gravel road, etc.
- Absolute minimum of 10 cores per sample, prefer 12 to 15 cores per sample, and more cores per sample if there is more field variability (*i.e.* banding fertilizer).
- Sampling depth of 6” for corn/ soybean; 2-3” for pastures

ISU Extension publication CROP 3108

Take a Good Soil Sample to Help Make Good Fertilizer Decisions

https://store.extension.iastate.edu/product/3915

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Take a Good Soil Sample to Help Make Good Fertilization Decisions

A.P. Mallarino , John Sawyer

Learn more about the most important step in soil testing to make fertilization decisions - collecting the soil sample. Includes information on materials needed, when to sample, how to select a sample area, how often to sample and much more.

Pages / Length: 4
Publication Date: 12/2016

Format	Price	
PDF	$0.00	Download

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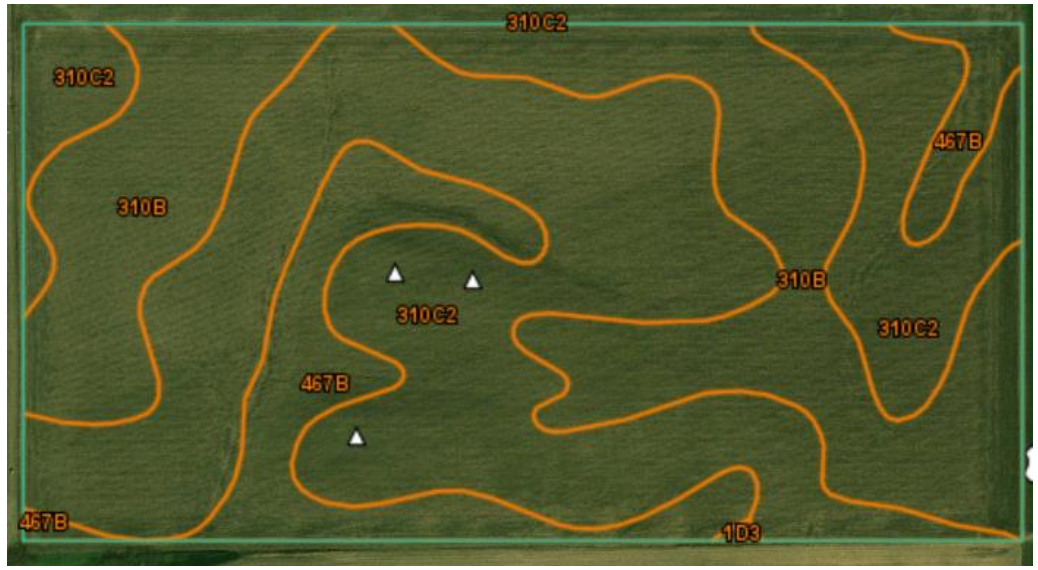
Permanent link for this product: https://store.extension.iastate.edu/Product/3915

Identify Areas of Fields to Soil Sample

Use a field map with the soil map units (SMU) outlined

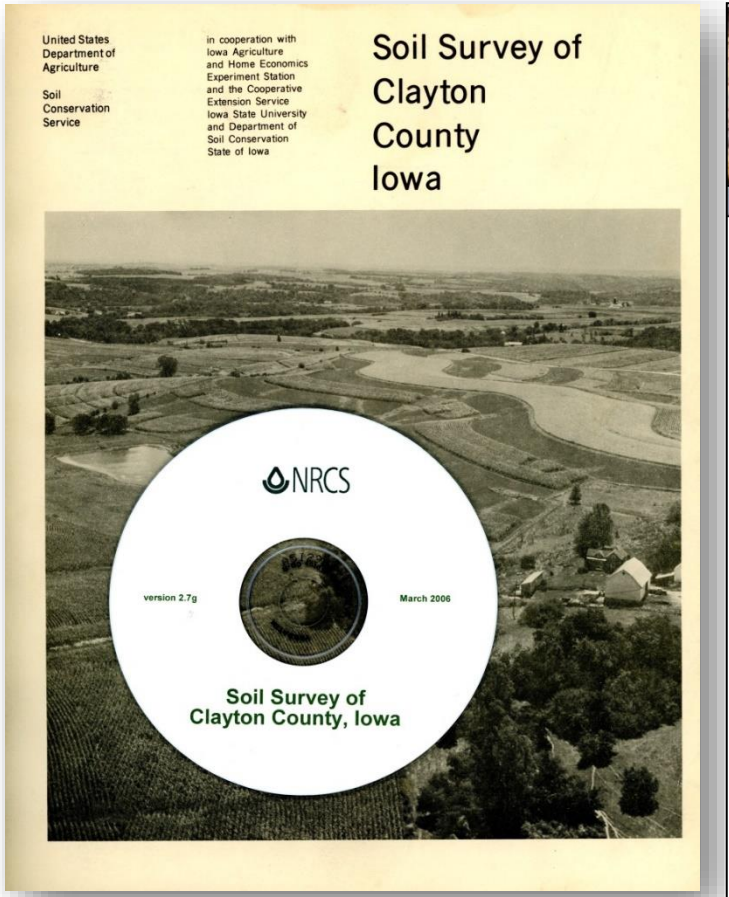
- County Soil Survey book
- Web Soil Survey
- County assessors office?
- NRCS?
- Acrevalue.com
- Other sites?

