ESTIMATED CROP YIELDS ON IOWA SOILS

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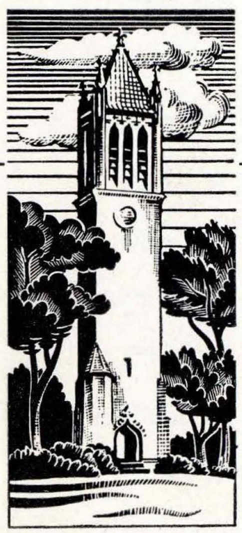

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CONTENTS

SUMMARY

This report presents detailed crop yield estimates developed for 67 Iowa soil types and phases. The yield estimates represent long-time average yields of corn, soybeans, oats and hay believed obtainable under two different levels of management. The management levels include (1) a *low level* which should result in yields near the low side now experienced by many farmers and (2) a *high level* which should result in yields near the maximum that most farmers could produce profitably. In general, other yield levels resulting from other management assumptions would then fall within these limits.

For soil types not included in the list of 67 soil types, a general evaluation of productive capacity is presented in Appendix B. In this presentation each soil type is placed in a yield group at only the high level of management.

Average crop yields in Iowa vary widely among soil types. Highest yields are believed obtainable on Muscatine soils. Average yields per acre on Muscatine silt loam soil under the high level of management are estimated to be 90 bushels for corn, 32 bushels for soybeans, 56 bushels for oats and 3.6 tons for hay. Clarinda silty clay loam is one of the lowest-yielding soils, and average yields per acre at the high management level are estimated to be 20 bushels for corn, 15 bushels for oats and 0.8 ton for hay. The average yields per acre on a large group of Iowa soils are estimated to range as follows: corn, 65 to 80 bushels; soybeans, 20 to 30 bushels; oats, 35 to 55 bushels; and hay, 2 to 3 tons.

There are many factors which influence crop yields, such as soil type, slope, erosion, cropping system, fertility, crop varieties, planting rates and timeliness of operation. These factors are evaluated as specifically as possible to show their yield effect or the contribution which they make to the total crop yield. With this information, the yield estimates presented, which are based on rather specific conditions, can be adjusted to fit other soil and crop conditions or management assumptions. Furthermore, a method is presented for developing estimated yields for a particular field or farm, based on information in this report plus other available information.

The yield estimates presented are approximate values only and should be considered so. It is recognized that numerous factors may cause the estimates to be either too high or too low for a given field or farm. The estimates are based on the best information available at the present time, however, and can serve as a useful guide to persons concerned with problems of primary production on Iowa farms.

Estimated Crop Yields on Iowa Soils[1]

BY W. D. SHRADER, F. W. SCHALLER, J. T. PESEK, D. F. SLUSHER AND F. F. RIECKEN

Everyone interested in agriculture is concerned, to some degree, with estimating crop yields. Estimated yields are a basis for appraising farmland and frequently are used for establishing rental arrangements and determining farm sale and loan values. They also are used in planning the farm business and in developing various agricultural programs.

Factors and interactions of factors which determine crop yields are complex, and information regarding them often is inadequate. Research during past years has helped greatly to evaluate these factors and to aid in understanding the many interrelationships involved. In the future it can be expected that research and experience will continue to provide additional information on factors of crop production. Consequently, any set of crop yield estimates must be considered tentative and subject to periodic revision to keep pace with the development of new and more precise facts and interpretations and changes in production technology.

This report should be considered a progress report; however, it contains the most accurate information available at the present time. It can serve as a useful guide to persons concerned with problems of primary production on Iowa farms.

The report is presented in two sections. The first section presents the crop yield estimates for the major Iowa soils plus information to aid in understanding and evaluating the estimates. The latter information includes a discussion of the sources of yield information, a summary of important properties of the soils concerned and a description of the management assumptions on which the yield estimates are based.

Section 2 discusses the effect of various soil, climatic and management factors on crop yields. This information forms the basis for predicting yields on other soils and under management conditions not included in the specific estimates given in Section 1. Finally, a procedure is outlined for estimating the yield potential for a specific field or farm.

Section 1.

CROP YIELD ESTIMATES FOR MAJOR IOWA SOILS

PRESENTING THE YIELD ESTIMATES

Table 1 presents the corn, soybean, oats and hay yield estimates developed for 67 Iowa soil types and phases. In addition, an index of the probable year-to-year variation in yield for each crop except hay is provided. This index of variability indicates that, in about 2 out of 3 years, the yields for large areas can be expected to be within the plus or minus range stipulated.[2]

The yields in table 1 represent long-time averages (at least 10 years) believed obtainable under two different management levels. The two management levels are briefly described as follows:

1. A *low level*, which should result in yields near the lower limits now experienced by many farmers.

2. A *high level*, which should result in yields near the maximum level that most farmers could produce.

At the low yield level, the fertilization practices, cropping system, corn planting rate and erosion control are insufficient for high yields. At the high yield level, these same practices are applied to an extent which favors high yields. A detailed description of management practices and assumptions considered in making the yield estimates are given in Appendix A.

In table 1 the yield estimates are listed by soil types in alphabetical order. The soil association area (or areas) in which each soil type occurs is given in the table, and its location in Iowa is

[1]Projects 1148, 1151, 1189 and 1205 of the Iowa Agricultural and Home Economics Experiment Station.

[2]The indices of variability are taken from the coefficients of variation for annual county yields in the soil association areas. Hence the variability indices will fit closely for relatively large areas such as a county, but the variability on individual fields will be greater. Perhaps in only half of the years will the yield of a given field fall within the range indicated. It is felt that the indices of variability are a good indication of relative variability among soils within a soil association area and among different areas.

TABLE 1. ESTIMATED LONG TIME AVERAGE YIELDS OF SELECTED CROPS ON PRINCIPAL IOWA SOILS UNDER SPECIFIED LEVELS OF MANAGEMENT.

Mapping unit No.[a]	Soil type	Slope phase (%)	Erosion phase[b]	Soil Association area	Erosion control practices	Estimated yields and an index of probable year to year yield fluctuations							
						Corn		Soybeans		Oats		Hay	
						Management levels		Management levels		Management levels		Management levels	
						Low (bu./a.)[c]	High (bu./a.)[d]	Low (bu./a.)[e]	High (bu./a.)[f]	Low (bu./a.)[g]	High (bu./a.)[h]	Low (tons/a.)[i]	High (tons/a.)[j]
192	Adair (Lagonda) silty clay loam	5–9	2	SSE, SGH, SSW	Without	20 (6)[k]	25 (7)	....	....	15 (5)	....	0.8	....
					With	20 (6)	25 (7)	....	....	....	20 (6)	....	1.0
156	Albaton silty clay	0–1	0	B		40 (10)	50 (13)	20 (6)	22 (7)	26 (8)	32 (9)	2.0	2.2
260	Beckwith (Marion) silt loam	0–1	1	WL		25 (7)	40 (10)	12 (3)	16 (4)	20 (7)	28 (9)	0.8	1.4
130	Belinda silt loam	0–1	0	SSE, WL		30 (7)	50 (10)	15 (3)	20 (4)	24 (7)	36 (10)	1.5	2.2
222	Clarinda silty clay loam	5–9	2	SGH, SSW	Without	15 (5)	20 (6)	....	....	10 (3)	....	0.6	....
					With	15 (5)	20 (6)	....	....	....	15 (5)	....	0.8
138	Clarion loam	2–5	1	CW	Without	48 (9)	68 (14)	21 (4)	....	36 (7)	....	2.4	....
					With	52 (9)	72 (14)	....	28 (5)	....	52 (10)	....	3.0
80	Clinton silt loam	5–9	2	CL	Without	36 (7)	56 (10)	20 (4)	....	30 (7)	....	2.0	....
					With	40 (7)	60 (10)	....	24 (5)	....	44 (10)	....	2.8
84	Clyde silty clay loam	1–2	0	CC		44 (8)	72 (13)	19 (3)	25 (4)	36 (8)	48 (10)	2.2	3.0
133	Colo silty clay loam	0–1	0	All		60 (10)	70 (12)	26 (4)	29 (5)	42 (7)	52 (8)	2.8	3.0
783	Cresco loam	2–5	1	CKC	Without	35 (12)	60 (13)	13 (3)	....	30 (7)	....	1.8	....
					With	35 (12)	60 (13)	....	19 (4)	....	40 (9)	....	2.8
175	Dickinson fine sandy loam	2–5	1	CW, CC	Without	32 (7)	45 (10)	15 (4)	....	25 (6)	....	1.4	....
					With	35 (7)	48 (10)	....	18 (5)	....	36 (7)	....	1.8
162	Downs silt loam	2–5	1	F, FDS, TD	Without	50 (7)	75 (11)	24 (5)	....	36 (6)	....	2.5	....
					With	54 (7)	78 (11)	....	29 (6)	....	50 (9)	....	3.2
162	Downs silt loam	5–9	2	F, FDS, TD	Without	43 (6)	71 (10)	22 (5)	....	33 (6)	....	2.2	....
					With	48 (6)	75 (10)	....	27 (6)	....	46 (8)	....	3.0
211	Edina silt loam	0–1	0	SSE		34 (8)	62 (13)	20 (4)	26 (5)	28 (8)	38 (11)	1.6	2.2
163	Fayette silt loam	2–5	1	F, FDS	Without	41 (6)	70 (11)	22 (5)	....	33 (6)	....	2.2	....
					With	46 (6)	74 (11)	....	28 (6)	....	48 (9)	....	3.0
163	Fayette silt loam	5–9	2	F, FDS	Without	36 (6)	67 (11)	20 (5)	....	30 (6)	....	2.0	....
					With	41 (6)	72 (11)	....	26 (6)	....	44 (8)	....	2.8
198	Floyd loam	1–3	0	CC		45 (8)	75 (13)	20 (3)	26 (2)	38 (7)	53 (3)	2.4	3.2
310	Galva silt loam	2–5	1	GPS, MPS	Without	45 (8)	60 (11)	20 (4)	....	35 (6)	....	2.4	....
					With	49 (8)	65 (11)	....	25 (5)	....	50 (9)	....	3.0
118	Garwin silty clay loam	0–1	0	TM		68 (10)	88 (13)	25 (5)	30 (6)	40 (9)	55 (11)	2.8	3.4
6	Glencoe silty clay loam	0	0	CW		45 (8)	60 (20)	18 (3)	20 (5)	35 (7)	40 (8)	2.2	2.5
364	Grundy silt loam	2–5	1	SGH, GH	Without	36 (7)	64 (12)	22 (4)	....	30 (8)	....	2.0	....
					With	40 (7)	66 (12)	....	28 (5)	....	42 (11)	....	2.6
41	Hagener (Thurman) sand and loamy sand	2–5	1	All	Without	16 (5)	32 (11)	14 (5)	....	15 (4)	....	1.2	....
					With	18 (5)	35 (11)	....	18 (6)	....	25 (6)	....	1.6
362	Haig silt loam	0–1	0	SGH, GH		40 (9)	65 (14)	22 (4)	28 (6)	30 (9)	42 (12)	2.0	2.6
95	Harpster loam	0–1	0	CW		35 (8)	60 (15)	15 (3)	24 (5)	30 (6)	40 (8)	1.0	2.5
168	Hayden loam	5–9	2	CW	Without	32 (10)	51 (12)	....	....	28 (8)	....	1.8	....
					With	36 (10)	55 (12)	....	....	....	40 (10)	....	2.6
38	Haynie fine sandy loam	0–1	0	B		45 (8)	53 (10)	16 (5)	18 (6)	28 (7)	32 (9)	1.8	2.2
137	Haynie silt loam	0–1	0	B		55 (7)	70 (12)	24 (6)	26 (7)	35 (8)	52 (11)	2.0	3.0
269	Humeston silt loam	0–1	0	SSE, SGH, WL, SSW		40 (10)	50 (12)	18 (5)	22 (6)	30 (9)	40 (12)	1.8	2.2
1	Ida silt loam	9–14	3	MIH	Without	16 (4)	43 (10)	....	....	15 (4)	....	0.5	....
					With	20 (4)	51 (10)	....	....	....	32 (8)	....	2.4
781	Kasson loam	2–5	1	CKC	Without	27 (6)	52 (12)	12 (3)	....	25 (6)	....	1.8	....
					With	27 (6)	52 (12)	....	17 (4)	....	35 (9)	....	2.4
83	Kenyon (Carrington) loam	2–5	1	CC	Without	38 (7)	70 (13)	19 (3)	....	36 (7)	....	2.0	....
					With	42 (7)	75 (13)	....	25 (4)	....	50 (9)	....	3.2
76	Ladoga silt loam	2–5	1	MT, CL, SSW	Without	42 (9)	60 (13)	17 (5)	....	30 (7)	....	2.2	....
					With	46 (9)	67 (13)	....	24 (6)	....	40 (10)	....	3.0
65	Lindley loam	9–14	3	CL, WL	Without	18 (5)	35 (9)	....	....	15 (5)	....	0.8	....
					With	20 (5)	38 (9)	....	....	....	26 (8)	....	1.4
66	Luton silty clay and clay	0–1	0	B		38 (11)	45 (13)	20 (7)	22 (7)	24 (8)	28 (9)	2.3	2.4

