Effectively Understanding and Communicating Iowa’s Corn Suitability Rating 2 (CSR2)

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Outline

**Background Information**
- My Background, Education, and Work Experience
- Current Employer
- My Family

**Why I Chose A Module**
- Topic Selection
- Why a Module?

Module

Quiz Questions

Questions
My Background, Education, & Work Experience

- Grew up in Cedar Rapids, Iowa
- Received Physics and Electrical Engineering degrees in 1983
- Worked at AT&T for 9 years as a customer support engineer and sales associate in Chicago and Indianapolis
- After getting an MBA in 1992, left AT&T for family business in Iowa – HandiMart Food Stores
- Family business was sold in 2006 to Casey’s Convenience Store
- Bought my first farm in 2009 in Black Hawk county
- Started taking agriculture classes at Kirkwood Community College in 2011
- Entered ISU Agronomy Program in Fall of 2013
Current Employer

Nordstrom Family Farms LLC

- Two shareholders in the LLC
- Own four farms in Iowa – one in Black Hawk county and three in Fayette county
- Cash rent the farms
- Work with three different tenants
- Considering managing the farms myself
My Family

Nordstrom Family

• Carol – married 30 years
• Danny (28) – financial security lawyer in Denver
• Michael (24) – financial advisor in Boston
• Samuel (22) – senior at University of Iowa
• Maggie – soft-coated Wheaten Terrier
Soil Productivity is Critical to Farmland Purchases

• Entered program to be a better landowner and farm manager

• Wanted to understand soil productivity inside and out – especially CSR2

• Wanted to do the creative component project on something useful for my work

• CSR and CSR2 were developed at ISU
Why A Learning Module?

Learning Module is an Interactive Learning Tool

• Guide is needed to show someone how to find the data and do the calculation

• Learning module is ideal for educating about a soil productivity ratings and explaining how to calculate CSR2

• CSR2 is a quantitative soil productivity index that uses online survey data for its calculation

• Wide audience for understanding CSR2 – farmers, landowners, investors, land assessment officials, realtors, and conservationists.
Module Content

Introduction
- Objective
- History of agricultural land classification in US
- Current Soil Productivity Indexes in the Midwest
- Soil Formation Background

Understanding CSR?
- Why is CSR important
- Technical Description of CSR

Reasons for changing from CSR to CSR2

Understanding CSR2?
- The CSR2 Equation and Technical Description
- Details of the CSR2 parameters
- Data for CSR2 Calculation
- Example calculation of CSR2

Differences between CSR and CSR2

Summary and Quiz

From - http://www.yukonenvirothon.com
Introduction

Iowa’s Corn Suitability Rating (CSR) is a unique cropland rating system that measures Iowa’s soil capability to grow corn. It is a soil productivity rating system that is only used in Iowa. It was developed by an Iowa State University (ISU) scientist in 1971 and has been used by Iowans for over four decades (ISU-IAHEES, 2013). Recently, CSR2 (second generation CSR) has been developed by the ISU scientific community to replace CSR. CSR2 was designed to closely replicate the original CSR result, and enhance it so that anyone can understand how the calculation of CSR2 is made. CSR2 was developed to use the latest soil science, be transparent, be easy to calculate, and be consistent with the original CSR values (Burras et al., 2010).

The objectives of this module are:

1. To gain a perspective on the history of agricultural land classification and soil productivity ratings in the United States, and provide background information on the Jenny model of soil formation.
2. To understand of how CSR was developed, what it is, and why it is important.
3. To understand the reasons for developing CSR2.
4. To understand what CSR2 is, and to provide a guide for doing the actual calculation.
5. To highlight the differences between CSR and CSR2.
Introduction

CSR2 is an amazingly easy to understand soil productivity index. It starts with a value that is defined by its taxonomic subgroup class for the dominant soil series. Then, soil productivity deductions are made for family particle sizes, increasing slopes, increasing May flooding and ponding, moderate and severe erosion classes, decreasing available water holding capacity in the top 60 inches, and less top soil depth (as measured by RUSLE T factors that are less than 5). Once you begin to understand CSR2 and see how it is calculated, you begin to easily see why CSR2 is a valuable soil productivity index and why Iowa’s farms have different CSR2 values.
History of Agricultural Land Classification and Soil Productivity in US

Soil productivity rating systems in the United States have ranged between qualitative and quantitative throughout history. Qualitative soil productivity ratings can simply be descriptions of soils and the crops that best grow on them. Quantitative soil productivity ratings can use soil and landform properties (inductive) or use crop yield records (deductive) to define the soil productivity rating for a soil (Huddleston, 1983).

United States Department of Agriculture (USDA) created under President Lincoln

The USDA was created under President Lincoln in 1862. Lincoln was a farmer and understood its importance to the United States. Over 50 percent of the US population were farmers. The first Commissioner of Agriculture was Isaac Newton and during his first annual report he said that collecting agricultural data and analyzing soils was an objective of the USDA (Rasmussen, 1986).
Government rated cropland since late 19\textsuperscript{th} century

The US government has always wanted to rate agricultural soils land since the late 19\textsuperscript{th} century. The main reason was the equalization of land values and tax assessments. The government needed to be able to rate the economic benefits of cropland so that the proper property taxes could be assessed (Huddleston, 1983).

USDA created Division of Soils in 1894

Division of Soils first examined soil moisture and temperature in important soils. The first director, Milton Whitney, quickly moved the Division of Soils towards soil survey work (Huddleston, 1983). Early soil surveys in the U.S. began in 1896 (Soil Survey Division Staff, 1993).
History of Agricultural Land Classification and Soil Productivity in US

Division of Soils became USDA Bureau of Soils in 1901

Their main focus was creating qualitative soil surveys that showed some soil properties, such as texture and structure, but emphasized the best crops for the soil based on crop yields (Huddleston, 1983). The only way to do this was to survey soil throughout the United States. The first soil survey in Iowa was published in 1903 in the Dubuque County area (Fenton and Miller, 2011).

1920

After World War I, the USDA began to emphasize land classifications rather than soil productivity (Huddleston, 1983).
The National Resources Board (NRB) was created to analyze the use of sub-marginal land for agriculture that had occurred because of the Homestead Act and the economic depression (USDA-ERS, 1965). The NRB requested the USDA to help inventory the agricultural land of the country. This resulted in the USDA asking that state soil scientists provide data on the soils of their state. The result was the first effort at a national soil productivity rating system. Productivity ratings for major crops then began to show up in the USDA soil surveys by the mid-1930s.

Crop yield data for soil types began to replace soil productivity ratings in soil surveys. By the 1950s, tables of estimated yields had replaced soil productivity ratings (Huddleston, 1983). Yield data was simply easier to understand.
History of Agricultural Land Classification and Soil Productivity in US

1950-1970

Over the next few decades, agronomists from individual states began to develop their own productivity rating systems for cropland based on the state’s soil variations. Qualitative and quantitative soil productivity ratings were developed. Because using only yield data for creating soil productivity ratings has limitations, most soil scientists began to use a combination of soil properties, landscape features, weather conditions, and yield data to determine soil productivity ratings for all soils. Yield data was used to confirm the productivity potential of soils (Huddleston, 1983).

