AGRONOMY
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Establishing Realistic Yield Goals

Are you managing your crop production program for 150-bushel average corn yields when your soils have a 98-bushel optimum average yield potential? Or are you managing for 110-bushel average corn yield when your soils have a 140-bushel optimum average yield potential?

Establishing realistic yield goals provides a basis for enhancing management effectiveness and increasing efficiency of crop production. Realistic yield goals should be established for each field. Yield goals can be established by use of historical records, by projecting a maximum yield based on management inputs without regard to the soil resource base, or by using soil maps and soil productivity potentials.

Realistic yield goals are those average yield levels that produce the greatest difference between the value of the crop and the cost of producing the crop.

Figure 1, for example, illustrates the relationship between yield levels, the total revenue realized, and increased production costs. If no inputs, such as seed, fertilizer, and weed control, are used, no production or total revenue results. These are examples of variable costs. However, certain fixed costs, such as machinery ownership and land charges, do occur and can result in a loss to the producer.

As the level of inputs used is increased, the yield produced eventually is more than sufficient to pay all production costs and returns a profit to the producer. At some point, however, the added cost of increasing yields is greater than the value of the additional product. At the point just before this occurs, profits are maximized. This yield level represents an economic optimum and is the yield goal that producers should strive to achieve.

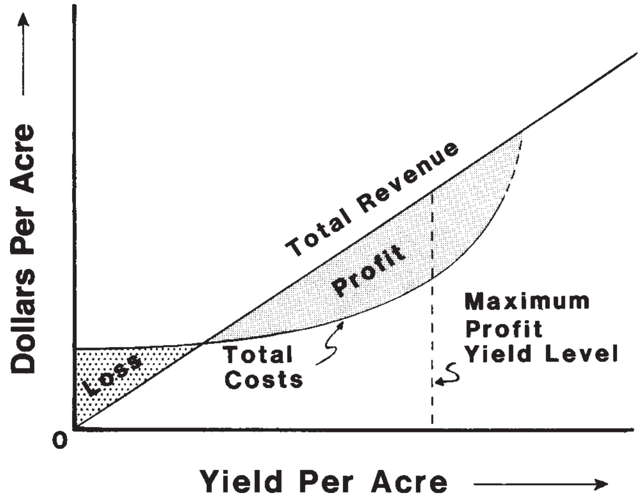

Figure 1. Relationship between total production (horizontal axis) and costs and revenues (vertical axis) to attain optimum return.
Source: William Edwards, extension economist, Iowa State University.

Historical Record Approach

The historical record approach is a useful method for identifying yield goals when soil maps are unavailable or outdated or when an operator has been farming a field for five or more years and has maintained production records. Yield records based on actual field-by-field averages or average farm yields or average county yields can be used to establish yield goals. A minimum of five years of production records should be used if a yield goal is to be established based on the historical records.

Yield goals can and likely will differ from the yield a field or area has been known to produce. Table 1 illustrates how a producer can manipulate known average county-wide yield information to identify historical yield level for the general area. In this example, the current 5-year moving average is 124.1 bushels per acre, the 10-year moving average is 111.7 bushels per acre, and the median yield for the 1974 through 1984 period is 116.5 bushels per acre.

The fact that the present 5-year moving average is 124.1 bushels per acre compared to the 10-year moving average of 111.7 bushels per acre suggests a lag in the production technology used by producers. On the other hand, the 1977 drought caused the 5-year moving average to be low compared to the 10-year moving average during the 1977 to 1980 period (table 1). Therefore, 10-year average data may be more useful when

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abnormal weather causes major deviations in yields produced. Similar field-by-field or farm data can be analyzed if the information is available.

The producer should establish goals slightly above the historical record for the field or area if the soils are loam, silt loam, or silty clay loam in the surface and subsurface and occur on slopes of 10 percent or less. A 10 percent adjustment above the average historical yield will challenge the skills of the one thing the producer controls—management.

Maximum Yield Approach

Maximum yields are based solely on inputs and management skills. Little or no consideration is given to soil productivity potential and soil differences within a field and typical weather for the area.

Table 1. Alternate methods for identifying a yield level for an area based on average corn yields reported for Story County, Iowa.

