STUDENT UNDERSTANDING OF SOIL CLASSIFICATION USING THE *SIMPLIFIED GUIDE TO SOIL TAXONOMY*

by

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Abstract

Soil Taxonomy is the official soil classification system used in the United States and many other countries. Any soil in the world can be classified from the order to the family level using a set of classification keys that are currently in an eleventh edition. The classification system is quite complex and can be too complicated for beginning soil science students to understand and use. Thus, a national advisory working group of the National Cooperative Soil Survey developed an abbreviated guide called the *Simplified Guide to Soil Taxonomy*. The goal of the simplified guide is to help reduce the complexity of soil taxonomy and aid in the classification of soils from the order to the great group level. The purpose of this study was to evaluate the effectiveness of the simplified guided when used by students in soil science courses to classify soils as compared to traditional methods using the more detailed keys. Classes at Kansas State University were used in the study and included the laboratory sections of AGRON 305 (Soils) and AGRON 515 (Soil Genesis and Classification). Student learning was evaluated using pre and post-test scores, assignments, and evaluation surveys. Results from the fall and spring semesters of AGRON 305 vary based on pre and post test scores and the assignment. Written evaluations indicated that both methods were easy to understand, especially as the lab progressed, but students responded more favorably to the abbreviated descriptions of taxa, pictures, and hyperlinks associated with the simplified guide. The *Simplified Guide to Soil Taxonomy* can be used in introductory soils courses. However, it is more suited for mid to upper level soil science courses, such as AGRON 515, where students responded favorably to the shorter and more comprehensible descriptions of taxa at the order, suborder, and great group level.

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Dedication

This work is dedicated to my family.

Chapter 1 - Introduction

Soil Taxonomy (Soil Survey Staff, 1999) is the official soil classification system used in the United States and other parts of the world. *Keys to Soil Taxonomy* (Soil Survey Staff, 2010) is a publication of the taxonomic key necessary to classify soils and provides users with recent changes in the system, including amendments to incorporate newly described soils and their properties. Soils can be classified to the order, suborder, great group, subgroup, and family level using *Keys to Soil Taxonomy*. The system was developed and is maintained by the United States National Cooperative Soil Survey (NCSS) program, or the "Soil Survey Staff," that is comprised of national, state, university, and private soil scientists as well as international communities. Due to the diversity of soils and because the soil classification system is comprehensive so that any soil in the world can be classified, the system is extremely detailed and complex. For beginning soil scientists and students, soil taxonomy can be a daunting and complicated system to learn. Thus, a national advisory working group of the NCSS developed an abbreviated guide called the *Simplified Guide to Soil Taxonomy* (Soil Survey Staff, 2013). The goal of the simplified guide is to help reduce the complexity of soil taxonomy and aid in the classification of soils to the great group level for students studying soil science or for individuals without an extensive background in soil science. The guide is presented in three parts. Each part covers a specific aspect of *Soil Taxonomy* (Soil Survey Staff, 2013). Included in the guide are flow charts, diagrams, colored pictures, maps, and expanded descriptions of soil orders aimed at improving the users understanding of soil classification. The guide is in an electronic format that allows the use of hyperlinks for quick referencing and to assist in navigation. The basis for this study is to determine whether students in beginning soil science courses can correctly classify soils using the new guide as compared to traditional methods. Classes included in this study were AGRON 305 (Soils) laboratory sections, where students used either the simplified guide or the required textbook for the course to classify soils to the order level, and AGRON 515 (Soil Genesis and Classification), where students used both the simplified guide and *Keys to Soil Taxonomy* (Soil Survey Staff, 2010) to classify soils to the great group level. Lesson design was based off the triangulation concept (Sagor, 1992), which involves using multiple measures to collect data. Student learning was gauged based on Sousa's (2011) concept of sense and meaning.

Study Objectives

The objectives of this study were to; (a) evaluate the effectiveness of the simplified guide to classify soils as compared to the more detailed traditional methods for students enrolled in AGRON 305 (Soils) and AGRON 515 (Soil Genesis and Classification) and (b) assess students' prior knowledge of soil classification and how that correlates to their correct use of the simplified guide and traditional method and (c) to assess student learning based on triangulation and evaluating the presence of sense and/or meaning as a result of using different soil classification systems.

Chapter 2 - Literature Review

Background on Soil Classification

The study of soil science in the United States is relatively young, beginning a little over a century ago (Helms et al., 2002). Soil was first largely regarded as weathered rock. As a result, the geologic origin of the mineral fraction was considered one of the most important properties for soil classification (Smith, 1983). Through field studies and research, soil scientists began to understand the complexity of soil. They started to recognize that the formation of parent material through geological processes was only one of the multiple interconnected processes responsible for developing individual, distinctive soil bodies (Helms et al., 2002). This concept originated in Russia. A very different scientific classification was produced at a Russian school of agriculture and forestry founded by Vasily Dokuchaev, who developed the concept of soils as natural bodies with properties due to climate, living organisms, parent rock, and relief. He also mentioned time or age, but did not use it in his classification of soil (Arnold, 1983). These concepts were brought forth by several different soil scientists in the United States, beginning with George Coffey (Smith, 1983).

In 1912, George Nelson Coffey applied Russian theories to the soils he was studying in the United States. These theories were developed from the works of Dokuchaev and his followers (Smith, 1983). They centered on the idea that several interrelated factors of soil formation create distinctive, natural soil bodies (Helms et al., 2002). However, according to Helms (2002), Coffey thought the Russian classification system placed too much emphasis on climate as a genetic factor. Coffey added the unique, and now accepted, idea that soil classification should be based on measured and observed characteristics and not on one or more genetic processes (Helms et al., 2002). However, Coffey's ideas were rejected and instead, Curtis Marbut is credited for introducing the Russian theories to the United States (Helms et al., 2002). After reading Glinka's (a member of the Russian school) publication of the Russian concepts, Marbut brought the idea emphasizing soil profile characteristics for classification of soils rather than focusing on the geologic origin to American soil scientists. In 1928, Marbut published an outline form of his classification system based on eight properties he considered to contribute significantly to the differentiation of a soil series (Smith, 1983). According to Helms et al.

(2002), in 1935, Marbut published a soil classification in the *Atlas of American Agriculture* (Marbut, 1935). Out of Marbut's system arose two classifications of soils. The first placed soils into types and series and the other into great soil groups. Both carried over into the next classification (Baldwin et al., 1938).

Charles Kellogg followed Marbut as head of the U.S. soil survey and initiated the work that eventually ended in a new soil classification system. In 1938, Kellogg, along with Mark Baldwin and James Thorp, published a revised version of Marbut's classification system. It was published in the 1938 Yearbook of Agriculture, *Soils and Men* (Baldwin et al., 1938). Another revision was published in 1949 (Helms et al., 2002). Kellogg's experience with these early classification systems found inconsistencies in classifying individual soils into the upper-level classification groups. To resolve these anomalies, Kellogg sought the assistance of Guy D. Smith, who was given the critical job of leading the effort to develop a new soil classification system. This system was ultimately published as *Soil Taxonomy* (Soil Survey Staff, 1975). Before starting work on *Soil Taxonomy*, soil scientists agreed that it would be best developed through a series of approximations. The approximations would be distributed for use to as many people as possible. They would be revised and edited based on the suggested criticisms (Smith, 1983). The *7th Approximation* (Soil Survey Staff, 1960) was the first and last approximation published. The first published edition of *Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys* was in 1975 (Soil Survey Staff, 1975) and emphasized qualitative and quantitative definitions and descriptions of soil characteristics of individual soil series. The increased precision helped build interpretations for safe and efficient uses of the soil (Helms et al., 2002). As knowledge continued to increase, soil taxonomy was revised and changed to account for new information, which resulted in the second edition of Soil Taxonomy (Soil Survey Staff, 1999).

A major strength of *Soil Taxonomy* is the way in which it categorizes individual soils. As stated by the Soil Survey Staff (1999), "the primary objective of soil taxonomy is to establish hierarchies of classes that permit us to understand, as fully as possible, the relationship among soils and between soils and the factors responsible for their character". *Soil Taxonomy* provides for a six level hierarchy with the first five levels in an eliminatory key format. These levels include order, suborder, great group, subgroup, and family. Although the series level is part of the hierarchy, series classification must be accomplished by comparing soil properties to a data base of Official Series Descriptions (see USDA-NRCS, 2014).

In this classification system, the names of classes are descriptive and built from scientific terms. Eswaran (2003) explains that "*Soil Taxonomy* is structured as a nested hierarchy, in which classes of the lower levels are an integral part of and confined by the defining properties of the classes at higher levels." With these connections between the levels in a hierarchy, one can appreciate and recognize the functional relationships between classes (Eswaran, 2003).

Although very precise, *Soil Taxonomy* is very complex and can be very hard to follow for the untrained user. For example, the classification fine, smectitic, mesic Typic Argiustoll provides a trained pedologist with important information. To an untrained user, such as a college student, engineer, or the general public, this classification provides little to no information. In addition, since *Soil Taxonomy* was written by many authors, the writing style is not consistent. Also, there are no colored pictures (Galbraith et al., 2014).

In order to assist novice users, a national advisory working group of the National Cooperative Soil Survey developed an abbreviated guide called the *Simplified Guide to Soil Taxonomy* (Soil Survey Staff, 2013). This guide is not intended to replace *Keys to Soil Taxonomy* (a subset of *Soil Taxonomy*), but rather to reduce the complexity and aid in the classification of soils to the great group level. As with any simplified classification key, it is difficult to obtain 100% accuracy because information has been left out. Thus, the workgroup set a goal of 90% accuracy. The guide consists of three separate parts that corresponds to *Keys to Soil Taxonomy*. The three parts are; Part 1: How to use this Version of the Keys, Part 2: Diagnostic Horizon and Features, and Part 3: Keys-Orders, Suborders, and Great Groups. Included in the three parts are flow charts, diagrams, colored pictures, maps and expanded descriptions of soil orders designed to improve understanding of soil classification. The simplified guide is available in an electronic format that allows the use of hyperlinks for quick reference and to assist in navigation. Compared to the quantitative limits and technical guide used in Keys, the simplified guide uses concept statements and a more visual approach for teaching (Galbraith et al., 2014).

Why Classify Soils?

Humans classify things in order to organize information and to makes sense of the world (Brady and Weil, 2009). Objects are classified according to relationships and the system becomes a scientific model of the topic of interest. The model describes and explains our current understanding of these relationships (Eswaran, 2003), thus taxonomies are tools made for a specific purpose and are not truths to be discovered (Smith, 1983). According to Smith (1983) and Soil Survey Staff (1999), the original purpose of a new soil classification system or *Soil Taxonomy* was to improve the soil survey by addressing the problems of interpretations by its users. When developing *Soil Taxonomy,* Smith (1983) said “The aim of *Soil Taxonomy* was to devise taxa about which the largest number of important statements could be made. The statements that were important to the purposes of the soil survey were interpretations about the use and management of soils, not about their genesis”. In the past few decades, *Soil Taxonomy* has evolved into a form of communication in soil science. The primary objective of soil taxonomy defined in *Soil Taxonomy* (Soil Survey Staff, 1999) “is to establish hierarchies of classes that permit us to understand, as fully as possible, the relationship among soils and between soils and the factors responsible for their character.” The second objective is to offer a way of enhancing communication in the soil science discipline (Soil Survey Staff, 1999). With a universal language, soil classification allows people to take information gathered from research and experience at one location and used it to predict the behavior of similar soils in another place (Brady and Weil, 2009).

Classification is a broader term than taxonomy. Taxonomy is included in classification, but classification also involves grouping soils based on limitations that impact practical purposes, such as soil limitations that affect construction of buildings. Taxonomy on the other hand deals mainly with relationships. It is important to remember that classifications are made to suit a purpose and are not truths to be discovered. A perfect classification system would be flawless when used for its intended purpose (Soil Survey Staff, 1999).

Background on Student Learning

According to Sousa (2011), “learning is the process by which we acquire new knowledge and skills.” This process, however, occurs in the mind and is a biological process. Thus, learning can only be inferred to have taken place through students’ products or performances (Ambrose et al., 2010). To develop lesson plans that emphasize student learning, it is essential for teachers to understand how the brain processes information, as well as the concept of sense and/or meaning.

Sousa (2011) suggests an information processing model that represents a simplified description of what the brain does with information it receives from the environment (Figure 2.1).

Sousa's (2011) model begins with the senses. The brain takes in information detected by the five senses: sight, hearing, smell, touch and taste. Over an individual's lifetime, sight, hearing, and touch contribute the most to learning. In the classroom, students are gathering information through lecture and laboratory activities. Once taken in, the information travels to the sensory register. Represented as blinds, the sensory register filters the new data to determine its importance. In less than a second, the information is filtered out as insignificant or moved into the immediate memory. Sousa (2011) describes the immediate memory as a clipboard, where information is placed temporarily until a choice is made on how to dispose of it. This decision is based on the individual's experiences and whether or not the item is of importance. After approximately thirty seconds, the decision is made and the information is discarded or moved into the working memory. Also a temporary memory, the working memory is where ideas are assimilated, broken down, or reworked for eventual storage elsewhere. Once again, information can be dropped if deemed unimportant or sent to long term storage if sense and meaning are present.

According to Sousa (2011), teachers should plan their lessons around two basic questions. The first question is "Does this make sense?" How students answer this question determines whether or not they understood the material. Does the item "fit" into their understanding of how the world works based on their past experiences? The second question is "Does this have meaning?" The answer to this question determines whether the material is relevant to the student. Whether or not the information has meaning depends on the individual and again is influenced by their experiences. Of the two, meaning has the greater influence on memory storage. Student learning will increase if the student can find a connection between the new information they are receiving and their past experiences. Ambrose et al. (2010) also states that the previous knowledge students bring into the classroom influences their filtering and interpretation of the new information they are learning. If the learner's prior knowledge is accurate and stimulated, it offers a solid foundation for constructing new knowledge (Ambrose et al., 2010).

Because sense and meaning are independent of each other, it is possible for information to be stored without both being present. It is possible to remember something that makes sense but has no meaning or something that has meaning but makes no sense. However, the probability of storing information significantly increases if both sense and meaning are present (Sousa, 2011). Figure 2.2 shows how the probability of an individual to store new information varies depending on the presence or absence of sense and/or meaning. The concept of having sense and meaning present is important for teachers as they develop curricula for the classroom. Emphasizing the connection between past experiences and the curriculum will enhance student retention of the new knowledge (Sousa, 2011).

If the student deems the information to have sense and meaning, they will then place the information in long term storage. Represented as file cabinets in the model, information in long-term storage is filed away in some type of order and can be retrieved at a later time (Sousa, 2011). The gained knowledge forms the foundation for their view of the world. Sousa (2011) continues on to further explain how past experiences shape self-concept, which is the way a person views themselves in the world. These emotions dictate whether the experiences are stored as positive or negative. If negative, the new learning could be rejected (Sousa, 2011).

Figures

Figure 2.1 The Information Processing Model explains how the brain processes information from the environment (Sousa, 2011, pg. 43).