280	Mahaska silt loam	1–3	0	MT		60 (9)	84 (13)	26 (5)	31 (6)	38 (8)	53 (11)	2.8	3.4
92	Marcus silty clay loam	0–1	0	GPS, MPS		50 (9)	70 (13)	21 (4)	26 (5)	38 (6)	50 (8)	2.4	3.0
9	Marshall silt loam	2–5	1	M	Without	48 (9)	69 (12)	24 (5)	....	35 (8)	....	2.4	....
					With	53 (9)	74 (12)	....	28 (6)	....	45 (10)	....	3.0
9	Marshall silt loam	5–9	2	M	Without	43 (8)	61 (12)	22 (5)	....	30 (7)	....	2.2	....
					With	48 (8)	67 (12)	....	26 (6)	....	40 (9)	....	2.8
9	Marshall silt loam	9–14	2	M	Without	35 (8)	54 (11)	....	....	25 (6)	....	2.2	....
					With	39 (8)	60 (11)	....	....	....	36 (9)	....	2.8
10	Monona silt loam	2–5	1	MIH	Without	47 (8)	64 (11)	22 (5)	....	36 (8)	....	2.4	....
					With	51 (8)	69 (11)	....	27 (6)	....	44 (10)	....	3.0
10	Monona silt loam	5–9	2	MIH	Without	40 (8)	54 (10)	20 (4)	....	32 (7)	....	2.2	....
					With	45 (8)	62 (10)	....	25 (6)	....	40 (9)	....	2.8
10	Monona silt loam	9–14	3	MIH	Without	33 (7)	47 (10)	....	....	28 (7)	....	2.0	....
					With	38 (7)	55 (10)	....	....	....	36 (9)	....	2.6
410	Moody silt loam	2–5	1	MO	Without	40 (8)	55 (13)	18 (4)	....	33 (6)	....	2.2	....
					With	44 (8)	60 (10)	....	22 (5)	....	48 (8)	....	2.8
119	Muscatine silt loam	1–3	0	TM		65 (9)	90 (13)	27 (5)	32 (6)	40 (8)	56 (10)	3.0	3.6
55	Nicollet loam	1–3	0	CW		55 (9)	78 (13)	23 (4)	30 (5)	40 (8)	55 (9)	2.8	3.4
220	Nodaway silt loam	0–1	0	All		60 (15)	75 (19)	27 (7)	30 (8)	42 (12)	55 (16)	2.6	3.2
144	Onawa silty clay loam	0–1	0	B		50 (10)	65 (13)	26 (7)	26 (7)	40 (9)	52 (12)	2.6	3.0
281	Otley silt loam	2–5	1	TM	Without	51 (9)	75 (15)	25 (5)	....	38 (8)	....	2.6	....
					With	55 (9)	78 (13)	....	50 (6)	....	50 (10)	....	3.2
281	Otley silt loam	5–9	2	TM	Without	45 (8)	66 (12)	23 (5)	....	34 (7)	....	2.4	....
					With	50 (8)	71 (12)	....	28 (6)	....	46 (10)	....	3.0
131	Pershing silt loam	2–5	2	WL	Without	26 (6)	46 (9)	15 (3)	....	24 (7)	....	1.5	....
					With	30 (6)	50 (9)	....	20 (4)	....	36 (10)	....	2.2
91	Primghar silt loam	1–3	0	MPS, GPS		50 (16)	72 (12)	21 (4)	26 (5)	38 (6)	50 (8)	2.6	3.2
77	Sac silt loam	2–5	1	MPS, GPS	Without	45 (8)	60 (11)	20 (4)	....	35 (6)	....	2.4	....
					With	49 (8)	65 (11)	....	25 (5)	....	50 (9)	....	3.0
46	Salix silt loam	0–1	0	B		58 (9)	74 (11)	26 (7)	28 (7)	42 (8)	55 (10)	2.8	3.2
237	Sarpy loamy sand and sand	0–1	0	B		20 (10)	25 (10)	15 (4)	18 (5)	20 (7)	25 (8)	1.0	2.0
312	Seymour silt loam	2–5	1	SSE	Without	29 (6)	57 (11)	20 (6)	....	28 (8)	....	1.8	....
					With	33 (6)	60 (11)	....	26 (5)	....	40 (11)	....	2.4
370	Sharpsburg silt loam	2–5	1	SSW	Without	49 (9)	68 (13)	23 (5)	....	34 (7)	....	2.4	....
					With	53 (9)	72 (13)	....	28 (6)	....	45 (9)	....	3.0
370	Sharpsburg silt loam	5–9	2	SSW	Without	43 (8)	61 (12)	21 (4)	....	29 (6)	....	2.2	....
					With	48 (8)	66 (12)	....	26 (5)	....	40 (8)	....	2.8
24	Shelby loam	9–14	2	SSE, SGH, SSW, MT	Without	25 (7)	42 (11)	....	....	22 (7)	....	1.0	....
					With	27 (7)	45 (11)	....	....	....	32 (11)	....	1.8
62	Storden loam	9–14	2	CW	Without	15 (10)	40 (8)	....	....	20 (7)	....	1.0	....
					With	18 (10)	45 (8)	....	....	....	35 (11)	....	1.8
279	Taintor silty clay loam	0–1	0	MT		65 (9)	84 (12)	26 (5)	31 (6)	40 (7)	52 (9)	2.8	3.4
120	Tama silt loam	2–5	1	TM	Without	60 (9)	82 (11)	26 (5)	....	38 (11)	....	2.8	....
					With	65 (9)	85 (11)	....	31 (6)	....	55 (11)	....	3.5
120	Tama silt loam	5–9	2	TM	Without	52 (9)	78 (13)	24 (5)	....	36 (11)	....	2.6	....
					With	57 (9)	82 (13)	....	29 (6)	....	50 (10)	....	3.4
172	Wabash silty clay	0–1	0	All		38 (9)	45 (11)	20 (6)	22 (6)	25 (7)	30 (8)	2.2	2.4
108	Waukegan loam, moderately deep	1–2	1	CW, CC, TM		35 (12)	43 (12)	15 (5)	20 (6)	25 (7)	33 (10)	1.5	2.0
107	Webster silty clay loam	0–1	0	CW		53 (9)	76 (14)	22 (4)	29 (5)	40 (8)	55 (10)	2.6	3.2
132	Weller silt loam	2–5	2	WL	Without	24 (6)	40 (10)	12 (3)	....	20 (7)	....	1.0	....
					With	27 (6)	42 (10)	....	16 (4)	....	32 (11)	....	1.8
369	Winterset silty clay loam	0–1	0	SSW		56 (11)	76 (15)	25 (5)	28 (6)	35 (8)	50 (10)	2.6	3.2

[a]This number is used to designate areas of this soil type on soil maps.
[b]This expresses the amount of erosion on the land: 0 = slight or no apparent erosion (over 12 inches of topsoil); 1 = slight to moderate erosion, with little or no subsoil exposed (7 to 12 inches of topsoil); 2 = moderate to severe erosion with 3 to 7 inches of topsoil and includes areas of surface soil mixed with subsoil and some areas of exposed subsoil; 3 = severe erosion including erosion of the subsoil (less than 3 inches of topsoil).
[c]Second-year corn after not more than 1 year of meadow. Little or no fertilizer used.
[d]First-year corn after at least 1 year of meadow. Fertilizer applied in amounts near the optimum for this management level.
[e]Soybeans in a rotation with less than 1 year of meadow in 5 years. Little or no fertilizer used.
[f]Soybeans in a rotation with at least 1 year of meadow in 5 years. Fertilizer applied in amounts near the optimum for this management level.
[g]Oats after 2 years of corn which followed 1 or more years of meadow. Little or no fertilizer used.
[h]Oats after 2 years of corn which followed 1 or more years of meadow. Fertilizer applied in amounts near the optimum for this management level.
[i]First-year hay yields with three cuttings. Crop is alfalfa-brome whenever adapted, otherwise red clover-timothy if yield would be greater. Little or no fertilizer used in rotation.
[j]First-year hay yields with three cuttings. Crop is alfalfa-brome whenever adapted, otherwise red clover-timothy if yields would be greater. Fertilizer applied in amounts near the optimum for this management level.
[k]Numbers in parentheses are indices of average year-to-year variation expressed in bushels.

shown in fig. 1. The estimated effect of conservation practices on yield is indicated for sloping land.

To supply yield information on soil types not included in table 1, Appendix B has been prepared. This provides a general evaluation of the productive capacity of most established soil types in the state. Each soil type is placed in a yield group at only the high level of management.

Discussion of Yield Estimates

The estimates given in table 1 show that average yields vary widely among soil types. Under the high level of management, average corn yields of 90 bushels per acre are obtainable on the Muscatine soils. On Clarinda soils under this same level of management, corn yields are expected to average about 20 bushels per acre. Average yields of 65 to 80 bushels per acre are obtainable on a large group of Iowa soils under a high level of management.

In general, corn yields are estimated to average about 20 bushels per acre greater under the high level as compared with the low level of management. These increases in yields are considered to be obtainable primarily by using proper fertilization, heavier planting rates, proper cultural practices and needed conservation practices. The amounts of fertilizer and the kinds of other practices needed will vary with soil type.

On some soils, yield increases of more than 30 bushels of corn per acre are indicated as resulting from improved management. In other cases only a 5-bushel increase is considered possible. For example, it is believed possible to increase average corn yields on the Ida soils from 16 to 51 bushels per acre by improved management. At the other extreme, it is believed that improved management on the Clarinda soils would probably increase corn yields only from 15 bushels per acre under poor management to 20 bushels per acre under good management for a 5-bushel increase. Ida soils yield lower than the average because they are very low in nitrogen and phosphorous, but when these nutrients are added yields are greatly increased. Clarinda soils have low yields primarily because of fine textures and poor drainage, and there is no economical method now known for correcting this condition.

Oat yields are generally some 20 bushels per acre lower than corn yields. As oats are of lower value per bushel than corn, oats will probably continue in a poor competitive position with corn.

Soybean yields on a bushels-per-acre basis are estimated at about one-third to one-half as high as corn yields. Responses to management are somewhat less for soybeans than for the other crops, but, in general, the soils that produce high corn yields also produce relatively high soybean yields.

SOIL PROPERTIES DESCRIBED

Some of the major soil properties that are considered to be of the most importance in determining yield potentials are listed in table 2. This table is designed to furnish a general understanding of the properties of the soils classified in table 1.

More detailed descriptions of these soils are available in Principal Upland Soils of Iowa,[3] Understanding Iowa Soils[4] or in the soil survey reports of the various counties.

Further information concerning properties of the soils is furnished in table 3 which presents the average soil tests of the different soils.

FERTILIZER LEVELS AND SOIL TESTS

Crop yields at the low-management level shown in table 1 are assumed to be possible with the use of little or no fertilizer. No accurate estimates of soil fertility for each soil type are available for this fertility level. Table 3, however, includes the average soil tests based largely on summaries of over 300,000 soil samples tested by the Iowa State University Soil Testing Laboratory.[5] The average soil test, as shown, is probably slightly higher than that assumed for the low-fertility level on most soils, but it is the best available indicator of the present fertility status of the soils. The average soil tests furnish a base from which general fertilizer recommendations can be made, but the recommendations apply only to the specific soil tests that are shown in table 3. Recommendations for a particular field should be based on soil tests from that field.