Year	Corn yield bu/A[1]	5-year moving average	10-year moving average
1974	99.9	108.2	102.0
1975	101.6	109.0	103.5
1976	106.6	109.3	105.3
1977	32.4	91.8	98.8
1978	116.5	91.4	100.2
1979	139.4	99.3	103.8
1980	126.5	104.3	106.7
1981	131.5	109.3	109.3
1982	128.5	128.5	110.2
1983	114.4	128.1	109.7
1984	119.5	124.1	111.7
Median yield for 11-year period: 116.5			

[1]Annual yield data from Iowa Crop and Livestock Reporting Service

In practice, it is very expensive to strive for the maximum potential yield based solely on management inputs without regard to the soil resource and differences in soils within a field. Risk of failure in a given year is high. A maximum yield goal does not consider the costs of inputs needed to reach that yield goal.

Soil Productivity Approach

Realistic yield goals based on soil productivity potential consider optimum economic returns, available water supply including rainfall and available subsoil moisture, management for past yield levels in a given field, and current management skills of the producer. Management is the one factor directly under the producer's control. A producer must consider how a given field has been managed during the past five years and his or her ability to modify or change management skills to achieve optimum yields.

Evaluation of soil productivity requires four critical pieces of information and calculation of a weighted average for the area being considered. First, a soil map is essential. Soil maps can be found in the modern county soil survey reports published since 1960. Next, the field boundaries must be traced or outlined on the soil map.

Third, the yield potential for each different soil in the field must be identified. Estimated yields for major crops grown in Iowa have been established for each of more than 1,900 soil map units identified in modern Iowa county soil survey reports. These yield estimates are available at county extension service and soil conservation district offices, and the Department of Agronomy, Iowa State University. Estimated yields for selected soil map units are listed in table 4.

Fourth, the acreage of each soil in the field must be estimated or measured and recorded on a worksheet. A dot grid transparent overlay can be

Table 2. Calculation of the weighted average corn yield potential for an 80-acre field using the soil map shown in figure 2.

Soil map number	Soil type name	Acreage	Yield potential (bu/A)	Acreage × Yield Potential
55	Nicollet loam	5.9	156	920.4
62D	Storden loam	6.4	118	755.2
62E	Storden loam	1.9	101	191.9
95	Harps clay loam	8.0	125	1000.0
107	Webster clay loam	13.8	145	2001.0
135	Coland clay loam	2.0	136	272.0
138B	Clarion loam	36.1	145	5234.5
138C2	Clarion loam	3.9	136	530.4
201B	Coland-Terrill complex	2.0	139	278.0
		80.0		11183.4

$$\frac{11{,}183.4}{80.0} = 139.8 \text{ bushels per acre = weighted average corn yield potential for field.}$$

Table 3. Calculation of the weighted average corn yield potential for an 80-acre field using the soil map shown in figure 3.

Soil map number	Soil type name	Acreage	Yield potential (bu/A)	Acreage × Yield Potential
55	Nicollet loam	5.7	156	889.2
90	Okoboji mucky silt loam	0.5	119	59.5
107	Webster clay loam	30.5	145	4422.5
138B	Clarion loam	2.3	145	333.5
138C2	Clarion loam	11.2	136	1523.2
507	Canisteo silty clay loam	6.4	139	889.6
828C2	Zenor sandy loam	23.4	81	1895.4
		80.0		10012.9

$$\frac{10{,}012.9}{80.0} = 125.2 \text{ bushels per acre = weighted average corn yield potential for field.}$$

used to estimate acreage for each soil delineation.

The final step is calculation of a weighted average yield for the field. This is accomplished by multiplying the yield potential times the acreage (table 2 and 3). The sum of these products is divided by the total acres in the field. This figure is the weighted average yield. The estimated yield potential for the field provides a benchmark to compare the producer's yield goal and actual yields.

Soil maps for two 80-acre fields are shown in figures 2 and 3. Both fields are located in central Iowa within the Clarion-Nicollet-Webster soil association area. Both fields contain several of the same soil map units, for example, 55, 107, 138B, and 138C2. However, both fields include different soil map units.