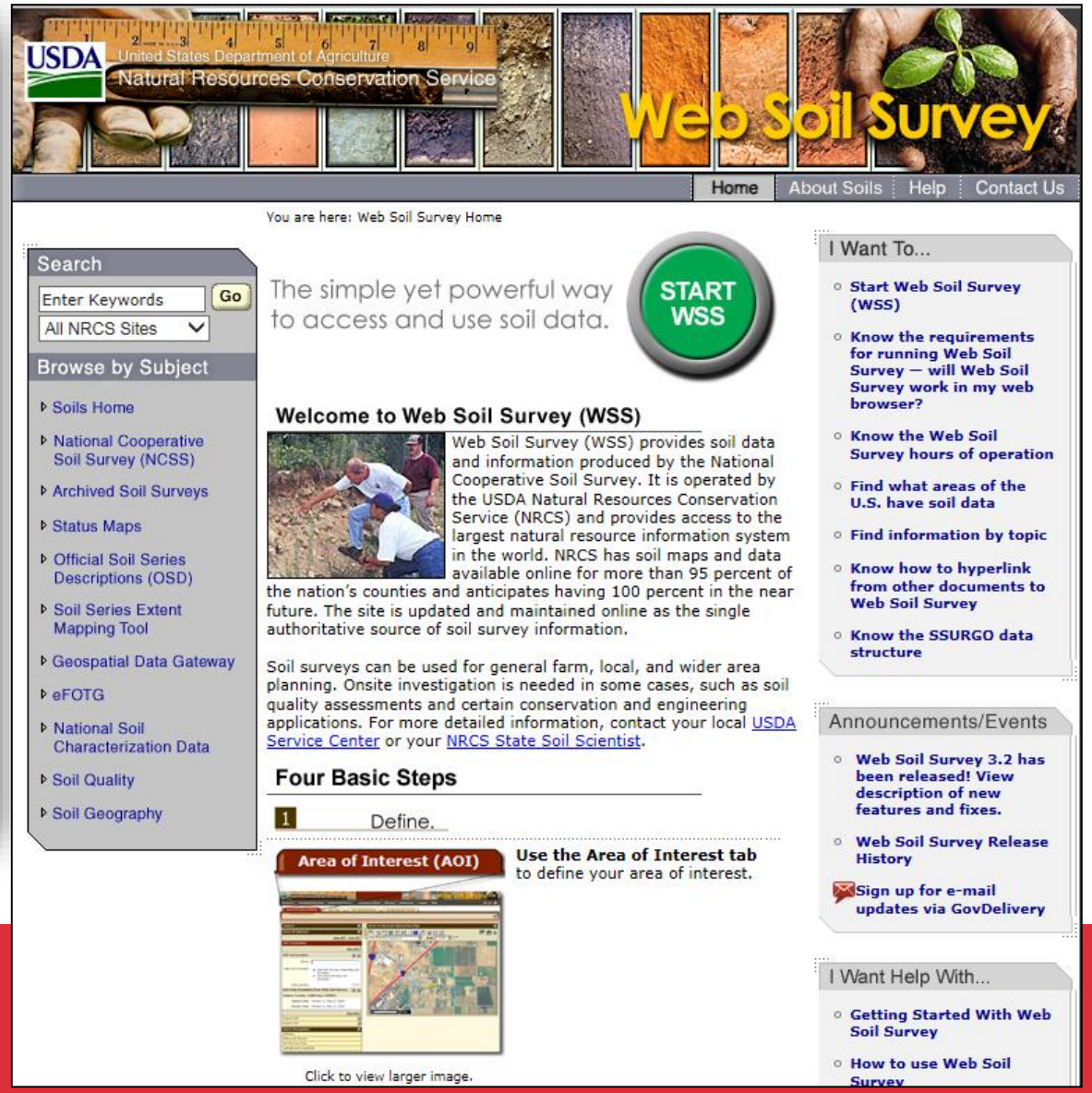


Soil Survey

Progressed from book to disc to on-line with the Web Soil Survey

All future soil survey information will only be available on the Web Soil Survey

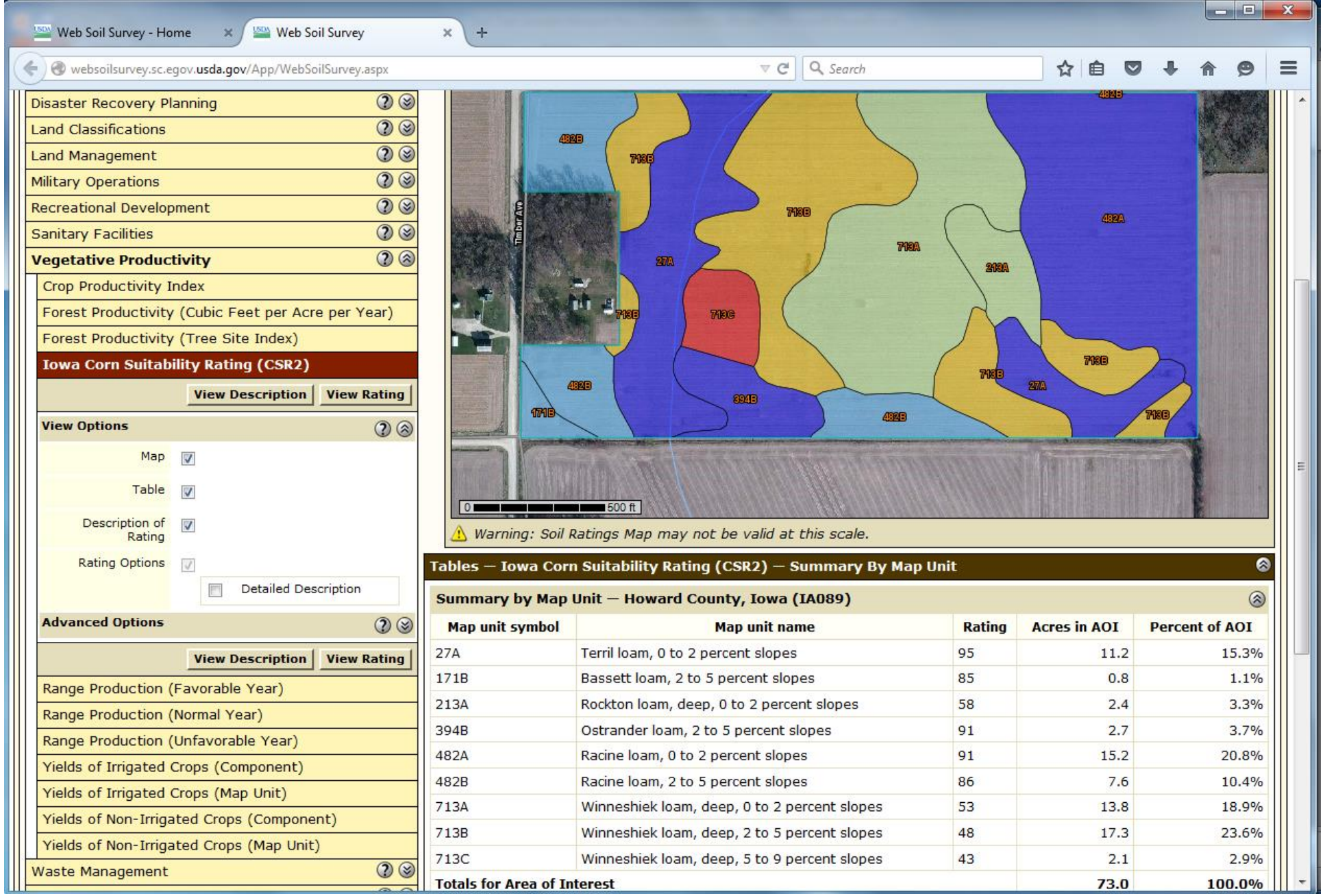




Tips for using the Web Soil Survey

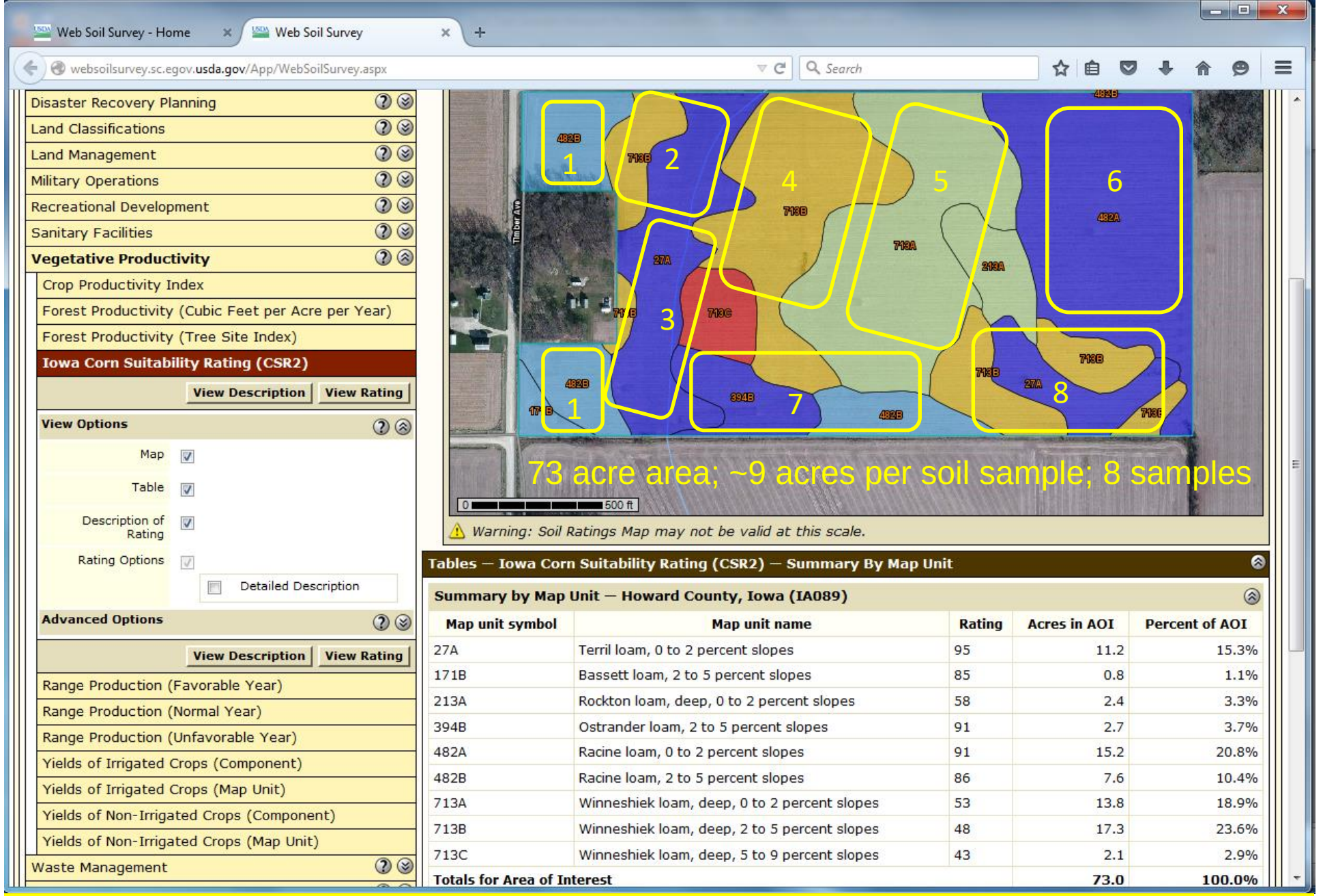
- ISU Ag Decision Maker provides a tutorial for using Web Soil Survey to “Compute the Iowa Corn Suitability Rating for Your Farm,” https://www.extension.iastate.edu/agdm/wholefarm/html/c2-87.html

- YouTube provides some “how-to” videos for using Web Soil Survey. Here is one: https://www.youtube.com/watch?v=QRSipAAYQ1w



Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
27A	Terril loam, 0 to 2 percent slopes	95	11.2	15.3%
171B	Bassett loam, 2 to 5 percent slopes	85	0.8	1.1%
213A	Rockton loam, deep, 0 to 2 percent slopes	58	2.4	3.3%
394B	Ostrander loam, 2 to 5 percent slopes	91	2.7	3.7%
482A	Racine loam, 0 to 2 percent slopes	91	15.2	20.8%
482B	Racine loam, 2 to 5 percent slopes	86	7.6	10.4%
713A	Winneshiek loam, deep, 0 to 2 percent slopes	53	13.8	18.9%
713B	Winneshiek loam, deep, 2 to 5 percent slopes	48	17.3	23.6%
713C	Winneshiek loam, deep, 5 to 9 percent slopes	43	2.1	2.9%
Totals for Area of Interest			**73.0**	**100.0%**

Example from Web Soil Survey – with the CSR2 mapping option selected.