ISU Agronomists and Scientists Were Active in Developing Productivity Rating System

With extensive soil surveys and detailed crop yield data for most soils, agronomists at ISU developed a quantitative soil productivity rating system for Iowa soils. Dr. Thomas Fenton developed the Corn Suitability Rating in 1971 (ISU-IAHEES, 2013), which was in use until CSR2 was officially introduced. Dr. Lee Burras was given the task of updating CSR into CSR2 in 2010. CSR2 was officially rolled out in 2013.
The Midwestern states in the corn belt have several versions of soil productivity indexes (Sassman and Burras, 2016). Each one has a slightly different angle. Some are quantitative and some are qualitative. Some are inductive and some are deductive. Iowa, of course, has CSR and CSR2, which is quantitative inductive.

- **Iowa** – CSR/CSR2 - Quantitative
- **Minnesota** – CPI (Crop Productivity Index) - Quantitative
- **North Dakota** – Soil Survey Productivity Index - Quantitative
- **South Dakota** – Soil Productivity Rating - Quantitative
- **Wisconsin** – Land Productivity Grade - Qualitative
- **Illinois** – OPI (Optimum Productivity Index) - Quantitative
- **Missouri** – Agricultural Land Grades - Qualitative
- **Nebraska** – Land Capability Groups (LCG) - Qualitative
- **Indiana** – Soil Productivity Ranking Factor (SRF) – Quantitative
Soil Formation Background

To create Iowa’s soils, you begin with residual bedrock as the foundation that was formed billions of years ago (Prior, 1991). Then, you add parent material (glacial till and wind-blown loess), climate (temperature, precipitation, and wind), topography (slope and flatness), life organisms (plants, animals, microbes, and humans), and time (which allows for weathering of soil). These five factors are from the Hans Jenny model that was published in 1941 (Schaetzl and Thompson, 2015).

Soil Formation Results from:

- Geology – Bedrock and Parent Material
- Climate – Temperature, Wind, and Precipitation
- Biota – Plants and Animals
- Relief – Catena Formation across the Landscape
- Time – 4.5 Billion Years of Soil Formation

**More information is available at the “Basics of Soil Formation” module on the Crop Advisor Institute website (Anthofer, 2006).**
Soil Formation Background

Bedrock
The bedrock of Iowa consists of multiple layers of prehistoric sediment that was compressed into shale, dolomite, limestone, sandstone, and other sedimentary rock. The ancient sediment was from shallow seas, swamps, and deltas that once covered parts of Iowa. Some of the ancient rocks date back to the Precambian period (0.545 – 4.5 billion years) (Prior, 1991).

Iowa's geological cross section

The geologic time scale
Soil Formation Background

Parent Material

Transported parent material consists of unconsolidated deposits. Glacial ice sheets that once covered Iowa and wind-blown soils (loess material) from the Missouri River Valley and glacial areas played a huge role in Iowa’s soils. Glaciers moved rocks and other material from northern territories into Iowa and other Midwestern areas. This glacial till covered sedimentary and metamorphic bedrock that had formed over time when volcanoes flowed and shallow ocean water covered Iowa (Prior, 1991).

Areas of Glaciation –
From http://skywalker.cochise.edu/wellerr/students/glacial-iowa/project_files/image001.gif

Midwest Loess Deposits
From - http://skywalker.cochise.edu/wellerr/students/glacial-iowa/project.htm
Soil Formation Background

Biota

The natural vegetation that formed in the early soils of Iowa included prairies and forests. The decayed roots and decayed plant materials on the surface contributed to the soil’s organic matter that formed in the upper profiles. Micro fauna and micro flora also added organic matter to the soil. Because of the large amount of prairie vegetation that originally grew in Iowa, rich black fertile soil was formed in the A horizon (Brady and Weil, 2008).

Loess Hill

Iowa’s Native Vegetation
From https://masters.agron.iastate.edu/classes/502/lesson01/1.1.1.html
Soil Formation Background

Climate

The three climatic processes that affect soil formation include precipitation, temperature, and wind.

- Measurable precipitation causes plant growth, chemical reactions, erosion, and translocation of minerals.
- Warmer temperature causes plant growth, soil life, chemical reactions, and faster organic matter decay periods. Intermittent freezing temperatures cause freezing and thawing, and helps break rocks and compacted soil (USDA-NRCS, 2010).
- Higher wind speeds cause light dry soil particles to be moved to new locations.

http://www.des-moiness.climatemps.com/temperatures.php
Soil Formation Background

Relief (Topography)

The topography of the land helps to determine the type of soil that forms. Generally, the slope and location point on the landscape influences the drainage and the erosion. Erosion occurs more readily on a steep hill than on a flat footslope. Moisture will runoff slopes more readily than low lying areas (USDA-NRCS, 2010). Erosion and drainage of sloped landscape influences the formation of the soil and their horizons.

Drawing by Greg D. Pillar
Soil Formation Background

Time

The earth is approximately 4.5 billion years old. Iowa’s oldest known bedrock dates back to the Precambian period (0.54 - 4.5 billion years ago). Iowa’s ancient bedrock is buried by the glacial till and wind-blown loess from the Pleistocene Epoch (10,500 – 1.65 million years). The last glacial ice to cover parts of Iowa was the Wisconsin glacier (10,500 to 14,000 years ago). Thus, Iowa’s soils have been forming and evolving for thousands of years (Prior, 1991). Time allows for the weathering of soil and the consolidation of the horizon layers. The figures below illustrate the effects of time on changing soil horizon profiles.

![Stages of Soil Development](https://soils.ifas.ufl.edu/faculty/grunwald/teaching/eSoilScience/formation.shtml)

Stages of Soil Development
Soil Formation Background

Soil Association Results

The final results of the soil formation processes are soil regions of Iowa (lower left figure) that translate into soil association areas of Iowa (lower right figure). The soil association areas show the principal soils that formed in the different regions of Iowa, which are the result of parent material, biota, climate, relief, and time (Burras, 2014) The CSR and CSR2 take into account the morphological characteristics of these soils.

Understanding CSR?

Brief Description

- CSR is a soil productivity index that rates each soil mapping unit (SMU) in Iowa for its potential corn row-crop productivity. CSR values range from 5 to 100 with 100 being the best (Fenton et al. 1971).

- Dr. Thomas Fenton and his team from Iowa State University developed CSR in 1971.

- As Dr. Burras puts it, they used a statistical approach linking crop yields to pedological features of 290 of Iowa’s soil series and phases.

- The yields came from the 15 test farm study sites across Iowa, and the pedological features came from the NRCS soil survey.

- Expert interpretation was used.
Understanding CSR?