Because the acreage of the same map units differs and because the mix of specific kinds of soils differ, the potential yield decreases from 139.8 bushels to 125.2 bushels, a difference of 14.6 bushels per acre (tables 2 and 3). In terms of management, the average corn yield for these two fields indicates that a reduction of 18 pounds of nitrogen per acre is recommended for growing corn on the field in the second example (figure 3, table 3) compared to the first example (figure 2, table 2).

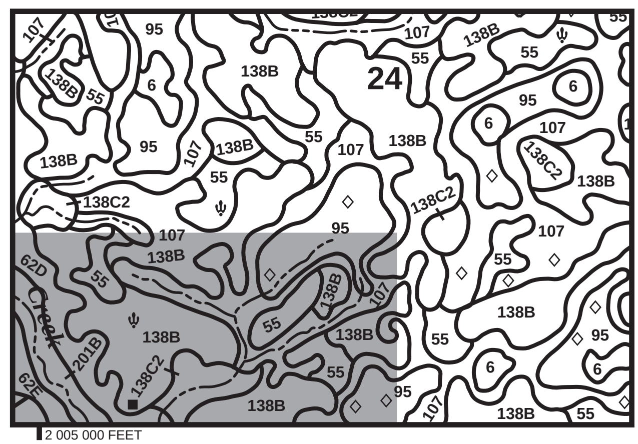

Figure 2. A soil map showing the soil inventory for an 80-acre field (area within rectangle).

Map symbol	Soil Phase
55	Nicollet loam, 1 to 3 percent slopes, no erosion
62D	Storden loam, 9 to 14 percent slopes, slight erosion
62E	Storden loam, 14 to 18 percent slopes, slight erosion
95	Harps clay loam, 0 to 2 percent slopes, no erosion
107	Webster clay loam, 0 to 2 percent slopes, no erosion
135	Coland clay loam, 0 to 2 percent slopes, no erosion
138B	Clarion loam, 2 to 5 percent slopes, slight erosion
138C2	Clarion loam, 5 to 9 percent slopes, moderate erosion
201B	Coland-Terril Complex, 1 to 5 percent slopes, slight erosion

Special Symbols

- —·-—·- Waterway crossable with farm implements
- —-·-—-- Waterway not crossable with farm implements
- ψ Wet spot
- ◇ Depression containing less than 2 acres of Okoboji soil
- ■ Farmstead

Slope Symbols

Blank = 0 to 2% or 1 to 3%
B = 2 to 5%
C = 5 to 9%
D = 9 to 14%
E = 14 to 18%

Erosion Symbols

Blank = none or slight
2 = moderate

Yield Estimates for High Level Management

Table 4 lists estimated yields for corn, soybeans, and alfalfa hay by kind of soil for selected soils in the 12 major soil areas (figure 4). These yield estimates are based on high level management. Most likely, 10 to 20 percent of the producers are achieving these yield levels, while a few will exceed the yield estimates. These yields are normalized for a 5-year average. Five-year estimates are used to smooth the effects of weather variation on a year-to-year basis. Yield estimates listed in table 4 are benchmark figures. These values may be adjusted for weather conditions in a specific county or area of the state.

High level management includes the adoption

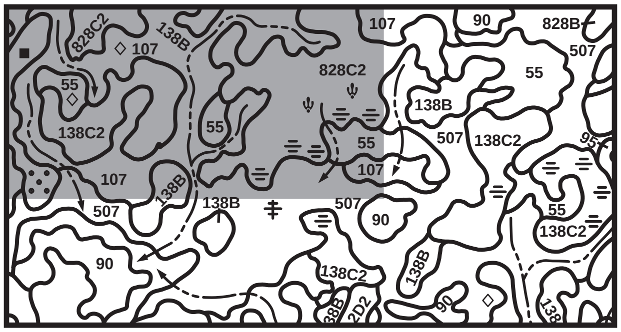

Figure 3. A soil map showing the soil inventory for an 80-acre field (area within rectangle).