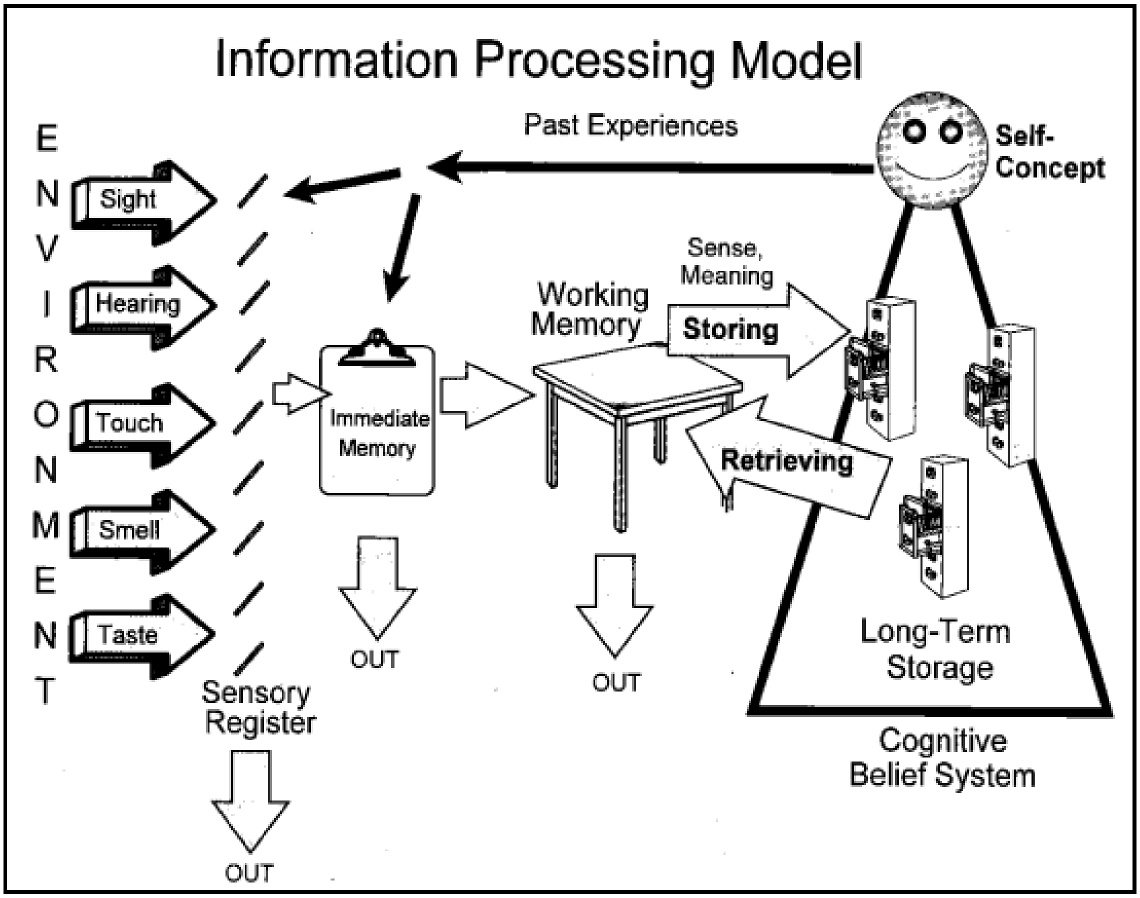
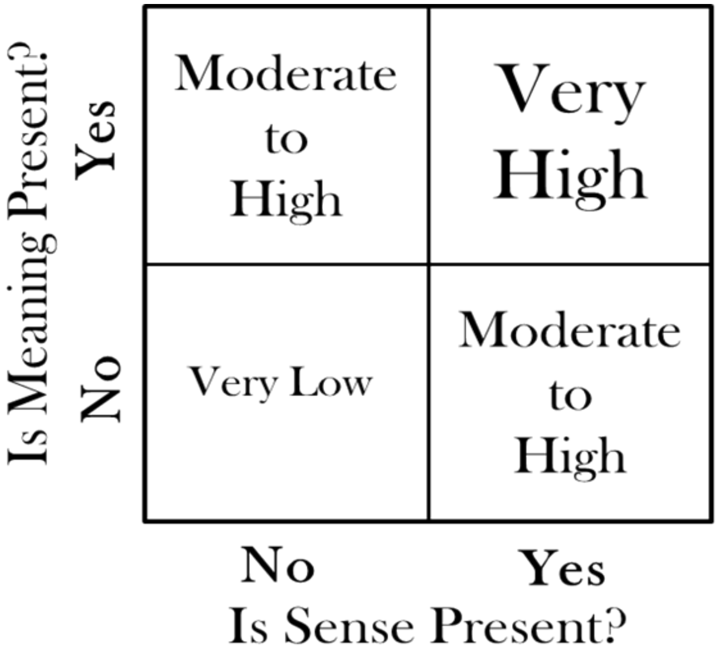


Figure 2.2 The probability of an individual to store new information varies depending on the presence of sense and/or meaning (Sousa, 2011, pg. 53).



Chapter 3 - Teaching with the *Simplified Guide to Soil Taxonomy*

Introduction

Soil Taxonomy can be intimidating for beginning soil science students to understand and use. In order to help students learn the fundamental concepts of soil classification, a national advisory working group of the National Cooperative Soil Survey developed an abbreviated guide called the *Simplified Guide to Soil Taxonomy*. The simplified guide has many features that make it easy to use and understand, including colored pictures, flow charts, embedded hot links and narrative descriptions of the soil orders, diagnostic horizons, and temperature and moisture regimes. The simplified guide is currently in its first version and is being tested in college classrooms. The purpose of this study was to evaluate the effectiveness of the simplified guided when used by beginning soil science students to classify soils as compared to traditional methods. Classes in the study included AGRON 305 (Soils) laboratory sections and AGRON 515 (Soil Genesis and Classification). Student learning was evaluated using pre and post-test scores, assignments, and evaluation surveys.

Materials and Methods

Background on AGRON 305 (Soils)

Students enrolled in AGRON 305 (Soils) attend a 50 minute lecture period three times a week and a two-hour laboratory period once a week. In the fall 2013 semester, there were 116 students enrolled and 119 in the Spring of 2013. In both semesters, there were a total of five lab sections with a range of 18-25 students in each section. Three sections were taught on Tuesday, at 9:30 a.m., 12:30 p.m., and 2:30 p.m. and two sections were taught on Thursday, at 9:30 a.m. and 12:30 p.m. One lab period in each semester was used to teach soil classification. In each semester, three of the lab sections were taught using the new *Simplified Guide to Soil Taxonomy*. Two of the lab sections were taught using the required textbook for the course, *Elements of the Nature and Properties of Soils* (Brady and Weil, 2009), which was considered a traditional method.

In the fall 2013 semester, the Tuesday 12:30 p.m. and both Thursday classes used the simplified guide. The 9:30 a.m. and 2:30 p.m. sections on Tuesday used the textbook. The Tuesday 9:30 a.m. and 12:30 p.m. class was taught by Dr. Steve Thien, the Tuesday 2:30 p.m. and the Thursday 12:30 p.m. were taught by me. A fellow graduate teaching assistant, Megan Brown, taught the Thursday 9:30 a.m. section.

In the spring 2014 semester, the lab times remained the same, but I was the only instructor for all of the classification labs. The Tuesday 9:30 a.m., 12:30 p.m., and Thursday 9:30 a.m. classes used the *Simplified Guide to Soil Taxonomy.* The Tuesday 2:30 p.m. and Thursday 12:30 p.m. used the textbook. Classes will be compared two ways. First, all textbook classes will be compared to all classes who used the simplified guide. Secondly, two textbook classes and two simplified guide classes from each semester (8 total) will be compared. For the fall semester, the two sections taught by Dr. Thien and the two sections taught by myself will be used for comparison. The section omitted was taught by another graduate teaching assistant. That class was removed to eliminate teaching style as a factor, as well as to have similar number of students for each method. For the spring semester, the Tuesday 12:30 and 2:30 classes and both Thursday classes were used to interpret statistical data. This was to keep methods consistent between semesters. The lab periods being compared between semesters are not the same days and time due to adverse weather conditions in the spring semester, where lab periods were cancelled, and the course schedule had to be adjusted. Student responses totaled 84 for the fall semester and 88 for the spring semester. Due to two students failing to turn in all of the handouts, only 82 student responses in the fall will be used to calculate statistics on assignments and pre/post-tests. Table 3.1 lists the laboratory sections, teachers, methods, and total number of students.

Background on AGRON 515 (Soil Genesis and Classification)

Students enrolled in AGRON 515 (Soil Genesis and Classification) attended a 50 minute lecture period on Monday and Wednesday and a 3-hour laboratory period on Thursday. A total of 13 students were enrolled in the spring 2014 semester. A recommended prerequisite for the class is AGRON 305 (Soils) or an introductory geology course. Class and laboratory periods involving soil classification were taught by the primary instructor, Dr. Michel Ransom, and me.

Description of the Research Process for AGRON 305 (Soils)

One two-hour AGRON 305 (Soils) laboratory out of the semester was used for teaching soil classification. The soil classification lab was designed to guide students through the process of classifying soils to the order level using one of two different classification methods when given pedon data. The pedon data were collected from the National Cooperative Soil Survey Soil Characterization Database (National Cooperative Soil Survey, 2014). The two methods included the *Simplified Guide to Soil Taxonomy* (Soil Survey Staff, 2013) or the course textbook, *Elements and Properties of Soils* (Brady and Weil, 2009). The development of the lab activity was based on the following two questions associated with content and procedure: 1) What do we want the students to learn? and 2) How will we help the students learn the material? Lesson plans were guided by these two questions along with suggested lesson designs from Sousa (2011) and Sagor (1992).

The first step to designing the soil classification laboratory was to answer the question "What do we want students to learn by the end of the class?" To answer this question, learning outcomes were developed. Learning outcomes are statements that help instructors more precisely tell students what they are expected to be able to do after the learning activity. Learning outcomes were developed based on Bloom's taxonomy (Bloom, 1956), which is a widely used and tested model that categorizes learning and is used to determine the complexity of learning throughout an activity. The six levels of Bloom's taxonomy, as revised in 2001, from least to most complex are remember, understand, apply, analyze, evaluate, and create (Sousa, 2011). With each level the complexity and level of learning increases. In AGRON 305 (Soils), the learning outcomes were created using the first four levels, remember, understand, apply, and analyze, of Bloom's revised taxonomy as described by Sousa (2011). Active verbs associated with the various levels in the taxonomy guided the wording of the learning outcomes. Learning outcomes are listed in Table 3.2**.** In addition to Bloom's taxonomy, learning outcomes were developed to include the performance objectives needed for the competency area of Soil Genesis, Morphology, and Classification of the Soil Science Fundamentals Exam developed by the Soil Science Society of America (Council of Soil Science Examiners, 2012).

After the learning outcomes were outlined, the teaching methods were designed that answer the question "How will we help the students learn the material?" The main purpose of the lab was to evaluate the effectiveness of the simplified guided when used by beginning soil science students to classify soils as compared to traditional methods using the textbook. In order to collect reliable data and to ensure that our findings were of high quality, we used a technique called triangulation. Triangulation, as described by Sagor (1992), entails gathering multiple sources of data for every issue being researched or studied. This allows us to compensate for imperfections of data-gathering techniques. Also, triangulation is beneficial because when multiple measures produce the same results, our confidence in those results increases. In addition, if the different measures do not yield the same results, it can bring forth critical follow-up questions (Sagor, 1992). For this study, we used pre and post-test scores, an in-class assignment, and an evaluation survey as our multiple measurement sources.

In addition to the triangulation concept, student learning was assessed based on the presence of sense and meaning as described by Sousa (2011). Sousa explains that if both sense and meaning are present, it is more likely the student will learn the material and put the information in long-term storage for future use. Questions included on the evaluation sheet were used to evaluate the presence of sense and meaning.

Procedure for AGRON 305 (Soils)

At the beginning of each lab, students were briefed that the class period was going to be used for research. Students were then given a pretest that consisted of four questions that were based on the learning outcomes for the soil classification lab (Appendix A). A total of 8 points were available. When they turned in the pretest, students were given handouts that contained pedon data (Appendix B) for 12 pedons as well as an assignment to fill out the classifications of the pedons and questions about the different characteristics of the soil orders (Appendix C). Next, students viewed an approximately 30-minute visual presentation that introduced the twelve soil orders. The beginning of the presentation included the learning outcomes of the activity. The learning outcomes were as follows, with the level of Bloom's taxonomy at which the statement refers to in parentheses after:

1. Understand why soils are classified (**Understand**)
2. Identify the characteristics that differentiate the 12 different soil orders of Soil Taxonomy (**Remember**)
3. Determine the diagnostic subsurface horizons of pedons (**Apply**)
4. Classify soils to the order level by analyzing pedon lab data (**Analyze**)

The purpose of soil classification was also discussed at the beginning of the presentation. This was intended to establish meaning to the lab activity for the students. In addition, during the visual presentation, a college mascot matching quiz provided an entertaining activity to help engage students and to help them practice classifying and sorting objects that they were familiar with. At the end of the visual presentation, an example was given of how to classify soils with the given pedon data using the method (textbook or simplified guide) appointed for that class. Students were then given approximately 40 minutes to work on the assignment. For the assignment, students had to classify 12 different pedons to the order level and answer follow- up questions regarding the important features of that soil that led the students to classify the soil to that particular order. Lab data necessary for classification purposes was given for the first 9 pedons (Appendix B). The last 3 pedons were more generic in design as the classification for these particular soil orders is too complex for an introductory soil science class. Students using the *Simplified Guide to Soil Taxonomy* used personal computers to complete the assignment while the traditional method classes used the textbook. The table students used out of the textbook can be found in Appendix D. *Keys to Soil Taxonomy* was not used for comparison in AGRON 305 (Soils) because the keys are far too complex for this introductory course. Traditionally, classification is only taught using the textbook; therefore we chose to compare the simplified guide to the required textbook for the course.

After 40 minutes had passed, students turned in the assignment regardless of the number of soils classified. During the remaining class time, students completed a post-test that was identical to the pretest (Appendix A) and an evaluation that consisted of short answer response questions, yes/no questions, and questions answered based on a Likert scale of very low to very high (Appendix E). The format of the evaluation survey was based on a similar study by Harms (2011). The questions on the evaluation survey were intended to grasp student opinions on whether or not the learning outcomes were achieved as well as to assess prior knowledge and the presence of sense and meaning. Students were encouraged to write any comments regarding the specific method they were assigned.

Description of the Research Process for AGRON 515 (Soil Genesis and Classification)

The research process for AGRON 515 (Soil Genesis and Classification) was similar to that for AGRON 305 (Soils). Since the class curriculum already includes soil classification, no new learning outcomes were developed. Rather, the learning outcome associated with soil classification for this class was used. The triangulation concept was also used for AGRON 515, but there were no pre or post-tests given. Students in AGRON 515 used both the full version of

Keys to Soil Taxonomy and the *Simplified Guide to Soil Taxonomy* on homework assignments. Evaluation surveys were given to assess student opinions on the use of both methods and to assess the presence of sense and meaning. Students were encouraged to answer the short answer questions and to provide comments about using the two different methods.