Importance of CSR

Over the past 40 years CSR has been used to help determine land values for property taxation, evaluate land values for sales, help predict yields, negotiate cash rents with tenants, and help plan for conservation planning (Miller, 2005).

- Determine land values for property taxation
- Evaluate land values for sales
- Predict yields
- Negotiate cash rents
- Plan for conservation planning

From - http://realestate.hertz.ag/LandForSale
Understanding CSR?

Technical Description of CSR

- Historical yield data, weather, and soil property data were used to assign CSR index values to soil mapping units.

- The quantitative system that Dr. Fenton developed starts with 100 for the best soil with high corn yields in normal weather conditions and then subtracts amounts for various soil and weather conditions. The Tama and Muscatine silty clay loam soil types were the only soils assigned a CSR value of 100 (Fenton et al., 1971).

- The CSR of 100 was assigned to benchmark soils that had high yield data, had no physical limitations, were located in the areas of the most favorable weather conditions in Iowa, could be continuously row cropped, and occurred on minimal slopes (Fenton et al., 1971).

- Eleven adjustments are made for the non-benchmark soils.
Understanding CSR?

Technical Description of CSR

CSRs for non-benchmark soils are based on 11 parameter deductions. This list shows the actual 11 CSR parameter deductions that Dr. Fenton used to penalize non-perfect soils. The parameters that could affect the CSR value the most included slope, erosion, depth phase, parent material, and wetness (Fenton et al., 1971).

1. Slope (Slope Groups - A through G)
2. Erosion (Erosion Groups - 1 through 3)
3. Biosequence (Prairie, Prairie/Forest, Forest)
4. Wetness (Landscapes and Drainage)
5. Calcareous soils (Calcareous soils have lower CSRs)
6. Depth Phase (Soils with thin solums have lower CSRs)
7. Sandy or gravelly soils
8. Precipitation factors for Iowa (Western and NW Iowa have lower CSRS)
9. Deposition and special soil modifiers
10. Parent materials (Glacial till soils have lower CSRs than loess soils)
11. Muck and peaty soil
Reasons for Changing from CSR to CSR2

Reasons for CSR2 Development

The main problem with CSR was that it was not easily understood and could not be replicated by anyone other than a soil scientist (Jensen, 2013).

Current soil knowledge and mapping techniques have improved dramatically since the early 1970s (Jensen, 2013).

The current national soil taxonomy classification system was not used in developing CSR (Burras et al., 2013). This national soil taxonomy classification system was published in 1975. Dr. Fenton used the 1938 classification system.

CSR assumed a pure soil type and did not measure the soil variability within the soil-mapping unit (Burras et al., 2010). CSR2 in the Web Soil Survey uses an area-weighted average including dominant and minor soils (USDA-NRCS, 2013).

The intent of developing CSR2 was to make it fully transparent and easily calculated using online soil survey data from the NRCS, which includes dominant and minor soils in each soil mapping unit (Burras et al., 2010). The intent was also to use the same pedological principals and be comparable to CSR.

A final reason for the development of CSR2 was the desire to be able to calculate CSR2 values on any soil in the United States (Jensen, 2013). Currently, there are multiple productivity indexes throughout the United States.
Understanding CSR2?

The CSR2 Equation

The calculation of CSR2 is somewhat similar to CSR. Instead of 11 parameter deductions, CSR2 uses a starting parameter and 5 parameter deductions (Burras et al., 2015):

\[
CSR2 = S - M - F - W - D +/- EJ, \text{ where:}
\]

- **S** is the *taxonomic subgroup class* of the soil series
- **M** is the *family particle size class*
- **F** refers to the *field conditions of a particular SMU* (slope, May flooding, May ponding, and erosion class)
- **W** is the *available water holding capacity*
- **D** is a soil depth and erosion factor RUSLE T (*soil resiliency*)
- **EJ** is deductions based on parent materials
Understanding CSR2?
The Method used by Dr. Burras and his team

- Used the Soil Taxonomy publication of 1975 to classify Iowa’s soil series.
- Used statistical analysis and evaluation of CSR values to determine the appropriate CSR2 component deduction values.

Used the taxonomic subgroup class (S) of the soil series to group them into a starting productivity parameters. The S factor represents the parent material, biosequence, wetness, and calcareous soil of CSR.

Used family particle size (M) to represent soil parent material, texture, wetness, sandy or gravelly soils of CSR.

Used field conditions (F) to represent slope, erosion, and wetness of CSR.

Used available water holding (W) capacity to represent wetness of CSR.

Used soil depth and tolerable rate of soil erosion (D) to represent erosion and depth phase of CSR.

Used expert judgment (EJ) to represent unusual soil scenarios, such as extremely sandy or clayey conditions.
Understanding CSR2? Details of the Parameters

Taxonomic Subgroup Class of the Soil Series - S

The CSR2 equation starts by rating the taxonomic subgroup class of the soil series (S). The taxonomic subgroup class includes the taxonomic order, suborder, great group, and subgroup of Iowa’s soils (Burras et al., 2015). Iowa’s soil orders include Mollisols, Alfisols, Entisols, Inceptisols, Histosols, and Vertisols (Fenton and Miller, 2011). The top 3 soil orders in Iowa are Mollisols (67.7%), Alfisols (20.5%), and Entisols (6.9%). The highest S factors in Iowa start with a Mollisols soil order in a humid region (Udolls). These soils were formed from glacial till and wind-blown loess, and developed under tall prairie grasses with plenty of moisture for plant growth. They have a thick, soft Mollic epipedon with an accumulation of organic matter.

The highest S factors (100) are Typic Hapludolls, Typic Argiudolls, Aquic Hapludolls, Oxyaquic Argiudolls, Oxyaquic Hapludolls, Pachic Argiudolls, and Pachic Hapludolls (Burras et al., 2015). The lowest S factors (42) include Lithic Hapludolls and Lithic Hapludalfs, because of the stone diagnostic horizons (Burras et al., 2015). Iowa currently has about 100 taxonomic subgroup classes for the soil series (Burras et al., 2015). Dr. Burras used statistical analysis of the CSR values of the 500 soil series in Iowa to determine these S values (Burras et al., 2010).
Understanding CSR2?

Family Particle Size - M

The CSR2 equation then makes a deduction based on the average family particle size (M). The deductions are based on the decreasing ability of the larger soil particles to hold water and nutrients, and to have an adequate drainage rate (Burras et al., 2010). Basically, the particle classes are divided into 4 general family particle size classes for Iowa soils. The fine-silty and organic classes have zero deductions. The fine-loamy and clayey classes have a deduction of 4. The coarse-loamy and coarse-silty classes have a deduction of 12. Finally, the sandy classes have a deduction of 35 (Burras et al., 2015).