Map symbol	Soil Phase Name
55	Nicollet loam, 1 to 3 percent slopes, no erosion
90	Okoboji mucky silt loam, 0 to 1 percent slopes, no erosion
107	Webster clay loam, 0 to 2 percent slopes, no erosion
138B	Clarion loam, 2 to 5 percent slopes, slightly eroded
138C2	Clarion loam, 5 to 9 percent slopes, moderately eroded
507	Canisteo silty clay loam, 0 to 2 percent slopes, no erosion
828C2	Zenor sandy loam, 5 to 9 percent slopes, moderately eroded

Special Symbols

Waterway crossable with farm implements
◇ Depression of Okoboji soil (<2 acres)
Wet area (<2 acres)
Severely eroded area (<2 acres)
Sandy area (<2 acres)
■ Farmstead

of best available technology for crop production. For example, best available technology for corn production includes tillage and engineering practices that maintain soil erosion rates at or below tolerance limits. This implies that conservation tillage or terraces or a combination of conservation and terraces are used to control soil erosion. If conservation tillage and terraces are not used, then a rotation with a sod-based crop is used to maintain soil loss within tolerance levels.

Also, best available technology includes use of artificial drainage on soils requiring the removal of excess water for optimum plant root growth and development and protection from periodic flooding for soils adjacent to drainageways, streams, and rivers. Other optimum management practices include cultivar selection; seed quality; planting dates; population; row-spacing; fertilization and liming rates; weed, disease, and insect control; and timely and efficient harvest practices all employed at profit maximizing levels. All yield estimates are for dry land (non-irrigated) conditions.

Yield estimates for each kind of soil are based on corn yield data. These yield data were collected by Iowa State University researchers throughout Iowa from activities such as the Iowa Corn Yield Test trials, long-term fertility, population, and rotation studies conducted at ISU research centers, industry plots, and farmers' fields.

The corn yield estimates for each soil considers the kind of parent material, slope class, topsoil thickness, natural drainage class, the nature of the subsoil and substratum in terms of rooting environment, and the native productivity. Rooting environment considers depth of the soil, depth to limiting or less favorable layers, and plant available water holding capacity. Potential for periodic flooding and weather conditions are also included.

Yield estimates for soybeans and alfalfa-grass hay are calculated from a percentage of the estimated corn yields. Location in the state and kind of parent material are considered in the calculation of soybean yield estimates. Natural soil drainage class is considered in the calculation of alfalfa-grass hay yield estimates. Yield estimates are sharply reduced for soils having poor and very poor natural drainage. The alfalfa-grass hay yields assume 80 percent or more alfalfa in the stand with either orchardgrass or bromegrass.

Realistic Yield Goals and Management

Realistic yield goals and high level crop management practices are compatible. For example, nitrogen application rates and plant population stands for corn production should be based on yield goals that maximize profits.

Management of specific crop production inputs, such as amount of fertilizer per acre, plant populations, cultivar selection, and related best management practices, can be adjusted on a field-by-field basis, based on yield potential and average yield goals. For example, if fertilizer is applied to one field to produce 150 bushels of corn and the optimum yield potential is only 110 bushels, then it is apparent that inputs are excessive and expensive for the optimum yield potential. On the other hand, a yield that is too low can greatly reduce profits.

Realistic yield goals should be established for a minimum 5-year average. This means that in some years the producer will exceed the established yield goal and in other years the producer will realize yields below the established yield goal.

Establishment of realistic yields for each field can and should be the goal of every producer. Setting a realistic goal provides a benchmark for the producer to compare against actual yield. The historical record approach is a useful tool to evaluate yields for a large area such as a township or county or for farms and fields where soil maps are unavailable or outdated or where production records are not available. The maximum yield approach can be expensive and does not provide adequate credit to the soil resource base. The soil productivity approach provides a producer with a tool to combine management skills and the potential of the soil resource base.

Figure 4. Map of Iowa delineating the 21 principal soil association areas (coded by letters) and the 12 major soil areas (coded by numbers) (modified from Fenton et al., 1971).