Procedure for AGRON 515 (Soil Genesis and Classification)

For AGRON 515 (Soil Genesis and Classification), the format of the class varied little from the normal schedule. Changes were made to homework assignments to include the use of the *Simplified Guide to Soil Taxonomy*. The first half of the course was devoted to teaching soil morphology, pedogenic processes and factors of soil formation. By the time soil classification was taught, students had received a thorough background on soil science. The learning outcome associated with soil classification used for this study was as follows: Students should be able to use Soil Taxonomy to classify soils to the family level and be able to compare Soil Taxonomy to other soil classification systems, specifically the *Simplified Guide to Soil Taxonomy*.

Two lab periods were devoted to teaching soil classification as well as multiple lecture periods. The first lab covered how to use the simplified keys and how to determine diagnostic subsurface horizons. Students were given lab data for 10 pedons (Appendix F). Pedon data was again collected using the National Cooperative Soil Survey Soil Characterization Database (National Cooperative Soil Survey, 2014). Using this information, they were to determine the epipedons and diagnostic subsurface horizons of the given soils. For half of the pedons, they were directed to use the simplified guide, and for the other half they were to use the full version of *Keys to Soil Taxonomy*. Both systems were used on personal computers. The first assignment was designated Homework 1 (Appendix G). For Homework 2 (Appendix H), students were required to classify the pedons to the order level. Again, half were classified with the simplified guide and the other half with the full keys. Homework 3 (Appendix I) required students to classify soils to various levels, but were only graded to the great group level. A total of 6 pedons were classified. Half were classified using the simplified guide; the full version of Keys was used to classify the other half. The answers were graded by level. For example, if students incorrectly classified the pedon at the order level, but they correctly classified the other levels based on the given information, then they were only counted off at the order level. Each level was worth 3 points, with a maximum score of 9 per pedon.

Data Analysis

All data compilation and statistics were completed using Microsoft Excel 2010. A two-sample t-test assuming equal variance was run for AGRON 305 (Soils) data. A paired two-sample for means t-test was run for AGRON 515 (Soil Genesis and Classification) data. Since the goal of the committee was 90% accuracy, the level of significance was determined using a p-value of 0.10. No student names are associated with scores. For AGRON 305 (Soils), some scores and evaluations were not used due to incomplete answers. In other cases, the student failed to turn in the assignment or the pre/post-test or evaluation. Therefore, total numbers for assignments, pre/post-tests, and evaluations do not always match. In addition, results reported as "All Classes" include all ten laboratory sections taught. Fall 2013 and Spring 2014 data only include eight out of the ten laboratory sections (four per semester). This includes two sections taught with the textbook and two sections taught with the simplified guide. By comparing only four out of the five classes, we have similar number of student responses to compare.

In AGRON 515 (Soil Genesis and Classification), one homework assignment was omitted because it was incomplete. Also, two students failed to turn in an evaluation survey. This is the reason the total number of homework assignments and evaluation surveys turned in do not match.

Qualitative data was analyzed by coding the comments and then grouping similar comments under a heading. This process is a modified version of the inductive approach recommended by Elo and Kyngäs (2008).

Results and Discussion

Results from AGRON 305 (Soils)

Change in pre- and post-test scores was compared for the textbook and simplified guide method. Comparing all classes, a significant difference was observed between methods ($p=0.05$). The change in score by students using the textbook method was 2.14 points whereas the simplified guide only saw a 1.63 point difference (Table 3.3). Breaking the scores down by semester can help explain this difference. Using the four classes as described in the material and methods, a significant difference ($p=0.05$) was found only in the fall semester (Table 3.3). Students using the simplified guide improved their scores by approximately 1.5 questions whereas students using the textbook version improved by nearly 2.5 points. Change in the pre-and post-test score was not significant for the spring semester between methods (p=0.46). It is important to note that in the fall, both classes using the textbook method were taught on Tuesday. Students in the Tuesday classes did not have any prior exposure to soil taxonomy from lecture, and thus their pre-test scores were lower. Students in Thursday classes, however, had exposure to soil taxonomy in lecture on Wednesday, and their pre-test scores were higher.

Comparing the change in scores (p=0.03) in the fall between Tuesday and Thursday classes (not methods) (Table 3.4), post-test scores were approximately 2 points higher for students with no prior exposure to the material. Students on Thursday, who had some background on soil classification from class on Wednesday, only had approximately a one point increase in their score. Similar results occurred in the spring semester (p=<.0001). Students in lab on Thursday had no prior exposure and saw a near 3 point increase in their score. Students in Tuesday's labs only had a 1 point increase in their score. Results therefore indicate that prior exposure played a role in student performance on the pre- and post-test. Having some background decreases the change in scores between days, but there was no difference between methods, suggesting it is helpful to for students to have some exposure regardless of the classification system used.

Assignments were graded with two scores. The first score was based on how many pedons were correctly classified out of the number of pedons students were able to classify in the allotted time. Student scores were calculated by dividing the number of pedons correctly classified by the total number of pedons classified and multiplying by 100 to obtain a percent. Overall mean scores are located in Table 3.5. All students using the simplified guide averaged a score of 93.8% whereas all students using the textbook averaged 91.6%. This difference was significant (p=0.07). Mean scores broken down by semester are presented in Table 3.5 as well. For the fall semester, students in two of the classes using the simplified guide had an average score of 93.4%. Students using the textbook method averaged 89%. This difference was significant (p= 0.05). However, scores in the spring semester were not different (p=0.46) with both methods averaging 94%. Although the difference between the two methods was significant for all classes (p=0.07), it is difficult to conclude that the simplified guide is better than the textbook since the results in the fall semester were significant (p=0.05), but the results in the spring semester were highly insignificant (p=0.46).

In addition to classifying the pedons, students were also asked questions over key characteristics of the soil orders. The simplified guide was designed to provide abbreviated yet descriptive descriptions of the soils, including general characteristics, environment and processes, and location. In addition, many of the soil terms in the simplified guide have basic definitions in parenthesis within the text. This information is located all on one page and can be quickly navigated to by using hyperlinks. There are also color pictures of soil profiles used to illustrate each order. The textbook also has descriptions and pictures, but it is spread out over an entire chapter and students must flip back and forth between pages to read. Overall, as seen in Table 3.6, students using the textbook missed more questions (3.1) compared to simplified guide users (1.9) ($p=<.0001$). Breaking it down by semester, the average number of questions students missed in the fall using the simplified guide was 1.7. Students using the textbook missed 2.5 questions on average. This difference was significant ($p=0.019$). Students using the textbook method in the spring also missed more questions, missing nearly 4 questions on average. Individuals using the simplified guide only missed approximately 2 questions. This difference was also significant ($p=<.0001$). The results suggest that the descriptions and information found in the simplified guide allowed students to better answer the questions as compared to students who used the textbook to answer the questions. The breakdown of information within each order allowed students to easily locate the answer rather than having to read the entire section, as is in the case with the textbook.

Student responses on the evaluation surveys provided helpful insight in determining the advantages and disadvantages for each method as well as information covering student learning. This included an assessment of prior knowledge and the presence of sense and meaning. When asked about their prior knowledge, 90% (Figure 3.1) of students indicated they had low to very low prior knowledge. This number combines the four classes from each semester. Even though some classes had some exposure to soil classification during lecture, it was not enough for students to feel comfortable marking a higher level.

Two questions were asked on the evaluation survey to assess student learning based on Sousa's (2011) concept of sense and meaning. Students were asked to rate their interest in learning about soil classification based on a scale of very low, low, medium, high, and very high. The purpose of this question was to gauge the meaning of soil classification to the students. The assumption is that if students are interested in learning about soil classification, then students have attached some meaning to the topic. As seen in Table 3.7, 84% of students using the textbook ranked their interest in soil classification as medium to high (44% reporting high to very high). Of the students using the simplified guide, 88% (Table 3.8) ranked their interest between medium and very high (36% high to very high). Enough meaning must have been present for the majority of students to have a fairly high interest in soil classification.

The question geared towards the concept of sense asked students whether or not they understood the fundamental concepts of soil classification. The majority of students responded yes (98% textbook, 93% simplified guide, Tables 3.9 and 3.10). Based on these responses, students appeared to have attached both sense and meaning to the activity, increasing the chances that the information went to long-term storage. In other words, the students learned the material. When asked to rate the amount they thought they learned during the activity, over half the students (54%) using the simplified guide responded high to very high (Table 3.8). Only 7% reported low to very low levels. As seen in Table 3.7, 69% of students using the textbook reported high to very high levels in regards to the amount they learned. A mere 3% reported low levels of learning using the textbook. According to these responses, it appears that students using the textbook felt they learned more. This, again, could be a result of the lack of prior exposure and/or that the simplified guide is still too complex for introductory soils students. However, when asked if they felt that the particular method they used was helpful for classifying soils, 96% of both textbook and simplified guide users answered yes (Tables 3.9 and 3.10). Additionally, student responses regarding their confidence in correctly classifying soils were similar for both methods (Tables 3.7 and 3.8); 81% of textbook users reported medium to very high confidence while 79% of the simplified guide users reported medium to very high confidence levels. These results suggest that students feel either method is useful for classifying soils to the order level.

Although similar results were recorded (Tables 3.9 and 3.10) from the question regarding the students ability to determine the diagnostic horizons (73% responding yes for both methods), it is important to take a look at the “no” responses. As can be seen in Figure 3.2, over half (58%) of the “no” responses were from students in the fall classes who did not have a supplemental handout over horizon nomenclature. After realizing that students were struggling with the diagnostic horizons, a separate handout (Appendix K) was prepared that gave a list of diagnostic horizons and their associated symbols. The symbols are lowercase letters that provide soil scientists a method to label individual soil horizons in profile descriptions. This improved student responses to this particular question. Although the handout was taken from the textbook and given to students using the simplified guide, it appears unlikely that students using the textbook utilized this table during the first class periods. This is most likely due to it being in a different chapter in the book.

An insightful part of this research is found in the student comments on the written part of the evaluation survey. Students were asked about whether they thought the terminology was easy or difficult to understand and to offer any suggestions that would improve the method they used to classify the pedons. Students using the simplified guide were also asked to respond to questions regarding the breakdown of the guide into three parts and to explain which parts or features of the guide they found useful. All students were given the opportunity to suggest comments, but not all students provided feedback. Student responses from eight labs used for comparison are summarized in Tables 3.11 and 3.12. To summarize the written evaluations, both methods appeared to be easy to use. However, many of the complaints regarding the textbook were the type of problems the simplified guide was trying to solve. For example, there were multiple comments about the hassle of flipping through so many pages (7 comments) and how an abbreviated list would be helpful (16 comments) as well as the lack of colored pictures (6). Eight students reported that the textbook terminology was hard to understand. In addition, 6 students remarked that it was a lot of new information, which was overwhelming and confusing (2). Even with these complaints, many students (41) still said the vocabulary and terminology was easy to understand.

Students using the simplified guide were asked whether the terminology and vocabulary in the guide was easy to understand. A total of 36 comments stated that it was easy to comprehend. An additional 6 reported that it was relatively easy. A total of 6 difficult and 4 somewhat difficult responses were recorded, and 9 remarked that it was a little difficult, but it was easier with time. Contrary to the textbook comments, many students found the layout and organization of the simplified guide easy to use. Students commented on the convenience of navigating through the guide (11), the helpful descriptions of the soil orders (43), and that the pictures and diagrams were useful (5). In addition, student responses indicated that the guide made classifying soils easy to understand (24) (Table 3.12).

Results from AGRON 515 (Soil Genesis and Classification)

Only two means of data collection, a homework assignment and evaluation survey, were used in AGRON 515 (Soil Genesis and Classification). There were three homework assignments given through the semester. Only scores from Homework 3 will be reported in this study, but results from questions on the survey regarding Homework's 1 and 2 will be discussed later. Homework 3 required students to classify soils to various levels. For this study, they were only graded to the great group level. There were 6 pedons to classify. Half were classified with the simplified guide, the other half with the full version of *Keys to Soil Taxonomy*. Results from the assignment can be seen in Table 3.13. The combined average score for the 3 pedons in each method was higher for the simplified guide (8) as compared to the *Keys to Soil Taxonomy* (6.4) (p=0.01). Overall, students scored higher using the simplified guide. Breaking it down by level, we can see that the simplified guide scores were statistically higher at both the order (2.75 compared to 2.25) (p=0.04) and suborder (2.7 compared to 2.1) levels (p=0.07). However, there was no significant difference between scores at the great group level. The simplified guide average was 1.8, and the *Keys to Soil Taxonomy* was 2.1 (p=0.14). Even though simplified guide scores dropped off at the great group level, 82% of the students reported medium to high confidence in correctly classifying soils to the great group level (Table 3.14). Only 45% felt confident using the *Keys to Soil Taxonomy*. Both methods contained one pedon that had very low scores at the great group level which caused the average scores to drop.

Student responses on the evaluation survey indicated that the simplified guide was more useful for classifying soils (Table 3.15). When asked if the vocabulary and terminology was easy to understand, the responses regarding the simplified guide were mainly positive. There were 4 comments that said the vocabulary was easy to understand and another 5 responded that it was easier than the vocabulary in *Keys to Soil Taxonomy*. Students also indicated that the abbreviated definitions, especially the ones in parenthesis, were helpful in understanding the unfamiliar terminology. Comments about *Keys to Soil Taxonomy* generally indicated that it was difficult because there was too much information (7 comments). Two additional comments suggested that the vocabulary was meant for people with experience in classification. Students were also asked which method they preferred to use to classify soils, the *Simplified Guide to Soil Taxonomy* or *Keys to Soil Taxonomy*. Out of 10 responses, 9 chose the simplified guide. Students commented that it was more summarized, easier to navigate with the hotlinks, and less confusing than the full version of *Keys to Soil Taxonomy*. The student who preferred *Keys to Soil Taxonomy* remarked that it was more thorough and provided more information. However, they concluded their comment by saying that the simplified guide is much quicker and easier to use. Overall, students overwhelmingly preferred using the simplified guide over the *Keys to Soil Taxonomy*. This is also supported by the responses to the questions on the survey regarding the three homework assignments. Table 3.16 shows the responses. All students responding said "yes" in terms of the simplified guide being useful for helping them complete the homework assignments. Responses for the *Keys to Soil Taxonomy* being useful were not as favorable. Only 40% said "yes" on Homework 1, 60% on Homework 2, and 70% on Homework 3.

Students were asked to rank their prior knowledge of soil classification. As stated before, prior knowledge plays an important role in student learning. Approximately 70% of the students indicated low to medium levels of prior knowledge (Table 3.14). The question asked was specifically towards soil classification. Although students indicated low levels of prior knowledge, they should have a rather extensive background in general soil science. A background in soil science provides an advantage when using the simplified guide, or even *Keys to Soil Taxonomy*. Two questions regarding prior knowledge should be asked instead-one about general soil knowledge and another specifically about soil classification.

To evaluate the presence of sense and meaning, students were asked to rate their interest in learning about soil classification as well their confidence in classifying soils. Overall, the majority (82%) of students had a high to very high interest in learning about soil classification (Table 3.14). Thus, it can be inferred that meaning was present for the students. As discussed above, 82% of the students reported medium to high levels in their confidence in classifying soils using the simplified guide (Table 3.14). Only 45% reported the same levels for the *Keys to Soil Taxonomy*. Therefore, it is more likely the new information is transferred to students' long term storage when using the simplified guide. In other words, they learned more using the simplified guide compared to the *Keys to Soil Taxonomy*.