<table>
<thead>
<tr>
<th>Particle-size Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sandy-skeletal</td>
<td>Have 35 percent or more (by volume) rock fragments and a fine-earth fraction with a texture of sand or loamy sand, including less than 50 percent (by weight) very fine sand</td>
</tr>
<tr>
<td>Loamy-skeletal</td>
<td>Have 35 percent or more (by volume) rock fragments and less than 35 percent (by weight) clay</td>
</tr>
<tr>
<td>Clayey-skeletal</td>
<td>Have 35 percent or more (by volume) rock fragments and don't meet criteria for sandy-skeletal or loamy skeletal</td>
</tr>
<tr>
<td>Sandy</td>
<td>Have a texture of sand or loamy sand, including less than 50 percent (by weight) very fine sand in the fine-earth fraction, very fine sand, or sandy, including less than 35 percent (by weight) clay in the fine-earth fraction (excluding Vertisols)</td>
</tr>
<tr>
<td>Loamy</td>
<td>Have a texture of loamy very fine sand, very fine sand, or fine, including less than 35 percent (by weight) clay in the fine-earth fraction (excluding Vertisols)</td>
</tr>
<tr>
<td>Coarse-loamy</td>
<td>Have, in the fraction less than 75 mm in diameter, 15 percent or more (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter) and, in the fine-earth fraction, less than 18 percent (by weight) clay,</td>
</tr>
<tr>
<td>Fine-loamy</td>
<td>Have, in the fraction less than 75 mm in diameter, 15 percent or more (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter) and 18 to 35 percent (by weight) clay (Vertisols are excluded).</td>
</tr>
<tr>
<td>Coarse-silty</td>
<td>Have, in the fraction less than 75 mm in diameter, less than 15 percent (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter) and, in the fine-earth fraction, less than 18 percent (by weight) clay</td>
</tr>
<tr>
<td>Fine-silty</td>
<td>Have, in the fraction less than 75 mm in diameter, less than 15 percent (by weight) particles with diameters of 0.1 to 75 mm (fine sand or coarser, including rock fragments up to 7.5 cm in diameter) and, in the fine-earth fraction, 18 to 35 percent (by weight) clay (Vertisols are excluded).</td>
</tr>
<tr>
<td>Clayey</td>
<td>Have between 35 - 60 percent or more (by weight) clay in the whole soil (more than 30 percent in Vertisols)</td>
</tr>
<tr>
<td>Fine</td>
<td>Have between 35 - 60 percent (by weight) clay in the fine-earth fraction</td>
</tr>
<tr>
<td>Very-fine</td>
<td>Have 60 percent or more clay</td>
</tr>
</tbody>
</table>

Relative Soil Particle Sizes
From https://school.discoveryeducation.com/schooladventures/soil/name_soil.html

Common Particle-size classes for Agricultural Soils
From https://masters.agron.iastate.edu/classes/502/lesson01/1.1.1.html
The CSR2 equation then makes a deduction based on the field condition of the mapping unit (F). These are factors that affect productivity, but are not part of the soils inherent geomorphology (Burras et al., 2010). This includes deductions for increasing landscape slope (representative values), increasing flooding and ponding in May, and having a moderately eroded erosion class (Burras et al., 2010). Increasing slopes and moderately eroded topsoil generally lead to a reduction in productivity due to a narrower A horizon. The increase in flooding and ponding in May results in less oxygen in the soil, a restricted crop emergence time period, and denitrification, which translates into a reduction in productivity.
Understanding CSR2?

Available Water Holding Capacity (AWC) - W

The CSR2 equation then makes a deduction based on the available water holding capacity of top 60 inches of soil (W) (Burras et al., 2010). Water accessibility for plant growth is very important and the water storage capacity of soil is critical. As Dr. Burras puts it, “the W factor integrates four properties: texture, organic matter content, structure, porosity throughout the rooting zone” (Burras et al., 2010). As the AWC of the soil decreases, the W deduction increases (or the soil productivity decreases). As you can see from the two illustrations, silt loam soils have the highest available water holding capacities.

<table>
<thead>
<tr>
<th>Textural class</th>
<th>Water holding capacity, inches/foot of soil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse sand</td>
<td>0.25 - 0.75</td>
</tr>
<tr>
<td>Fine sand</td>
<td>0.75 - 1.00</td>
</tr>
<tr>
<td>Loamy sand</td>
<td>1.10 - 1.20</td>
</tr>
<tr>
<td>Sandy loam</td>
<td>1.25 - 1.40</td>
</tr>
<tr>
<td>Fine sandy loam</td>
<td>1.50 - 2.00</td>
</tr>
<tr>
<td>Silt loam</td>
<td>2.00 - 2.50</td>
</tr>
<tr>
<td>Silty clay loam</td>
<td>1.80 - 2.00</td>
</tr>
<tr>
<td>Silty clay</td>
<td>1.50 - 1.70</td>
</tr>
<tr>
<td>Clay</td>
<td>1.20 - 1.50</td>
</tr>
</tbody>
</table>

Water Holding Capacity Varies by Soil Texture

Available Water Capacity over a Range of Soil Textures
From - https://stormwater.pca.state.mn.us/index.php/
Understanding CSR2?

Soil Depth and Tolerable Rate of Soil Erosion - D

The CSR2 equation then makes a deduction based on the RUSLE (Revised Universal Soil Loss Equation) T value, which predicts the tolerable amount of soil loss from a field without hindering crop productivity (D) (Schober, 2013). Dr. Burras states that the T value is really the measure of the resiliency of the soil to erosion. The higher the T value, the lower the CSR2 equation deduction. If a soil series has a T value of 5 tons per acre, the CSR2 deduction is zero (Burras et al., 2010). This implies the soil can tolerate up to 5 tons of annual sheet and rill erosion, and still not lose any productivity. If a soil series has a T value of 1 ton per acre, the CSR2 deduction is 40 (Burras et al., 2010). This implies the soil can only tolerate up to 1 ton of annual sheet and rill erosion, and still not lose any productivity.

Because the average soil erosion in Iowa is 5 tons per acre per year, a low T value of 1 ton per acre implies a reduction in crop productivity.

[Images of sheet and rill erosion with links to resource pages for more information on soil erosion.]
Understanding CSR2?

Expert Judgment - EJ

The CSR2 equation then makes a deduction or an addition based on a complex soil property that requires a crop productivity adjustment. This adjustment is made by mutual consensus between NRCS soil scientists and the ISU representative to the Iowa Cooperative Soil Survey (ISU-IAHEES, 2013). Shallow soils or soils with rock and gravel in stratified layers are the most common soils that need adjustment, because of the difficulty in determining soil productivity (Burras et al., 2010).
Understanding CSR2?

Data for CSR2 Calculation

• The Web Soil Survey website (http://websoilsurvey.sc.egov.usda.gov) can automatically calculate the CSR2 value for any piece of property in the state of Iowa. Instructions for this are found at https://www.extension.iastate.edu/agdm/wholefarm/html/c2-87.html (Johanns, 2014).