FERTILIZER NUTRIENTS REQUIRED AT THE HIGH YIELD LEVEL

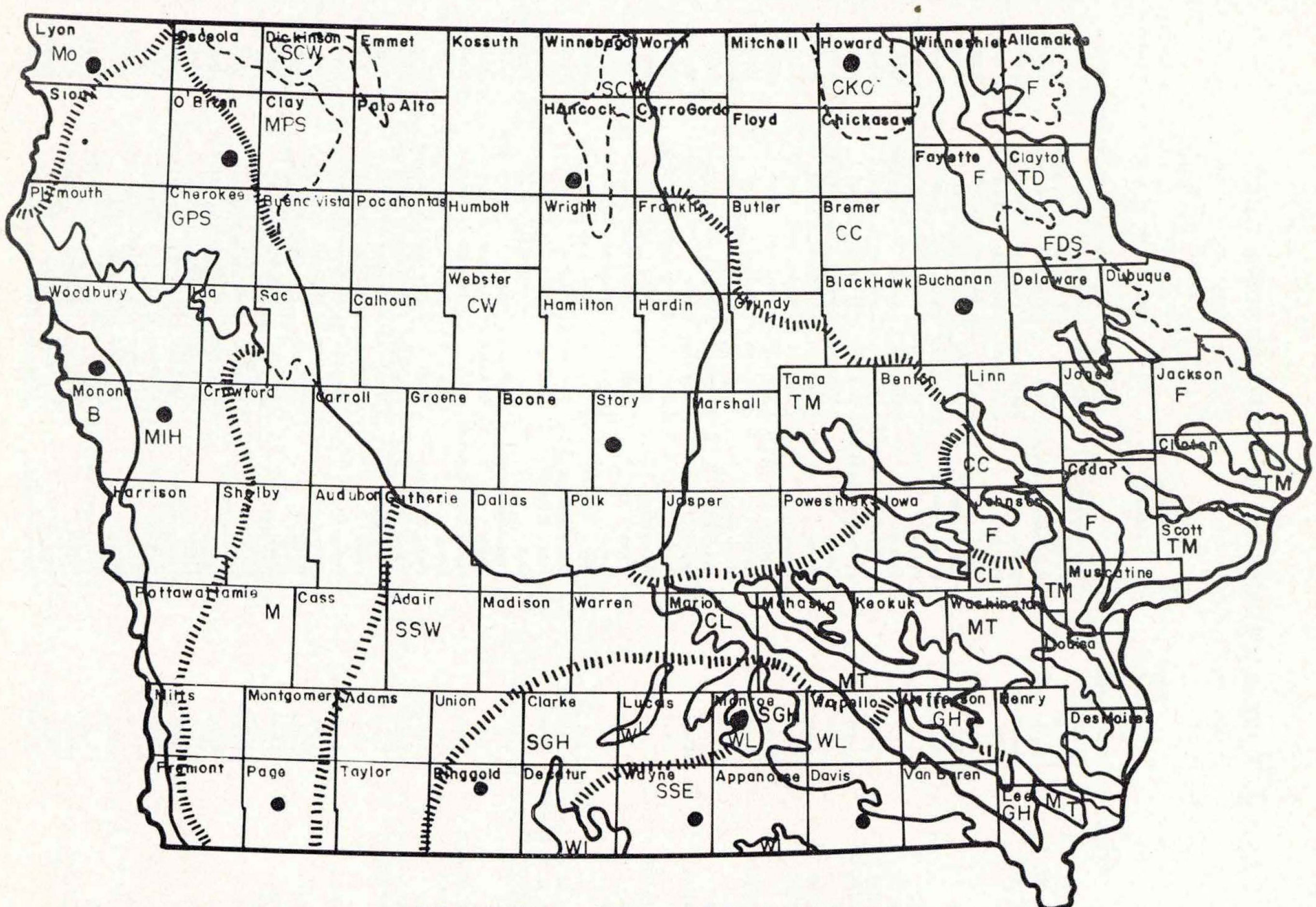
The fertilizer nutrient rates specified for the high yield level in table 3 are the rates that are believed to be needed annually to raise the fertility of the soil from the level specified in the average soil test to a level sufficiently high to produce the yields listed under the higher management level.

An important consideration in the fertilizer nutrient requirements is that the amounts of N, P_2O_5 and K_2O listed in table 3 are those additional quantities believed to be needed by that crop on that particular soil for 1 year. These quantities may come from commercial fertilizer, green manure, barnyard manure, meadow crops or residual carryover of previously applied fertilizers or manures. Excellent meadows should be credited with 60 to 90 pounds of N per acre, and green-manure catch crops and average meadows with about half that much. A ton of manure may be considered to provide about 10 pounds of N, 5 pounds P_2O_5 and 10 pounds of K_2O. Nitrogen carryover from previously applied quantities in

[3]Riecken, F. F. and Smith, G. D. Principal upland soils of Iowa. Agron. 49 Iowa State University, 1949 (mimeo).

[4]Simonson, R. W., Riecken, F. F. and Smith, G. D. Understanding Iowa soils. Wm. C. Brown, Dubuque, Iowa. 1952.

[5]Agron. 350. (Mimeo.) 1956. The authors wish to acknowledge the help of Dr. J. J. Hanway, Iowa State University Soil Testing Laboratory, in making the estimates for the individual soil series.



PRINCIPAL SOIL ASSOCIATIONS

CC: Carrington and Clyde
CKC: Cresco-Kasson-Clyde
CL: Clinton and Lindley
CW: Clarion and Webster
F: Fayette
FDS: Fayette, Dubuque, and Stony Land
GH: Grundy and Haig
GPS: Galva, Primghar, and Sac
M: Marshall
MIH: Monona, Ida, and Hamburg
B: Soils of Bottomlands

Mo: Moody
MPS: Marcus, Primghar, and Sac
MT: Mahaska and Taintor
SCW: Storden, Clarion, and Webster
SGH: Shelby, Grundy, and Haig
SSE: Shelby, Seymour, and Edina
SSW: Shelby, Sharpsburg, and Winterset
TD: Tama and Downs
TM: Tama and Muscatine
WL: Weller and Lindley

● Experimental Farms and Fields

— Abrupt Boundary
--- Tentative Boundary
IIII Gradational Boundary

Fig. 1. The principal soil association areas in Iowa and locations of experimental farms and fields from which soil management and some fertilization data were collected.

TABLE 2. SOME BASIC PROPERTIES AND SITE CHARACTERISTICS OF SELECTED IOWA SOILS.

Mapping unit No.[a]	Soil type	Slope phase (%)	Erosion phase[b]	Soil Association area	Parent material[c]	Natural vegetation	Organic matter level[d]	Subsoil permeability	Natural internal aeration	Erosion hazard	Subsoil group[e]
192	Adair (Lagonda) silt loam	5–9	2	SSE, SGH, SSW	Weathered till	Prairie	Mod. low	Very slow	Fair to imperfect	Severe	3
156	Albaton silty clay	0–1	0	B	Alluvium	Prairie or forest	Mod. low	Very slow	Poor	None	...
260	Beckwith (Marion) silt loam	0–1	1	WL	Loess	Forest	Low	Very slow	Very poor	None	3
130	Belinda silt loam	0–1	0	SSE, WL	Loess	Prairie-forest transition	Low	Very slow	Very poor	None	3
222	Clarinda silty clay loam	5–9	2	SGH, SSW	Gumbotel	Prairie	Moderate	Very slow	Poor	Severe	3
138	Clarion loam	2–5	1	CW	T-1	Prairie	Moderate	Moderate	Good	Moderate	1
80	Clinton silt loam	5–9	2	CL	Loess	Forest	Low	Mod. slow	Good	Severe	2
84	Clyde silty clay loam	1–2	0	CC	T-2	Marsh grass	Very high	Mod. slow	Poor	None	...
133	Colo silty clay loam	0–1	0	All	Alluvium	Prairie or forest	Mod. high	Mod. slow	Poor	None	...
783	Cresco loam	2–5	1	CKC	T-2	Prairie	Moderate	Slow	Fair to poor	Moderate	2
175	Dickinson fine sandy loam	2–5	1	CW, CC	Sand	Prairie	Mod. low	Rapid	Very good	Moderate	1
162	Downs silt loam	2–5	1	F, FDS, TD	Loess	Prairie-forest transition	Mod. low	Moderate	Good	Moderate	1
162	Downs silt loam	5–9	2	F, FDS, TD	Loess	Prairie-forest transition	Mod. low	Moderate	Good	Severe	1
211	Edina silt loam	0–1	0	SSE	Loess	Prairie	Mod. low	Very slow	Very poor	None	3
163	Fayette silt loam	2–5	1	F, FDS	Loess	Forest	Mod. low	Moderate	Good	Moderate	1
163	Fayette silt loam	5–9	2	F, FDS	Loess	Forest	Low	Moderate	Good	Severe	1
198	Floyd loam	1–3	0	CC	T-2	Prairie	Mod. high	Mod. slow	Fair to poor	Slight	2
310	Galva silt loam	2–5	1	GPS, MPS	Loess	Prairie	Moderate	Moderate	Good	Moderate	1
118	Garwin silty clay loam	0–1	0	TM	Loess	Marsh grass	High	Moderate	Poor	None	...
6	Glencoe silty clay loam	0	0	CW	T-1	Marsh grass	Very high	Slow	Very poor	None	...
364	Grundy silt loam	2–5	1	SGH, GH	Loess	Prairie	Mod. high	Slow	Imperfect	Moderate	2
41	Hagener (Thurman) sand and loamy sand	2–5	1	All	Sand	Prairie	Low	Very rapid	Very good	Moderate	1
362	Haig silt loam	0–1	0	SGH, GH	Loess	Marsh grass	High	Slow	Poor	None	3
95	Harpster loam	0–1	0	CW	T-1	Prairie	High	Moderate	Poor	None	2
168	Hayden loam	5–9	2	CW	T-1	Forest	Low	Moderate	Good	Severe	2
38	Haynie fine sandy loam	0–1	0	B	Alluvium	Prairie or forest	Mod. low	Mod. rapid	Good	None	...
137	Haynie silt loam	0–1	0	B	Alluvium	Prairie or forest	Mod. low	Moderate	Good	None	...
269	Humeston silt loam	0–1	0	SSE, SGH, WL, SSW	Alluvium	Prairie or forest	Mod. low	Slow	Poor	None	2
1	Ida silt loam	9–14	3	MIH	Loess	Prairie	Low	Mod. rapid	Good	Very severe	1
781	Kasson loam	2–5	1	CKC	T-2	Prairie-forest transition	Moderate	Slow	Fair to poor	Moderate	2
83	Kenyon (Carrington) loam	2–5	1	CC	T-2	Prairie	Moderate	Moderate	Fair	Moderate	2
76	Ladoga silt loam	2–5	1	MT, CL, SSW	Loess	Prairie-forest transition	Low	Moderate	Good	Moderate	2
65	Lindley loam	9–14	3	CL, WL	T-3	Forest	Low	Slow	Fair to good	Very severe	2
66	Luton silty clay and clay	0–1	0	B	Alluvium	Prairie or forest	High	Very slow	Very poor	None	...
280	Mahaska silt loam	1–3	0	MT	Loess	Prairie	Mod. high	Mod. slow	Imperfect	Slight	2
92	Marcus silty clay loam	0–1	0	GPS, MPS	Loess	Marsh grass	High	Moderate	Poor	None	...
9	Marshall silt loam	2–5	1	M	Loess	Prairie	Moderate	Moderate	Good	Moderate	1
9	Marshall silt loam	5–9	2	M	Loess	Prairie	Mod. low	Moderate	Good	Severe	1
9	Marshall silt loam	9–14	2	M	Loess	Prairie	Mod. low	Moderate	Good	Very severe	1
10	Monona silt loam	2–5	1	MIH	Loess	Prairie	Moderate	Mod. rapid	Good	Moderate	1
10	Monona silt loam	5–9	2	MIH	Loess	Prairie	Mod. low	Mod. rapid	Good	Severe	1
10	Monona silt loam	9–14	3	MIH	Loess	Prairie	Mod. low	Mod. rapid	Good	Very severe	1
410	Moody silt loam	2–5	1	MO	Loess	Prairie	Moderate	Moderate	Good	Moderate	1
119	Muscatine silt loam	1–3	0	TM	Loess	Prairie	Mod. high	Moderate	Imperfect	Slight	1
55	Nicollet loam	1–3	0	CW	T-1	Prairie	Mod. high	Moderate	Fair	Slight	1
220	Nodaway silt loam	0–1	0	All	Alluvium	Prairie or forest	Mod. low	Moderate	Fair to imperfect	None	...
144	Onawa silty clay loam	0–1	0	B	Alluvium	Prairie or forest	Moderate	Rapid	Good	None	2
281	Otley silt loam	2–5	1	TM	Loess	Prairie	Moderate	Mod. slow	Fair	Moderate	2
281	Otley silt loam	5–9	2	TM	Loess	Prairie	Mod. low	Mod. slow	Fair	Severe	2
131	Pershing silt loam	2–5	2	WL	Loess	Prairie-forest transition	Low	Slow	Imperfect	Severe	2
91	Primghar silt loam	1–3	0	MPS, GPS	Loess	Prairie	Mod. high	Moderate	Imperfect	Slight	1
77	Sac silt loam	2–5	1	MPS, GPS	Shallow loess over T-2	Prairie	Moderate	Moderate	Good	Moderate	1
46	Salix silt loam	0–1	0	B	Alluvium	Prairie or forest	Moderate	Mod. rapid	Good	None	...

237	Sarpy loamy sand and sand	0–1	0	B	Alluvium	Prairie or forest	Low	Rapid	Good	None	...
312	Seymour silt loam	2–5	1	SSE	Loess	Prairie	Moderate	Very slow	Imperfect	Severe	3
370	Sharpsburg silt loam	2–5	1	SSW	Loess	Prairie	Moderate	Mod. slow	Fair	Moderate	2
370	Sharpsburg silt loam	5–9	2	SSW	Loess	Prairie	Moderate	Mod. slow	Fair	Severe	2
24	Shelby loam	9–14	2	SSE, SGH, SSW, MT	T-3	Prairie	Mod. low	Mod. slow	Fair to good	Very severe	2
62	Storden loam	9–14	2	CW	T-1	Prairie	Low	Moderate	Good	Severe	1
279	Taintor silty clay loam	0–1	0	MT	Loess	Marsh grass	High	Mod. slow	Poor	None	...
120	Tama silt loam	2–5	1	TM	Loess	Prairie	Moderate	Moderate	Good	Moderate	1
120	Tama silt loam	5–9	2	TM	Loess	Prairie	Mod. low	Moderate	Good	Severe	1
172	Wabash silty clay	0–1	0	All	Alluvium	Prairie or forest	High	Very slow	Poor	None	...
108	Waukegan loam, moderately deep	1–2	1	CW, CC, TM	Outwash	Prairie	Mod. low	Very rapid	Very good	Slight	2
107	Webster silty clay loam	0–1	0	CW	T-1	Marsh grass	Very high	Moderate	Poor	None	...
132	Weller silt loam	2–5	2	WL	Loess	Forest	Low	Slow	Imperfect	Severe	3
369	Winterset silty clay loam	0–1	0	SSW	Loess	Marsh grass	High	Mod. slow	Poor	None	...