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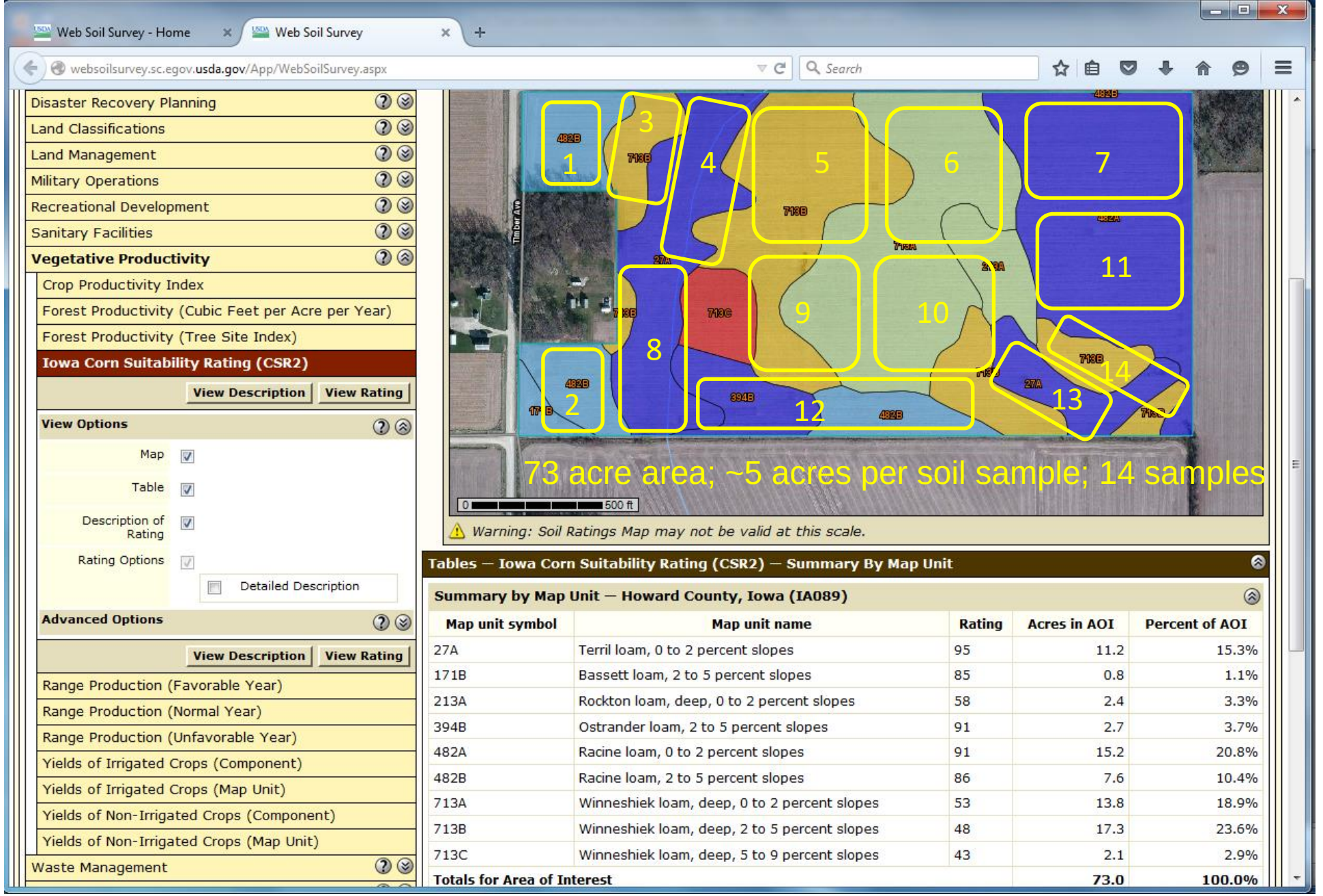
Example of 8 soil samples from somewhat similar areas averaging about 9 acres per soil test.
We stayed in at least 100 feet from the limestone gravel road on the west side of the field.



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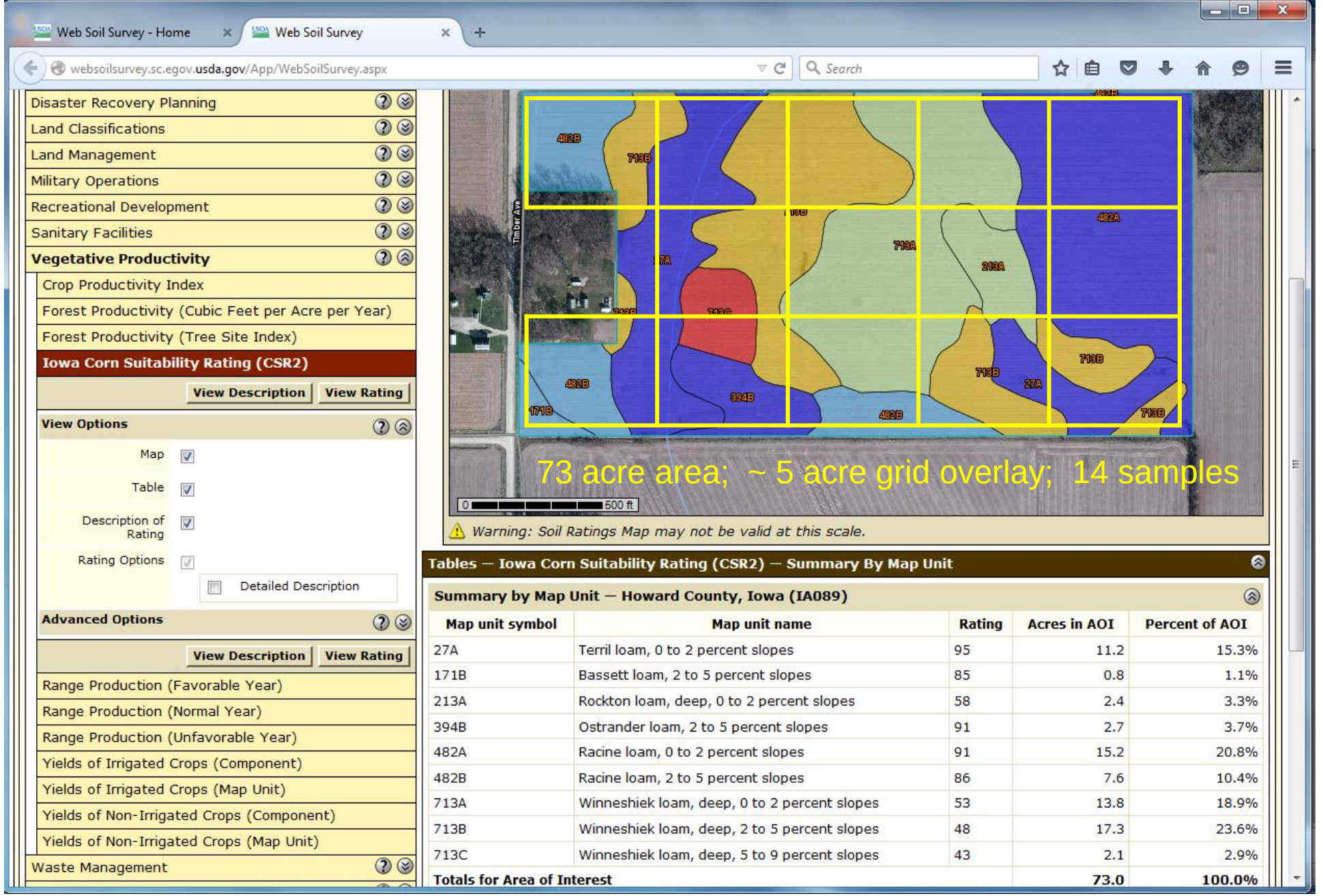
Example of 14 soil samples averaging about 5 acres per soil test.



