Corn Suitability Ratings — An Index to Soil Productivity

Corn Suitability Rating (CSR) is an index procedure developed in Iowa to rate each different kind of soil for its potential row-crop productivity. Soil profile properties and weather conditions are the dominant factors that affect productivity. Slope characteristics are major factors that determine how land should be used. Slope gradient and slope length affect potential erosion rates, water infiltration, and ease and efficiency of machine operation.

CSRs provide a relative ranking of all soils mapped in the state of Iowa based on their potential to be used for row-crop production. The CSR is an index that can be used to rate one soil's potential yield production against another over a period of time.

The CSR considers average weather conditions as well as frequency of use of the soil for row-crop production. Ratings range from 100 for soils that have no physical limitations, occur on minimal slopes, and can be continuously row-cropped, to as low as 5 for soils with severe limitations for row crops.

The CSR assumes: (a) adequate management, (b) natural weather conditions (no irrigation), (c) artificial drainage where required, (d) soils lower on the landscape are not affected by frequent floods, and (e) no land leveling or terracing. The CSR for a given field or farm can be modified by sandy spots, rock outcroppings, field boundaries, wet spots, and other special soil conditions.

Predicted yields are expected to change with time, CSRs are expected to remain relatively constant in relation to one another. CSRs can be used to quantify the productivity potential for individual fields, farms, or larger tracts of land.

Why *Corn* Suitability

Each year approximately 80 percent or more of Iowa's cropland is planted to corn and soybeans. More than 50 percent of the row crop is corn, which annually ranges from 12 to 14 million acres planted.

Since the introduction of hybrid corn seed on a wide scale in the 1930s, research has been conducted at Iowa State University to study the relationship among soil properties, weather, and corn yields. These investigations have been carried out throughout Iowa on major soils under varying weather conditions at outlying research centers, on farmers' fields, and on industry plots. A long-term and detailed data base is available concerning corn yields.

CSRs Versus Yields

Crop yields for a given kind of soil are expected to change from year to year. Factors that determine crop yields for a specific crop are soil properties, topography, weather, and management. The interaction of these variables in terms of yield is difficult to isolate. Yields are usually estimated for a specified level of management and normalized for a 5- or 10-year average.

New developments in technology and changes in weed, insect, and disease control may make any estimate of yield obsolete. Technological developments include: new and improved crop varieties, changes in tillage methods, improvements in artificial drainage techniques, improved fertilization and liming techniques for optimum efficiency, new disease, weed, and insect control methods, and improved timely and efficient harvest practices. New diseases, insects, or weeds can result in lower yields. Consequently, yield estimates must be considered tentative, and revision will be necessary over time as new information becomes available.