[a]This number is used to designate areas of this soil type on soil maps.

[b]This expresses the amount of erosion on the land: 0 = slight or no apparent erosion, over 12 inches of topsoil remaining; 1 = slight to moderate erosion with little or no subsoil exposed, 7 to 12 inches of topsoil remaining; 2 = moderate to severe erosion with 3 to 7 inches of topsoil remaining and includes areas of surface soil mixed with subsoil and areas of exposed subsoil; 3 = severe erosion including erosion of the subsoil, less than 3 inches of topsoil remaining.

[c]Parent material: T–1 = glacial till of late Wisconsin age.
T–2 = glacial till of Iowan age.
T–3 = glacial till of Kansan and Nebraskan age.

[d]Organic matter level: Low = less than 1% organic matter; Mod. low = 1 - 2% organic matter; Moderate = 2 - 3% organic matter; Moderate high = 3 - 4% organic matter; High = 4 - 5% organic matter; Very high = over 5% organic matter.

[e]Subsoil group: 1 = subsoil texture about same as surface soil texture. Not more than about 34 percent clay. Subsoils favorable for crop growth.
2 = subsoils moderately unfavorable for crop growth because of slow permeability or high plasticity.
3 = subsoils very unfavorable for crop growth. Silty clay and clay textures. Very slow permeability and very high plasticity.

TABLE 3. AVERAGE SOIL TESTS AND ADDITIONAL FERTILIZER NUTRIENTS REQUIRED AT THE HIGH MANAGEMENT LEVEL.

Mapping unit No.[a]	Soil type	Slope phase (%)	Erosion phase[b]	Soil Association area	Average soil test[c]			Fertilizer nutrients (pounds per acre)[d] Corn			Soybeans			Oats			Hay		
					N	P	K	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O	N	P_2O_5	K_2O
192	Adair (Lagonda) silt loam	5–9	2	SSE, SGH, SSW	VL+	VL+	M—	110	45	0	...	...	...	35	35	0	0	10	0
156	Albaton silty clay	0–1	0	B	L+	M	H+	65	10	0	0	0	0	25	0	0	0	10	0
260	Beckwith (Marion) silt loam	0–1	1	WL	VL+	L—	M—	110	35	30	0	30	0	35	35	0	0	20	10
130	Belinda silt loam	0–1	0	SSE, WL	L—	L	M—	95	30	25	0	20	0	35	30	0	0	10	10
222	Clarinda silty clay loam	5–9	2	SGH, SSW	L—	VL+	M—	95	45	0	...	...	...	35	35	0	0	10	0
138	Clarion loam	2–5	1	CW	L—	L—	M	95	60	20	0	30	0	35	35	0	0	25	20
80	Clinton silt loam	5–9	2	CL	L	L	M—	80	25	20	0	20	0	30	30	0	0	10	10
84	Clyde silty clay loam	1–2	0	CC	M—	L+	L—	55	45	60	0	10	30	25	25	10	0	15	45
133	Colo silty clay loam	0–1	0	All	M	M	H+	45	20	0	0	0	0	20	20	0	0	10	0
783	Cresco loam	2–5	1	CKC	L	L—	L	80	60	50	0	30	20	30	35	0	0	25	45
175	Dickinson fine sandy loam	2–5	1	CW, CC	VL+	VL+	VL	110	65	75	0	40	50	35	35	30	0	25	45
162	Downs silt loam	2–5	1	F, FDS, TD	L+	L	M+	65	30	10	0	20	0	25	30	0	0	10	0
162	Downs silt loam	5–9	2	F, FDS, TD	L	L	M	80	30	15	0	20	0	30	30	0	0	10	0
211	Edina silt loam	0–1	0	SSE	L	L	M—	80	30	20	0	20	0	30	30	0	0	10	10
163	Fayette silt loam	2–5	1	F, FDS	L—	L+	M+	95	25	10	0	10	0	35	25	0	0	10	0
163	Fayette silt loam	5–9	2	F, FDS	VL+	L+	M	110	25	15	0	10	0	35	25	0	0	10	0
198	Floyd loam	1–3	0	CC	M—	L	L	55	55	50	0	20	20	25	30	0	0	20	45
310	Galva silt loam	2–5	1	GPS, MPS	L	L	H	80	55	0	0	20	0	30	30	0	0	20	0
118	Garwin silty clay loam	0–1	0	TM	M	M—	M	45	20	15	0	0	0	20	15	0	0	10	0
6	Glencoe silty clay loam	0	0	CW	M	L—	M	50	60	45	0	30	0	20	35	0	0	25	35
364	Grundy silt loam	2–5	1	SGH, GH	L+	L+	M+	65	25	10	0	10	0	25	25	0	0	10	0
41	Hagener (Thurman) sand and loamy sand	2–5	1	All	VL+	VL+	VL	110	65	75	0	40	50	35	35	30	0	25	45
362	Haig silt loam	0–1	0	SGH, GH	M—	L+	M	55	25	15	0	10	0	25	25	0	0	10	0
95	Harpster loam	0–1	0	CW	M—	VL+	L	55	75	70	0	40	20	25	25	0	0	50	45
168	Hayden loam	5–9	2	CW	VL+	L—	L+	110	60	40	0	30	10	35	35	0	0	25	30
38	Haynie fine sandy loam	0–1	0	B	L+	M	H+	65	30	0	0	0	0	25	0	0	0	15	0
137	Haynie silt loam	0–1	0	B	L+	H	H+	65	0	0	0	0	0	25	0	0	0	0	0
269	Humeston silt loam	0–1	0	SSE, SGH, WL, SSW	L+	H	H+	65	0	0	0	0	0	25	0	0	0	0	0
1	Ida silt loam	9–14	3	MIH	VL+	VL	H—	110	85	0	...	...	...	35	40	0	0	60	0
781	Kasson loam	2–5	1	CKC	L—	L	VL+	95	55	65	0	20	40	35	30	20	0	20	45
83	Kenyon (Carrington) loam	2–5	1	CC	L+	L	L+	65	55	40	0	20	10	25	30	0	0	20	30
76	Ladoga silt loam	2–5	1	MT, CL, SSW	L	L+	H	80	25	0	0	10	0	30	25	0	0	10	0
65	Lindley loam	9–14	3	CL, WL	VL	VL+	M—	130	65	50	...	...	...	40	35	0	0	25	10
66	Luton silty clay and clay	0–1	0	B	L+	M	H—	65	10	0	0	0	0	25	0	0	0	10	0
280	Mahaska silt loam	1–3	0	MT	M—	L—	M	55	35	15	0	30	0	25	35	0	0	10	0
92	Marcus silty clay loam	0–1	0	GPS, MPS	L+	L	H	65	55	0	0	20	0	25	30	0	0	20	0
9	Marshall silt loam	2–5	1	M	L+	M	H	65	10	0	0	0	0	25	0	0	0	10	0
9	Marshall silt loam	5–9	2	M	L	L+	H	80	25	0	0	10	0	30	25	0	0	10	0
9	Marshall silt loam	9–14	2	M	L—	L	H	95	30	0	...	...	...	35	30	0	0	10	0
10	Monona silt loam	2–5	1	MIH	L+	M—	H	65	20	0	0	0	0	25	15	0	0	10	0
10	Monona silt loam	5–9	2	MIH	L	L+	H	80	25	0	0	10	0	30	25	0	0	10	0
10	Monona silt loam	9–14	3	MIH	L—	L	H	95	30	0	...	...	...	35	30	0	0	10	0
410	Moody silt loam	2–5	1	MO	L—	L—	H	95	60	0	0	30	0	35	35	0	0	25	0
119	Muscatine silt loam	1–3	0	TM	M	M—	M	45	20	15	0	0	0	20	15	0	0	10	0
55	Nicollet loam	1–3	0	CW	L+	L—	M	65	60	20	0	30	0	25	35	0	0	25	20
220	Nodaway silt loam	0–1	0	All	L	M—	H—	80	20	0	0	0	0	30	15	0	0	10	0
144	Onawa silty clay loam	0–1	0	B	L+	M	H+	65	10	0	0	0	0	25	0	0	0	10	0
281	Otley silt loam	2–5	1	TM	L+	L—	M—	65	35	20	0	30	0	25	35	0	0	10	10
281	Otley silt loam	5–9	2	TM	L—	L—	M—	95	35	20	0	30	0	35	35	0	0	10	10
131	Pershing silt loam	2–5	2	WL	L—	L—	M—	95	35	25	0	30	0	35	35	0	0	15	10
91	Primghar silt loam	1–3	0	MPS, GPS	L	L+	H	80	45	0	0	10	0	30	25	0	0	15	0

77	Sac silt loam	2–5	1	MPS, GPS	L–	L	H	95	55	0	0	20	0	35	30	0	0	20	0
46	Salix silt loam	0–1	0	B	M	H	H	0	0	0	0	0	0	20	0	0	0	0	0
237	Sarpy loamy sand and sand	0–1	0	B	L–	L	M	95	65	0	0	20	0	35	30	0	0	40	0
312	Seymour silt loam	2–5	1	SSE	L	L	M+	80	30	10	0	20	0	30	30	0	0	10	0
370	Sharpsburg silt loam	2–5	1	SSW	L	M–	H–	80	20	0	0	0	0	30	30	0	0	10	0
370	Sharpsburg silt loam	5–9	2	SSW	L–	L+	H–	95	25	0	0	10	0	35	35	0	0	10	0
24	Shelby loam	9–14	2	SSE, SGH, SSW, MT	VL+	VL+	L+	110	45	45	......	......	......	35	35	0	0	25	25
62	Storden loam	9–14	2	CW	VL+	VL+	M–	110	75	45	......	......	......	35	35	0	0	50	25
279	Taintor silty clay loam	0–1	0	MT	M	L+	M	45	25	15	0	10	0	20	25	0	0	10	0
120	Tama silt loam	2–5	1	TM	M–	L	M	55	30	15	0	20	0	25	30	0	0	10	0
120	Tama silt loam	5–9	2	TM	L+	L	M	65	30	15	0	20	0	25	30	0	0	10	0
172	Wabash silty clay	0–1	0	All	L+	M	H+	65	10	0	0	0	0	25	0	0	0	10	0
108	Waukegan loam, moderately deep	1–2	1	CW, CC, TM	L	L	L–	80	55	60	0	20	30	30	30	10	0	20	45
107	Webster silty clay loam	0–1	0	CW	M–	L–	M	55	60	20	0	30	0	25	35	0	0	25	20
132	Weller silt loam	2–5	2	WL	L–	L	M	95	30	20	0	20	0	35	30	0	0	15	0
369	Winterset silty clay loam	0–1	0	SSW	L+	M	H–	65	10	0	0	0	0	25	25	0	0	10	0

[a]This number is used to designate areas of this soil type on soil maps.

[b]This expresses the amount of erosion on the land: 0 = slight or no apparent erosion, over 12 inches of topsoil remaining; 1 = slight to moderate erosion with little or no subsoil exposed, 7 to 12 inches of topsoil remaining; 2 = moderate to severe erosion with 3 to 7 inches of topsoil remaining and includes areas of surface soil mixed with subsoil and areas of exposed subsoil; 3 = severe erosion including erosion of the subsoil, less than 3 inches of topsoil remaining.

[c]VL, L, M and H refer to very low, low, medium and high soil test levels, respectively, as determined by the Iowa State University Soil Testing Laboratory and are based on a summary of over 300,000 farmers' soil samples tested (Agron. 350, Mimeo., 1956). The symbols + and – refer to levels within the ranges VL, L, M and H.

[d]The fertilizer nutrient rates recommended are those which are considered optimum for the assumed high level of management. These quantities are those needed in addition to those quantities supplied by the soil at the indicated soil test level and may come from barnyard manure, legume meadow, green manure, commercial fertilizer or residual of previously applied manure or fertilizer.

excess of 40 pounds of N per acre varies from 20 to 33 percent depending on the season, while P_2O_5 carryover ranges from 40 to 60 percent. The carryover of K_2O applied to grain crops when straw or stover are not removed may be as high as 60 to 90 percent, but carryover from nominal rates applied to hay crops is insignificant if the hay is taken from the field. This also is true of grain crops if stover or straw is removed.