• If you wanted to find the actual data that is used to make the CSR2 calculation, this section explains how this is done. The soil survey data is gathered by the NRCS and compiled in the Web Soil Survey website. The data used is gathered from soil surveys that occur on all agricultural land. As the surveys are updated, the data is automatically uploaded into the Web Soil Survey website once a year (Jensen, 2013). This section assumes that the reader is versed in the use of the Web Soil Survey website.
Understanding CSR2?

Data for CSR2 Calculation
• As we stated before, the data we need to calculate the CSR2 equation includes:

\[ CSR2 = S - M - F - W - D \pm EJ, \]

where:
- S is the **taxonomic subgroup class** of the soil series
- M is the **family particle size** class
- F refers to the field conditions of a particular SMU (**slope, flooding, ponding, and erosion class**)
- W is the **available water holding capacity**
- D is a soil depth and erosion factor **RUSLE T value**
- EJ is deductions based on parent material

• The steps to find the data and calculate the CSR2:
  1. **find the CSR2 component values worksheet**,  
  2. **identify the land (area of interest) and soil map units**,  
  3. **get the surveyed data** for the soil map units, and  
  4. **calculate the CSR2 rating** using the appropriate component values.
Understanding CSR2?

1. Find the CSR2 Component Values Worksheet

To find the CSR2 Component Values, go to the ISU Extension website - http://www.extension.iastate.edu/soils/suitabilities-interpretations, and click on equation under Iowa Corn Suitability Rating 2 (CSR2). A four page document will appear (the figure below on the right is from the first page of the document).
Understanding CSR2?

Find the CSR2 Component Values Worksheet

All parameter values for S, M, W, F, D, and EJ are found in this document. Statistical analysis of the CSR values related to the soil series map unit characteristics was used to create the values in the table (Burras et al., 2010).

Table 2. S factors used in the CSR2 formula.

<table>
<thead>
<tr>
<th>Taxonomic Subgroup</th>
<th>S factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aquic Aridic Haplic Haplustalf</td>
<td>72</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrustalf</td>
<td>76</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrastalf</td>
<td>70</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrustalf</td>
<td>66</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrustalf</td>
<td>60</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrastalf</td>
<td>54</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrustalf</td>
<td>48</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrastalf</td>
<td>42</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrastalf</td>
<td>36</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrastalf</td>
<td>30</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrastalf</td>
<td>24</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrastalf</td>
<td>18</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrastalf</td>
<td>12</td>
</tr>
<tr>
<td>Aquic Aridic Haplic Natrastalf</td>
<td>6</td>
</tr>
</tbody>
</table>

Table 3. M, W, and F factors in the CSR2 formula.

<table>
<thead>
<tr>
<th>Family Particle Size Class</th>
<th>F factor</th>
<th>M factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finely divided</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Coarse divided</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Medium divided</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Very coarse divided</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Coarsest divided</td>
<td>20</td>
<td>20</td>
</tr>
</tbody>
</table>

Table 4. Values used in CSR2 formula.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective depth</td>
<td>0.30 m</td>
</tr>
<tr>
<td>Available Water Capacity</td>
<td>0.20 m</td>
</tr>
<tr>
<td>Crop coefficient for water capacity</td>
<td>0.80</td>
</tr>
<tr>
<td>Crop coefficient for water deficit</td>
<td>0.40</td>
</tr>
<tr>
<td>Crop coefficient for water stress</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Table 5. Factors that reduce CSR2 values.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>Erosion hazard class is &quot;high&quot; or &quot;very high&quot;</td>
</tr>
<tr>
<td>D</td>
<td>Erosion hazard class is &quot;extremely high&quot;</td>
</tr>
<tr>
<td>F</td>
<td>Erosion hazard class is &quot;extreme&quot; or &quot;severe&quot;</td>
</tr>
<tr>
<td>M</td>
<td>Erosion hazard class is &quot;moderate&quot;</td>
</tr>
<tr>
<td>W</td>
<td>Erosion hazard class is &quot;light&quot;</td>
</tr>
</tbody>
</table>

Table 6. Map units (MU) with conditions that negate the use of the regular CSR2 formula.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Assigned MU CSR value</th>
</tr>
</thead>
<tbody>
<tr>
<td>All MU</td>
<td>0</td>
</tr>
</tbody>
</table>

CSR2 formula: CSR2 = S*M*W*F*D/EJ
Understanding CSR2?

2. Identify the Land (area of interest) and Soil Map Units

To identify the land and soil map units, go to the web soil survey at http://websoilsurvey.sc.egov.usda.gov and click on the green button (Start WSS). Access your area of interest. Once your area is defined and you click on the soil map tab, you are able to see the different soil map units for your land. The calculation of CSR2 requires finding parameter data of the soil map unit in the web soil survey, and determining the translation factor to use in the CSR2 Equation and Component Value (Burras et al., 2015).

![Web Soil Survey](image-url)
Understanding CSR2?

3. Get the Surveyed Data for the Soil Map Units

To find S and M - go to Soil Data Explorer tab for your AOI and then to Suitabilities and Limitations for Use tab. Look at **Soil Taxonomy Classification** under Land Classification. View the rating:
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

To find S and M - after clicking on the rating button for the **Soil Taxonomy Classification**, the table on the bottom left will appear. Find the corresponding value on the CSR2 Equation and Component Values worksheet (the lower two right figures).

<table>
<thead>
<tr>
<th>Soil Taxonomy Classification — Summary by Map Unit — Black Hawk County, Iowa (IA013)</th>
<th>Map unit symbol</th>
<th>Map unit name</th>
<th>Rating</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>83B</td>
<td>Kenyon loam, 2 to 5 percent slopes</td>
<td>Fine-loamy, mixed, superactive, mesic Typic Hapludolls</td>
<td>13.0</td>
<td>0.4%</td>
<td></td>
</tr>
<tr>
<td>84</td>
<td>Clyde silty clay loam, 0 to 3 percent slopes</td>
<td>Fine-loamy, mixed, superactive, mesic Typic Hapludolls</td>
<td>30.6</td>
<td>18.5%</td>
<td></td>
</tr>
<tr>
<td>133</td>
<td>Colo silty clay loam, 0 to 2 percent slopes, occasionally flooded</td>
<td>Fine-silty, mixed, superactive, mesic Cumulic Endoaquolls</td>
<td>3.1</td>
<td>1.9%</td>
<td></td>
</tr>
<tr>
<td>377B</td>
<td>Dinsdale silty clay loam, 2 to 5 percent slopes</td>
<td>Fine-silty, mixed, superactive, mesic Typic Arguidolls</td>
<td>76.6</td>
<td>47.3%</td>
<td></td>
</tr>
<tr>
<td>382</td>
<td>Maxfield silty clay loam, 0 to 2 percent slopes</td>
<td>Fine-silty, mixed, superactive, mesic Typic Endoaquolls</td>
<td>22.1</td>
<td>13.7%</td>
<td></td>
</tr>
<tr>
<td>426B</td>
<td>Aredale loam, 2 to 5 percent slopes</td>
<td>Fine-loamy, mixed, superactive, mesic Typic Hapludolls</td>
<td>3.3</td>
<td>2.1%</td>
<td></td>
</tr>
<tr>
<td>426C</td>
<td>Aredale loam, 5 to 9 percent slopes</td>
<td>Fine-loamy, mixed, superactive, mesic Typic Hapludolls</td>
<td>2.0</td>
<td>1.3%</td>
<td></td>
</tr>
<tr>
<td>426C2</td>
<td>Aredale loam, 5 to 9 percent slopes, moderately eroded</td>
<td>Fine-loamy, mixed, superactive, mesic Typic Hapludolls</td>
<td>5.2</td>
<td>3.2%</td>
<td></td>
</tr>
<tr>
<td>1226</td>
<td>Lawler loam, 24 to 40 inches to sand and gravel, 0 to 2 percent slopes</td>
<td>Fine-loamy over sandy or sandy-skeletal, mixed, superactive, mesic Aquic Hapludolls</td>
<td>5.3</td>
<td>3.3%</td>
<td></td>
</tr>
<tr>
<td><strong>Totals for Area of Interest</strong></td>
<td></td>
<td></td>
<td><strong>162.0</strong></td>
<td><strong>100.0%</strong></td>
<td></td>
</tr>
</tbody>
</table>