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Example of 14 soil samples in a grid averaging about 5 acres per soil test.

Maximize Economic Returns to Fertilizer Inputs

1. Definitions & crop nutrient removal
2. Soil sampling
3. **Send soil samples to a certified lab**
4. Reading the soil test & interpret recommendations
5. Secondary and micronutrients
6. Soil pH and lime recommendations

3. **Send soil samples to a certified lab** in accordance with IDALS standards

- The list of IDALS certified labs is at: https://iowaagriculture.gov/commercial-feed-and-fertilizer-bureau

- Results of each mineral (P, K, etc.) is provided in parts per million (ppm).

https://iowaagriculture.gov/commercial-feed-and-fertilizer-bureau

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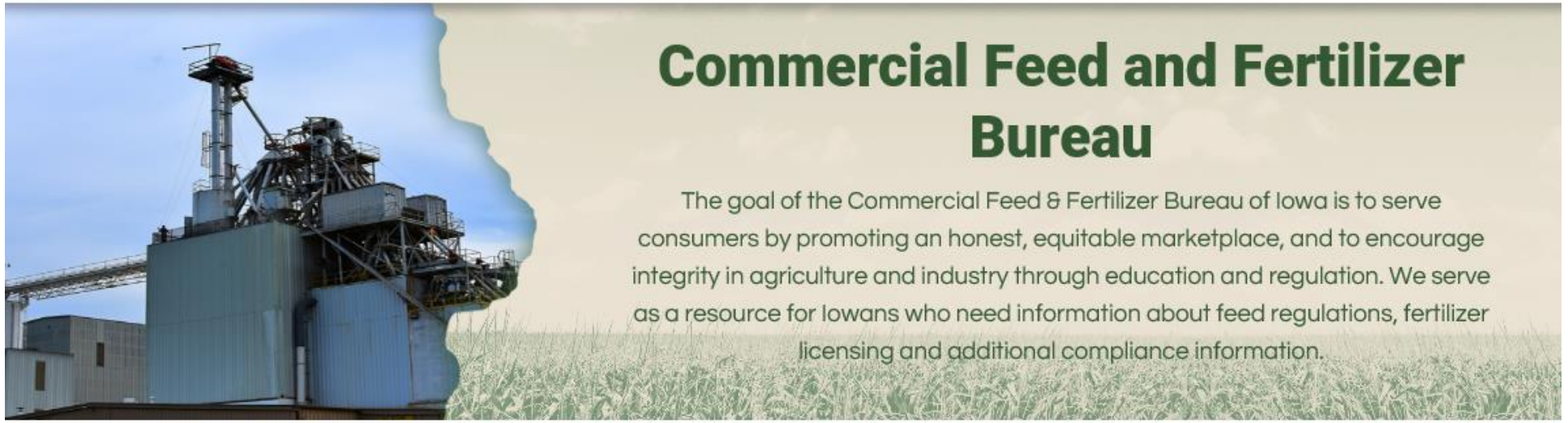

Commercial Feed and Fertilizer Bureau

The goal of the Commercial Feed & Fertilizer Bureau of Iowa is to serve consumers by promoting an honest, equitable marketplace, and to encourage integrity in agriculture and industry through education and regulation. We serve as a resource for Iowans who need information about feed regulations, fertilizer licensing and additional compliance information.

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Commercial Feed

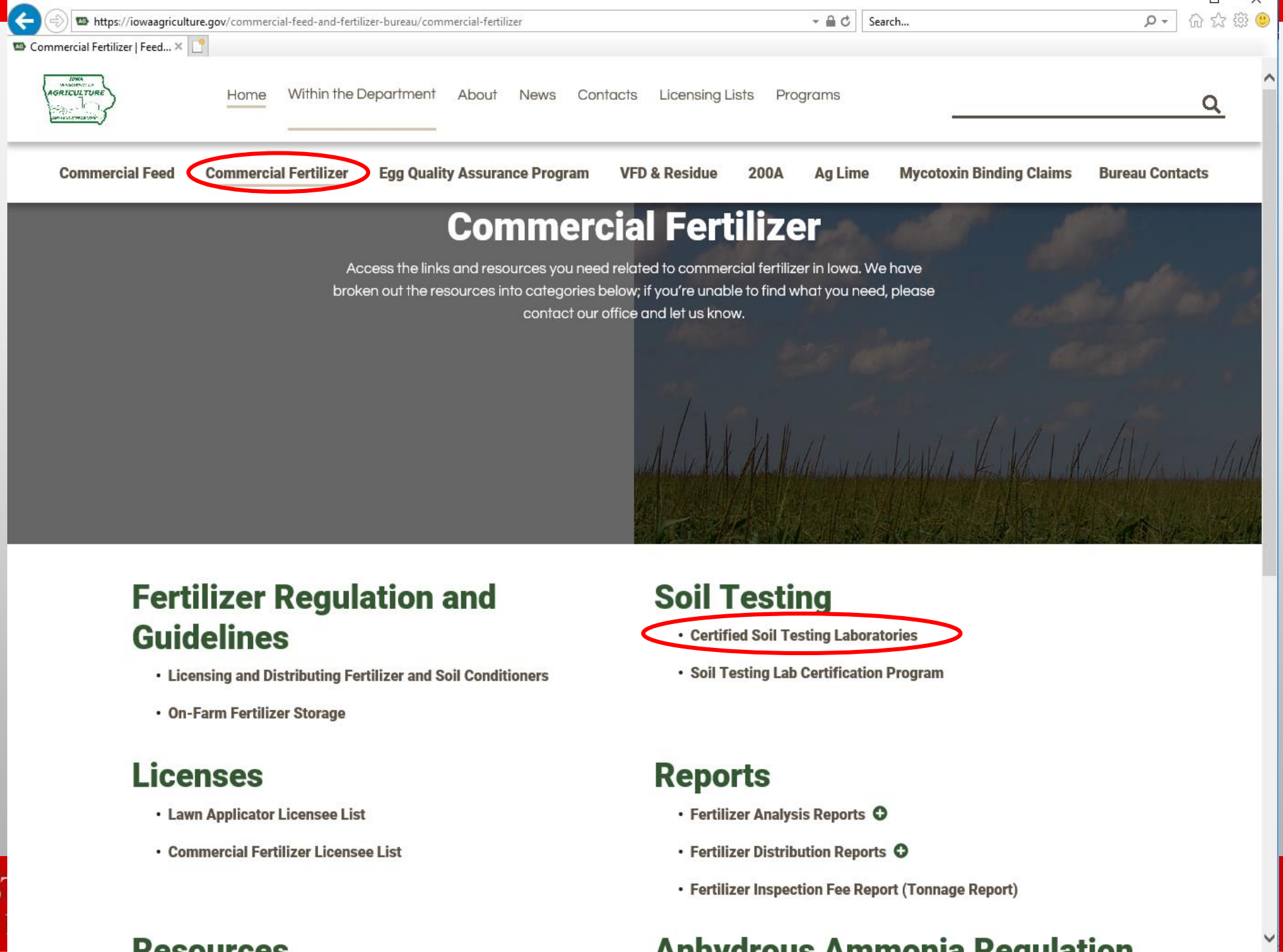
Find the resources you need in relation to feed licensing, labeling and commercial feed reports. Feel free to **contact us** with additional questions or concerns.

FEED RESOURCES

Commercial Fertilizer

We have information available about aspects of commercial fertilizer, soil conditioners and regulations in Iowa. Check out our information about licensing, distribution, certified soil testing labs and more.