Recommendations for hay are those in addition to fertilizer needed for the oats companion crop. Often it is more practical to apply enough P_2O_5 and K_2O to the oats and legume seeding to carry the first hay year. On some soils, such as Ida silt loam and even Harpster silty clay, it is not possible to achieve desired results without fertilizing the oats-legume seeding. On some other soils, good stands may be obtained without fertilizing the companion crop and legume seeding.

In almost all cases, part of the fertilizer recommended for corn should be applied in the hill or row at time of planting with the fertilizer attachment on the corn planter. This is also true for soybeans. The balance of the P_2O_5 and K_2O application should be plowed under or placed at plow depth in bands. Additional N may be plowed under, disked under after broadcasting or side-dressed.

Sources of Yield Information and Their Relative Suitability

All available sources of yield information were fully utilized in preparing the yield estimates for this report, including data from the federal census, Iowa farm census, Iowa Farm Business Associations' records, experimental farms, cooperative experiments with farmers and from on-farm experience by extension workers, soil surveyors and others.

Yield information from the Bureau of the Census and the annual Iowa Farm Census records was of primary importance in establishing relative yields among the different major soil areas of the state. It was also of value in setting some benchmarks of average yields and in studying yearly fluctuations in yield. Information taken from the Iowa Farm Census is summarized in figs. 2, 3 and 4. Estimates of the reliability of these data are not available, but they are believed sufficiently reliable for the purposes outlined.

Data from the Iowa Farm Business Associations' records are too limited in number to be of great value. They served primarily as "spot checks" or case studies of yields under known farm conditions.

Yield records from the experimental farms in Iowa are the most valuable sources of yield information on a soil-type basis. The length of record for these farms varies, but continuous records are available for over 40 years on one site, over 10 years at two sites and for over 5 years at eight additional sites. The location of the experimental farms is shown in conjunction with the soil association areas in fig. 1. Since each farm was

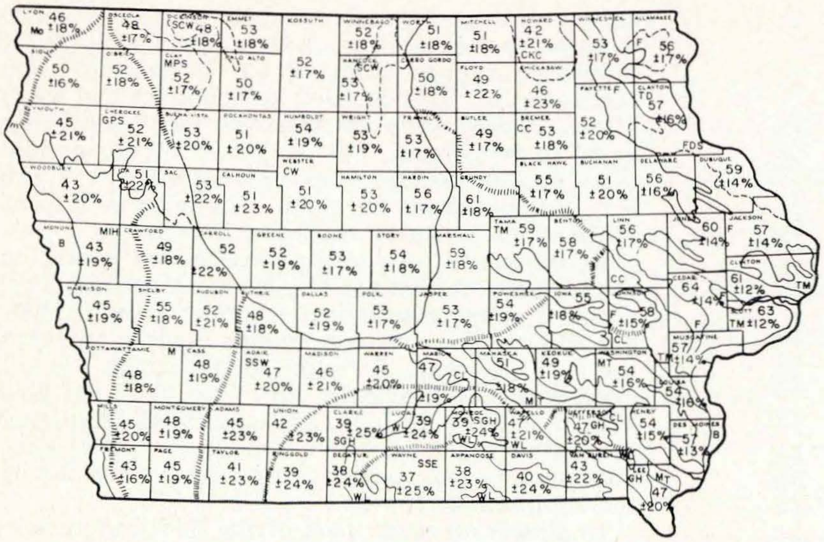


Fig. 2. Mean corn yields by counties for the period 1940 to 1956 and the coefficient of variation of county yields as a percentage of the mean.

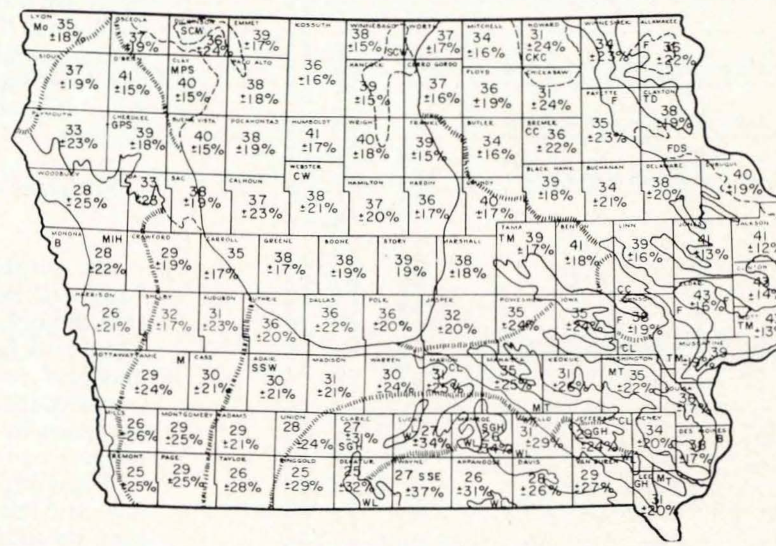


Fig. 3. Mean oat yields by counties for the period 1940 to 1956 and the coefficient of variation of county yields as a percentage of the mean.

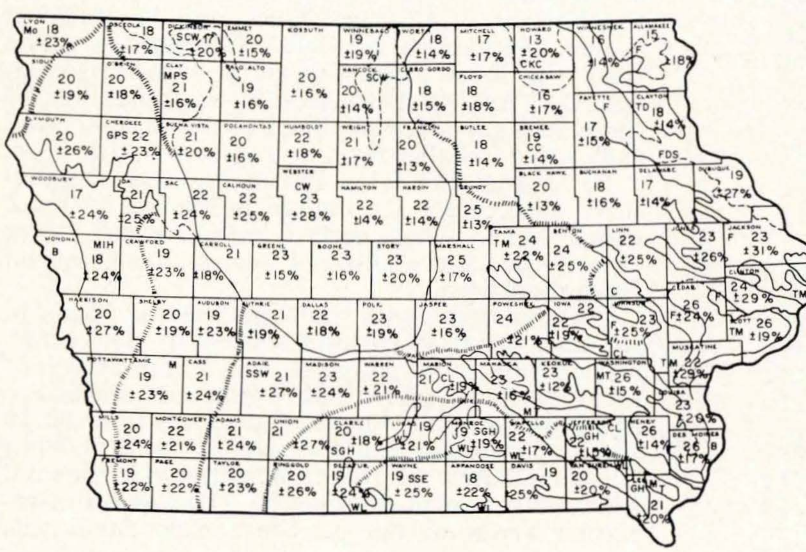


Fig. 4. Mean soybean yields by counties for the period 1940 to 1956 and the coefficient of variation of county yields as a percentage of the mean.

originally selected to represent an important soil type or types, the yield information obtained from research studies is very useful in preparing yield estimates such as are presented in table 1.

Yields obtained on experimental plots are commonly somewhat higher than yields obtained by farmers. This is mainly because experimental plots are hand picked and gleaned. Consequently, adjustments usually are necessary when making estimates based on small plot yields. Yield estimates in table 1 are at least 10 to 15 percent lower than those found in experimental farm reports mostly because of harvesting losses that commonly occur with field equipment.

The farmer cooperative field trials with fertilizers are a valuable supplement to the experimental farm data. They often include a wider range of fertility levels for some of the same soil types found on the experimental farms, as well as for soil types not found on the experimental farms. Such trials, however, usually are of short duration, and some adjustments are often needed to arrive at long-time-average yields.

On-farm experience of various technicians helps greatly to evaluate and interpret the yield data available from the different sources. The observations of soil surveyors furnish valuable clues as to the relative yield potential of different soils and the suitability of various soils for different crops.

It should be apparent that information on *relative* yields among soil association areas, soil types and management practices is more reliable than is information on *absolute* yields.

Uses and Limitations of the Yield Estimates

The yield estimates presented in table 1 are designed to serve as guides in making yield predictions. They are approximate values only and should be so considered. Numerous factors may cause the estimates to be either too high or too low for a given field or farm.

The estimates are based primarily on a projection of yield records and experience from about 1940 to 1957. There is evidence that yields have increased gradually with time. A study by Thompson, Johnson, Pesek and Shaw[6] indicates that average corn yields in the United States for the period 1940 through 1958 have increased about 1 bushel per acre per year. This upward trend was not projected in preparing the estimates.

The estimates in table 1 are the predicted average yields for a period of 10 or more years under average weather conditions. They are averages for the entire area occupied by the designated soil type. On some fields or farms managed by exceptionally able farmers, the long-time average yields may exceed the estimated yields by at least 10 percent. For example, there are records available that show long-time average corn yields of about 100 bushels per acre on a few outstanding farms in the Muscatine soil area. The 90-bushel yield estimated in this report for the Muscatine soil is believed to be as high as can be expected as an average over the entire soil type area.

Yield differences of only a few bushels are indicated among some soil types. These small differences show mainly that there are reasons to believe that one soil may be slightly less productive than another, even though the difference may be less than the probable error range for either estimate.

Most of the major soil types in Iowa are listed in table 1, but this list represents only about 25 percent of all soil types recognized in the state. Yield information for many of these other soil types is too meager to justify attempting detailed yield predictions such as are given in table 1. A generalized grouping of probable yields for most soil types in Iowa has been developed, however, and is presented in Appendix B. This grouping indicates in a general way the relative productivity of all soils under one system of management.

[6]Thompson, Louis M., Johnson, Iver J., Pesek, John T., Jr. and Shaw, Robert H. Some causes of recent high yields of feed grains. In, Proceedings of the feed-livestock workshop, Feb. 16-18, 1959. Iowa State University, College of Agriculture, 1959.

Section 2.

ADJUSTING YIELD ESTIMATES TO FIT DIFFERENT SOIL AND MANAGEMENT SITUATIONS

The yield estimates presented in table 1 and in Appendix B are based on rather specific soil conditions and management assumptions. Nevertheless, these yields can serve as benchmarks for predicting average yields for many other situations common to Iowa farms. To do this, it is necessary to evaluate, as specifically as possible, the yield effect or contribution of the many individual factors composing the whole. With this information at hand, the benchmark yields can be adjusted in accordance with deviations from the conditions assumed for estimating the benchmark yields in table 1 and in Appendix B.

Most of the important factors influencing yields are discussed in Appendix B. Specific information will be provided wherever possible to aid in adjusting the yield estimates presented in Section 1 to different conditions of soil, climate and management.

Effect of Geographic Location on Soil Type Yields

In general, there is no need to correct the average yield estimates in table 1 because of variations in climate, geographical location or soil profile properties within a soil type. Where an individual soil type covers a large geographic area, however, some yield variation within the type may be expected. Such a variation exists in Iowa on the soils of the Clarion-Webster soil association area which extends from Des Moines to the Minnesota state line. A study made in this area some years ago[7] indicates that average corn yields on comparable soils decrease about 1 bushel per acre for every 15 miles north from the southern limit of their occurrence. The estimates for the Clarion-Webster soils in the yield table (table 1) are for the latitude in the vicinity of Fort Dodge.

Fayette, Tama and Downs soils of eastern Iowa also extend for a great enough distance north and south so that some yield differences resulting from geographical location and climate should be expected. The yields in table 1 are for the approximate center of this large soil area. The same correction for latitude as suggested for the Clarion-Webster soils can be used on the Fayette, Tama or Downs soils.

In addition to the north-to-south changes in yields observed in the state, there are east-to-west changes as well. These changes, which are thought to be the result of diminishing annual rainfall as one moves west in Iowa, amount to an average decrease of about 1 bushel per acre for every 25 miles as one moves from east to west. This should apply within soil association areas, but not between areas.

The change from one soil-type area to another often is not a sharp line but is a gradual change. This area of change is called a transition zone. Where the transition zone between different soil types is less than a few hundred feet in width, there usually is no advantage to be gained by attempting to adjust a yield estimate to fit the transition, rather than the modal, soil type. Where the transition zones extend over several miles, however, some adjustment in the yield estimates may be desirable.

The largest group of soils where soil properties change slowly over many miles is found in southwestern and southern Iowa. Here, wide belts of soils derived from loess are found. Their properties change slowly from west to east. The Monona, Marshall, Sharpsburg, Grundy and Seymour soils found in this area are all members of the same sequence, and each type grades into the next over several miles. The yield estimates for these soils shown in table 1 are for the modal, or middle of the range, conditions—roughly for the conditions which occur near the center of the particular soil area. In estimating yields at a particular site, its location with reference to the location of the mode can be determined and an appropriate correction made.

[7]In an unpublished study made in 1949 by A. R. Aandahl, then Research Associate, Iowa State University, now Regional Soil Correlator, ARS, Lincoln, Nebr., the following regressions were obtained: The regression for corn is $Y = 58.7 - 0.4042X$, and the regression for soybeans is $Y = 23 - 0.211X$; where Y is the yield and X is the township tier.

Effect of Slope on Yields

Differences in slope frequently result in yield differences within any one soil type, primarily through the effect of slope on past and current erosion, on the amount of water that infiltrates into the soil and on the ease and efficiency of machine operations.

Soil erosion by water is directly related to the percentage and length of slope. Erosion rates on comparable slopes differ greatly, depending on soil type and plant cover. Most Iowa soils are subject to some erosion when slopes greater than 2 to 3 percent are used for row crops. Erosion losses are frequently excessive when slopes steeper than 6 to 8 percent are cultivated without the use of special erosion-control practices.