From the Web Soil Survey – soil taxonomy classification

From CSR2 Component Values Worksheet
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

Or another way to find $S$ and $M$ - go to [https://soilseries.sc.egov.usda.gov/osdname.aspx](https://soilseries.sc.egov.usda.gov/osdname.aspx) (USDA-NRCS, 2013). Enter the soil name (e.g., Aredale) and Find Series.
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

To find \textbf{W} - go to Soil Data Explorer tab and then to Soil Properties and Qualities tab. Look at the \textbf{Available Water Capacity} under Soil Physical Properties. Run the \textbf{rating} for 0 to 60 inches. The result is in cm/cm. So, multiply results by 60 inches to get AWC in inches.
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

To find W - after clicking on the rating button for the **Available Water Capacity**, the table on the bottom left will appear. Find the corresponding value on the CSR2 Equation and Component Values worksheet (the lower right figure). The result is in cm/cm. So, multiply 0.17 by 60 inches to get AWC as 10.2 inches.
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

To find $F$, we need to find the representative slope ($F_{\text{slope}}$), the flooding frequency for May ($F_{\text{flooding}}$), the ponding frequency for May ($F_{\text{ponding}}$), and the erosion class ($F_{\text{erosion}}$).

- **To find $F_{\text{slope}}$** - go to Soil Data Explorer tab and then to Soil Properties and Qualities tab. Look at **Representative Slope** under Soil Qualities and Features. View the rating:
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

- **To find $F_{\text{slope}}$** after clicking on the rating button for the **Representative Slope**, the table on the bottom left will appear. Find the corresponding value on the CSR2 Equation and Component Values worksheet (the lower right figure).

<table>
<thead>
<tr>
<th>Map unit symbol</th>
<th>Map unit name</th>
<th>Rating (percent)</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>83B</td>
<td>Kenyon loam, 2 to 5 percent slopes</td>
<td>3.0</td>
<td>13.6</td>
<td>8.4%</td>
</tr>
<tr>
<td>84</td>
<td>Clyde silty clay loam, 0 to 3 percent slopes</td>
<td>1.0</td>
<td>30.6</td>
<td>18.9%</td>
</tr>
<tr>
<td>133</td>
<td>Colo silty clay loam, 0 to 2 percent slopes, occasionally flooded</td>
<td>1.0</td>
<td>3.1</td>
<td>1.9%</td>
</tr>
<tr>
<td>377B</td>
<td>Dinsdale silty clay loam, 2 to 5 percent slopes</td>
<td>4.0</td>
<td>76.6</td>
<td>47.3%</td>
</tr>
<tr>
<td>382</td>
<td>Maxfield silty clay loam, 0 to 2 percent slopes</td>
<td>1.0</td>
<td>22.1</td>
<td>13.7%</td>
</tr>
<tr>
<td>426B</td>
<td>Aredale loam, 2 to 5 percent slopes</td>
<td>4.0</td>
<td>3.3</td>
<td>2.1%</td>
</tr>
<tr>
<td>426C</td>
<td>Aredale loam, 5 to 9 percent slopes</td>
<td>7.0</td>
<td>2.0</td>
<td>1.3%</td>
</tr>
<tr>
<td>426C2</td>
<td>Aredale loam, 5 to 9 percent slopes, moderately eroded</td>
<td>7.0</td>
<td>5.2</td>
<td>3.2%</td>
</tr>
<tr>
<td>1226</td>
<td>Lawler loam, 24 to 40 inches to sand and gravel, 0 to 2 percent slopes</td>
<td>1.0</td>
<td>5.3</td>
<td>3.3%</td>
</tr>
</tbody>
</table>

**Slope values:**
- slope is NULL: 0
- slope RV < 2: 0
- slope RV < 5: 5
- slope RV < 9: 15
- slope RV ≥ 9: 3 * slope RV

From CSR2 Component Values Worksheet

From the Web Soil Survey – soil taxonomy classification
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

- **To find** $F_{\text{flooding}}$ - go to Soil Data Explorer tab and then to Soil Properties and Qualities tab. Look at **Flooding Frequency Class** under Water Features. View the **rating**:
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

- To Find $F_{\text{flooding}}$ - after clicking on the rating button for the **Flooding Frequency Class**, the table on the bottom left will appear. Find the corresponding value on the CSR2 Equation and Component Values worksheet (the lower right figure).

** Note – for occasional or frequent ratings, the modifier information is at the Iowa Field Office Technical Guide website ([https://efotg.sc.egov.usda.gov](https://efotg.sc.egov.usda.gov)). The next slide has the instructions to get to the form.
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

➢ To Find Occasional or Frequent Ratings – go to the Iowa Field Office Technical Guide website https://efotg.sc.egov.usda.gov. Click on Iowa and then on Black Hawk County. Pull up Section II. Then, click on Soils Information, Soil Survey Area, Black Hawk, Soil Tables, and Water Table and Flooding.

Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

➢ To Find Occasional or Frequent Ratings – after clicking on Water Table and Flooding, the table on the bottom left will appear. Find the corresponding value on the CSR2 Equation and Component Values worksheet (the lower right figure).

From CSR2 Component Values Worksheet

From the Iowa Field Office Technical Guide website
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

➢ **To find** $F_{\text{ponding}}$ - go to Soil Data Explorer tab and then to Soil Properties and Qualities tab. Look at **Ponding Frequency Class** under Water Features. View the **rating**:
Understanding CSR2?
Get the Surveyed Data for the Soil Map Units

➢ To Find $F_{\text{ponding}}$ - after clicking on the rating button for the **Ponding Frequency Class**, the table on the bottom left will appear. Find the corresponding value on the CSR2 Equation and Component Values worksheet (the lower right figure).