Conclusions

AGRON 305 (Soils)

A new laboratory activity, including learning outcomes, was developed, implemented, and evaluated in the fall of 2013 and spring of 2014. Classifying soils can be intimidating for individuals with little background in soil science. The *Simplified Guide to Soil Taxonomy* was developed to help students understand the fundamental concepts of soil classification. However, it is assumed that the users will have some basic understanding of soil science. Results from the evaluation survey indicated that a majority of the students had very low or low prior knowledge of soil classification. This lack of prior knowledge impacts the use of the simplified guide by beginning soil science students. In results such as the number of soils correctly classified and the change in the pre- and post-test scores, students using the simplified guide had lower scores as compared to students using the textbook. These results suggest that the textbook is a better method to teach soil classification for this class. This can be linked back to prior exposure, as students using the textbook had been exposed to soil classification in the lecture portion of the class. The higher textbook scores could also be attributed to the fact that the textbook is designed for beginning soil science students, so it was not surprising that students were able to successfully classify soils using the textbook. However, although their scores showed that the textbook had a slight advantage, results from the survey indicated that the majority of students in both methods felt fairly confident in their ability to classify soils to the order level.

Although students classified more soils with the textbook method, student performance on the questions associated with the key characteristics of the soil orders was lower compared to the simplified guide. These results suggest that the simplified guide does a better job of describing the characteristics of the soil orders. However, when asked if they found the descriptions for the soil orders helpful in understanding the broad concepts of categories of soils, nearly all students in both methods (97-98%) responded yes. This seems conflicting to the number of questions students missed as well as comments on the short answer part of the survey. This question would be better asked on a scale basis rather than yes/no in order to better capture if one method was better than the other.

Survey responses regarding vocabulary and terminology were similar for both methods. This is encouraging for the simplified guide, as it must be simple enough for students to understand. Based on student comments, the layout of the simplified guide was beneficial and easy to use and that the pictures and diagrams enhanced their learning. Students did complain about the textbook layout, mainly evolving from the large amount of page flipping that was necessary.

Students who did not use a handout on diagnostic subsurface horizons struggled with determining which horizons were present. This information was relayed to the committee developing the simplified keys, and they are planning on including diagnostic horizon nomenclature information in the final version of the simplified guide.

Overall, the survey assessment indicated that students using the simplified guide and the textbook made sense and found meaning in the soil classification activity. It is likely, then, that the information learned in the activities was transferred into their brain's long-term storage using both methods. However, based on survey comments, students were able to better organize and comprehend the information in the guide because of the flow charts, maps, color pictures, and lists included in the guide. These components enhanced student learning by allowing students to conceptually organize the process of soil classification (Examples in Appendix L).

It is hard to pinpoint which method was better. If given enough background information and used correctly, the simplified guide can be used to teach soil classification in beginning soil science courses. It also depends on the amount of detail the instructor wants to cover on soil classification. The simplified guide provides more guidance on the process of classifying soils, whereas the textbook provides very basic details. If the simplified guide was explained and used in the lecture portion of the class, it might improve student scores and responses. This idea would need to be further investigated in another study.

In addition, if the study is replicated, in order to correct and control for the level of prior knowledge of soil classification, it would be important to schedule the AGRON 305 (Soils) labs when all students had the same prior exposure. If all the students came to lab with a general understanding of the different orders, the time spent in the visual presentation covering the orders could be used to explain more about how to use the guide and its different features.

AGRON 515 (Soil Genesis and Classification)

AGRON 515 (Soil Genesis and Classification) already included soil classification using *Keys to Soil Taxonomy* in the curriculum. Rather than developing a new activity as in AGRON 305, the homework assignments were altered to include the use of both the *Simplified Guide to Soil Taxonomy* as well as *Keys to Soil Taxonomy*. This allowed students to make a direct comparison. On Homework 3, students received overall higher scores when they used the simplified guide compared to *Keys to Soil Taxonomy*. Scores at the great group level were not significantly different between the two methods. Each method had a pedon where students scored poorly at the great group level, which resulted in lower scores.

Survey results clearly indicate that the students preferred the simplified guide over *Keys to Soil Taxonomy*. Students thought *Keys to Soil Taxonomy* contained too much information and was confusing. The simplified guide, on the other hand, was well summarized and was easy to navigate through using the hotlinks. In addition, students liked the abbreviated definitions that explained unfamiliar terms as well as the colored pictures and maps. These components enhanced student learning by allowing students to conceptually organize the process of soil classification. One area students thought the guide could improve on was in diagnostic subsurface horizon nomenclature. Providing an example of what symbols to look for when determining diagnostic horizons would be very helpful. For example, placing the potential horizons Bk, Btk, Ck under the calcic horizon description would help students anticipate when a calcic horizon might be present. This additional information would be important to include if this study was replicated.

In addition to providing horizon nomenclature in future studies, it would be beneficial to spend extra time demonstrating how to use the hyperlinks throughout the simplified guide. It would also be advantageous to more fully discuss Part 1: How to Use this Version of the Keys and Part 2: Diagnostic Horizons and Features of the guide. Spending additional time on these areas would help reduce confusion when first introducing students to the simplified guide.

Limitations of the Study

This study was limited in its scope and duration, as it only included two semesters for AGRON 305 (Soils) and one semester for AGRON 515 (Soil Genesis and Classification). A longer longitudinal study could detect trends over time that might be missed or exaggerated over the one to two semesters used in the study. In addition, a longer study would provide an opportunity to adjust teaching techniques based on knowledge gained from student responses. Hence, additional data could be collected on determining if these adjustments improved student learning of soil classification.

Recommendation for Further Research

Upon reflecting on the findings of this study, at least one major question remains that could be answered in future studies. As a result, the following recommendation for additional research is made.

How would the Simplified Guide to Soil Taxonomy help other individuals in the soil science discipline who are not college students studying a soils curriculum?

The current study does not offer any information about how the *Simplified Guide to Soil Taxonomy* could be expanded to people who are not college students, such as agronomists, engineers, and soil conservationists, who work with soil survey information. Research in this area could help support the findings in this study and present changes to the guide that would be beneficial to those outside the college classroom.

Final Thoughts

In this age of agriculture where the focus is producing enough food to feed the growing population, the importance of the soil cannot be minimized. Soil classification is part of that knowledge, but can be intimidating to learn. Based on the conclusions of this study, the *Simplified Guide to Soil Taxonomy* is a useful teaching tool that can be used in the classroom to help students learn the fundamental concepts of soil classification and, as a result, have a better understanding of the relationships between and among soils.

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Figures and Tables

Figure 3.1 Self-reported prior knowledge of soil classification by student in AGRON 305 (Soils).

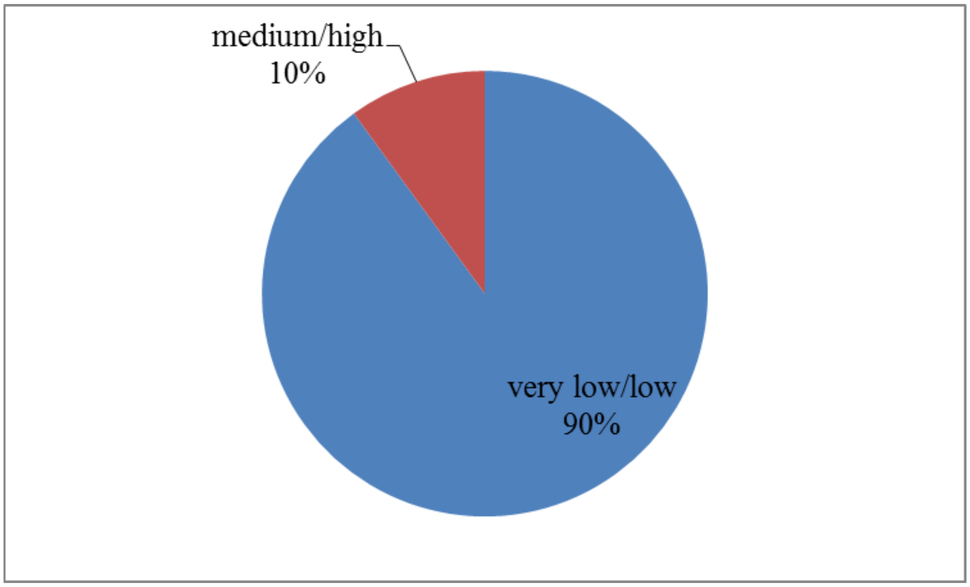


Figure 3.2 Breakdown of "No" responses in AGRON 305 (Soils) to the question "I was able to determine the diagnostic subsurface horizons of the given pedons." The majority of students responding "No" did not have a supplemental horizon nomenclature handout to help with classification.

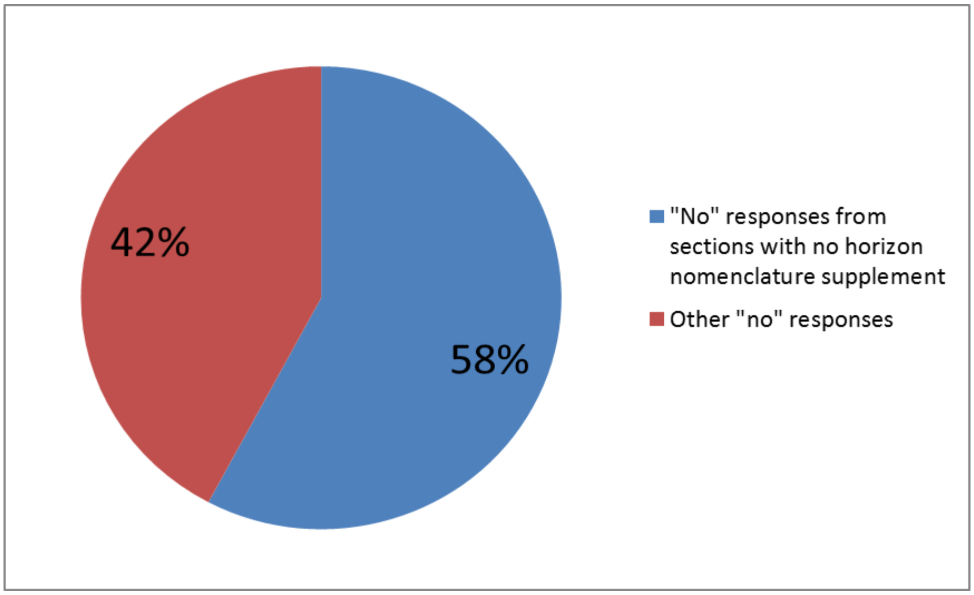


Table 3.1 Distribution of teachers, methods, and total number of students for AGRON 305 (Soils) laboratory sections

Lab Section		Fall 2013			Spring 2014		
Day	**Time**	**Teacher**	**Method**	**Total Number of students**	**Teacher**	**Method**	**Total Number of students**
Tuesday	9:30	Dr. Thien*	Textbook	25	Kim Kerschen	Simplified Guide	23
Tuesday	12:30	Dr. Thien*	Simplified Guide	21	Kim Kerschen	Simplified Guide*	25
Tuesday	2:30	Kim Kerschen*	Textbook	20	Kim Kerschen	Textbook*	24
Thursday	9:30	Megan Brown	Simplified Guide	22	Kim Kerschen	Simplified Guide*	20
Thursday	12:30	Kim Kerschen*	Simplified Guide	18	Kim Kerschen	Textbook*	19

*Classes used for semester by semester comparisons

Table 3.2 Learning outcomes for AGRON 305 (Soils) developed based on Bloom's Revised Taxonomy as described by Sousa (2011)

New activity	Learning outcomes
Soil Classification	1. Understand why soils are classified 2. Identify the characteristics that differentiate the 12 different soil orders of Soil Taxonomy 3. Determine the diagnostic subsurface horizons of pedons 4. Classify soils to the order level by analyzing pedon data

Table 3.3 Change in pre- and post-test scores for AGRON 305 (Soils)

	Change in Pre- and Post-test Score					
	Fall 2013*		**Spring 2014***		**All Classes**	
	Simplified Guide	***Textbook***	***Simplified Guide***	***Textbook***	***Simplified Guide***	***Textbook***
Change	1.47	2.45	1.78	1.83	1.63	2.14
Observations	38	44	45	43	128	87
	p-value 0.05		**p-value 0.46**		**p-value 0.05**	

*Fall and Spring semester values calculated using 4 total classes-2 textbook, 2 simplified guide

Table 3.4 Change in pre- and post-test scores comparing students who had prior exposure to soil classification and those who did not for AGRON 305 (Soils)

Change in Pre- and Post-test Score based on Exposure vs. No Exposure				
	Fall 2013-All Classes		Spring 2014-All Classes	
	No Exposure	Exposure	No Exposure	Exposure
Change in Score	2.23	1.36	2.86	1.19
Observations	65	39	39	72
	p-value 0.03		p-value <.0001	

Table 3.5 Accuracy of classifying soils to the order level for AGRON 305 (Soils)

Accuracy of Classifying Soils to the Order Level						
	Fall 2013		**Spring 2014**		**All Classes**	
	Simplified Guide	***Textbook***	***Simplified Guide***	***Textbook***	***Simplified Guide***	***Textbook***
Score	93.4	89.1	94.1	94.3	93.8	91.6
Observations	38	44	45	43	128	87
	p-value 0.05		**p-value 0.46**		**p-value 0.07**	

Table 3.6 Number of missed questions on the assignment for AGRON 305 (Soils)

	Number of Missed Questions on the Assignment					
	Fall 2013		**Spring 2014**		**All Classes**	
	Simplified Guide	***Textbook***	***Simplified Guide***	***Textbook***	***Simplified Guide***	***Textbook***
Number Missed	1.7	2.5	2.2	3.9	1.9	3.1
Observations	38	44	45	43	128	87
	p-value 0.019		**p-value <.0001**		**p-value <.0001**	

Table 3.7 Total number of AGRON 305 (Soils) student responses (2 classes in fall 2013, 2 classes spring 2014) who used the textbook reporting “Very low”, “Low”, “Medium”, “High”, or “Very High” levels to questions on the evaluation survey.