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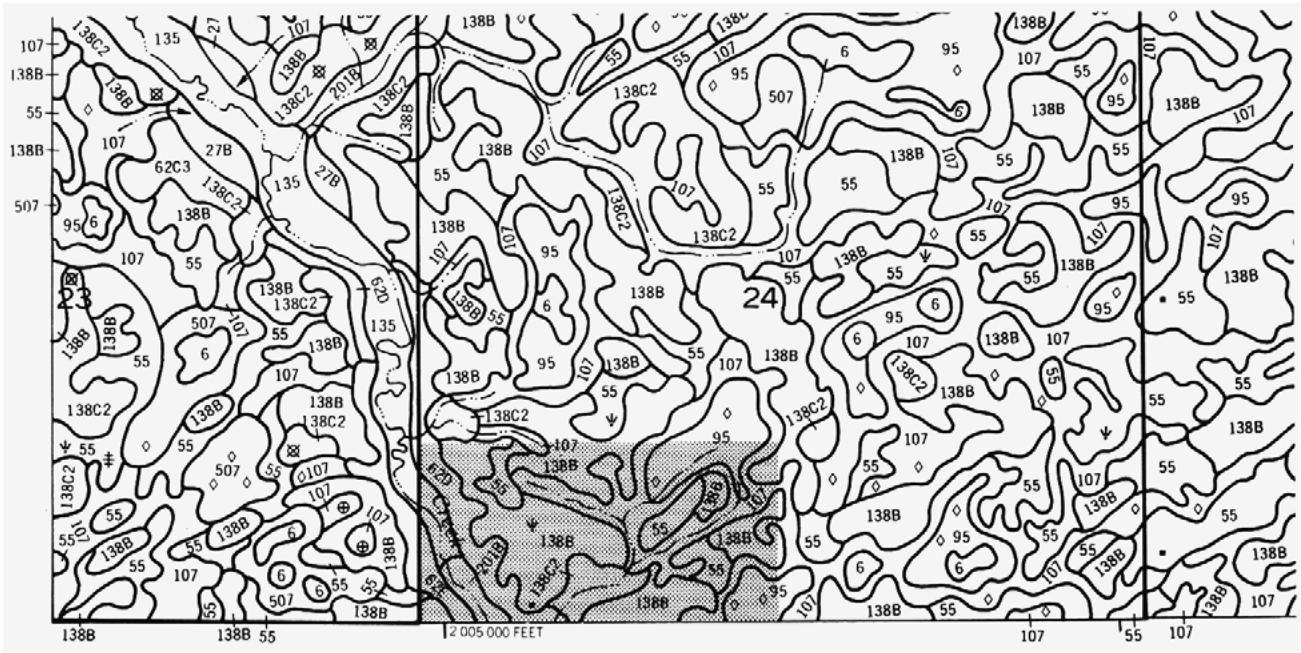

Figure 1. A soil map showing the soil inventory for an 80-acre field (shaded area).

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
201 B	Coland-Terril Complex, 1 to 5 percent slopes, slight erosion

Scale: 1 inch = 1,320 feet

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

Special Symbols

- waterway crossable with farm implements
- waterway not crossable with farm implements
- wet spot
- ◊ depression containing less than 2 acres of Okoboji soil
- ▪ farmstead

Table 1. A comparison of CSRs and estimated corn yields for different slope and erosion phases of Clarion loam.

Soil map number	Percent slope gradient	Erosion class	CSR	Estimated yield bu/ acre*
138B	2-5	slight	82	223
138C	5-9	slight	67	217
138C2	5-9	moderate	65	208
138D	9-14	slight	57	207
138D2	9-14	moderate	55	199

*Yield estimate for high level management 5-year average

Corn Suitability Ratings are based on soil properties, average weather, and the inherent potential of each kind of soil for corn production. CSRs are specified for average management and assume that new developments in technology and changes in the need for pest management practices will be relatively applicable to all soils.

Yield estimates generally are based on a high or an above average level of management. This level of management includes an implicit assumption that soil conserving activities on sloping lands are part of the management practices used to obtain high yields.

A comparison of the CSR values and estimated corn yields for different slope and erosion phases of a Clarion loam are shown in Table 1. Note the change in CSR and yield for a Clarion loam, 2 to 5 percent slopes, slightly eroded, and for a Clarion loam, 9 to 14 percent slopes, moderately eroded. The CSR changes from 82 to 55 while the estimated corn yield changes from 223 to 199.

This difference in CSR implies fewer inputs will be required to achieve an average yield of 223 bushels per acre on the 2 to 5 percent slope compared to inputs required to achieve 199 bushels per acre on the 9 to 14 percent slope gradient.

The additional inputs required on the steeper sloping soil may include agronomic and engineering practices such as some form of conservation tillage, and a four- or five-year crop rotation that includes a grass or grass-legume crop with corn and soybeans, conservation structures, and above average addition of fertilizer and lime.

Table 2. Calculation of the weighted average CSR for an 80-acre field using the soil map shown in Figure 1.