From the Web Soil Survey – soil taxonomy classification

From CSR2 Component Values Worksheet

** Note – for occasional or frequent ratings, the detailed information is at the Iowa Field Office Technical Guide website (https://efotg.sc.egov.usda.gov). The previous slide (slide 53) has the instructions to get to the form.
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

➢ **To find F\textsubscript{erosion}** - go to Soil Map tab and then to Map Unit Legend. Look at the Kenyon loam and Aredale loam soil map unit:
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

- **To Find F_{erosion}** - after clicking on the Map Unit Legend for the AOI, the table on the bottom left will appear. Look at the **map unit name** and note if the term “moderately eroded” or “channeled” is included. Find the corresponding value on the CSR2 Equation and Component Values worksheet (the lower right figure).

![Map Unit Legend]

<table>
<thead>
<tr>
<th>Map Unit Symbol</th>
<th>Map Unit Name</th>
<th>Acres in AOI</th>
<th>Percent of AOI</th>
</tr>
</thead>
<tbody>
<tr>
<td>83B</td>
<td>Kenyon loam, 2 to 5 percent slopes</td>
<td>13.6</td>
<td>8.4%</td>
</tr>
<tr>
<td>84</td>
<td>Clyde silt loam, 0 to 3 percent slopes</td>
<td>30.6</td>
<td>18.9%</td>
</tr>
<tr>
<td>133</td>
<td>Colo silt loam, 0 to 2 percent slopes, occasionally flooded</td>
<td>3.1</td>
<td>1.9%</td>
</tr>
<tr>
<td>377B</td>
<td>Dinsdale silt loam, 2 to 5 percent slopes</td>
<td>76.6</td>
<td>47.3%</td>
</tr>
<tr>
<td>382</td>
<td>Maxfield silt loam, 0 to 2 percent slopes</td>
<td>22.1</td>
<td>13.7%</td>
</tr>
<tr>
<td>426B</td>
<td>Display map unit description slopes</td>
<td>3</td>
<td>2.1%</td>
</tr>
<tr>
<td>426C</td>
<td>Aredale loam, 5 to 9 percent slopes</td>
<td>2.0</td>
<td>1.3%</td>
</tr>
<tr>
<td>426C2</td>
<td>Aredale loam, 5 to 9 percent slopes, moderately eroded</td>
<td>5.2</td>
<td>3.2%</td>
</tr>
<tr>
<td>1226</td>
<td>Lawler loam, 0 to 2 percent slopes, rarely flooded</td>
<td>5.3</td>
<td>3.3%</td>
</tr>
</tbody>
</table>

**Totals for Area of Interest**: 162.0 100.0%

![Other F factor Conditions]

<table>
<thead>
<tr>
<th>Component Local phase is “channeled”</th>
<th>F factor - local</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>40</td>
</tr>
</tbody>
</table>

**Component erosion class is “2” - moderately eroded**: 3

From the Web Soil Survey – soil taxonomy classification

From CSR2 Component Values Worksheet
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

To find D, go to Soil Data Explorer tab and then to Soil Properties and Qualities tab. Look at T Factor under Soil Erosion Factors. View the rating:
Understanding CSR2?

Get the Surveyed Data for the Soil Map Units

**To find D**, after clicking on the rating button for the **T Factor**, the table on the bottom left will appear. Find the corresponding value on the CSR2 Equation and Component Values worksheet (the lower right figure).

![CSR2 Equation and Component Values Worksheet](From CSR2 Component Values Worksheet)

From the Web Soil Survey – soil taxonomy classification
Understanding CSR2?

**Get the Surveyed Data for the Soil Map Units**

To find EJ, use the CSR2 Equation and Component Values worksheet. Go to Table 5a and 5b, and look to see if your soil series name is listed and has a deduction or addition. If the soil series name is not in Tables 5a and 5b, there is no EJ factor.

```
<table>
<thead>
<tr>
<th>Series</th>
<th>EJ Deduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adair</td>
<td>10</td>
</tr>
<tr>
<td>Armstrong</td>
<td>10</td>
</tr>
<tr>
<td>Ashgrove</td>
<td>10</td>
</tr>
<tr>
<td>Bucknol</td>
<td>10</td>
</tr>
<tr>
<td>Carlin</td>
<td>15</td>
</tr>
<tr>
<td>Clarinda</td>
<td>15</td>
</tr>
<tr>
<td>Clearfield</td>
<td>20</td>
</tr>
<tr>
<td>Donnan</td>
<td>20</td>
</tr>
<tr>
<td>Galland</td>
<td>15</td>
</tr>
<tr>
<td>Keswick</td>
<td>10</td>
</tr>
<tr>
<td>Lagonda</td>
<td>5</td>
</tr>
<tr>
<td>Lamoni</td>
<td>10</td>
</tr>
<tr>
<td>Lineville</td>
<td>20</td>
</tr>
<tr>
<td>Malvern</td>
<td>20</td>
</tr>
<tr>
<td>Mystic</td>
<td>15</td>
</tr>
<tr>
<td>Northboro</td>
<td>15</td>
</tr>
<tr>
<td>Rinda</td>
<td>15</td>
</tr>
</tbody>
</table>
```

```
<table>
<thead>
<tr>
<th>Series</th>
<th>EJ Deduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cresco</td>
<td>5</td>
</tr>
<tr>
<td>Cresken</td>
<td>5</td>
</tr>
<tr>
<td>Protivin</td>
<td>5</td>
</tr>
<tr>
<td>Jameston</td>
<td>5</td>
</tr>
<tr>
<td>Lourdes</td>
<td>5</td>
</tr>
<tr>
<td>Riceville</td>
<td>5</td>
</tr>
</tbody>
</table>
```

```
<table>
<thead>
<tr>
<th>Series</th>
<th>EJ Deduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farrar</td>
<td>15</td>
</tr>
<tr>
<td>Olin</td>
<td>10</td>
</tr>
</tbody>
</table>
```

```
<table>
<thead>
<tr>
<th>Series</th>
<th>EJ Deduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appanoose</td>
<td>15</td>
</tr>
<tr>
<td>Kniffin</td>
<td>15</td>
</tr>
<tr>
<td>Seymour</td>
<td>10</td>
</tr>
<tr>
<td>Rathbun</td>
<td>15</td>
</tr>
</tbody>
</table>
```

```
<table>
<thead>
<tr>
<th>Series or Map unit symbol</th>
<th>EJ Addition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macksburg</td>
<td>15</td>
</tr>
<tr>
<td>Mahaska</td>
<td>15</td>
</tr>
<tr>
<td>Kelona</td>
<td>10</td>
</tr>
<tr>
<td>Rowley</td>
<td>10</td>
</tr>
<tr>
<td>All components in map units 221B</td>
<td>10</td>
</tr>
<tr>
<td>Waukee</td>
<td>10</td>
</tr>
</tbody>
</table>
```

From CSR2 Component Values Worksheet
Understanding CSR2?