Evaluation Survey Responses-Textbook						
	Very low	**Low**	**Medium**	**High**	**Very High**	**Total**
Interest in learning about soil classification	3[1] (3)[2]	11 (12)	36 (40)	31 (35)	8 (9)	89
Prior knowledge of soil classification	46 (52)	33 (37)	8 (9)	2 (2)	0 (0)	89
Amount you learned from the lab activity	0 (0)	3 (3)	24 (27)	51 (57)	11 (12)	89
Confidence in correctly classifying soils to the order level	2(2)	15 (17)	42 (47)	25 (28)	5 (6)	89

[1]Numbers without ( ) indicate total number of student responses for each rating

[2]Numbers with ( ) indicate the percentage of student responses for each rating

Table 3.8 Total number of AGRON 305 (Soils) student responses (2 classes in fall 2013, 2 classes spring 2014) who used the simplified guide reporting "Very low", "Low", "Medium", "High", or "Very High" levels to questions on the evaluation survey

Evaluation Survey Responses-Simplified Guide						
	Very low	**Low**	**Medium**	**High**	**Very High**	**Total**
Interest in learning about soil classification	1[1] (1)[2]	9 (11)	44 (52)	24 (29)	6 (7)	84
Prior knowledge of soil classification	49 (58)	28 (33)	6 (7)	1 (1)	0 (0)	84
Amount you learned from the lab activity	2 (2)	4 (5)	33 (39)	35 (42)	10 (12)	84
Confidence in correctly classifying soils to the order level	4 (5)	13 (15)	43 (51)	22 (26)	2 (2)	84

[1]Numbers without ( ) indicate total number of student responses for each rating

[2]Numbers with ( ) indicate the percentage of student responses for each rating

Table 3.9 Total number of AGRON 305 (Soils) student responses (2 classes in fall 2013, 2 classes in spring 2014) who used the textbook reporting "Yes" or "No" to questions on the evaluation survey

Evaluation Survey Responses-Textbook			
	Yes	**No**	**Total**
I was able to identify the characteristics that differentiate the 12 different soil orders	69[1] (78)[2]	20 (22)	89
I found the descriptions for the soil orders helpful in understanding the broad concepts of categories of soils	85 (97)	3 (3)	88
I was able to determine the diagnostic subsurface horizons of the given pedons	65 (73)	24 (27)	89
I understand why diagnostic horizons are important features in the soil	80 (90)	9 (10)	89
I understand the fundamental concepts of soil classification	87 (98)	2 (2)	89
Do you feel the textbook was useful in helping you classify soils?	85 (96)	4 (4)	89

[1]Numbers without ( ) indicate total number of student responses for each rating

[2]Numbers with ( ) indicate the percentage of student responses for each rating

Table 3.10 Total number of AGRON 305 (Soils) student responses (2 classes in fall 2013, 2 classes in spring 2014) who used the simplified guide reporting "Yes" or "No" to questions on the evaluation survey

Evaluation Survey Responses-Simpified Guide			
	Yes	**No**	**Total**
I was able to identify the characteristics that differentiate the 12 different soil orders	64[1] (80)[2]	16 (20)	80
I found the descriptions for the soil orders helpful in understanding the broad concepts of categories of soils	78 (98)	2 (2.5)	80
I was able to determine the diagnostic subsurface horizons of the given pedons	58 (73)	21 (27)	79
I understand why diagnostic horizons are important features in the soil	73 (91)	7 (9)	80
I understand the fundamental concepts of soil classification	74 (93)	6 (8)	80
Do you feel the *Simplified Guide to Soil Taxonomy* was useful in helping you classify soils?	77 (96)	3 (4)	80
Did you find the breakdown of the *Simplified Guide to Soil* Taxonomy into three separate parts helpful?	71 (90)	8 (10)	79

[1]Numbers without ( ) indicate total number of student responses for each rating

[2]Numbers with ( ) indicate the percentage of student responses for each rating

Table 3.11 Summary of AGRON 305 (Soils) student comments on the short answer portion of the written evaluation. This table only summarizes students who used the textbook.

Textbook			
	Easy	**Difficult**	**Confusing or Overwhelming**
Was the terminology and vocabulary easy to understand?	• Yes, it was easy (41)[1] • Yes, but lots of page jumping • Yes, after reading multiple times and slowly reading (2)	• Hard to understand (2) • Difficult (3) • Horizons are hard to understand • Hard terminology (6)	• A lot of new information and new vocab-makes it overwhelming (6) • Need to break it down • Confusing (2) • Too much page flipping (7)
Suggestions: 1. Have the information closer together for easier access (4) 2. Have a list/table of the definitions and identifying characteristics about each soil order (12) 3. Make a list of steps to take when classifying soil 4. Would be helpful to have colored pictures and diagrams (6) [1]Number in ( ) indicates number of students who responded with that comment			

Table 3.12 Summary of AGRON 305 (Soils) student comments on the short answer portion of the written evaluation. This table only summarizes students who used the simplified guide (2 classes in fall 2013, 2 classes in spring 2014).

Simplified Guide			
Was the terminology and vocabulary easy to understand?	**Easy**	**Difficult**	**Confusing or Overwhelming**
	• Easy (36)[1] • Relatively easy (6)	• Difficult (6) • Somewhat difficult (4) • Little difficult, but easier with time (9)	• A lot of new terms (4)
What features were helpful to you when classifying the pedons?	**Descriptions**	**Links, Pictures and Diagrams**	**Organization**
	• Simplified descriptions of the soil orders was helpful (43)	• Hyperlinks were helpful for quick navigation (11) • Graphs, charts and pictures were useful (5)	• Easy to know the steps/describes the process (8) • Made classification easy to understand (24) • Layout made it easy to use, especially list of orders (12)

Suggestions: 1. Need more time (5)
2. Brand new material, would be helpful to have more prior knowledge (2)
3. Have a vocab list or definitions page (4)
4. Needs to be more simplified (3)
5. More information about diagnostic horizons/hyperlink diagnostic horizons

Other comments: 1. Guide is easy to use and operate (8)
2. Very thorough and specific (3)

[1]Number in ( ) indicates number of students who responded with that comment

Table 3.13 Results showing the average student scores on Homework 3 in AGRON 515 (Soil Genesis and Classification). Overall, order level, suborder level, and great group level averages are reported

AGRON 515 Homework 3 Scores				
	Max Score	**Simplified Guide**	**Keys to Soil Taxonomy**	**p-value**
Average Total Score	9	8	6.4	0.01
Average on Order Level	3	2.75	2.25	0.04
Average on Suborder level	3	2.7	2.1	0.07
Average on Great Group level	3	1.8	2.1	0.14

Table 3.14 Total number of AGRON 515 (Soil Genesis and Classification) student responses reporting "Very low", "Low", "Medium", "High", or "Very High" levels to questions on the evaluation survey

Evaluation Survey Responses-AGRON 515 (Soil Genesis and Classification)						
	Very Low	**Low**	**Medium**	**High**	**Very High**	**Total**
Interest in learning about soil classification (soil classification has meaning to you)	0[1] (0)[2]	0(0)	2 (18)	5 (45)	4 (36)	11
Prior knowledge of soil classification	3 (27)	5 (45)	3 (27)	0 (0)	0 (0)	11
Amount learned from the homework's 1,2, and 3	0 (0)	0 (0)	4 (36)	7 (64)	0 (0)	11
Confidence in correctly classifying soils to the great group level using the simplified guide (it makes sense to you)	1 (9)	1 (9)	6 (55)	3 (27)	0 (0)	11
Confidence in correctly classifying soils to the great group level using Keys to Soil Taxonomy (it makes sense to you)	3 (27)	3 (27)	4 (36)	1 (9)	0 (0)	11

[1]Numbers without ( ) indicate total number of student responses for each rating

[2]Numbers with ( ) indicate the percentage of student responses for each rating

Table 3.15 Summary of AGRON 515 (Soil Genesis and Classification) student comments on the short answer portion of the written evaluation.

AGRON 515: Summary of Written Responses on Surveys		
	Simplified Guide	**Keys to Soil Taxonomy**
Was the terminology easy of difficult to understand?	• Easy to understand (4)[1] • Easier than Keys (5) • Abbreviated definitions in parenthesis were helpful (6) • Abbreviated definitions did not help • Difficult • Visual aids more linked to terminology and vocabulary	•Difficult-Too much information and confusing terms (7) • Somewhat difficult, vocab is more for people with experience in classification (2) •Easy (2)
Suggestions for improvement to help you in understanding how to classify soils	• Provide a back button to previous page • More Pictures • Orthent hyperlink did not work •Printed version •Didn't always understand certain "contacts" •Continue it to families •Examples of horizon nomenclature	• Having words linked to a glossary (2) • Printed (3) • Page breaks were extremely confusing (2) • Hyperlinks (2) • More pictures
Which method do you prefer to use?	• Simplified guide (9) because: • Summarized and is less confusing (4) •Easier to read and figure out moisture/temperature regimes • It was easier to navigate (3)	• Keys (1) because: • It gives a more thorough understanding of the classification and provided more information, but simplified guide is much quicker and easier
Useful features	•Shortened length/Summarized information (3) • Abbreviated characteristics (2) •Maps and pictures were nice to get a visual representation •Hot links for quick navigation (4)	N/A
[1]Number in ( ) indicates number of students who responded with that comment		

Table 3.16 Total number of AGRON 515 (Soil Genesis and Classification) student responses reporting either "Yes" or "No" to questions on the evaluation survey

Evaluation Survey Responses-AGRON 515 (Soil Genesis and Classification)			
	Yes	**No**	**Total**
I was able to determine the diagnostic subsurface horizons of the given pedons using the simplified guide (Homework 1)	10[1] (100)[2]	0 (0)	10
I was able to determine the diagnostic subsurface horizons of the given pedons using Keys to Soil Taxonomy (Homework 1)	4 (40)	6 (60)	10
Did the simplified guide help you identify the characteristics that differentiate the 12 different soil orders? (Homework 2)	10 (100)	0 (0)	10
Did Keys to Soil Taxonomy help you identify the characteristics that differentiate the 12 different soil orders? (Homework 2)	6 (60)	4 (40)	10
Do you feel the Simplified Guide to Soil Taxonomy was useful in helping you classify soils to the great group level? (Homework 3)	10 (100)	0 (0)	10
Do you feel Keys to Soil Taxonomy was useful in helping you classify soils to the great group? (Homework 3)	7 (70)	3 (30)	10

[1]Numbers without ( ) indicate total number of student responses for each rating
[2]Numbers with ( ) indicate the percentage of student responses for each rating

Appendix A - Pre- and Post-test for AGRON 305 (Soils)

Major: ____ Lab: ________________________

1. The general steps to follow when classifying a soil include
   A. Consider where the soil is located
   B. Describe the soil profile
   C. Determine which diagnostic horizons and features are present
   D. Determine the classification
   E. All of the above
   F. B, C, D only
   G. A, C, D only
2. The goal of the classification system is
   A. To create a universal language of soils that enhances communication among users of soils around world.
   B. Take advantage of research and experience at one location to predict the behavior of similar soils at another location
   C. To not only understand the "what" and "why" of soils, but also the "where"
   D. All of the above
   E. None of the above
3. Rather than define classes based directly on theories of soil genesis, the classes are based largely on the presence of _______________, which are a reflection of important pedogenic processes (i.e. additions, removals, transfers and transformations) that are either occurring now, or have occurred in the past, to produce the kinds of soil profiles we see today in the landscape.
   A. Pedons
   B. Organic soil materials
   C. diagnostic horizons and features
   D. different soil textures

4. Describe five characteristics that differentiate the 12 different soil orders of Soil Taxonomy (examples: Ultisols are highly leached, Inceptisols are young soils with minimal development)

Appendix B - Example Pedon Data for AGRON 305 (Soils)

Pedon 1

Location Details
Series Name: Cherokee
Latitude: 37:7:50
N
Longitude: 94:59:55 W
County/City/State:Cherokee County, KS
Temperature Regime: thermic
Moisture Regime: Aquic
Potential Soil Orders: Mollisol, Entisol, Alfisol, Ultisol, Inceptisol, Vertisol

Other Taxonomy Information
Epipedon: Ochric

Diagnostic subsurface horizons:

Soil Characterization Information

Horizon	Depth (cm)	Clay %	Texture	% Base Saturation	Organic Carbon %	$CaCO_3$ equivalent %
Ap	0-25	9.5	SiL	90	0.93	
E	25-34	15.2	SiL	74	0.83	
Btg1	34-54	50.5	SiC	70	1.11	
Btg2	54-75	41.9	SiC	82	0.84	
BC	75-117	33	SiCL	82	0.38	
C1	117-156	38.3	SiCL	80	0.32	
C2	156-200	39.8	SiCL	85	0.2	

Other Information:
For AOI, make a square around the 'Cherokee' quarter

Classification
Order:

Pedon 2

Location Details
Series Name: Goodman
Latitude: 45:42:48 N
Longitude: 88:20:10 W
County/City/State: Marinette County, WI
Temperature Regime: frigid
Moisture Regime: udic
Potential Soil Orders: Mollisol, Entisol, Alfisol, Ultisol, Inceptisol, Histisol, Spodosol, Vertisol

Other Taxonomy Information
Epipedon: Ochric
Diagnostic subsurface horizons:

Soil Characterization Information

Horizon	Depth (cm)	Clay %	Texture	% Base Saturation	Organic Carbon %	$CaCO_3$ equivalent %
A	0-10	10.8	SiL	39	8.16	
E	15-Oct	6.9	SiL	34	2.14	
Bs1	15-28	3.1	SiL	11	1.74	
Bs2	28-64	1.5	SiL	10	1.22	
E/B	64-79	3.2	SiL	18	0.19	
B/E	79-89	10.6	SiL	25	0.25	
2BC	89-94	5.1	FSL	30	0.18	
2C	94-152	6.5	SL	35	0.15	

Classification
Order:

Other Information:
For AOI, make a square around the word Marinette

Appendix C - Soil Classification Assignment for AGRON 305 (Soils)

Major: ____________________________________ Lab: ___________________

Directions: Classify the given pedons to the order level using the provided pedon data and answer the following questions.

Pedon 1:

1. What order does this pedon belong to?

2. a. What main characteristic (or diagnostic subsurface horizon) led you to classify the pedon to this order?

b. What weathering process is involved in the formation this horizon?

Pedon 2:

1. What order does this pedon belong to?

2. a. What type of vegetation do these soils typically form under?

b. What critical processes lead to the formation of these soils?

3. Are Spodosols commonly used for farmland? Why or why not?

Pedon 3:

1. What order does this pedon belong to?

2. What diagnostic subsurface horizon and soil property were important in classifying this pedon?

3. Why do these soils have such a low base-status?

Pedon 4:

1. What order does this pedon belong to?

2. a.What epipedon is required for this order?

   b. Describe some of the characteristics of this type of epipedon.

3. These soils have a dark colored surface horizon that extends deep into the profile. Where does this dark color come from?

Pedon 5:

1. What order does this pedon belong to?

2. What 3 properties or characteristics of this pedon classifies it in this order?

Pedon 6:

1. What order does this pedon belong to?

2. What moisture regime is required for this order?

3. Why do these soils have at least one diagnostic subsurface horizon and tend to be high in salts?

Pedon 7

1. What order does this pedon belong to?

2. What are some typical landscapes settings for soils under this order?

Pedon 8:

1. What order does this pedon belong to?

2. From what parent material have most of the soils in this order formed from?

Digging Deeper: These soils tend to be very fertile soils with a high water holding capacity and low bulk density. See if you can locate average values for these properties in a Kansas soil and compare the numbers.