FERTILIZER RESOURCES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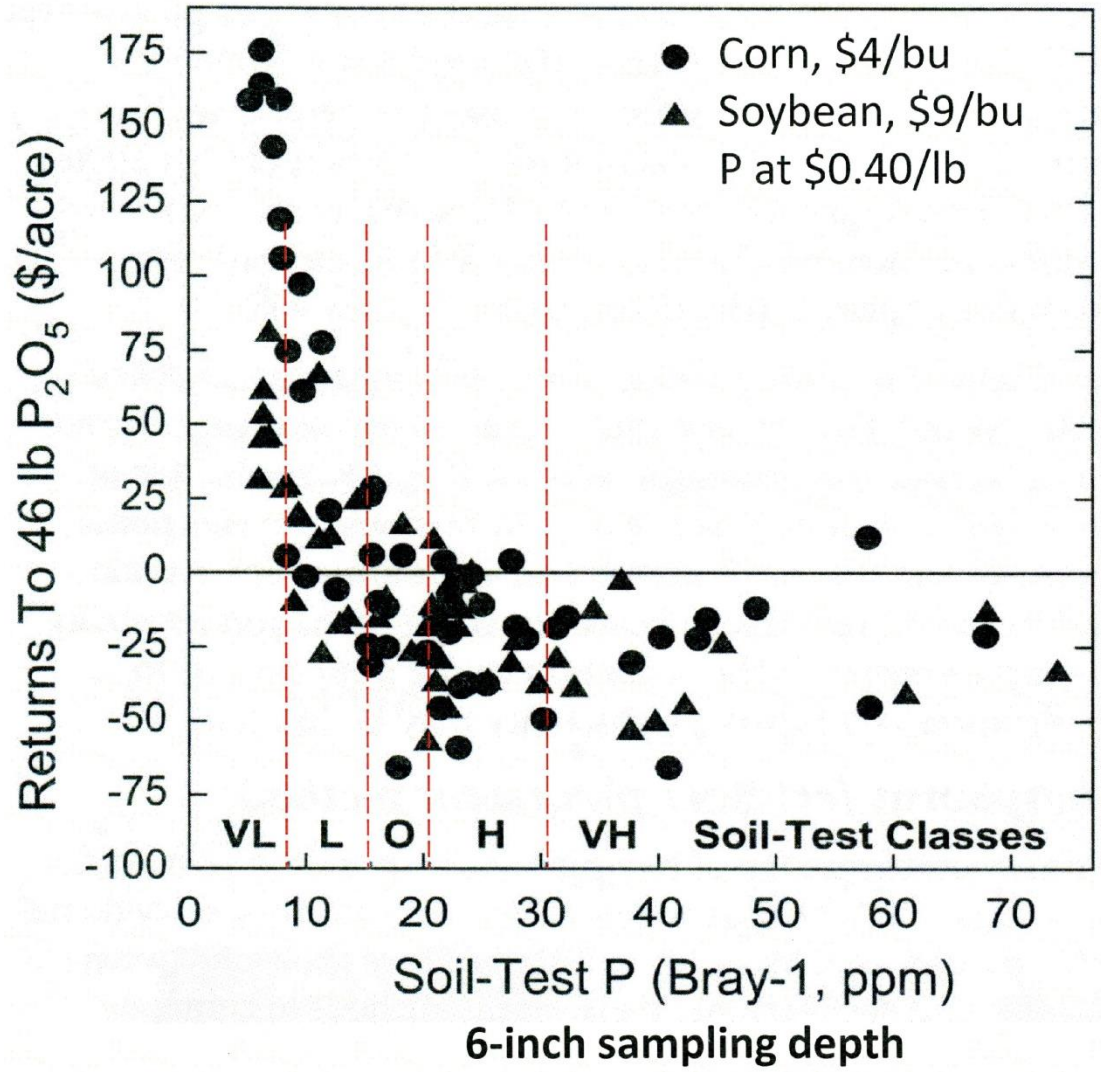
200A
Ag Lime
Mycotoxin Binding Claims
Bureau Contacts
Commercial Fertilizer
Access the links and resources you need related to commercial fertilizer in Iowa. We have broken out the resources into categories below; if you're unable to find what you need, please contact our office and let us know.
Fertilizer Regulation and Guidelines
Licensing and Distributing Fertilizer and Soil Conditioners
On-Farm Fertilizer Storage
Soil Testing
Certified Soil Testing Laboratories
Soil Testing Lab Certification Program
Licenses
Lawn Applicator Licensee List
Commercial Fertilizer Licensee List
Reports
Fertilizer Analysis Reports
Fertilizer Distribution Reports
Fertilizer Inspection Fee Report (Tonnage Report)

What do you need to soil test for?

- Soil pH and buffer pH - for all crops, plus useful for some herbicide choices and rates
- P - for all crops
- K - for all crops (oven-dry or field-moist/slurry “wet" test)
- OM correlates to S and also is useful for some herbicide choices and rates
- Zn for corn mainly on calcareous or low OM soils
- B for alfalfa on low OM soils
- Soil tests for Ca, Mg, S, Fe, Cu, Mn; not reliable for making recommendations.

Returns to Cost of Fertilizer



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.

Maximize Economic Returns to Fertilizer Inputs

1. Definitions & crop nutrient removal
2. Soil sampling
3. Send soil samples to a certified lab
4. **Reading the soil test & interpret recommendations**
5. Secondary and micronutrients
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4. Read the soil test & interpretation recommendations

- Recommendations are provided as lb/ac of nutrient *i.e.* phosphate (P_2O_5), potash (K_2O).
- Certified labs are NOT required to use ISU fertilizer recommendations.
- Find the corresponding table in PM-1688 for the crop nutrient recommendations and needs

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

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on 180 bu corn grain per acre. Nutrient removal amounts can be adjusted higher or lower for other yield levels. In the high soil test category, banded NP or NPK starter fertilizer may be advantageous under conditions of limited soil drainage, cool soil, crop residues on the soil surface, or late planting dates with full-season hybrids.

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

Soil test = 15 ppm P & 165 ppm K ISU recs = 75 lb./ac P_2O_5 & 40 lb./ac K_2O

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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

*The recommended amounts of P_2O_5 and K_2O for the optimum soil test category are based on approximate nutrient removal for the harvested yield. The amounts shown in the table for the optimum soil test category are based on 180 bu corn grain per acre. Nutrient removal amounts can be adjusted higher or lower for other yield levels. In the high soil test category, banded NP or NPK starter fertilizer may be advantageous under conditions of limited soil drainage, cool soil, crop residues on the soil surface, or late planting dates with full-season hybrids.

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

Soil test = 19 ppm P & 134 ppm K

ISU recommendations = 80 lb./ac P_2O_5 & 240 lb./ac K_2O

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

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

Table 10. Phosphorus and potassium recommendations for alfalfa and alfalfa-grass hay and pastures. What if the soil test = 220 ppm K?

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

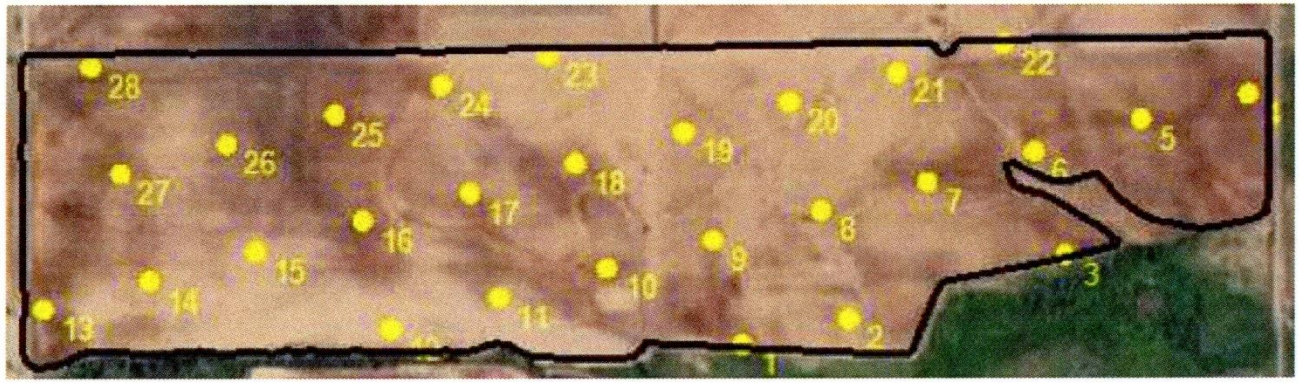
Footnotes explain Table 10 fertilizer recommendations are for 5 ton/ac of harvested hay.