Soil map number	Soil type name	Acreage	CSR	Acreage x CSR
55	Nicollet loam	5.9	90	531.0
62D	Storden loam	6.4	45	288.0
62E	Storden loam	1.9	35	66.5
95	Harps clay loam	8.0	63	504.0
107	Webster clay loam	13.8	85	1173.0
135	Coland clay loam	2.0	80	160.0
138B	Clarion loam	36.1	82	2960.2
138C2	Clarion loam	3.9	65	253.5
201B	Coland-Terrill Complex	2.0	40	80.0
		80.0		6016.2

$\frac{6016.2}{80.0}$ = 75.2 = weighted average CSR for field

The change in value of the CSR by 27 points implies a need to conserve the soil on steeper slopes for maintenance of its long-term productivity. When CSR and yields are compared, do not expect a linear one-to-one relationship among different slope classes and erosion phases for the same kind of soil.

Calculation of an Average CSR Value

Corn Suitability Ratings can be used with soil maps to calculate a weighted average CSR value for any size of land tract. A typical soil map of an 80-acre field located in the Clarion-Nicollet-Webster soil association area of north central Iowa is shown in Figure 1. Calculation of a weighted average CSR is illustrated in Table 2. The weighted average CSR for the 80-acre field is 75.2.

Symbols on the soil map in addition to the soil map unit designation can be useful in evaluating a tract of land. Special soil symbols identify soil areas less than two acres that vary significantly from the soil mapping unit delineation in which they occur (Figure 1). Many of these symbols indicate hazards or features that detract from the optimum use of the land and must be considered in evaluation of a tract. For example, the diamond-shaped symbol that occurs in soil delineation number 95 (Figure 1) represents an area of Okoboji silty clay loam soil. The Okoboji soil often is saturated with water at or near the ground surface and has a CSR of 58.