Loss of crop stands through sheet erosion, rilling and siltation are more severe on steep than on gentle slopes. Long slopes also are much more likely to be damaged in this way than are short slopes. No estimates as to the extent of yield reduction from these erosion effects are available, and only the direction of possible adjustment can be estimated.

The rate at which water infiltrates a soil is not greatly influenced by slope itself but is affected by the depth of topsoil. Removal of topsoil by erosion usually reduces water infiltration. The amount of reduction varies considerably among different soil types. There is no reliable data for evaluating this factor.

Most modern machinery is best adapted to level or gently sloping areas. Uniform slopes up to 8 to 10 percent and without gullies usually present no serious problem. As slopes become steeper and more irregular, machinery problems increase rapidly. Machinery operation problems on steep land are more severe for row crops than for small grain or meadow crops. Yield reductions frequently occur as a result of inadequate land preparation, poor initial stands, loss of stand during cultivation and harvesting difficulties.

Most of the steeper slopes in Iowa that are used for cropland are in the Monona-Ida soil area in the western part of the state and in the Fayette area of northeastern Iowa. These soils can be terraced, thus lessening reductions in yield from problems of machine operation. This assumes that terrace backslopes are not farmed on slopes steeper than about 12 percent.

Effect of Surface Soil Thickness on Yields

Thickness of the original, dark-colored surface horizon varies considerably in Iowa. Some soils originally had thick, dark-colored surface horizons, while, in others, the surface horizon was never more than a few inches in depth. On nearly all of the sloping land, erosion has removed a part or all of the original dark-colored surface soil.

Nearly all nitrogen originally present in most soils was in the surface layer. Thus, when the surface soil is removed and no additional nitrogen added, crop yields are reduced. Furthermore, as surface soil is lost, yields and crop response to treatment become closely associated with texture, permeability and consistence of the subsoil. As an indication of the amount of damage associated with loss of topsoil, the subsoils have been classified into three groups based on texture, consistence and permeability. The subsoil groups for soils that are subject to erosion are given in table 2 and are described as follows:

Subsoil Group 1 includes those soils with subsoils only a little finer textured than the surface soils. In no case is the subsoil finer textured than a silty clay loam. This group of subsoils can be fertilized and tilled so that yields will not be appreciably below the uneroded soils of the same type. Production costs usually are higher, however. Some examples of soil in this group are Ida, Monona, Tama, Marshall, Galva and Clarion. They range from Ida, with the most permeable subsoil, to Marshall silt loam which has a light silty clay loam subsoil.

Subsoil Group 2 includes those soils with subsoils that are considerably finer textured than the surface soils. These subsoils are largely in the light silty clay range, but some till-derived soils with clay loam subsoils are included. These subsoils can be farmed with ordinary tillage methods. Grain yields on the eroded sites will be much lower than on the same soil types uneroded, regardless of the fertility program followed. The soils are hard to work, and seedbeds difficult to prepare. Meadow crops are more difficult to establish, but once established yields are not much influenced by lack of surface soil, provided fertility needs are met. Examples of the soils found in this group are Grundy, Shelby, Lindley and Clinton.

Subsoil Group 3 includes soils with heavy silty clay or clay textured subsoils. When the surface soil is removed by erosion these soils have low value as cropland. Even though heavy fertilization is practiced, tillage and other problems are so severe that satisfactory grain yields are doubtful. Meadow crops do relatively better than grain crops, but alfalfa is not well suited. Returns for any crop will probably be low on severely eroded soils in this group. Seymour, Adair (Lagonda), Clarinda and Weller soils are examples of this group.

There are other soil conditions on which erosion can be very serious. Soils that are shallow to bedrock can become completely nonarable if the soil mantle is lost. The groupings previously suggested, however, are designed to serve as guides for adjustment of yield estimates within different soil types. Loss of soil down to bed rock would result in the area affected being classified as a different soil type. The decreased yield potential, in this case, would be reflected in the yield estimates for the new soil type.

Effect of Cropping Systems on Yields

Only two cropping and treatment situations are considered in table 1. There are, of course, many other combinations of crop rotations and soil treatments which can and are being used in Iowa.

On most soils, it is difficult to predict the effect of cropping systems on yields without a knowledge of the fertility level. Nevertheless, on soils that have adequate lime, phosphorus and potassium added according to crop needs indicated by soil tests, it is possible to predict the probable effects of different cropping systems with and without additional nitrogen. Data obtained from rotation experiments at 10 different experimental fields in Iowa provide basic information for making such predictions.[8]

The relative yields of corn that can be expected under a number of different cropping systems are indicated in table 4. Relationships shown in this table can be expected to be valid only under the fertility conditions that are specified and only if erosion is controlled. Predictions from this table should also be limited to soils moderate to high in organic matter similar to those on most of the experimental farms.

Table 4 is based on long-time results from field experiments with and without nitrogen fertilizer but with adequate levels of lime, phosphorus and potassium. The data in table 4 show that corn yields are increased slightly with nitrogen applications, even when the corn follows a grass-legume meadow crop. First-year corn yields are all quite similar, regardless of length of the meadow stand. On low-fertility soils, however, first-year corn yields sometimes are higher in rotations which have more than 1 year of meadow.

Second-year corn yields are slightly lower than first-year yields. Second-year corn yields are also slightly lower following 1 year of meadow compared with following 2 years of meadow.

The difference in corn yields that results from differences in cropping systems is small if proper fertility treatments are used.

Effect of Fertility Level on Yields

The fertility level of a field or soil area has a large effect on crop yields. It is a property that

[8]Unpublished data, Department of Agronomy, Iowa Agricultural and Home Economics Experiment Station, Ames, Iowa.

TABLE 4. RELATIVE EFFECT OF CROPPING SYSTEMS ON ESTIMATED CORN YIELDS IN IOWA.

	Relative yield[a]	
	No nitrogen	Nitrogen used
COMM	94	100
COM	93	100
CCOMM	93	100
C**C**OMM	90	100
CCOM	93	100
C**C**OM	82	98
CSbOM	93	100
CSbCOM	93	100
CSb**C**OM	83	98
CCOsd	80	98
C**C**Osd	75	98
Continuous corn	50	95

[a]It is assumed that the soil is adequately supplied with mineral nutrients. Where nitrogen is used the rate would vary according to the requirements of the particular rotation system. A relative yield of 100 percent would occur when corn followed 1 or 2 years of legume meadow with some extra nitrogen applied.

cannot be predicted from the soil type, except in a general way. It can be evaluated by means of a soil test together with other information.

There are 13 essential elements that plants must get from the soil. Iowa soils generally contain sufficient quantities of all but four of the essential elements in a form available to plants. The elements that most frequently limit plant growth in Iowa are nitrogen, phosphorus, potassium and calcium (lime). These are the elements that are measured in the standard soil test. Other elements which have been observed to limit yields on a few minor soil conditions in Iowa are iron, manganese and boron for soybeans, oats and alfalfa seed, respectively.

To have meaning, any yield prediction has to be based on some assumed soil fertility level. The level used in table 3 is an average soil test level, based on summaries of soil samples received by the Iowa State University Soil Testing Laboratory. The estimates for the low level of fertility in table 1 are based on fertility only slightly below this. Since the soil test in any particular field in a specific soil area will probably deviate from the average, a soil test is needed to relate the particular soil to the yields in table 1. If soil test results for any of the elements tested are below the average results reported in table 3, the yield estimates for the low level should be lowered, but if all test results are equal to and some are above the average reported, these estimates should be raised. To achieve the high yield levels shown in table 1, it is necessary to add more fertilizer to the soils below the average in soil test as given in table 3, and, conversely, less fertilizer is needed on fields testing higher than the average.

Other Soil and Site Factors

The table of yields reflects only yields of the actual soil area in crops. The estimates assume no reduction in yield resulting from the following or similar factors: (1) inaccessibility, (2) flood hazard, (3) gullied areas, (4) waterways, (5) streams, (6) drainage ditches, (7) levees, (8) rock outcrops, (9) gravel pits and (10) terrace backslopes and outlets.

Since these factors are not considered in the estimates, they should be taken into account when figuring yields for a particular field or farm. For example, a 14-acre field of Marshall silt loam with 11 percent slope and moderate erosion (erosion phase 2) may contain 1 acre of grassed waterways. The yield estimate for such a soil might be 60 bushels per acre. The yield from the field would not be 14x60 = 840 bushels, but 13x60 = 780 bushels. Thus, the average yield per acre for the entire field is not 60 bushels, but 55.7 bushels. Reduction due to other factors can be calculated in a similar manner. Soil survey maps may show these trouble spots by symbols but may not indicate the area involved.

Flood hazard must be taken into account when planning production on bottomland soils. The Soil Conservation Service farm planning soil survey maps carry an overscore symbol, such as $\overline{87}$, indicating that the soil is subject to flooding. It does not indicate the frequency or magnitude of the problem. The experience of local people can be very helpful in estimating the flood hazard and probable yields of such soils and in helping to determine the proportion of years when the yield is likely to be nil.

The presence of small areas of related, but significantly different, types of soil within the boundaries of a mapped soil area may also influence field yields. The areas may be too small to map but could reduce or increase yields on a field basis.

Estimating crop yields and applying these estimates to fields and farm conditions require careful consideration and good judgment.

Weeds, Insects and Diseases

Weeds are an ever-present problem in most crops and can seriously reduce yields unless controlled. The yield estimates given in this report (table 1) are based on the assumption that weeds are well controlled; a downward adjustment will be required for moderate to excessively weedy fields.

Recent studies at Iowa State University have shown that, for corn, an average loss of 7 to 8 bushels per acre is a good estimate of the loss suffered by having only a moderately weedy field, where weeds were controlled between rows but not in the row, as compared with a weed-free field.[9] For soybeans, a moderately weedy field may cause average losses of about 4 bushels per acre.[10] Small grain and hay yields are not commonly reduced because of weed infestation. The presence of certain weeds, such as quackgrass, Canada thistle and wild garlic, however, may greatly reduce the value of the crop.

In addition to weeds there are many diseases and insects which hinder the growth and development of crop plants and influence yields. The yield estimates in this report assume that the degree of control of these hazards will be about the same as that accomplished by skillful farmers at the present time. For corn, this means fairly complete control of insects and diseases. Omission, when needed, of any of the seed, soil and plant treatments commonly used can be expected to result in decreased yields.

Control of oat diseases has been far from complete in the past, and it is assumed that yields will be reduced from this cause by about as much in the immediate future as they have been in the recent past. Development of more resistant oat varieties might justify an upward adjustment in yield estimates. On the other hand, the introduction or evolution of new and more virulent oat diseases could have the reverse effect.

[9] Staniforth, D. W., Sylvester, E. P. and Lovely, W. G. Weed control in corn. Iowa Farm Sci. 11:487-490. 1957.

[10] Staniforth, D. W. Soybean-foxtail competition under varying soil moisture conditions. Agron. Jour. 50:13-15. 1958.

Soybeans and meadow crops in Iowa are affected by diseases or insects, and control measures are sometimes used. Resistant varieties have been a great help in preventing diseases. Sometimes insects such as cloverleaf weevil, aphids and spittle bug become a serious problem on legumes and require control measures. Grasshoppers, especially in dry years, may do considerable damage to grasses, legumes and corn unless controlled with effective insecticides.

Seed Quality and Rate of Planting

In general, most farmers use good seed, but reductions in yield can be caused by seed of low quality or of the wrong variety. Losses may be slight to severe, depending on how poor the seed is or how poorly adapted the variety might be.

The best planting rates for most crops have been well worked out through research and farm experience. Farmers probably are using satisfactory rates for oats and grass-legume seedings. These crops have a wide range in quantity per acre which results in satisfactory stands and good yields. Although many farmers might be able to save some seed by using more precise seeding methods, most farmers plant sufficient seed, and yields are not greatly affected by the variation in rates used.

For soybeans and corn, planting rates are more critical and are an important factor in resulting yields. For both crops, yields may be reduced by seeding rates which are either too light or too heavy.

Soybeans normally should be planted to give one good seed for every inch of row. This necessitates a change in quantity per acre with different row widths. The quantity of seed used allows for losses from the use of weed-control equipment.

The most desirable stand of corn per acre varies with the soil fertility level and available water supply. The moisture reserve in the soil as well as the seasonal rainfall are important factors in any given year. Consequently, corn planting rates may vary considerably on different farms but will usually be within a range of 12,000 to 20,000 seeds per acre. Stands of 14,000 to 18,000 per acre usually are needed for best yields on productive, well-managed soils. Planting rates must be keyed closely to the soil type, fertilizer rates and the amount of moisture stored in the soil, plus expected seasonal rainfall. The number of corn plants per acre at harvest will usually be 10 to 20 percent lower than the number of seeds planted because of seedling mortality.