4. Example Calculation of CSR2 Value of Kenyon Loam (83B 2-5% Slope)

- Calculate the CSR2 value of Kenyon loam (83B 2-5% slope)

- At this point, we have the soil series data (previous slides) for the CSR2 calculation. We also have the CSR2 component value sheets that lists the starting number (S) and the deductions (M,F,W,D).
Understanding CSR2?

Example Calculation of CSR2 Value of Kenyon Loam (83B 2-5% Slope)

- Correlate the NRCS data (parameters) to the CSR2 component values.

- Parameters $S$ and $M$ are determined from the **TAXONOMIC CLASS** (slide 43-44). For Kenyon loam (83B 2-5%):
  - Taxonomic subgroup class is **Typic Hapludolls**, and the family particle size is **Fine-loamy**.
    - For Typic Hapludolls, this translates to $S = 100$.
    - For Fine-loamy, this translates to $M = 4$.

- Parameter $W$ is determined from the **available water holding capacity (AWC)** of the series in the top 60 inches of soil (slide 46-47). For Kenyon loam (83B 2-5%):
  - AWC is 10.2 inches (0.17cm/cm x 60 inches), and this translates to $W = 0$. 
Understanding CSR2?

Example Calculation of CSR2 Value of Kenyon Loam (83B 2-5% Slope)

• Parameter $F$ is determined by the **field condition** of the map unit. This includes the **representative value for slope**, the **flooding frequency for May**, the **ponding frequency for May**, and the **erosion class** (slides 48-57). For Kenyon loam (83B 2-5%):

  - The representative value for slope is 3, and this translates to $F_{\text{slope}} = 5$.
  - The flooding frequency is none, and this translates to $F_{\text{flooding}} = 0$.
  - The ponding frequency is none, and this translates to $F_{\text{ponding}} = 0$.
  - The erosion class is not moderately eroded or channeled, and this translates to $F_{\text{erosion}} = 0$.

Therefore, $F = F_{\text{slope}} + F_{\text{flooding}} + F_{\text{ponding}} + F_{\text{erosion}} = 5$. 
Understanding CSR2?

Example Calculation of CSR2 Value of Kenyon Loam (83B 2-5% Slope)

- Parameter $D$ is determined by the tolerable rate of soil erosion that can occur without affecting crop productivity (RUSLE T factor – slide 58-59). For Kenyon loam (83B 2-5%):
  - T factor is 5 tons per acre per year, and this translates to $D = 0$.

- Parameter $EJ$ is determined by looking for the soil series name in tables 5a and 5b in the file – Corn Suitability Rating 2 Equation and Component Values. Click on equation under Iowa Corn Suitability Rating 2 (CSR2) - http://www.extension.iastate.edu/soils/suitabilities-interpretations. For Kenyon loam (83B 2-5%):
  - There are no EJ deductions or additions (Kenyon is not listed – slide 60), and this translates to $EJ = 0$.

- Finally, the calculated CSR2 for Kenyon (83B 2-5%):
  - $CSR2 = S - M - F - W - D +/- EJ$
  - $= 100 - 4 - 5 - 0 - 0 +/- 0 = 91$
Another way to find the soil data is to use Google Earth with the Web Soil Survey. Steps to set this up include:

1. Make sure Google Earth is running on your computer.
3. Click on Soil Web in the quick links to get to UC Davis California Soil Resource Lab.
Understanding CSR2?

Another Method to Collect Data for CSR2 Calculation

Click on SoilWeb Earth and download Soilweb.kmz in Google Earth.

Soil Web Earth

Soil survey data are delivered dynamically in a KML file, allowing you to view mapped areas in a 3-D display. You must have Google Earth or some other means of viewing KML files installed on your desktop computer, tablet, or smartphone.
Understanding CSR2?

Another Method to Collect Data for CSR2 Calculation

After loading Google Earth with Web Soil Survey, search and pull up any piece of agricultural land in the US. The soil map is overlaid on the Google Earth map.
Understanding CSR2?

Getting Data for CSR2 Calculation

To find **S, M, W and D**, click on any soil series and the soil data pops up. Then, click on the component name to get the component details. **Currently, the field conditions, F, are not available with the Web Soil Survey overlay on Google Earth.**
Differences Between CSR and CSR2

• CSR2 can be calculated using available online data, while CSR values cannot

• CSR2 values are same statewide for a SMU, while CSR values vary by county (due to climate limitation in CSR)

• Climate limitation is not included in CSR2 (Sassman et al., 2015)
  ➢ Under CSR, north and west counties were thought to be climate-limited

• CSR and CSR2 are statistically similar, but not always the same
  ➢ Northern and Western counties will see an increase
Summary

- CSR2 is an amazingly easy to understand soil productivity index.
  - It starts with a value that is defined by its taxonomic subgroup class for the dominant soil series. Then, soil productivity deductions are made for family particle sizes, increasing slopes, increasing May flooding and ponding, moderate erosion class, decreasing available water holding capacity in the top 60 inches, and less top soil depth (as measured by RUSLE T factors that are less than 5).
- CSR2 is data driven, while CSR is more expert judgment based.
- CSR2 is calculated using online soil survey data from the NRCS, which includes dominant and minor soils in each soil mapping unit (Burras et al., 2010).
- CSR2 is calculated using weighted average of soil components of SMU.
- NRCS updated the Web Soil Survey in January, 2014 to include CSR2 values. CSR is not available on the Web Soil Survey anymore.
- CSR2 can be trusted.
Summary – Iowa Soil is Productive!

Picture by John Chehak
Quiz

1. The main reason that the US government wants to rate the soil productivity of cropland is to:
   a) Equalize land values for tax assessment. *
   b) Keep government workers busy.
   c) Keep statistics.
   d) Determine potential yields for pumpkins.

2. The Division of Soils, which was created by the USDA in 1894, first wanted to examine what soil conditions:
   a) Soil moisture and temperature. *
   b) Soil texture and particle size.
   c) The pH and CEC.
   d) Soil depth and erosion class.

3. Iowa’s CSR was published and released in:
   a) 1971  *
   b) 1945
   c) 1934
   d) 2013

4. Which of the following is not an assumption for Iowa’s CSR index:
   a) Terracing when needed  *
   b) Adequate management
   c) Artificial drainage where required (tiling)
   d) Natural weather conditions
References


Burras, C.L. 2013. Implementation of CSR2 at Iowa State University. 86th Annual Soil Management & Land Valuation Conference, Iowa State University.


References


Jensen, J. 2013. CSR Gets a Makeover in Forming the New CSR2 Productivity Index. [Online]. Available at https://www.extension.iastate.edu/agdm/articles/others/JenSept13.html. Iowa State University Extension and Outreach, AgDM Newsletter, September 2013


References


References