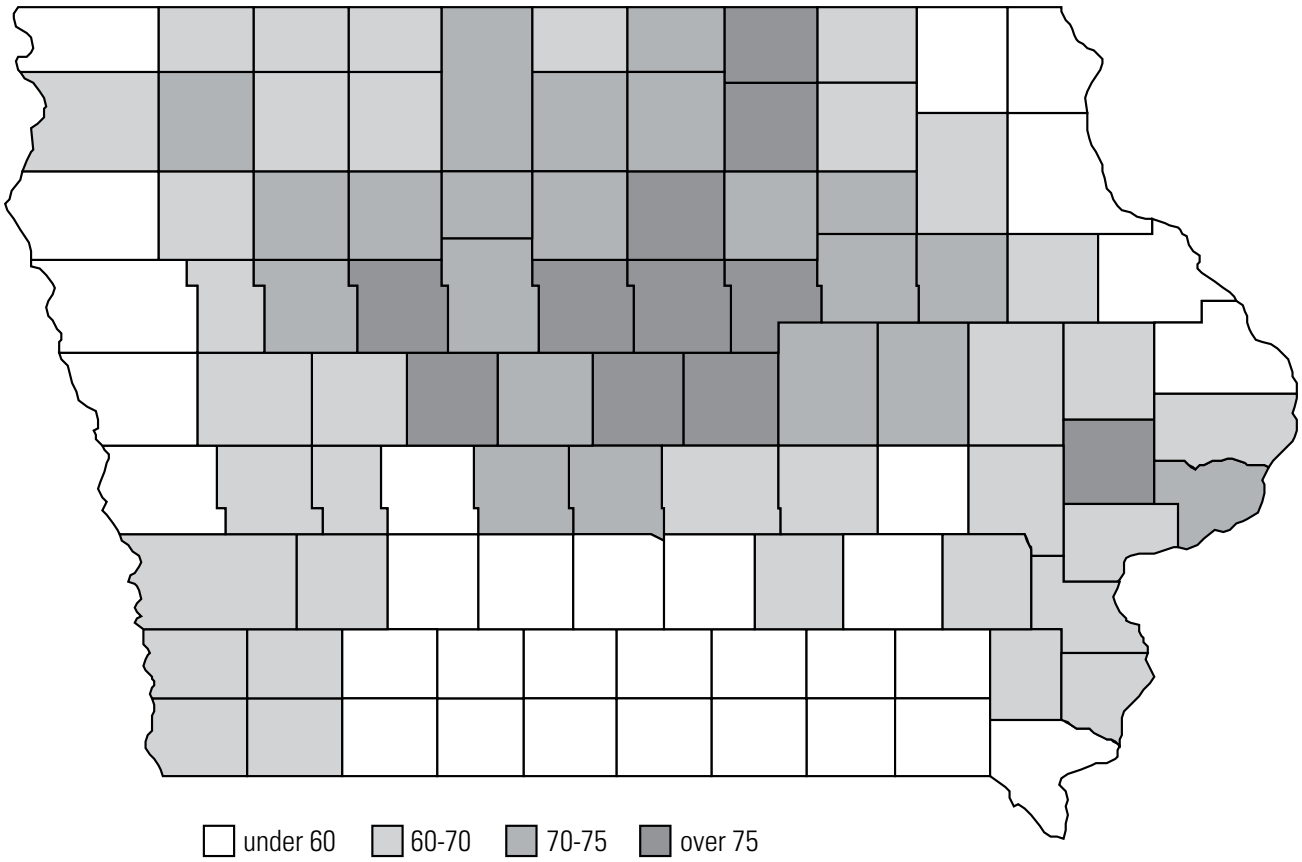

Figure 2. County weighted average Corn Suitability Ratings calculated from acreages listed in published soil survey report and CSRs listed in the published county soil survey report (beginning in 1995) or the Iowa Soil Property Interpretation Database. A current version of this figure is located at the following website: http://www.extension.iastate.edu/Documents/soils/wavcsr.pdf.

Weighted average CSRs can be calculated for larger tracts or any combination of land tracts. Examples include whole farms, sections, townships, and county-by-county summaries. Figure 2 illustrates weighted CSRs that have been summarized on a county-by-county basis.

Uses of Corn Suitability Ratings

Corn Suitability Ratings can be used for several practical purposes. CSRs provide a method for placing a numerical rating on land. A numerical rating provides a quantitative assessment of land compared to a qualitative rating. A primary use of CSRs is to quantify the productivity potential of a tract of land, field, or farm as described in Figure 1 and Table 2.

Other uses of CSRs are calculation of land values, comparison of farmland, aid in the equalization of tax assessment, and evaluation of farmland quality.

Calculation of Land Values

Appraisers, brokers, and farmers can use CSRs to calculate an index number for a tract of land based on its inherent productivity. To accomplish this, two pieces of information are required. First, an average CSR of a county, township, or other large land area is required. Figure 2 shows an example of the information needed. Second, the average price or sale value of the same land area is required. Using these two pieces of information, calculation of a current dollar value of each CSR point can be determined for the county, township, or other large land area. The next step is to take the dollar value of each CSR point and multiply this value times the average CSR of a specific tract of land or farm. This results in the dollar per acre value for the land tract or farm. An example of this procedure is illustrated in Table 3 using information from Figure 1 and Table 2.

Table 3. Worksheet for calculating the land value for an 80-acre field based on inherent productivity.

1. Average CSR of a county or other large area: (1) 70.0
2. Average sale price per acre of farmland for a county or other large area: (2) $6,800.00
3. Dollar value of each CSR point: (2)/(1) $6,800.00 / 70.0 = (3) $97.14
4. Value per acre of farmland for specific tract of land (e.g., use average CSR for 80-acre field shown in table 2).

   Weighted CSR per acre x dollar value
   75.2 X (3) $97.14 =(4) $7,305.14
5. Value of 80-acre field: 80 X (4) $7,305.14 =(5) $584,411.42