Pedon 9:

1. What order does this pedon belong to?

2. What is the distinguishing characteristic for this order?

3. This pedon has evidence of cryoturbation. What is cryoturbation?

***There is no lab data for the next three pedons. Answer the questions regarding important properties associated with the classification of these soils.*

Pedon 10:

1. Soils with organic material $\geq$ 40 cm thick are classified as ________________________.

2. Describe the environment these soils typically form under.

3. Are these soils common in Kansas? Explain your answer.

Pedon 11:

1. A soil with an oxic (highly weathered and low fertility) horizon is classified as an ________________.

2. Subsoil horizons in this order are generally rather red, due to

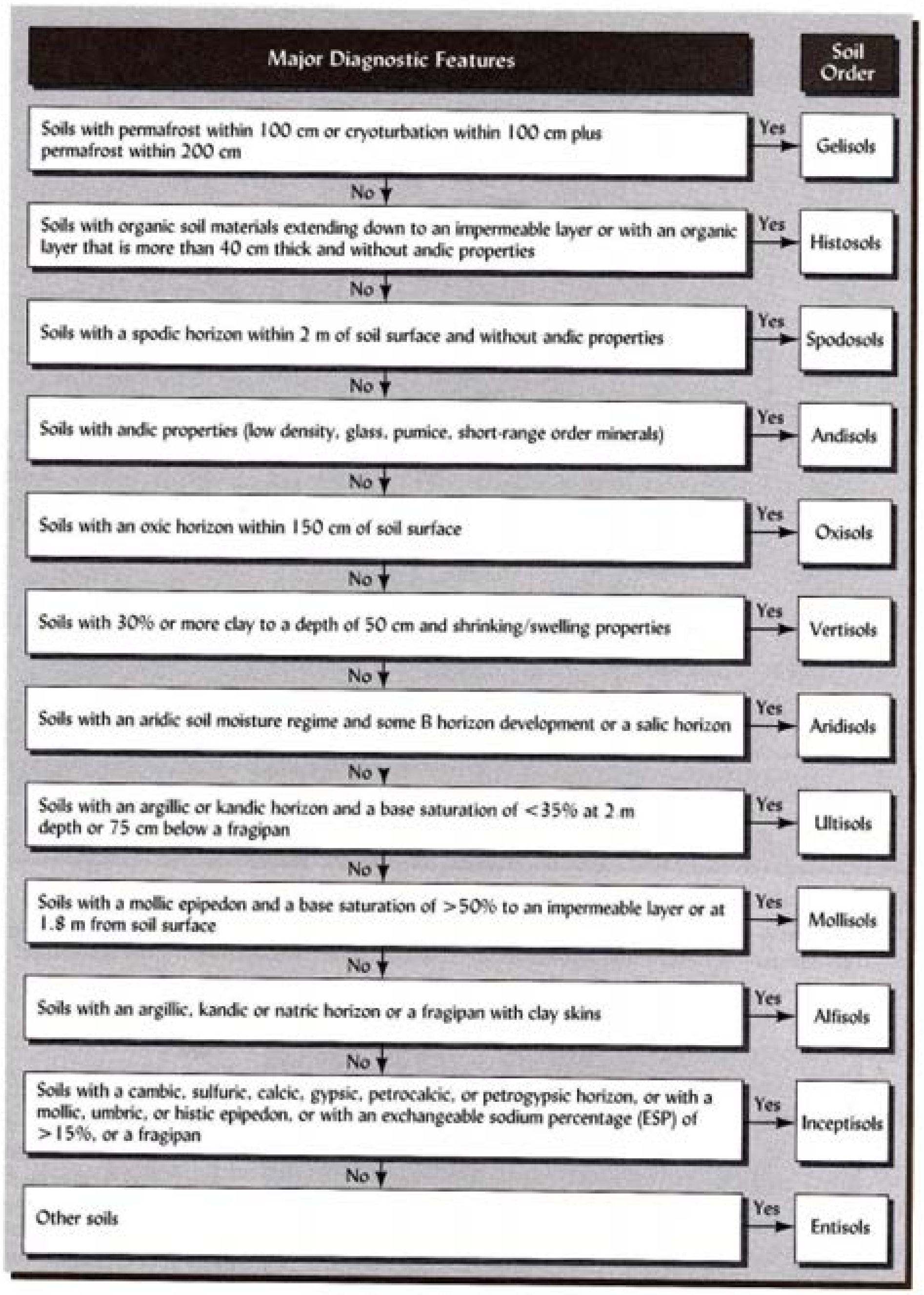
3. What type of climate and environment due these soils form under?

Pedon 12:

1. Young soils with a weak, but noticeable, degree of profile development are classified as ______________.

2. Describe how these soils differ from Entisols.

Appendix D - Simplified Key in Textbook used in AGRON 305 (Soils)



From Brady and Weil (2009).

Appendix E - Evaluation Survey for AGRON 305 (Soils)

Textbook

AGRON 305 – Soil Taxonomy Lab
Spring Course Evaluation-Textbook

Rate yourself on:
(1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high)

_____ your interest in learning about soil classification

_____ your prior knowledge of soil classification

_____ the amount you learned from the "Application of Soil Taxonomy" lab activity

______Your confidence in correctly classifying soils to the order level

Answer the following statements with a Yes or No answer:
(Y=Yes, N=No)

_______ I was able to identify the characteristics that differentiate the 12 different soil orders

______ I found the descriptions for the soil orders helpful in understanding the broad concepts of categories of soils

______ I was able to determine the diagnostic subsurface horizons of the given pedons

______ I understand why diagnostic horizons are important features in the soil

______ I understand the fundamental concepts of soil classification

______ Do you feel the textbook was useful in helping you classify soils?

Did you find the terminology and vocabulary in the textbook easy to understand? If it was difficult, what would you suggest be changed to help your understanding?

Please comment or suggest any improvements that would help you in understanding how to classify soils using the textbook.

Simplified Guide

AGRON 515
Spring Evaluation-Simplified Guide

Rate yourself on:
(1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high)

_____ your interest in learning about soil classification

_____ your prior knowledge of soil classification

_____ the amount you learned from the homeworks 1,2, and 3

______Your confidence in correctly classifying soils to the subgroup level

Answer the following statements with a Yes or No answer:
(Y=Yes, N=No)

_______ I was able to identify the characteristics that differentiate the 12 different soil orders

______ I found the descriptions for the soil orders helpful in understanding the broad concepts of categories of soils

______ I was able to determine the diagnostic subsurface horizons of the given pedons

______ I understand why diagnostic horizons are important features in the soil

______ I understand the fundamental concepts of soil classification

______ Do you feel the *Simplified Guide to Soil Taxonomy* was useful in helping you classify soils?

______ Did you find the breakdown of the *Simplified Guide to Soil* Taxonomy into three separate parts helpful?

What features of part one, How to Use This Version of the Keys, were helpful to you when trying to classify the given soils? Explain or give examples of what you found helpful.

What features of part two, Diagnostic Horizons and Features, were helpful to you when trying to classify the given soils? Explain or give examples of what you found helpful.

What features of part three, Keys to the Orders, Suborders, and Great Groups, were helpful to when trying to classify the given soils? Explain or give examples of what you found helpful.

Did you find the terminology and vocabulary in the guide easy or difficult to understand? If it was difficult, what would you suggest be changed to help your understanding?

Please comment or suggest any improvements that would help you in understanding how to classify soils using the *Simplified Guide to Soil Taxonomy*.

Appendix F - Example Pedon Data for AGRON 515 (Soil Genesis and Classification)

*** Primary Characterization Data ***

Pedon ID: PEDON 1 (White County, Arkansas)

Sampled as on Jun 01, 1977 :

Revised to correlated on Nov 01, 1984 :

			United States Department of Agriculture
SSL	- Project	TYPE LOCATION CHARACTERIZATION	Natural Resources Conservation Service
	- Site ID	Lat: 35° 30' 54.00" north Long: 91° 35' 4.00" west MLRA: 117	National Soil Survey Center
	- Pedon No.		Soil Survey Laboratory
	- General Methods 1B1A, 2A1, 2B		Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
79P00791	Ap	AP	0-15				L	L
79P00792	Bt1	B21T	15-33				CL	CL
79P00793	Bt2	B22T	33-64				CL	CL
79P00794	Bx	BX	64-105				CL	CL
79P00795	Bt3	B3T	105-135				CL	CL

Pedon Calculations

Calculation Name	Result	Units of Measure
Clay, carbonate free, Weighted Average	30	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	23	% wt
Volume, >2mm, Weighted Average	0	% vol
Clay, total, Weighted Average	30	% wt

Weighted averages based on control section: 15-64 cm

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-
PSDA & Rock Fragments				(- - - - - Total - - - - - -)			(- - Clay - - -)		(- - - - Silt - - - - -)		(- - - - - - - - - - - - Sand - - - - - - - - - - - -)					(Rock Fragments (mm))				
				Clay	Silt	Sand	Fine	CO_3	Fine	Coarse	VF	F	M	C	VC	(- - - - - - - - Weight - - - - - - -)				>2 mm
				<	.002	.05	<	<	.002	.02	.05	.10	.25	.5	1	2	5	20	.1-	wt %
	Depth			.002	-.05	-2	.0002	.002	-.02	-.05	-.10	-.25	-.50	-1	-2	-5	-20	-75	75	whole
Layer	(cm)	Horz	Prep	(- % of <2mm Mineral Soil -)												(- - - - - - - % of <75mm - - - - - -)				soil
				3A1	3A1	3A1			3A1	3A1	3A1	3A1	3A1	3A1	3A1	3B1	3B1	3B1		
79P00791	0-15	Ap	S	13.9	47.0	39.1			33.6	13.4	2.0	25.5	8.1	3.1	0.4	--	--	--	37	--
79P00792	15-33	Bt1	S	30.8	47.0	22.2			34.6	12.4	1.3	14.5	4.5	1.7	0.2	--	--	--	21	--
79P00793	33-64	Bt2	S	30.3	44.6	25.1			32.0	12.6	1.4	17.4	4.8	1.3	0.2	--	--	--	24	--
79P00794	64-105	Bx	S	36.3	31.4	32.3			19.8	11.6	1.7	22.9	6.2	1.4	0.1	--	--	--	31	--
79P00795	105-135	Bt3	S	32.3	43.1	24.6			12.8	30.3	2.5	10.5	9.0	2.2	0.4	--	--	--	22	--

*** Primary Characterization Data ***

Pedon ID: (White County, Arkansas) Print Date: Apr 11 2004 11:28AM

Sampled As :

USDA-NRCS-NSSC-National Soil Survey Laboratory ; Pedon No.

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-
Bulk Density & Moisture				(Bulk Density)		Cole	(- - - - - - - - - - - Water Content - - - - - - - - - - -)						WRD	Aggst		
				33	Oven	Whole	6	10	33	1500	1500 kPa	Ratio	Whole	Stabl	(- - Ratio/Clay - -)	
	Depth			kPa	Dry	Soil	kPa	kPa	kPa	kPa	Moist	AD/OD	Soil	2-0.5mm	CEC7	1500 kPa
Layer	(cm)	Horz	Prep	(- - - g cm^{-3} - - -)			(- - - - - - - - - - - - % of < 2mm - - - - - - - - - - - -)						cm^3 cm^{-3}	%		
				4A1d	4A1h				4B1c	4B2a		4B5	4C1			8D1
79P00791	0-15	Ap	S	1.69	1.75	0.012			13.2	4.7		1.006	0.14			0.34
79P00792	15-33	Bt1	S							8.2		1.012				0.27
79P00793	33-64	Bt2	S	1.52	1.71	0.040			21.2	9.7		1.016	0.17			0.32
79P00794	64-105	Bx	S	1.65	1.74	0.018			18.9	9.7		1.016	0.15			0.27
79P00795	105-135	Bt3	S							11.9		1.022				0.37

CEC & Bases				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(- - - - - - NH_4OAC Extractable Bases - - - - -)								CEC8	CEC7	ECEC		(- - - - Base - - - -)	
								Sum	Acid-	Extr	KCl	Sum	NH_4	Bases	Al	(- Saturation -)	
	Depth			Ca	Mg	Na	K	Bases	ity	Al	Mn	Cats	OAC	+Al	Sat	Sum	NH_4OAC
Layer	(cm)	Horz	Prep	(- - - - - - - - - - - - - - - - - cmol(+) kg^{-1} -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)			(- - - - - - - - % - - - - - - - - -)		
				6N2e	6O2d	6P2b	6Q2b		6H2b	6G1e		5A3a		5A3b	5G1	5C3	
79P00791	0-15	Ap	S	4.0	0.3	--	0.2	4.5	5.1	tr		9.6				47	
79P00792	15-33	Bt1	S	2.2	0.6	--	0.2	3.0	13.1	3.7		16.1		6.7	55	19	
79P00793	33-64	Bt2	S	1.0	1.4	0.1	0.2	2.7	14.0	5.3		16.7		8.0	66	16	
79P00794	64-105	Bx	S	0.3	1.6	0.1	0.2	2.2	15.8	5.6		18.0		7.8	72	12	
79P00795	105-135	Bt3	S	0.2	1.3	0.1	0.2	1.8	14.7			16.5				11	

pH & Carbonates				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-
				(- - - - - - - - - - - - - - - - - - pH - - - - - - - - - - - - - - - - - -)						(- - Carbonate - - -)		(- - Gypsum - - -)		
					$CaCl_2$					As $CaCO_3$		As $CaSO_4*2H_2O$		Resist
	Depth				0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Layer	(cm)	Horz	Prep	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - - - - - - - - - - % - - - - - - - - - - - -)				cm^{-1}
						8C1a								
79P00791	0-15	Ap	S			5.5								
79P00792	15-33	Bt1	S			4.6								
79P00793	33-64	Bt2	S			3.9								
79P00794	64-105	Bx	S			4.2								
79P00795	105-135	Bt3	S			4.2								

*** Primary Characterization Data ***

Pedon ID: (White County, Arkansas) Print Date: Apr 11 2004 11:28AM

Sampled As :

USDA-NRCS-NSSC-National Soil Survey Laboratory ; Pedon No.

Clay Mineralogy (				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				X-Ray					Thermal				Elemental							EGME	Inter
													SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	K_2O	Na_2O	Retn	preta
	Depth		Fract	7A2i					7A3b				7C3								tion
Layer	(cm)	Horz	ion	<- - - - - - - - - peak size - - - - - - - - - ->					<- - - - - - - - - % - - - - - - - - ->				<- - - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - - ->							mg g^{-1}	
79P00792	15-33	Bt1	tcly	KK 2	VR 2	MI 1	QZ 1		KK 5						8.7			0.5			

FRACTION INTERPRETATION:
tcly - Total Clay,

MINERAL INTERPRETATION:
KK - Kaolinite MI - Mica QZ - Quartz VR - Vermiculite

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Primary Characterization Data ***

Pedon ID: (White County, Arkansas)

Sampled As :

USDA-NRCS-NSSC-National Soil Survey Laboratory ; Pedon No.