Soil Test Results

Example Farm

Field 4: 138.87 acres

Soil Test Points



Field Boundary
Soil Test Points

Field Boundary

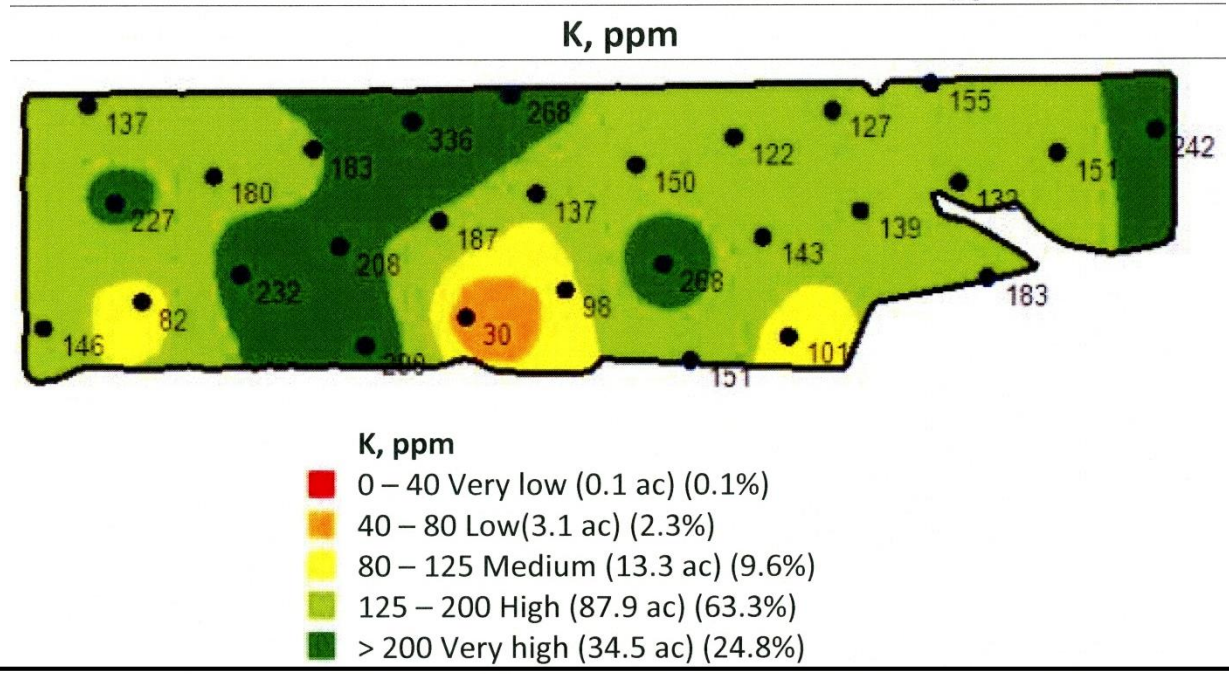
Soil Test Points

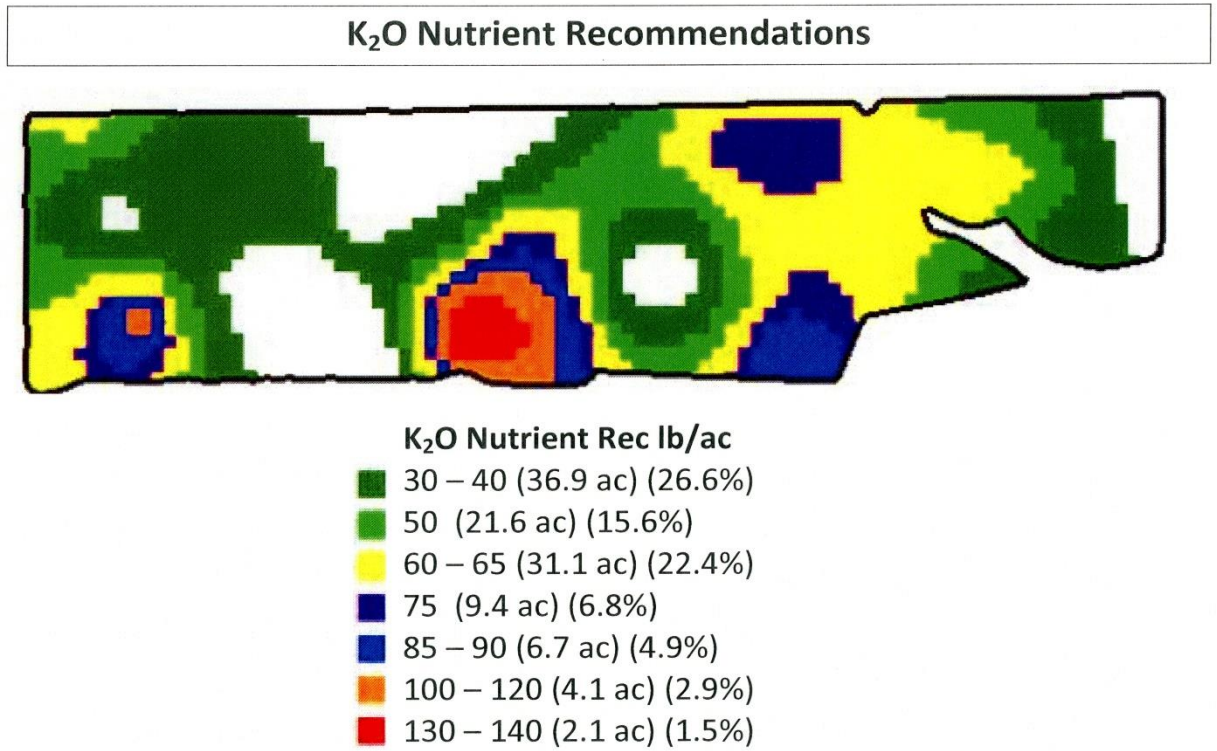
Field ID	K, ppm
4	242
5	151
6	132
7	139
8	143
9	268
10	98
11	30
12	290
13	146
14	82
15	232
16	208
17	187
18	137
19	150
20	122
21	127
22	155
23	268
24	336
25	183
26	180
27	227
28	137

Soil Test Results

Example Farm

Field 4: 138.87 acres





Maximize Economic Returns to Fertilizer Inputs

1. Definitions & crop nutrient removal
2. Soil sampling
3. Send soil samples to a certified lab
4. Reading the soil test & interpret recommendations
5. **Secondary and micronutrients**
6. Soil pH and lime recommendations

Sulfur deficiency in alfalfa.

Gunder
June 24, 2006
Fayette silt loam

Sulfur deficiency in corn.

Thorpe Sites
August 11, 2006

Chelsea fine loamy sand
Site 1

Kenyon loam
Site 2

Sulfur Management for Iowa Crop Production

ISU Extension publication CROP 3072 is available as a free pdf at:
https://store.extension.iastate.edu/product/14280

Sulfur Fertilizer Recommendations in a Nutshell:

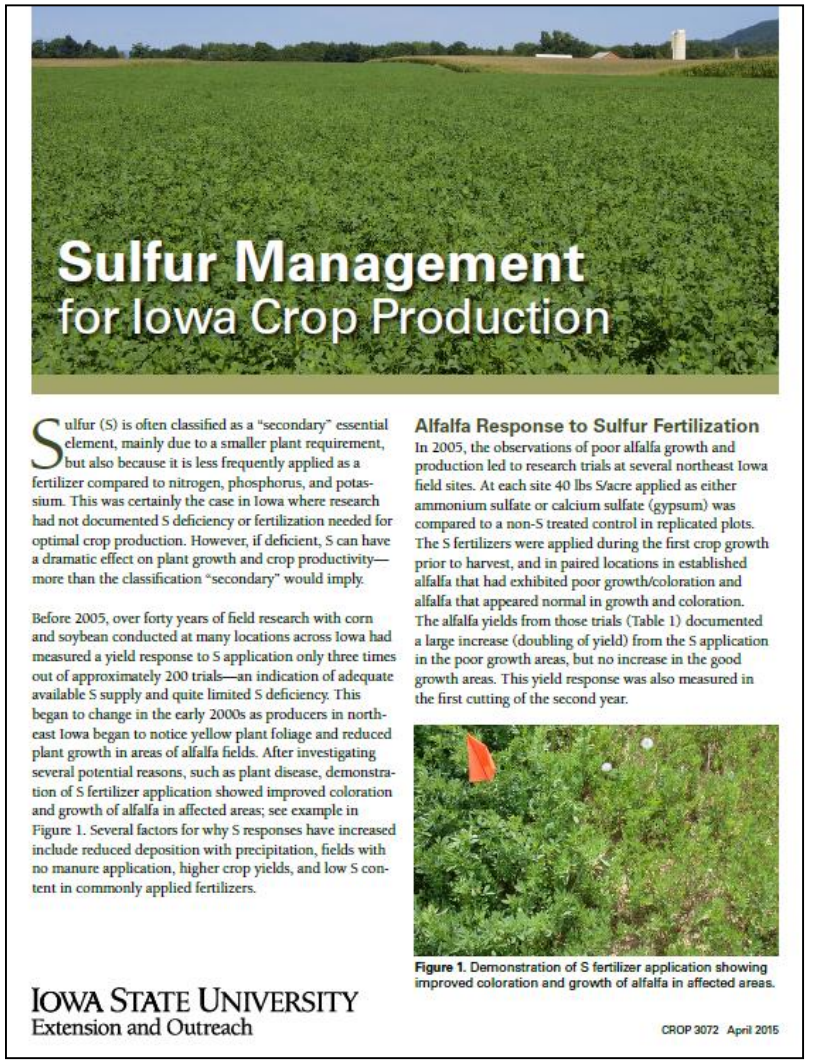
For corn:

- Soil and tissue tests are not reliable.
- Consider 10-15 lb./ac on most soils, but up to 25 lb./ac on sandy soils.