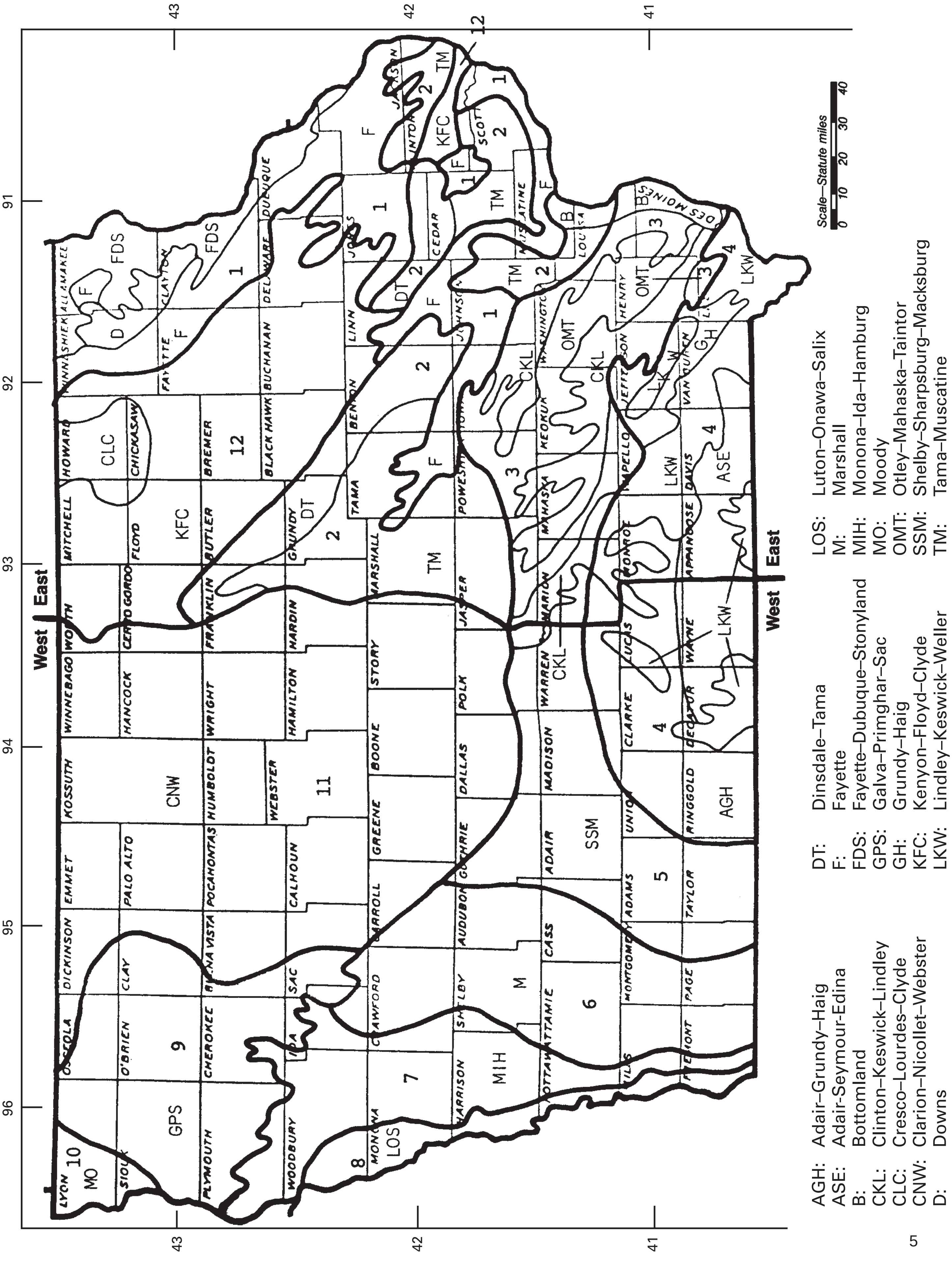

Table 4. Yield potentials of major crops for high level management for select soil map units listed by major soil areas (MSA) of Iowa (see figure 4).