Sand - Silt Mineralogy (2.0-0.002 mm)				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
						X-Ray					Thermal					Optical				EGME	Inter
													Tot Re			Grain Count				Retn	preta
	Depth		Fract													7B1a					tion
Layer	(cm)	Horz	ion	< - - - - - - - - peak size - - - - - >						<- - - - - - - - % - - - ->			<- % - - - - - - - - - - - - - - - - - - ->							mg g^{-1}	
79P00792	15-33	Bt1	fs										100	QZ 97	OP 3	MS tr					

FRACTION INTERPRETATION:
fs - Fine Sand, 0.1-0.25 mm

MINERAL INTERPRETATION:
MS - Muscovite OP - Opaques QZ - Quartz

RELATIVE PEAK SIZE: 5 Very Large 4 Large 3 Medium 2 Small 1 Very Small 6 No Peaks

*** Supplementary Characterization Data ***

Pedon ID: (White County, Arkansas) Print Date: Apr 11 2004 11:28AM

Sampled as on Jun 01, 1977 :

Revised to correlated on Nov 01, 1984 :

SSL - Project	TYPE LOCATION CHARACTERIZATION	United States Department of Agriculture Natural Resources Conservation Service
- Site ID	Lat: 35° 30' 54.00" north Long: 91° 35' 4.00" west MLRA: 117	National Soil Survey Center
- Pedon No.		Soil Survey Laboratory
- General Methods 1B1A, 2A1, 2B		Lincoln, Nebraska 68508-3866

Tier 1

Layer	Depth (cm)	Horz	Prep	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-	-19-	-20-	-21-	-22-	-23-	-24-	-25-
				(- - - Engineering PSDA - - -													(- - - Cumulative Curve Fractions - - - -) (<75mm)								(Atter-)		(Gradation)	
				Percentage Passing Sieve													USDA Less Than Diameters (mm) at								berg		Uni- fmty	Cur- vtur
				3	2	3/2	1	3/4	3/8	4	10	40	200	20	5	2	1.	.5	.25	.10	.05	60	50	10	LL	PI		
				(----Inches----)						(----Number----)				(------ Microns----)			(---------Millimeter----------)					(-----Percentile---)			(----%----)		CU	CC
79P00791	0-15	Ap	S	100	100	100	100	100	100	100	100	94	62	48	27	14	100	97	88	63	61	0.05	0.024	0.001			44.9	0.7
79P00792	15-33	Bt1	S	100	100	100	100	100	100	100	100	97	79	65	45	31	100	98	94	79	78	0.01	0.007	--			33.1	0.6
79P00793	33-64	Bt2	S	100	100	100	100	100	100	100	100	97	76	62	43	30	100	99	94	76	75	0.02	0.008	--			39.6	0.5
79P00794	64-105	Bx	S	100	100	100	100	100	100	100	100	97	69	56	44	36	100	99	92	69	68	0.03	0.010	--			72.2	0.2
79P00795	105-135	Bt3	S	100	100	100	100	100	100	100	100	95	77	45	37	32	100	97	88	78	75	0.03	0.023	--			76.9	0.2

Tier 2

-26-	-27-	-28-	-29-	-30-	-31-	-32-	-33-	-34-	-35-	-36-	-37-	-38-	-39-	-40-	-41-	-42-	-43-	-44-	-45-	-46-	-47-	-48-	-49-	-50-
(- - - Weight Fractions - - -)														(- - - Weight Per Unit Volume (g cm^{-3}) - - -)								(- - Void - -)		
Whole Soil (mm)						<75 mm Fraction								Whole Soil				<2 mm Fraction				Ratios		

Layer	Depth (cm)	Horz	Prep	>2	250-UP	250-75	75-2	75-20	20-5	5-2	<2	75-2	75-20	20-5	5-2	<2	Soil Sur 33 kPa	Soil Sur Oven-dry	Engineering Moist	Engineering Saturated	Soil Survey 33 kPa	Soil Survey 1500 kPa	Soil Survey Oven-dry	Engineering Moist	Engineering Saturated	At 33 kPa Whole Soil	At 33 kPa <2 mm
				(------------------- % of Whole Soil ------------------)								(--------- % of <75 mm ---------)															
													3B1	3B1	3B1						4A1d		4A1h				
79P00791	0-15	Ap	S	--	--	--	--	--	--	--	100	--	--	--	--	100	1.69	1.75	1.91	2.05	1.69	1.73	1.75	1.91	2.05	0.57	0.57
79P00792	15-33	Bt1	S	--	--	--	--	--	--	--	100	--	--	--	--	100	1.50										
79P00793	33-64	Bt2	S	--	--	--	--	--	--	--	100	--	--	--	--	100	1.52	1.71	1.84	1.95	1.52	1.63	1.71	1.84	1.95	0.74	0.74
79P00794	64-105	Bx	S	--	--	--	--	--	--	--	100	--	--	--	--	100	1.65	1.74	1.96	2.03	1.65	1.70	1.74	1.96	2.03	0.61	0.61
79P00795	105-135	Bt3	S	--	--	--	--	--	--	--	100	--	--	--	--	100	1.50										

Tier 3				-51-	-52-	-53-	-54-	-55-	-56-	-57-	-58-	-59-	-60-	-61-	-62-	-63-	-64-	-65-	-66-	-67-	-68-	-69-	-70-	-71-	-72-	-73-	-74-	-75-
				(- - - - - - - - - - - - - - - - - Volume Fractions - - - - - - - - - - - - - - - -)													C/N	(- - - - - - - Ratios To Clay - - - - - -)				(- - Linear Extensiblity - -)					(- - WRD - -)	
				Whole Soil (mm)											At 33 kPa			<2 mm Fraction				Whole Soil		<2 mm			Whole Soil	<2 mm
	Depth			>2 -UP	250 -75	25075 -2	75 -20	20 -5	5 -2	-2	<2	2- .05	.05- .002	LT .002	Pores D	F	Ratio	Fine Clay	CEC Sum Cats	NH$_4$OAC	1500 kPa H_2O 8D1	LEP	33 kPa	33 kPa	1500 kPa	to %	Oven -dry	1500 kPa	Oven -dry	(---in^3/in^3---) 4C1
Layer	(cm)	Horz	Prep	(---------------------------- % of Whole Soil ---------------------------)																								
79P00791	0-15	Ap	S	--	--	--	--	--	--	--	100	25	30	9	14	22			0.69		0.34	0.090	0.8		0.8		0.14	0.14
79P00792	15-33	Bt1	S	--	--	--	--	--	--	--	100	13	26	17	43				0.52		0.27							
79P00793	33-64	Bt2	S	--	--	--	--	--	--	--	100	14	26	17	11	32			0.55		0.32	0.130	2.4		2.4		0.17	0.17
79P00794	64-105	Bx	S	--	--	--	--	--	--	--	100	20	19	22	7	31			0.50		0.27	0.050	1.0		1.0		0.15	0.15
79P00795	105-135	Bt3	S	--	--	--	--	--	--	--	100	14	24	18	43				0.51		0.37							

Tier 4				-76-	-77-	-78-	-79-	-80-	-81-	-82-	-83-	-84-	-85-	-86-	-87-	-88-	-89-	-90-	-91-	-92-	-93-	-94-	-95-	-96-	-97-	-98-
				(- - - - - - - - - - - - - - - - - - - Weight Fractions - Clay Free - - - - - - - - - - - - - - - - - - -)															Texture	PSDA (mm)			pH	Elect.		Particle
				(--------------- Whole Soil ---------------)						(------------------- <2 mm Fraction ------------------)										Sand	Silt	Clay	Ca	Resist.	Conduct	Density
				>2	75	20	2-	.05-	<	(------------- Sands -------------)					(--- Silts ---)		Clay		by	2-	.05-	<	Cl_2			
Layer	Depth (cm)	Horz	Prep		-20	-2	.05	.002	.002	VC	C	M	F	VF	C	F			PSDA	.05	.002	.002	.01M	ohms	dS m^{-1}	
				(- % of >2 mm Sand and Silt -)						(------------------% of Sand and Silt -------------)									<2 mm	(---- % of 2 mm ----)			(-------- <2 mm -------)			g cm^{-3}
																			3A1	3A1	3A1	3A1				
79P00791	0-15	Ap	S				45	55	16	tr	4	9	30	2	16	39	16		l	39.1	47.0	13.9				
79P00792	15-33	Bt1	S				32	68	45	tr	2	7	21	2	18	50	45		cl	22.2	47.0	30.8				
79P00793	33-64	Bt2	S				36	64	43	tr	2	7	25	2	18	46	43		cl	25.1	44.6	30.3				
79P00794	64-105	Bx	S				51	49	57	tr	2	10	36	3	18	31	57		cl	32.3	31.4	36.3				
79P00795	105-135	Bt3	S				36	64	48	1	3	13	16	4	45	19	48		cl	24.6	43.1	32.3				

*** Taxonomy Characterization Data ***

Pedon ID: (White County, Arkansas) Print Date: Apr 11 2004 11:28AM

Sampled as on Jun 01, 1977 :

Revised to correlated on Nov 01, 1984 :

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

SSL - Project TYPE LOCATION CHARACTERIZATION
- Site ID Lat: 35° 30' 54.00" north Long: 91° 35' 4.00" west MLRA: 117
- Pedon No.
- General Methods 1B1A, 2A1, 2B

Taxonomy Tier 1

Layer	Depth (cm)	Horz	Prep	-1- Clay <.002	-2- Fine Clay <.0002	-3- $CaCO_3$ Clay <.002	-4- 1500 kPa /Clay	-5- Clay Est	-6- .1-75 mm Frac	-7- Bulk Den 33 kPa	-8- Cole Whole Soil	-9- Vol % of Whole	-10- Resist Min %
				(---------% of <2 mm-------)				(-------- % --------)		$g\ cm^{-3}$	$cm\ cm^{-1}$		
				3A1			8D1			4A1d			7B1a
79P00791	0-15	Ap	S	13.9			0.34		37	1.69	0.012	--	
79P00792	15-33	Bt1	S	30.8			0.27		21			--	100
79P00793	33-64	Bt2	S	30.3			0.32		24	1.52	0.040	--	
79P00794	64-105	Bx	S	36.3			0.27		31	1.65	0.018	--	
79P00795	105-135	Bt3	S	32.3			0.37		22			--	

Taxonomy Tier 2

Layer	Depth (cm)	Horz	Prep	-1- pH H_2O	-2- pH NaF	-3- Org C	-4- Tot C	-5- Al+½ Fe Oxal	-6- ODOE	-7- CO_3 as $CaCO_3$	-8- (--- Base Sat ---) NH_4	-9- Bases	-10- NZ P Ret	-11- ECEC cmol(+)/	-12- CEC7 /Clay	-13- ECEC /Clay	-14- Al Sat	-15- E C	-15- ESP
						(-- % --)								kg^{-1}			%	$dS\ m^{-1}$	%

			8C1a	5C3	5A3b		5G1
79P007910-15	Ap	S	5.5	47			
79P0079215-33	Bt1	S	4.6	19	6.7	0.22	55
79P0079333-64	Bt2	S	3.9	16	8.0	0.26	66
79P0079464-105	Bx	S	4.2	12	7.8	0.21	72
79P00795105-135	Bt3	S	4.2	11			

Pedon Calculations

Calculation Name	Result	Units of Measure
Clay, carbonate free, Weighted Average	30	% wt
Weighted Particles, 0.1-75mm, 75 mm Base	23	% wt
Volume, >2mm, Weighted Average	0	% vol
Clay, total, Weighted Average	30	% wt

Weighted averages based on control section: 15-64 cm

PEDON DESCRIPTION

Print Date: 04/11/2004
Description Date: 06/01/1977
Describer: W. A. Gore and L. A. Quandt
Site ID:
Site Note:
Pedon ID:
Pedon Note: Colors are for moist soil unless otherwise stated.
Lab Source ID: SSL
Lab Pedon #:
Soil Name as Described/Sampled:
Soil Name as Correlated:
Classification:
Pedon Type:
Pedon Purpose: full pedon description
Taxon Kind:
Associated Soils:
Physiographic Division:
Physiographic Province:
Physiographic Section:
State Physiographic Area:
Local Physiographic Area:
Geomorphic Setting: upland slope plateaus or tablelands
Upslope Shape:
Cross Slope Shape:
Particle Size Control Section:
Diagnostic Features: ? to ? cm.

Country:
State: Arkansas
County: White
MLRA:
Soil Survey Area:
Map Unit:
Quad Name:
Location Description: NE 1/4 NE 1/4 NE 1/4 Sec. 12 T. 10 N. R.6 W. White County Arkansas.
Legal Description:
Latitude: 35 degrees 30 minutes 54 seconds north
Longitude: 91 degrees 35 minutes 4 seconds west
Datum:
UTM Zone:
UTM Easting:
UTM Northing:
Primary Earth Cover: Crop cover
Secondary Earth Cover:
Existing Vegetation:
Parent Material:
Bedrock Kind:
Bedrock Depth:
Bedrock Hardness:
Bedrock Fracture Interval:
Surface Fragments:

Cont. Site ID: **Pedon ID:**

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
						124				

1A p--0 to 15 centimeters; brown (10YR 4/3) interior loam; weak fine subangular blocky structure; friable;

many fine roots; few fine tubular pores; 1 percent fine dark concretions; strongly acid, pH 5.3, Hellige-Truog; abrupt smooth boundary. Lab sample # 79P00791. few fine dark concretions concentrations; many fine roots

1Bt1--15 to 33 centimeters; strong brown (7.5YR 4/6) interior clay loam; moderate medium subangular blocky structure; friable; many fine roots; common fine tubular pores; 15 percent patchy , moist, clay films on faces of peds and 15 percent patchy , moist, clay films in root channels and/or pores; 1 percent fine dark concretions; very strongly acid, pH 4.8, Hellige-Truog; clear smooth boundary. Lab sample # 79P00792. few fine dark concretions concentrations; few clay films surface features on faces of peds; few clay films surface features in root channels and/or pores; many fine roots

1Bt2--33 to 64 centimeters; yellowish brown (10YR 5/6) interior clay loam; moderate medium subangular blocky structure; friable; common fine roots; common fine tubular pores; 15 percent patchy , moist, clay films on faces of peds and 15 percent patchy , moist, clay films in root channels and/or pores; extremely acid, pH 4.3, Hellige-Truog; gradual wavy boundary. Lab sample # 79P00793. few clay films surface features on faces of peds; few clay films surface features in root channels and/or pores; common fine roots

1Btx--64 to 105 centimeters; strong brown (7.5YR 5/6) interior clay loam; 11 percent medium distinct reddish brown (5YR 4/4) and 11 percent medium distinct light brownish gray (10YR 6/2) and 11 percent medium distinct gray (10YR 6/1) mottles; weak very coarse prismatic, and moderate medium angular blocky structure; firm; brittle; few fine roots; few fine tubular pores; continuous , moist, clay films on faces of peds and continuous , moist, clay films in root channels and/or pores; extremely acid, pH 4.3, Hellige-Truog; gradual smooth boundary. Lab sample # 79P00794. Streaks and patches of clean silt and sand grains between prisms and some peds. Prisms have a mean width of more then 4 inches. About 70% of material is brittle.; few fine roots; common medium distinct 5YR44 mottles; common medium distinct 10YR62 mottles; common medium distinct 10YR61 mottles

1Bt--105 to 135 centimeters; strong brown (7.5YR 5/6) interior clay loam; 11 percent medium distinct red (2.5YR 4/6) and 11 percent medium distinct gray (10YR 6/1) mottles; moderate very fine platy, and weak medium angular blocky structure; firm; brittle; 15 percent 2- to 75-millimeter sandstone fragments; extremely acid, pH 4.3, Hellige-Truog; clear wavy boundary. Lab sample # 79P00795. Many horizontal and common verticle streaks of continuous thick clay films and small patches of clean sand grains.; common medium distinct 2.5YR46 mottles; common medium distinct 10YR61 mottles

1R--135 to 136 centimeters; weathered bedrock.. Not sampled. Horizontal hard bedded sandstone.

*** Primary Characterization Data ***

Pedon ID: **PEDON 2** (Finney County, Kansas) Print Date: Apr 11 2004 1:40PM

Sampled as :

Revised to :

United States Department of Agriculture

SSL - Project

Natural Resources Conservation Service

- Site ID

National Soil Survey Center

- Pedon No.