Timeliness of Operation

Timeliness of operation can affect yields from seedbed preparation through crop harvest. It is a factor which is difficult to define properly, and its effect on yields is difficult to determine. Yet it is an important factor and must be considered when estimating expected yields for an area of land.

Planting at the right time is an objective of all farmers. Research and experience have established the range of planting dates for most crops and have shown its influence on yields. For example, oats should be planted in the spring as soon as a good seedbed can be prepared. This period usually ranges from about April 1 to April 15. Studies in central Iowa have shown that oat plantings between April 16 and May 7 were reduced by approximately 1 bushel per acre for each day's delay after April 16.

Grass and legume seedings, when seeded in oats or alone, also seem to do best when made during the April 1 to 15 period. They can often be seeded successfully, however, in the late summer from about mid-August to mid-September.

The average planting date for corn in Iowa is May 15. Highest yields normally are obtained when the crop is planted near this date. Nearly equal yields, however, can be expected from plantings made during the period May 5 to May 25.

The best time to plant soybeans is during the last half of May but, preferably, not later than May 25. For plantings extending into June, earlier maturing varieties outyield the adapted varieties planted on the same date.

Timeliness of operation is very important in the control of weeds, diseases and insects. Weeds can best be controlled early when they are small. A few days' delay in cultivation of corn and soybeans can allow weeds to get out of hand and seriously reduce yields. The same applies to the control of diseases and insects. Control measures must be applied to prevent infestation or timed to insure control before the problem becomes out of control. Even short delays can mean substantial yield losses.

Procedure for Estimating Yields on a Particular Field

Estimates of long-time average crop yields for the major soils in Iowa under two management situations have been presented in table 1. The effect on yields of slope, erosion, drainage, overflow, soil and crop management and various other factors have been discussed. Some general guides have been given for estimating the probable fertilizer needs (table 3). Furthermore, a somewhat more general evaluation of the productive capacity of all the established soil types in the state is given in Appendix B. By making use of this and other information, it is possible to establish fairly reliable ranges of probable yields in nearly any part of the state.

To estimate the yield potential of a specific field anywhere in the state, information in this bulletin should be supplemented by the following: (1) a detailed soil map of the area in question to indicate soil type, slope, erosion, general land use and to give some information on drainage conditions; (2) a complete soil test and fertilizer recommendation such as can be obtained from the Iowa State University Soil Testing Laboratory; (3) a general history of land use for at least the

TABLE 5. METHOD OF CALCULATING PROBABLE AVERAGE PRODUCTION ON THE 40-ACRE AREA SHOWN IN FIG. 5.

Soil unit	Corn yield[a]	Percent adjustment for: Slope	Erosion	Drainage[b]	Past use[c]	Location[d]	Fertilizer[e]	Management[f]	Average adjustment	Adjusted base yield (bu./a.)	Area (acres)	Yield X area
6-1-0	60	0	0	—50	0	+5	0	—10	—55	27	1.2	32.0
55-2-1	78	0	0	0	0	+5	0	—10	—5	74	9.6	710.4
95-1-1	60	0	0	—10	0	+5	—10	—10	—25	45	2.5	112.5
107-1-0	76	0	0	—15	0	+5	0	—10	—20	60	17.8	1,068.0
138-3-2	72	—5	—5	0	0	+5	0	—10	—15	61	7.4	451.4
Turn rows	0	...	...	...	...	...	...	...	...	...	1.5	0
											40	2,374.3

Average yield for field – 2,374/40 = 59 bu./a.

[a]Corn yield for high management level. (See table 1.)

[b]Drainage on this tract is poor in the pot holes and somewhat imperfect on the level areas.

[c]Past use. The field has been in a corn-corn-oats-meadow rotation, so no adjustment is needed for first-year corn. Second-year corn yields will be reduced by 2 percent. (See table 4.)

[d]Location. The location is near the southern edge of the Clarion-Webster area.

[e]Fertilizer. Recommended rates of fertilizer are used on all except the Harpster area. Less than the recommended rate is used on this area because a special application for this area would be required.

[f]Management. Manager is short on labor, so yields are liable to be r educed.

past few years; (4) a record of drainage and overflow conditions and (5) a record of various other factors such as location and size of inaccessible areas, amount of land in gullies or grass waterways and similar conditions which might affect cropping.

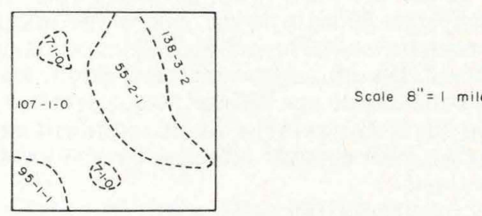
When this information is assembled, probable yields under various systems of management can be estimated. The precision of the estimation may be rather low for some of the minor soil conditions, but in most cases, a fairly accurate estimation of probable average yields should be obtainable.

In some cases it may be possible to determine the probable average yield directly from the table, but usually some adjustments may be necessary. The degree of detail necessary in making these adjustments will depend somewhat on the use to be made of the information, but the precision of the estimates is not sufficient to warrant concern about a few bushels difference in yield.

Very few fields in some soil association areas consist of only one soil condition. For example, Clarion, Nicollet, Webster, Glencoe and Harpster soils occur in the Clarion-Webster soil area. Not only are there yield differences among these soil types, but a specific soil type may have a different yield potential in one part of the field than in another. For example, yields on the Glencoe pot holes are extremely variable depending on drainage conditions, and some adjustment in the estimated yield may be necessary for each separate area.

An example of the type of analysis that might be used in evaluating the probable productivity on a 40-acre field in the Clarion-Webster area is given in fig. 5 and table 5. Some of the adjustment factors may be applied uniformly over the entire tract, others will vary with the soil condition.

The calculations in table 5 illustrate several of the factors that operate to establish the average yield on a field basis. The low yield on the Glen-



MAPPING UNIT	SOIL NAME	SLOPE	EROSION	AREA
6-1-0	GLENCOE SILTY CLAY LOAM	1%	NONE	1.2 ACRES
55-2-1	NICOLLET LOAM	2%	SLIGHT	9.6 ACRES
95-1-1	HARPSTER CLAY LOAM	1%	SLIGHT	2.5 ACRES
107-1-0	WEBSTER SILTY CLAY LOAM	1%	NONE	18.8 ACRES
138-3-2	CLARION LOAM	3%	MODERATE	7.9 ACRES

Fig. 5. Soil map and a soil inventory of a selected 40-acre field in the Clarion-Webster soil association area in Iowa.

coe spots, the lack of any yield on the 1.5 acres of turn rows (which allows for a 20-foot turn row on two sides of the field), a slight reduction in yield on the Webster soils because of poor drainage, and a slight reduction in yield resulting from somewhat poor management (lack of labor)—all operate to set the average yield of the 40-acre field at an average of 59 bushels per acre. Improvement in management (extra labor in this example) could raise this yield to 65 bushels per acre, but this would still be about 13 bushels per acre below the yield that is estimated as being obtainable on the best soil in the field. Improvements in drainage on the Glencoe and Webster areas, plus special fertilizer applications on the Harpster area, would be needed to bring the average yield on this 40 acres up to its estimated maximum potential of 74 bushels per acre.

On more steeply sloping land, the area lost in drainageways and on gullies may be enough to lower appreciably the average yield of a field. It should also be remembered that the skill of the farm operator in carrying out various practices will also affect yields.

Each field is different and must be judged on its own potential. Adjustments of the yields given in table 1 will have to be made to fit conditions as they exist. An analysis of the factors of production will not only indicate why the yields are below the potential, if such is the case, but will furnish information that can be used in increasing production if it is economical to do so.

APPENDIX A—MANAGEMENT ASSUMPTIONS

This study assumes two general levels of management—a low management level and a high management level. The first would produce yields near the low side now experienced by many farm operators. The second would produce about the maximum yields over a period of time that would seem obtainable at the present time by most good farmers. In this way the most practical yield range would be bracketed. In general, other yield levels resulting from other management assumptions would then fall within these limits. It would be expected, however, that a small number of exceptional farmers might exceed the high yield level by about 15 percent.

General Assumptions

For all yield estimates, it is assumed that the respective management systems have been applied for a sufficient period of time (at least 10 years) so that yields reflect the major effect of practices.

There are several practices which are generally used by most farmers and which are unusually difficult to define sharply except at a high management level. Consequently, these practices are presented as they would apply to the high level of management. At the low management level, it is assumed that the practices are generally followed but receive somewhat less attention by the operator. Thus, yields would be slightly reduced at the low management level as a result of occasionally failing to do an effective job on one or more of these practices:

1. For soils where tile or surface drainage is recommended, the systems have been installed and are working properly;
2. Recommended varieties are always used;
3. Weeds will be fairly well controlled using normal tillage and cultivation practices, and herbicides will be used as a secondary measure when conditions warrant;
4. Diseases and insects will be controlled in a manner now used by good farm operators—oats and corn seeds will be treated, corn rootworm controlled, and corn borer and grasshopper control will be carried out in accordance with current recommendations;
5. All farming operations will be timely within practical limits, since weather conditions occasionally cause delay and inconvenience even for the best operators; and
6. Flooding will be controlled on soils where it is a problem.

Cropping Systems

To keep the influence of cropping systems on a basis which meets the requirements of the low and high levels of management selected for this study the following assumptions are made:

1. For corn—The high yield level is based on the first corn crop following 1 or more years of meadow. This does not mean that high yields are restricted to first-year corn, however (see table 4). The low yield level is based on second-year corn following 1 year of meadow.
2. For soybeans—The high yield level is based on a cropping system which includes at least 1 year of meadow in 5. The low yield level would apply when meadow occurs less than 1 year in 5.
3. For oats—A cropping system is assumed in which oats follow 2 years of corn which followed 1 or more years of meadow.
4. For meadow—All hay yields are based on first-year stands and three cuttings during the year. The meadow crop is assumed to be alfalfa-brome on all soils where alfalfa is adapted. On other soils not well suited to alfalfa and where red clover would be higher yielding, its use with timothy as the grass is assumed.

Fertility Levels and Corn Planting Rates

Application of lime, fertilizer and manure sharply influence crop yields. Definite assumptions must be made regarding such applications if yield estimates are to be meaningful.

Lime—Many Iowa soils require lime for best crop yields. Liming is a relatively low-cost practice and should always be one of the first considerations in any soil-fertility program. On acid soils its use brings about many direct and indirect benefits. The indirect benefits, such as its influence on soil organisms and the fact that it increases the availability of nitrogen and phosphorus, make liming difficult to evaluate as a single practice. For these and other reasons, it was assumed that adequate lime was present or applied on all soils under both the high and low management levels.

Fertilizer and Manure—For low management, it was assumed that little or no commercial fertilizer was applied on any crop in the rotation. Most crop residues or comparable amounts of manure, however, are returned to the land. Corn stands at this management level were assumed to be 10,000 to 12,000 stalks per acre.

At high management, the rates of fertilizer nutrients specified in table 3 are used. They would be applied in accordance with soil test recommendations and at a level between the medium and high rate now established by the Iowa State University Soil Testing Laboratory. Most crop residues or comparable amounts of manure would be returned to the land. Corn stands at this fertility level were assumed to be 14,000 to 16,000 stalks per acre.