Soil Map Number	Soil Type Name	Corn bu/A	Soybeans bu/A	Alfalfa-grass T/A
Major Soil Area No. 1				
129B	Arenzville-Chaseburg complex	127	43	5.3
158	Dorchester silt loam	138	46	5.7
162B	Downs silt loam	158	53	6.6
162C	Downs silt loam	153	51	6.4
162C2	Downs silt loam	149	50	6.3
162D2	Downs silt loam	140	47	5.9
163C2	Fayette silt loam	140	47	5.9
163D2	Fayette silt loam	131	44	5.5
183D2	Dubuque silt loam	81	27	3.4
291	Atterberry silt loam	153	51	4.6
487B	Otter-Huntsville complex	143	48	6.0
Major Soil Area No. 2				
5B	Ackmore-Colo complex	131	44	3.9
11B	Colo-Ely complex	142	48	4.3
20D2	Killduff silty clay loam	144	48	6.1
118	Garwin silty clay loam	167	56	5.0
119	Muscatine silty clay loam	170	57	6.8
120B	Tama silty clay loam	167	56	7.0
120C	Tama silty clay loam	162	54	6.8
120C2	Tama silty clay loam	158	53	6.6
120D2	Tama silty clay loam	149	50	6.3
133	Colo silty clay loam	136	46	4.1
184	Klinger silty clay loam	165	55	6.6
377B	Dinsdale silty clay loam	160	54	6.7
382	Maxfield silty clay loam	160	54	4.8
442C2	Dickinson-Sparta-Tama complex	103	35	4.3
933B	Sawmill silty clay loam	133	45	4.0
Major Soil Area No. 3				
65D2	Lindley loam	97	32	4.1
75	Givin silt loam	148	50	5.9
76B	Ladoga silt loam	148	50	6.2
76C2	Ladoga silt loam	139	47	5.8
80B	Clinton silt loam	139	47	5.8
80C2	Clinton silt loam	130	44	5.5
80D2	Clinton silt loam	121	41	5.1
279	Taintor silty clay loam	155	52	4.7
280	Mahaska silty clay loam	162	54	6.5
281B	Otley silty clay loam	157	53	6.6
281C2	Otley silty clay loam	148	50	6.2
730B	Nodaway-Cantril complex	126	42	5.0
Major Soil Area No. 4				
13B	Olmitz-Vesser-Colo complex	127	43	3.8
24D2	Shelby loam	115	39	4.8
131B	Pershing silt loam	119	40	4.8
132C2	Weller silt loam	93	31	3.9
192C2	Adair clay loam	82	27	2.5
211	Edina silt loam	107	36	3.2
222C2	Clarinda silty clay loam	72	14	2.2
312B	Seymour silt loam	109	37	4.4
362	Haig silt loam	131	44	3.9
364B	Grundy silty clay loam	133	45	5.3
731C2	Pershing silty clay loam	107	36	4.6

Soil Map Number	Soil Type Name	Corn bu/A	Soybeans bu/A	Alfalfa-grass T/A
Major Soil Area No. 5				
11B	Colo-Judson complex	135	45	4.0
24D2	Shelby loam	115	39	4.8
54	Zook silty clay loam	126	42	3.8
69C	Clearfield silty clay loam	112	38	3.4
76C2	Ladoga silt loam	135	45	5.7
93D2	Shelby-Adair complex	90	32	2.7
192D2	Adair clay loam	76	25	3.0
368	Macksburg silty clay loam	161	54	6.4
369	Winterset silty clay loam	159	53	4.8
370B	Sharpsburg silty clay loam	153	51	6.4
370C2	Sharpsburg silty clay loam	144	48	6.1
370D2	Sharpsburg silty clay loam	135	45	5.7
570B	Nira silty clay loam	148	50	6.2
822D2	Lamoni silty clay loam	76	25	3.0
Major Soil Area No. 6				
8B	Judson silty clay loam	149	50	6.3
9B	Marshall silty clay loam	150	50	6.3
9C2	Marshall silty clay loam	141	47	5.9
9D2	Marshall silty clay loam	132	44	5.5
17B	Napier-Nodaway-Colo complex	129	43	3.9
93D2	Shelby-Adair complex	95	32	3.9
99C2	Exira silty clay loam	136	46	5.7
99D2	Exira silty clay loam	127	43	5.3
212	Kennebec silt loam	155	52	6.5
220	Nodaway silt loam	153	51	6.4
299	Minden silty clay loam	161	54	6.4
Major Soil Area No. 7				
1C3	Ida silt loam	111	37	4.7
1D3	Ida silt loam	102	34	4.3
1E3	Ida silt loam	85	28	3.6
10B	Monona silt loam	142	48	6.0
10B2	Monona silt loam	138	46	5.8
10C	Monona silt loam	137	46	5.7
10C2	Monona silt loam	133	45	5.6
10D2	Monona silt loam	124	42	5.2
12B	Napier silt loam	130	44	5.5
12C	Napier silt loam	125	42	5.3
Major Soil Area No. 8				
36	Salix silty clay loam	145	49	6.1
46	Keg silt loam	152	51	6.4
66	Luton silty clay	80	27	2.4
70	McPaul silt loam	133	45	5.6
137	Haynie silt loam	126	42	5.3
144	Blake silty clay loam	130	44	5.2
146	Onawa silty clay	120	40	3.6
147	Modale silty clay loam	126	42	5.0
156	Albaton silty clay	100	34	3.0
237	Sarpy loamy fine sand	45	15	1.9
436	Lakeport silty clay loam	138	46	5.5
Major Soil Area No. 9				
31	Afton silty clay loam	130	49	3.9
77B	Sac silty clay loam	122	46	5.1
77C2	Sac silty clay loam	113	42	4.8
91	Primghar silty clay loam	140	53	5.6
91B	Primghar silty clay loam	137	51	5.5