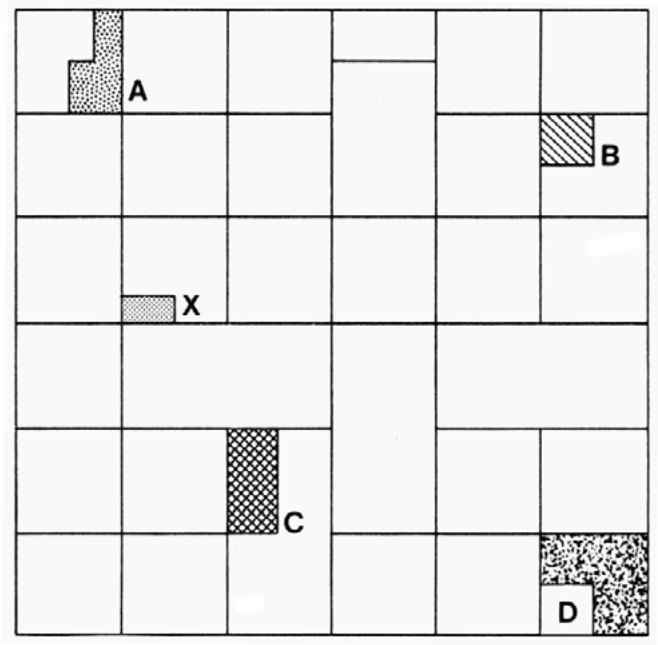

Figure 3. A rectangular township with 36 legal sections showing the location of farm X and comparable farms A, B, C, and D.

This method assesses only the inherent productivity of the land. It does not include the value of buildings, location, water supplies, and other management features.

Table 4. Comparison of weighted average CSR and acreage for farms illustrated in Figure 3.

Farm	Acres	Weighted average CSR
X	80	75.2
A	236	80.8
B	158	83.4
C	322	72.3
D	460	79.8

Comparison of Farmland

Calculation of the weighted average CSR for several farms or tracts of land within a defined soil association area provides a tool to compare the inherent productivity of one farm against another farm. Figure 3 shows a legal township containing 36 sections and the location of an 80-acre field designated as tract X. The average CSR of field X is 75.2 and can be compared to farms A, B, C, and D (Table 4). All the farms occur within the same major soil association area of Iowa and have some soil mapping units in common. These average CSR values can be used directly to compare the inherent productivity of each tract or farm with the other farms, regardless of size.

This method assesses only the inherent productivity. Factors such as buildings, location, water supplies, crop and noncrop acreages, and other management features must be subsequently evaluated.

Equalization of Tax Assessment

The Code of Iowa requires that farmland assessments be based on net earning capacity and productivity. The Code as legislated and made effective in 1977 states:

> ***The actual value of agricultural property shall be determined on the basis of productivity and net earning capacity of the property determined on the basis of its use for agricultural purposes capitalized at a rate of seven percent and applied uniformly among counties and among classes of property. [Code of Iowa, Sec. 441.21.1e]***

The major feature of the Code allows for the calculation of an average productivity on a county-by-county basis and the use of soil maps and CSRs for the equalization on an ownership tract basis. Concerning the use of soil map information, the Code states:

> ***In counties or townships in which field work on a modern soil survey has been completed since January 1, 1949, the assessor and the Department of Revenue shall place emphasis upon the results of such survey in determining the productivity and earning capacity of such agricultural property. [Code of Iowa, Sec. 441.21.1f]***

The present procedure in use requires the use of soil maps and CSRs. The first step is made by the Iowa Department of Revenue (IDR). IDR considers the county as one large unit and calculates an average productivity value per acre for the county by the landlord net income method. As an example, a county has an average productivity value of $1,500 per acre. This value is based on a five-year average of annual Iowa Crop and Livestock Reporting Service census data for cropland acreages, yields, estimated prices of farm products, and landlord expenses. Using a 7 percent capitalization rate the formula is:

$$(1)\quad \frac{\text{landlord net income per acre}}{\text{capitalization rate}}$$

= average productivity value per acre for county

$$(2)\quad \frac{\$105.00}{0.07} = \$1{,}500.00$$

On this basis each county in the state is assigned a productivity value.

The second step is made by the county assessor. The assessor uses the productivity value assigned by the Iowa Department of Revenue to calculate the total assessed value of taxable farmland in the county. For example, assume a county has 340,000 acres of taxable farmland and the average value of farmland is $1,500 per acre, the total assessed value is $510,000,000. The assessor then determines the total CSR points for the taxable farmland in the county by summing the CSR points for each ownership tract as illustrated in Table 2. Next the assessor divides the total assessed value of taxable land by the total CSR points and determines the average dollar value per CSR point. Assume the total CSR points in the county are 23,800,000. This value divided into $510,000.000, the total assessed value, yields an average dollar value of $21.43 for each CSR point.