For soybeans: No recommendation.

For alfalfa:

- The soil test not reliable.
- The tissue test is fairly reliable.
  - 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.



Commercial Fertilizer Sources of Sulfur

Sulfate-sulfur fertilizers are immediately available

Dry fertilizer	Chemical formula	Fertilizer analysis	Sulfur %
Ammonium sulfate	$(NH_4)_2SO_4$	21 - 0 - 0 - 24	24
Calcium sulfate (gypsum)	$CaSO_4$	0 - 0 - 0 - 17	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.			
Liquid fertilizer			
Ammonium thiosulfate	$(NH_4)_2SO_3$	12 - 0 - 0 - 26	26
50% sulfate-sulfur and 50% elemental sulfur.			

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

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.

Maximize Economic Returns to Fertilizer Inputs

1. Definitions & crop nutrient removal
2. Soil sampling
3. Send soil samples to a certified lab
4. Reading the soil test & interpret recommendations
5. Secondary and micronutrients
6. **Soil pH and lime recommendations**

Shaded region includes significant areas with high pH subsoil (calcareous soils)

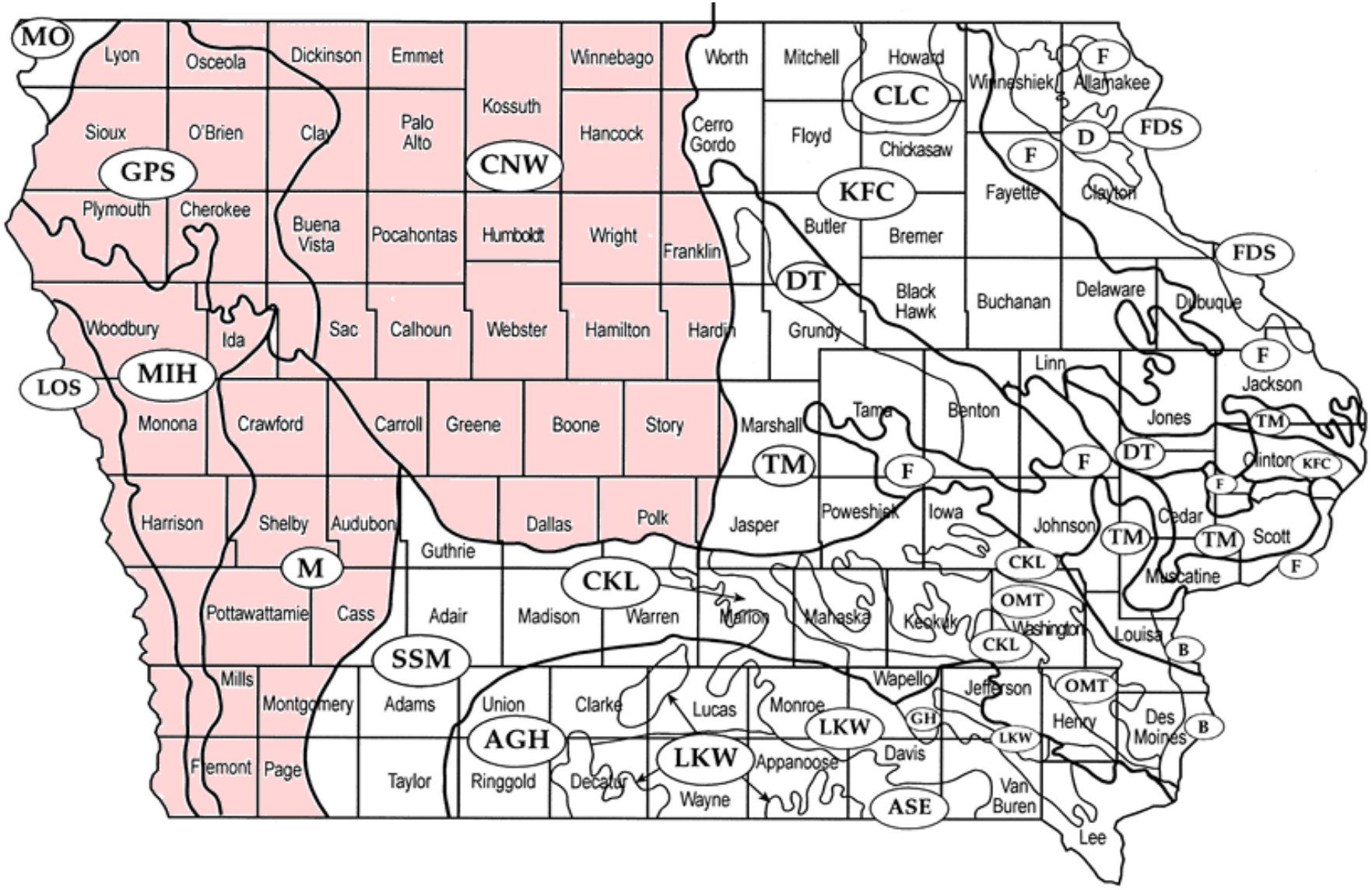


Figure 1. Map of Iowa delineating the 21 principal soil association areas (letters). B designates Mississippi bottomland.