Soil Map Number	Soil Type Name	Corn bu/A	Soybeans bu/A	Alfalfa-grass T/A
Major Soil Area No. 9 ***(continued)***				
92	Marcus silty clay loam	135	51	4.1
108B	Wadena loam	68	26	2.9
310B	Galva silty clay loam	129	48	5.4
310C2	Galva silty clay loam	120	45	5.0
455	Wilmonton clay loam	130	49	5.2
467B	Radford silt loam	138	52	4.1
577B	Everly clay loam	120	45	5.0
Major Soil Area No. 10				
410B	Moody silty clay loam	117	44	4.9
410B2	Moody silty clay loam	113	42	4.8
410C2	Moody silty clay loam	108	41	4.5
410D2	Moody silty clay loam	99	37	4.3
733	Calco silty clay loam	130	44	3.9
878C2	Ocheyedan loam	100	31	4.2
910	Trent silty clay loam	128	48	5.4
Major Soil Area No. 11				
6	Okoboji silty clay loam	115	37	3.4
55	Nicollet loam	156	50	6.2
62C2	Storden loam	123	39	5.2
90	Okoboji mucky silt loam	119	38	3.6
95	Harps clay loam	125	40	3.7
107	Webster clay loam	145	46	4.4
135	Coland clay loam	136	44	4.1
138B	Clarion loam	145	46	6.1
138C2	Clarion loam	136	44	5.7
259	Biscay clay loam, deep	131	42	3.9
288	Ottosen clay loam	150	48	6.0
329	Webster-Nicollet complex	145	46	4.4
383	Marna silty clay loam	126	40	3.8
388	Kossuth silty clay loam	134	43	4.0
507	Canisteo silty clay loam	139	44	4.2
638C2	Clarion-Storden loams	124	40	5.2
Major Soil Area No. 12				
41B	Sparta loamy fine sand	77	23	3.2
83B	Kenyon loam	154	47	6.5
83C2	Kenyon loam	145	44	6.1
84	Clyde silty clay loam	140	43	4.2
171B	Basset loam	145	44	6.1
177B	Saude loam	104	32	4.4
198	Floyd loam	147	45	5.9
225	Lawler loam, 24 to 32 inches to sand and gravel	119	36	4.8
391	Clyde-Floyd complex	137	42	4.1
394	Ostrander loam	157	48	6.6
398	Tripoli clay loam	152	46	4.6
399	Readlyn loam	157	48	6.3
407	Schley loam	133	41	5.3
485	Spillville loam	156	52	6.2

Yield estimates developed by Thomas E. Fenton, research agronomist, and Gerald A. Miller, extension agronomist, Iowa State University; Ronald J. Juehl, State Soil Scientist, and L. Dale Lockridge, Soil Specialist, Soil Conservation Service.

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