The assessor then multiplies the average CSR per ownership tract (some county assessors use 40-acre tracts or portions thereof based on ownership) times the value of each CSR point. In the example 80-acre field (Table 2), the average CSR is 75.2. This average value times $21.43 yields an equalized assessed value of $1,611.54 per acre. The total assessed value of the 80-acre field is $128,932.20 (Table 5).

This procedure allows county assessors to eliminate farm management skills of farmers in assessment of productivity of farmland. Instead, soil maps and CSRs provide the assessor with tools to evaluate soil properties and characteristics below the ground surface. This method provides for equalization of assessment on soil productivity, not how well or how poorly one is able to apply management skills.

Evaluation of Farmland Quality

Quality of farmland can be measured by several methods. One method commonly used is the USDA Land Capability Classification (LCC) system that rates each kind of soil at the map unit level in one of eight classes, I through VIII. The LCC system is a qualitative method that assesses soil limitations rather than soil productivity capacity. In Iowa the dominant soil limitation that separates soils into different classes of the LCC system is steepness of slope and erosion hazard.

The use of CSRs provides a method for quantification of the quality of farmland. The calculation of a weighted average CSR for each tract of land for a specified size or acreage

Table 5. Worksheet used by Iowa county assessors for equalization of assessed value of farmland based on inherent soil productivity.

1. Average value of an acre of farmland.					(1)	$1,500.00
2. Total taxable acres of farmland in county.					(2)	340,000
3. Total value of taxable farmland.	$1,500 (1)	X	340,000 (2)	=	(3)	$510,000,000
4. Total CSR points in county.					(4)	23,800,000
5. Value of each CSR point:	(3) $510,000,000 / (4) 23,800,000			=	(5)	$21.43
6. Average CSR for example land tract (from table 2).					(6)	75.2
7. Equalization per acre based on inherent productivity.	$21.43 (5)	X	75.2 (6)	=	(7)	$1,611.54
8. Equalization value of tract.	80.0 Acres	X	$1,611.54 (7)	=	(8)	$128,932.20

allows comparison of land areas and provides a numerical value for each tract. Several Iowa counties have implemented a system to identify high quality farmland based on the numerical ratings determined by assignment and calculation of CSRs.

Availability of Corn Suitability Ratings

A Corn Suitability Rating value is assigned to each kind of soil that occurs in Iowa. Currently there are approximately 400 soil types (example: Clarion loam) and more than 1,600 soil map units (example: Clarion loam, 5 to 9 percent slopes, moderately eroded) identified in Iowa. Many of these map units occur over wide geographical areas under different rainfall and temperature patterns. For example, the Clarion loam soil is identified in all or part of 29 counties in north central Iowa ranging in latitude from southern Polk County to the Iowa-Minnesota state line and east to west from Worth County to Osceola County.

Because of the large geographic extent of many soil map units and the range of rainfall and temperature conditions in Iowa, CSRs are adjusted on a county-by-county basis. These localized CSR values are published in county soil survey report supplements. Between 1975 and 1994 supplements listing a CSR for each soil map unit were printed and distributed for each county at the time of the release of the published soil survey report. Beginning in 1995, CSRs are listed in a table in the published soil survey report.

Copies of published soil survey reports and soil survey report supplements are available at the respective county extension office and soil and water conservation district office. Also, all published county soil survey reports in print and CD/DVD format are available at the ISU Extension Online Store at https://store.extension.iastate.edu/ProductList.aspx?CategoryID=94. Beginning in 2007 all newly published soil surveys are available only in DVD format or on the USDA Web Soil Survey at: http://websoilsurvey.nrcs.usda.gov/app/. In addition, CSRs are listed by for each soil map unit by county in the Iowa Soil Properties and Interpretation Database (ISPAID) at:

http://www.extension.iastate.edu/soils/ispaid.

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