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

Available Nutrients in Relation to Soil pH

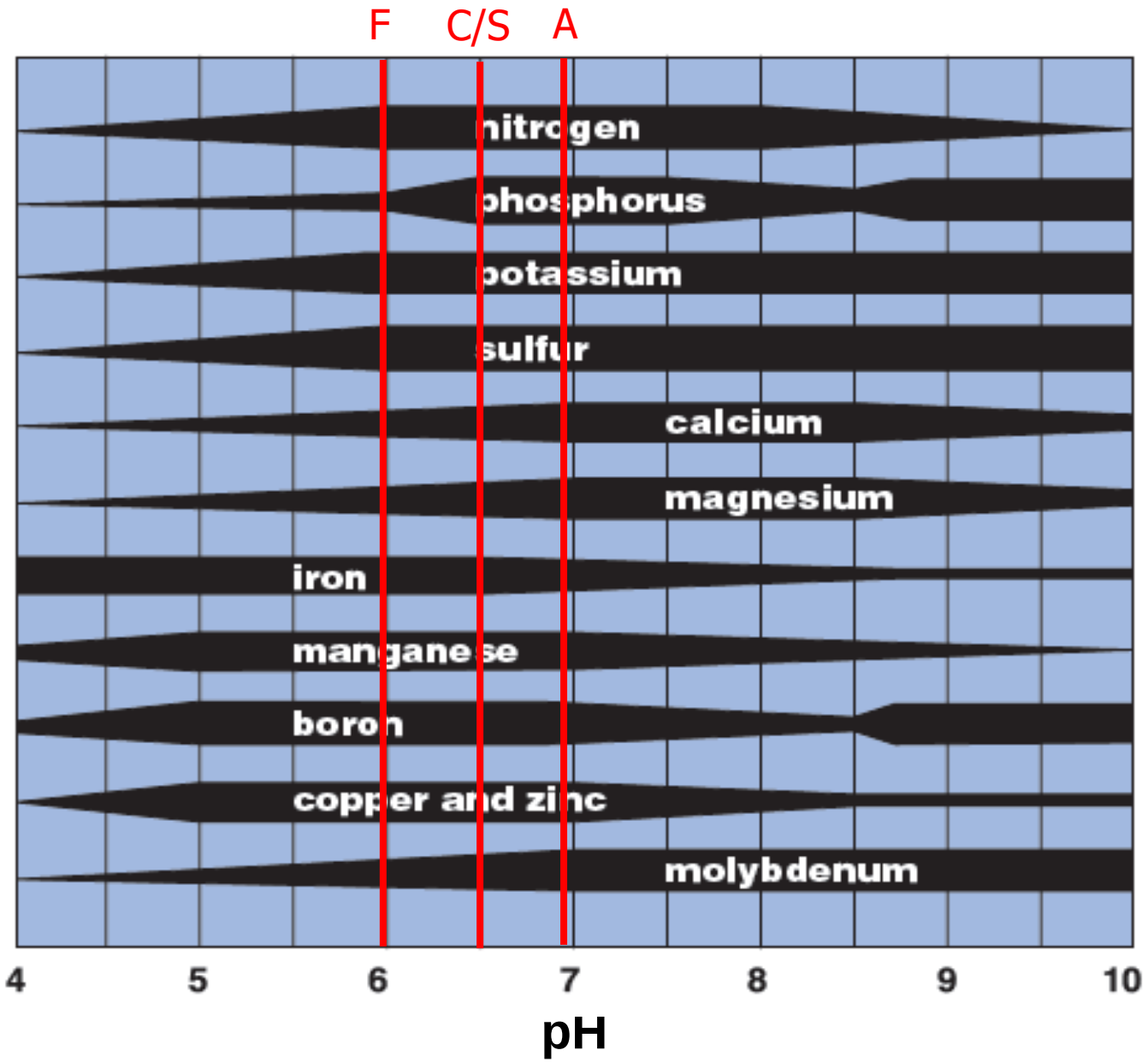


Table 16. Corn Example: Lime recommendations use Buffer pH to give lb/ac

Soil pH tells us if we need to apply lime…
Buffer pH tells us HOW MUCH

Target pH
alfalfa 6.9

other forages 6.0

corn & soybeans 6.5 (or 6.0 on calcareous soils)

Example:
6-inch soil depth
Soil pH of 6.1
Buffer pH of 6.4
Lime for corn to 6.5 pH

6.5 Buffer = 3,500 lb.

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

Table 16. Alfalfa Example: Lime recommendations use Buffer pH to give lb/ac

Soil pH tells us if we need to apply lime…
Buffer pH tells us HOW MUCH

Target pH
alfalfa 6.9

other forages 6.0

corn & soybeans 6.5 (or 6.0 on calcareous soils)

Example:
6-inch soil depth
Soil pH of 6.6
Buffer pH of 6.9
Lime for alfalfa to 6.9 pH

6.9 Buffer = 1,900 lb.

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

Table 16. Alfalfa Example: Lime recommendations use Buffer pH to give lb/ac

Soil pH tells us if we need to apply lime…
Buffer pH tells us HOW MUCH

Target pH
alfalfa 6.9

other forages 6.0

corn & soybeans 6.5 (or 6.0 on calcareous soils)

Example:
3-inch soil depth
Soil pH of 6.0
Buffer pH of 6.3
Lime for pasture to 6.0 pH

6.9 Buffer = 700 lb.

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

Josh's Soil Fertility "Order of Importance"

1. Take care of soil pH (typically the easiest and cheapest)
2. Address P and K concerns (ok to stair-step it)
3. Address Secondary Nutrients (Sulfur, Boron, Zinc)

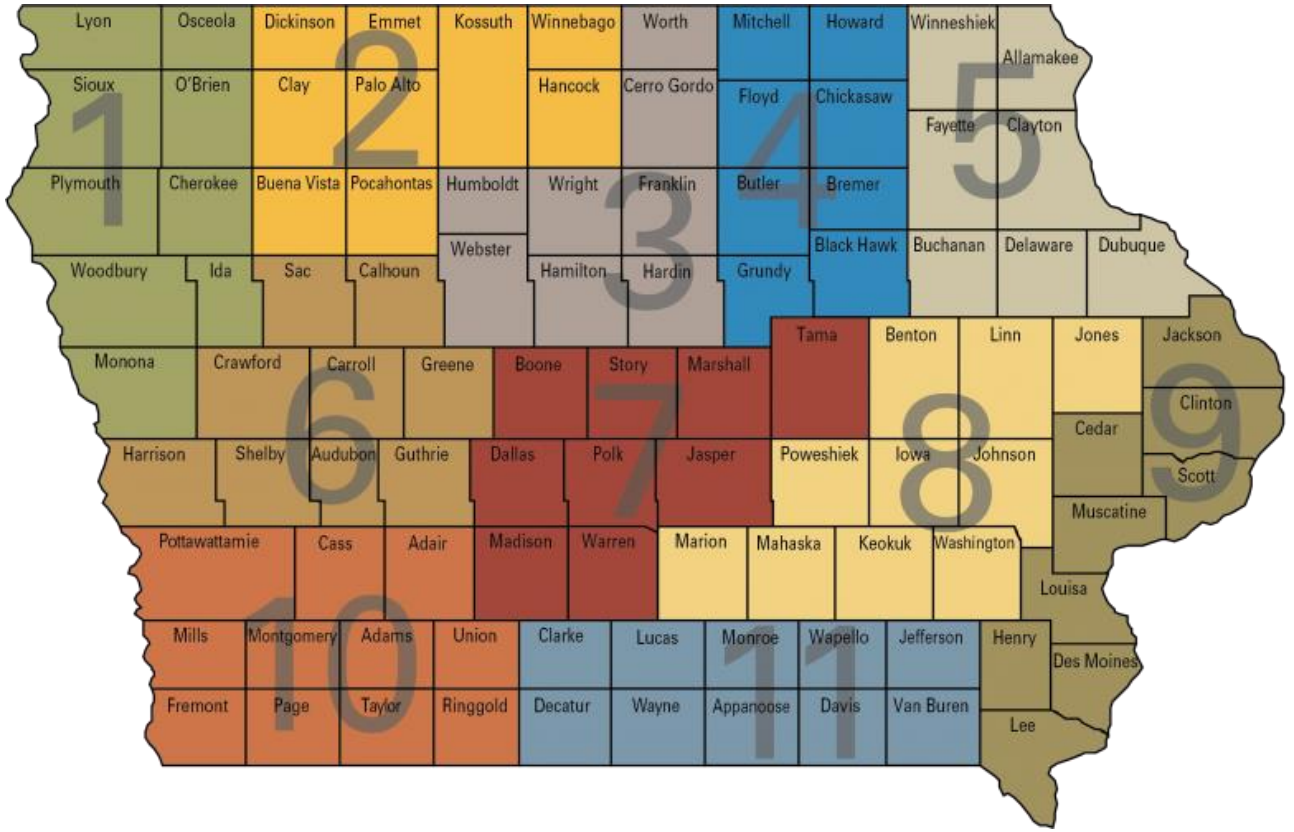
-Going to be crop and situation dependent

Supporting resources:

1. CROP 3108, "*Take a good soil sample to help make good fertilizer decisions"* https://store.extension.iastate.edu/product/3915
2. Web Soil Survey: https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
3. Iowa Soil Properties and Interpretations Database (ISPAID): http://www.extension.iastate.edu/soils/ispaid
4. Iowa Department of Agriculture and Land Stewardship: Commercial Feed & Fertilizer Bureau (Certified soil testing labs; Ag limestone quarry report): https://iowaagriculture.gov/commercial-feed-and-fertilizer-bureau
5. *"Some soil test information is important; Some isn't*," handout by Dr. George Rehm, University of Minnesota https://www.extension.iastate.edu/dairyteam/files/page/files/Some%20soil%20test%20information%20is%20important.pdf
6. PM-1688, "*A general guide for crop nutrients & limestone recommendations in Iowa"* https://store.extension.iastate.edu/Product/5232
7. CROP 3072, *"Sulfur Management for Iowa Crop Production"* https://store.extension.iastate.edu/product/14280
8. Corn Nitrogen Rate Calculator: http://cnrc.agron.iastate.edu/
9. PM-1558, "*How to sample manure for nutrient analysis"* https://store.extension.iastate.edu/product/5059
10. PMR-1003, "*Using manure nutrients for crop production"* https://store.extension.iastate.edu/product/12874
11. PM 1941, "Calibration and uniformity of solid manure spreaders" https://store.extension.iastate.edu/Product/5536
12. AE 3600, *"Distribution of liquid manure application"* https://store.extension.iastate.edu/product/14891
13. AE 3601A, *"Calibrating Liquid Tank Manure Applicators"* https://store.extension.iastate.edu/product/6499
14. ISU Extension soil fertility home page: http://www.agronext.iastate.edu/soilfertility/

What Questions or Comments Do You Have?

ISU Field Agronomists Across the State



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https://www.extension.iastate.edu/ag/crops