APPENDIX B

ESTIMATED LONG-TIME AVERAGE YIELDS OF SELECTED CROPS ON IOWA SOILS FERTILIZED AT THE OPTIMUM RATE FOR THE HIGH MANAGEMENT LEVEL AND EROSION CONTROL PRACTICES USED WHEN NECESSARY[a]

Mapping unit	Soil name	Slope phase (%)	Erosion phase	Estimated yields: Corn (bu./a.)	Soybeans (bu./a.)	Oats (bu./a.)	Hay (tons/a.)
192	Adair (Lagonda) silty clay loam	5-9	2	< 27	....	< 25	< 1.2
31	Afton silty clay loam	0-1	0	62-69	25-28	41-49	2.4-2.9
156	Albaton silty clay and clay	0-1	0	45-53	19-24	25-32	1.8-2.3
167	Ames silt loam	1-2	1	45-53	19-24	33-40	1.8-2.3
291	Atterberry silt loam	1-2	1	70-77	29-32	50-56	3.0-3.5
260	Beckwith (Marion) silt loam	0-1	1	36-44	< 18	25-32	1.2-1.7
130	Belinda silt loam	0-1	0	45-53	19-24	33-40	1.8-2.3
267	Bertrand group, 15-18 inches to sand or gravel	1-2	1	27-35	< 18	25-32	1.2-1.7
265	Bertrand group, 24-30 inches to sand or gravel	1-2	1	36-44	< 18	33-40	1.8-2.3
193	Bertrand group, 36 inches + to sand or gravel	1-2	1	62-69	25-28	41-49	2.4-2.9
57	Berwick silt loam	0-1	1	45-53	19-24	33-40	1.8-2.3
44	Blencoe silty clay	0-1	0	54-61	19-24	25-32	1.2-1.7
166	Blockton silt loam	0-1	1	54-61	19-24	33-40	1.8-2.3
43	Bremer silty clay loam	0-1	0	62-69	29-32	50-56	3.0-3.5
50	Carrington sandy loam	2-5	1	45-53	< 18	25-32	1.8-2.3
3	Castana silt loam	9-14	1	54-61	....	33-40	2.4-2.9
105	Chariton silt loam	0-1	1	54-61	19-24	25-32	1.2-1.7
142	Chaseburg silt loam	2-5	1	62-69	25-28	41-49	3.0-3.5
63	Chelsea loamy fine sand	5-9	2	< 27	< 18	< 25	< 1.2
222	Clarinda silty clay loam	5-9	2	< 27	....	< 25	< 1.2
138	Clarion loam	2-5	1	70-77	25-28	50-56	3.0-3.5
69	Clearfield silty clay loam	2-5	1	54-61	19-24	33-40	1.8-2.3
80	Clinton silt loam	5-9	2	54-61	19-24	41-49	2.4-2.9
152	Clyde & Marshan group, 36 inches to sand or gravel	0-2	0	70-77	25-28	50-56	3.0-3.5
84	Clyde silty clay loam	1-2	0	70-77	25-28	41-49	3.0-3.5
302	Coggon loam	2-5	1	45-53	19-24	33-40	1.8-2.3
133	Colo silty clay loam	0-1	0	70-77	29-32	50-56	3.0-3.5
87	Colo-Zook group	1	0	54-77[c]	26-32	50-56	3.0-3.5
783	Cresco loam	2-5	1	54-61	19-24	33-40	2.4-2.9
246	Curran silt loam	0-1	1	45-53	19-24	33-40	1.8-2.2
11	Dark colored alluvial-colluvial complex	1-5	0	54-77[c]	26-32	50-56	3.0-3.5
221	Deep muck	0	0	0-77[b]	0-32[b]	0-56[b]	1.2-2.9[b]
175	Dickinson fine sandy loam	2-5	1	45-53	< 18	33-40	1.8-2.2
285	Dickinson group, 15-18 inches to sand or gravel	1-2	1	< 27	< 18	< 25	< 1.2
284	Dickinson group, 24-30 inches to sand or gravel	1-2	1	27-35	< 18	25-32	1.2-1.7
283	Dickinson group, 36 inches + to sand or gravel	1-2	1	45-53	19-24	33-40	1.2-1.7
204	Dodgeville silt loam, deep phase	2-5	1	54-61	25-28	50-56	2.4-2.9
104	Dodgeville silt loam, shallow phase	5-9	2	36-44	< 18	33-40	1.8-2.3
22	Dow silt loam	9-14	3	45-53	....	25-32	1.8-2.3
162	Downs silt loam	5-9	2	70-77	25-28	41-49	3.0-3.5
182	Dubuque silt loam, deep phase	9-14	2	45-53	....	33-40	2.4-2.9
183	Dubuque silt loam, shallow phase	9-14	2	27-35	....	25-32	1.2-1.7
211	Edina silt loam	0-1	0	62-69	25-28	33-40	1.8-2.2
253	Farrar (Clarion) sandy loam	2-5	1	45-53	< 18	25-32	1.8-2.2
163	Fayette silt loam	5-9	2	70-77	25-28	41-49	2.4-2.9
198	Floyd loam	1-3	0	70-77	25-28	50-56	3.0-3.5
310	Galva silt loam	2-5	1	62-69	25-28	50-56	3.0-3.5
382	Garwin-like silty clay loam, shallow to Iowan drift	0-1	0	78-85	29-32	50-56	3.0-3.5
118	Garwin silty clay loam	0-1	0	86-92	29-32	50-56	3.0-3.5
75	Givin silt loam	1-3	1	62-69	25-28	41-49	3.0-3.5
6	Glencoe silty clay loam	0	0	0-69[b]	0-32[b]	0-56[b]	1.2-2.9[b]
268	Glenwood silt loam	9-14	2	54-61	....	33-40	2.4-2.9
313	Gosport silt loam	9-14	2	< 27	....	< 25	< 1.2
103	Gravity silt loam and silty clay loam	2-5	1	62-69	29-32	50-56	3.0-3.5
364	Grundy silt loam	2-5	1	62-69	25-28	41-49	2.4-2.9
41	Hagener (Thurman) sand and loamy sand	2-5	1	36-44	< 18	25-32	1.2-1.7
362	Haig silt loam	0-1	0	62-69	25-28	41-49	2.4-2.9
95 or 107aa	Harpster loam	0-1	0	54-61	19-24	33-40	2.4-2.9
168	Hayden loam	5-9	2	54-61	....	33-40	2.4-2.9
38	Haynie fine sandy loam	0-1	0	45-53	< 18	25-32	1.8-2.3
137	Haynie silt loam	0-1	0	70-77	25-28	50-56	3.0-3.5
269	Humeston silt loam	0-1	0	45-53	19-24	33-40	1.8-2.3
1	Ida silt loam	9-14	3	45-53	....	25-32	2.4-2.9
219	Jackson group, 36 inches + to sand or gravel	1-2	1	62-69	25-28	41-49	2.4-2.9
8	Judson silt loam	2-5	0	70-77	29-32	50-56	3.0-3.5
781	Kasson loam	2-5	1	45-53	< 18	33-40	2.4-2.9
224	Kato group, 15-18 inches to sand or gravel	1-2	1	27-35	< 18	25-32	1.2-1.7
225	Kato group, 24-30 inches to sand or gravel	1-2	1	36-44	19-24	33-40	1.8-2.3
226	Kato group, 36 inches + to sand or gravel	1-2	0	62-69	29-32	50-56	3.0-3.5
212	Kennebec silt loam	0-1	0	70-77	29-32	50-56	3.0-3.5
83	Kenyon (Carrington) loam	2-5	1	70-77	25-28	50-56	3.0-3.5
180	Keomah silt loam	2-5	1	54-61	19-24	41-49	2.4-2.9
76	Ladoga silt loam	2-5	1	62-69	19-24	33-40	3.0-3.5
124	Lamont group, 15-18 inches to sand or gravel	1-2	1	< 27	< 18	< 25	< 1.2
125	Lamont group, 24-30 inches to sand or gravel	1-2	1	27-35	< 18	25-32	1.2-1.7
126	Lamont group, 36 inches + to sand or gravel	1-2	1	36-44	< 18	25-32	1.2-1.7
236	Lester loam	2-5	1	62-69	25-28	41-49	3.0-3.5
65	Lindley loam	9-14	3	36-44	....	25-32	1.2-1.7
66	Luton silty clay and clay	0-1	0	45-53	19-24	25-32	2.4-2.9
67	Luton silty clay, silty clay loam substratum phase	0-1	0	45-53	19-24	25-32	1.8-2.2
280	Mahaska silt loam	1-3	0	78-85	29-32	50-56	3.0-3.5
60	Malvern silt loam	9-14	2	27-35	< 18	25-32	1.2-1.7
92	Marcus silty clay loam	0-1	0	70-77	25-28	50-56	3.0-3.5
9	Marshall silt loam	5-9	2	62-69	25-28	33-40	2.4-2.9
151	Marshan group, 24-30 inches to sand or gravel	0-1	0	54-61	25-28	50-56	2.4-2.9
70	McPaul-Dorchester group	0-1	0	62-69	25-28	50-56	3.0-3.5
49	Modale fine sandy loam	0-1	0	45-53	< 18	25-32	1.8-2.2
149	Modale silt loam	0-1	0	54-61	25-28	41-49	2.4-2.9
10	Monona silt loam	9-14	3	54-61	....	33-40	2.4-2.9
410	Moody silt loam	2-5	1	54-61	19-24	41-49	2.4-2.9
184	Muscatine-like silt loam shallow to Iowan till	1-3	0	78-85	29-32	50-56	3.0-3.5

Mapping unit	Soil name	Slope phase (%)	Erosion phase	Estimated yields			
				Corn (bu./a.)	Soybeans (bu./a.)	Oats (bu./a.)	Hay (tons/a.)
119	Muscatine silt loam	1–3	0	86–92	29–32	50–56	3.0–3.6
12	Napier silt loam	5–9	1	70–77	25–28	41–49	3.0–3.5
55	Nicollet loam	1–3	0	78–85	29–32	50–56	3.0–3.5
220	Nodaway silt loam	0–1	0	70–77	29–32	50–56	3.0–3.5
90	Okoboji silt loam	0	0	0–85	0–32	0–56	1.2–2.9
273	Olmitz group	2–5	0	70–77	29–32	50–56	3.0–3.5
146	Onawa silty clay and clay	0–1	0	54–61	19–24	33–40	1.8–2.2
144	Onawa silty clay loam	0–1	0	62–69	25–28	50–56	3.0–3.5
281	Otley silt loam	2–5	1	78–85	29–32	50–56	3.0–3.5
131	Pershing silt loam	2–5	2	45–53	19–24	33–40	1.8–2.2
61	Philby loam	9–14	2	45–53	....	33–40	1.8–2.2
282	Primghar silt loam, shallow to till phase	1–3	0	70–77	25–28	50–56	3.0–3.5
91	Primghar silt loam	1–3	0	70–77	25–28	50–56	3.0–3.5
247	Quandahl silt loam	9–14	1	54–61	....	41–49	2.4–2.9
471	Racine group, imperfectly drained	1–2	1	62–69	25–28	41–49	3.0–3.5
171	Racine loam	2–5	1	62–69	19–24	41–49	2.4–2.9
213	Rockton loam, deep phase	2–5	1	54–61	25–28	50–56	2.4–2.9
214	Rockton loam, shallow phase	2–5	1	36–44	19–24	33–40	1.8–2.3
274	Rolfe silt loam	0	0	0–61[b]	0–28[b]	0–49[b]	1.2–2.9[b]
205	Roseville silt loam, deep phase	2–5	1	45–53	19–24	41–49	2.4–2.9
207	Roseville silt loam, shallow phase	2–4	1	27–35	< 18	25–32	1.8–2.3
74	Rubio silt loam	0–1	1	54–61	19–24	33–40	2.4–2.9
77	Sac silt loam	2–5	1	62–69	25–28	50–56	3.0–3.5
46	Salix silt loam	0–1	0	70–77	25–28	50–56	3.0–3.5
36	Salix silty clay loam	0–1	0	62–69	25–28	50–56	3.0–3.5
237	Sarpy loamy sand and sand	0–1	0	< 27	< 18	< 25	1.8–2.2
148	Schapville silt loam	2–5	1	45–53	19–24	33–40	1.8–2.2
312	Seymour silt loam	2–5	1	54–61	25–28	33–40	2.5–2.9
21	Shallow muck	0	0	0–77[b]	0–32[b]	0–56[b]	1.2–2.9[b]
370	Sharpsburg silt loam	5–9	2	62–69	25–28	33–40	2.4–2.9
93	Shelby–Adair–Clarinda complex	9–14	2	[d]	[d]	[d]	[d]
24	Shelby loam	9–14	2	45–53	....	24–32	1.8–2.2
412	Sogn group	5–9	2	< 27	< 18	< 25	< 1.2
33	Steinauer loam	9–14	2	45–53	....	25–32	1.8–2.3
433	Storden light clay loam	9–14	2	45–53	....	33–40	1.8–2.3
62	Storden loam	9–14	2	45–53	....	33–40	1.8–2.3
165	Stronghurst silt loam	1–2	1	62–69	25–28	41–49	2.4–2.9
279	Taintor silty clay loam	0–1	0	78–85	29–32	50–56	3.0–3.5
120	Tama silt loam	5–9	2	78–85	29–32	50–56	3.0–3.5
377	Tama-like silt loam, shallow to Iowan till	2–5	1	78–85	29–32	50–56	3.0–3.5
27	Terril loam	2–5	0	70–77	29–32	50–56	3.0–3.5
164	Traer silt loam	0–1	1	54–61	19–24	41–49	2.4–2.9
172	Wabash silty clay	0–1	0	45–53	19–24	25–32	2.4–2.9
160	Walford silt loam	0–1	1	54–61	25–28	41–49	2.4–2.9
176	Waukegan group, 15-18 inches to sand or gravel	1–2	1	27–35	< 18	25–32	1.2–1.7
177	Waukegan group, 24-30 inches to sand or gravel	1–2	1	36–44	19–24	33–40	1.8–2.3
178	Waukegan group, over 36 inches to sand or gravel	1–2	1	62–69	25–28	50–56	2.4–2.9
108	Waukegan loam, moderately deep	1–2	1	36–44	19–24	33–40	1.8–2.3
7	Waukesha silt loam	1–2	1	78–85	29–32	50–56	3.0–3.5
107	Webster silty clay loam	0–1	0	70–77	29–32	50–56	3.0–3.5
132	Weller silt loam	2–5	2	36–44	< 18	25–32	1.8–2.3
369	Winterset silty clay loam	0–1	0	70–77	25–28	50–56	3.0–3.5
249	Zwingle silt loam	0–1	1	36–44	< 18	25–32	1.2–1.7

[a]See table 1 for explanation of column headings.

[b]Yields highly variable as a result of drainage difference.

[c]Yields variable because of dissection, flooding and drainage difference.

[d]See individual soil types.