Soil Survey Laboratory

- General Methods 1B1A, 2A1, 2B

Lincoln, Nebraska 68508-3866

Layer	Horizon	Orig Hzn	Depth (cm)	Field Label 1	Field Label 2	Field Label 3	Field Texture	Lab Texture
01P02745	Ap1	Ap1	0-12				SICL	SICL
01P02746	Ap2	Ap2	12-23				SICL	SICL
01P02747	Bt1	Bt1	23-35				SC	SIC
01P02748	Bt2	Bt2	35-53				SC	SIC
01P02749	Btk1	Btk1	53-72				SICL	SIC
01P02750	Btk2	Btk2	72-99				SICL	SICL
01P02751	Btk3	Btk3	99-122				SL	SIL
01P02752	Btk3	Btk3	122-145				SL	SIL
01P02753	Btk4	Btk4	145-180				SL	SIL

*** Primary Characterization Data ***

Pedon ID: (Finney County, Kansas) Print Date: Apr 11 2004 1:40PM

Sampled As :

USDA-NRCS-NSSC-National Soil Survey Laboratory ; Pedon No.

PSDA & Rock Fragments				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-
				(- - - - - Total - - - - - -)			(- - Clay - - -)		(- - - - Silt - - - - -)		(- - - - - - - - - - - - Sand - - - - - - - - - - - -)					(Rock Fragments (mm))				
				Clay	Silt	Sand	Fine	CO_3	Fine	Coarse	VF	F	M	C	VC	(- - - - - - - - Weight - - - - - - - -)				>2 mm
				<	.002	.05	<	<	.002	.02	.05	.10	.25	.5	1	2	5	20	.1-	wt %
	Depth			.002	-.05	-2	.0002	.002	-.02	-.05	-.10	-.25	-.50	-1	-2	-5	-20	-75	75	whole
Layer	(cm)	Horz	Prep	(- % of <2mm Mineral Soil -)												(- - - - - - - % of <75mm - - - - - -)				soil
				3A1	3A1	3A1	3A1	3A1	3A1	3A1	3A1	3A1	3A1	3A1	3A1					
01P02745	0-12	Ap1	S																--	
01P02745	0-12	Ap1	N	32.3	56.2	11.5	18.8		20.4	35.8	10.1	0.9	0.3	0.2	tr					
01P02746	12-23	Ap2	S																--	
01P02746	12-23	Ap2	N	34.1	58.5	7.4	23.8		18.9	39.6	6.6	0.6	0.1	0.1	--					
01P02747	23-35	Bt1	S																--	
01P02747	23-35	Bt1	N	40.2	51.6	8.2	27.3		16.0	35.6	7.5	0.6	0.1	tr	tr					
01P02748	35-53	Bt2	S																--	
01P02748	35-53	Bt2	N	42.4	50.4	7.2	22.9		18.6	31.8	6.0	0.9	0.1	0.1	0.1					
01P02749	53-72	Btk1	S																--	
01P02749	53-72	Btk1	N	41.9	51.5	6.6	10.9	2.1	22.2	29.3	5.7	0.7	0.1	0.1	tr					
01P02750	72-99	Btk2	S																--	
01P02750	72-99	Btk2	N	31.2	63.6	5.2	5.6	6.3	27.5	36.1	4.8	0.4	tr	tr	--					
01P02751	99-122	Btk3	S																--	
01P02751	99-122	Btk3	N	25.6	67.1	7.3	3.4	5.1	29.2	37.9	6.8	0.5	tr	tr	--					
01P02752	122-145	Btk3	S																--	
01P02752	122-145	Btk3	N	23.9	70.0	6.1	3.6	3.2	30.9	39.1	5.5	0.5	0.1	--	tr					
01P02753	145-180	Btk4	S																--	
01P02753	145-180	Btk4	N	24.5	68.9	6.6	3.9	3.0	30.1	38.8	6.0	0.5	0.1	--	--					

*** Primary Characterization Data ***

Pedon ID: (Finney County, Kansas) Print Date: Apr 11 2004 1:40PM

Sampled As :

USDA-NRCS-NSSC-National Soil Survey Laboratory ; Pedon No

Bulk Density & Moisture				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-
				(Bulk Density)		Cole	(- - - - - - - - - - - Water Content - - - - - - - - - - -)						WRD	Aggst		
				33	Oven	Whole	6	10	33	1500	1500 kPa	Ratio	Whole	Stabl	(- - Ratio/Clay - -)	
	Depth			kPa	Dry	Soil	kPa	kPa	kPa	kPa	Moist	AD/OD	Soil	2-0.5mm	CEC7	1500 kPa
Layer	(cm)	Horz	Prep	(- - - g cm^{-3} - - -)			(- - - - - - - - - - - - % of < 2mm - - - - - - - - - - - -)						cm^{3} cm^{-3}	%		
										4B2a		4B5		4G1	8D1	8D1
01P02745	0-12	Ap1	S											6	0.73	0.42
01P02745	0-12	Ap1	N							13.6		1.027				
01P02746	12-23	Ap2	S												0.70	0.45
01P02746	12-23	Ap2	N							15.2		1.030				
01P02747	23-35	Bt1	S												0.70	0.46
01P02747	23-35	Bt1	N							18.3		1.031				
01P02748	35-53	Bt2	S												0.72	0.46
01P02748	35-53	Bt2	N							19.5		1.033				
01P02749	53-72	Btk1	S												0.71	0.46
01P02749	53-72	Btk1	N							19.1		1.034				
01P02750	72-99	Btk2	S												0.74	0.48
01P02750	72-99	Btk2	N							15.0		1.028				
01P02751	99-122	Btk3	S												0.88	0.53
01P02751	99-122	Btk3	N							13.6		1.027				
01P02752	122-145	Btk3	S												0.94	0.54
01P02752	122-145	Btk3	N							12.8		1.028				
01P02753	145-180	Btk4	S												0.90	0.53
01P02753	145-180	Btk4	N							12.9		1.029				

*** Primary Characterization Data ***

Pedon ID: (Finney County, Kansas) Print Date: Apr 11 2004 1:40PM

Sampled As :

USDA-NRCS-NSSC-National Soil Survey Laboratory ; Pedon No.

Carbon & Extractions				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-16-	-17-	-18-
				(- - - - - Total - - - - -)			Org	C/N	(- - - Dith-Cit Ext - - -)			(- - - - - - - - Acid Oxalate Extraction - - - - - - - -)						(- - - Na Pyro-Phosphate - - -)			
	Depth			C	N	S	C	Ratio	Fe	Al	Mn	Al+½Fe	ODOE	Fe	Al	Mn	Si	C	Fe	Al	Mn
Layer	(cm)	Horz	Prep	(- - - - - - % of <2 mm - - - - - -)					(- - - - - - - - - - - - - - - - % of < 2mm - - - - - - - - - - - - - -)							mg kg^{-1}	(- - - - - - - - - % of < 2mm - - - - - - - - -)				
				6A2f	6B4b	6R3d			6C2h	6G7g	6D2g										
01P02745	0-12	Ap1	N	1.67	0.181	tr			0.7	0.1	tr										
01P02746	12-23	Ap2	N	0.99	0.124	tr			0.8	0.1	tr										
01P02747	23-35	Bt1	N	0.71	0.102	tr			0.8	0.1	tr										
01P02748	35-53	Bt2	N	0.61	0.097	tr			0.8	0.1	tr										
01P02749	53-72	Btk1	N	0.82	0.092	tr			0.8	0.1	tr										
01P02750	72-99	Btk2	N	1.91	0.061	tr			0.6	tr	tr										
01P02751	99-122	Btk3	N	1.67	0.058	--			0.7	tr	tr										
01P02752	122-145	Btk3	N	1.26	0.048	tr			0.7	tr	tr										
01P02753	145-180	Btk4	N	1.17	0.060	tr			0.7	tr	tr										

*** Primary Characterization Data ***

Pedon ID: (Finney County, Kansas) Print Date: Apr 11 2004 1:40PM

Sampled As :

USDA-NRCS-NSSC-National Soil Survey Laboratory ; Pedon No.

CEC & Bases				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-
				(- - - - - - NH_4OAC Extractable Bases - - - - -)								CEC8	CEC7	ECEC		(- - - - Base - - - -)	
								Sum	Acid-	Extr	KCl	Sum	NH_4	Bases	Al	(- Saturation -)	
	Depth			Ca	Mg	Na	K	Bases	ity	Al	Mn	Cats	OAC	+Al	Sat	Sum	NH_4OAC
Layer	(cm)	Horz	Prep	(- - - - - - - - - - - - - - - - - cmol(+) kg^{-1} -)							mg kg^{-1}	(- - - - cmol(+) kg^{-1} - - -)				(- - - - - - - - % - - - - - - - -)	
				6N2i	6O2h	6P2f	6Q2f		6H5a			5A3a	5A8b			5C3	5C1
01P027450-12		Ap1	S	*												92	100
01P027450-12		Ap1	N	18.6	5.7	0.6	2.9		2.4				23.7				
01P0274612-23		Ap2	S	*				26.2				28.9				91	100
01P0274612-23		Ap2	N	18.4	5.3	0.5	2.0		2.7				23.9				
01P0274723-35		Bt1	S	*												93	100
01P0274723-35		Bt1	N	24.3	5.9	0.4	1.9		2.6				28.3				
01P0274835-53		Bt2	S	*												98	100
01P0274835-53		Bt2	N	27.7	7.0	0.6	1.3		0.9				30.6				
01P0274953-72		Btk1	S	*												100	100
01P0274953-72		Btk1	N	59.2	8.7	0.8	1.2						29.7				
01P0275072-99		Btk2	S	*												100	100
01P0275072-99		Btk2	N	56.7	8.5	1.1	1.5						23.2				
01P0275199-122		Btk3	S	*												100	100
01P0275199-122		Btk3	N	56.0	8.5	1.1	1.7						22.6				
01P02752122-145		Btk3	S	*												100	100
01P02752122-145		Btk3	N	53.3	7.7	1.4	1.8						22.4				
01P02753145-180		Btk4	S	*												100	100
01P02753145-180		Btk4	N	57.2	7.3	1.7	2.0						22.1				

*Extractable Ca may contain Ca from calcium carbonate or gypsum., CEC7 base saturation set to 100.

*** Primary Characterization Data ***

Pedon ID: (Finney County, Kansas)

Sampled As :

USDA-NRCS-NSSC-National Soil Survey Laboratory ; Pedon No.

pH & Carbonates

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-
				(- - - pH - - -)						(- - Carbonate - -)		(- - Gypsum - - -)		
					$CaCl_2$					As $CaCO_3$		As $CaSO_4$*$2H_2O$		Resist
	Depth				0.01M	H_2O	Sat			<2mm	<20mm	<2mm	<20mm	ohms
Layer	(cm)	Horz	Prep	KCl	1:2	1:1	Paste	Sulf	NaF	(- - - % - - -)				cm^{-1}
					8C1f	8C1f				6E1h				
01P02745	0-12	Ap1	N		7.0	7.6				--				
01P02746	12-23	Ap2	N		6.7	7.2								
01P02747	23-35	Bt1	N		7.4	7.7				tr				
01P02748	35-53	Bt2	N		7.4	7.9				tr				
01P02749	53-72	Btk1	N		7.6	8.1				3				
01P02750	72-99	Btk2	N		7.7	8.4				14				
01P02751	99-122	Btk3	N		7.8	8.4				12				
01P02752	122-145	Btk3	N		7.8	8.3				8				
01P02753	145-180	Btk4	N		7.9	8.1				8				

Phosphorous

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-
					(- - - Phosphorous - - -)								
				Melanic	NZ	Acid	Bray	Bray	Olsen	H_2O	Citric	Mehlich	Extr
	Depth			Index		Oxal	1	2			Acid	III	NO_3
Layer	(cm)	Horz	Prep		%	(- - - mg kg^{-1} - - -)							mg kg^{-1}
							6S3e						
01P02745	0-12	Ap1	N				34.0						
01P02746	12-23	Ap2	N				6.0						
01P02747	23-35	Bt1	N				2.0						

*** Supplementary Characterization Data ***

Pedon ID: (Finney County, Kansas) Print Date: Apr 11 2004 1:40PM

Sampled as : ;

Revised to :

United States Department of Agriculture
Natural Resources Conservation Service
National Soil Survey Center
Soil Survey Laboratory
Lincoln, Nebraska 68508-3866

SSL - Project
- Site ID
- Pedon No.
- General Methods 1B1A, 2A1, 2B

Tier 3

(- - - - - - - - - - - - - - - - - Volume Fractions - - - - - - - - - - - - - - - -) Whole Soil (mm) At 33 kPa: >2 -UP; 250 -75; 75 -20; 20 -5; 5 -2; 2- <2; .05- .002; LT .002; Pores D; Pores F — C/N Ratio — (- - - - - - - Ratios To Clay - - - - - -) <2 mm Fraction: Fine Clay; CEC SumCats; CEC NH$_4$OAC; 1500 kPa H$_2$O — (- - Linear Extensiblity - -) Whole Soil LEP 33 kPa to 1500 kPa; <2 mm % 33 kPa to Oven-dry; 1500 kPa to Oven-dry — (- - WRD - -) Whole Soil; <2 mm (---in^3/in^3---)

(----------------------------- % of Whole Soil ---------------------------------)

Layer	Depth (cm)	Horz	Prep	-51-	-52-	-53-	-54-	-55-	-56-	-57-	-58-	-59-	-60-	-61-	-62-	-63-	-64-	-65-	-66-	-67-	-68-	-69-	-70-	-71-	-72-	-73-	-74-	-75-
																					8D1							
01P02745	0-12	Ap1	S																		0.42							
01P02746	12-23	Ap2	S																		0.45							
01P02747	23-35	Bt1	S																		0.46							
01P02748	35-53	Bt2	S																		0.46							
01P02749	53-72	Btk1	S																		0.46							
01P02750	72-99	Btk2	S																		0.48							
01P02751	99-122	Btk3	S																		0.53							
01P02752	122-145	Btk3	S																		0.54							
01P02753	145-180	Btk4	S																		0.53							

-76- -77- -78- -79- -80- -81- -82- -83- -84- -85- -86- -87- -88- -89- -90- -91- -92- -93- -94- -95- -96- -97- -98-

Tier 4

Layer	Depth (cm)	Horz	Prep	>2	75-20	20-2	2-.05	.05-.002	<.002	VC	C	M	F	VF	C	F	Clay	Texture by PSDA	Sand 2-.05	Silt .05-.002	Clay <.002	pH CaCl$_2$ .01M	Elect. Resist. ohms	Conduct dS m^{-1}	Particle Density
				(- - - Weight Fractions - Clay Free - - -)															PSDA (mm)						
				(--- Whole Soil ---)					(--- <2 mm Fraction ---)																
										(--- Sands ---)					(--- Silts ---)										
				(- % of >2 mm Sand and Silt -)					(--- % of Sand and Silt ---)									<2 mm	(---- % of 2 mm ----)			(--- <2 mm ---)			g cm^{-3}
																		3A1	3A1	3A1	3A1	8C1f			
01P02745	0-12	Ap1	N															sicl	11.5	56.2	32.3	7.0			
01P02746	12-23	Ap2	N															sicl	7.4	58.5	34.1	6.7			
01P02747	23-35	Bt1	N															sic	8.2	51.6	40.2	7.4			
01P02748	35-53	Bt2	N															sic	7.2	50.4	42.4	7.4			
01P02749	53-72	Btk1	N															sic	6.6	51.5	41.9	7.6			
01P02750	72-99	Btk2	N															sicl	5.2	63.6	31.2	7.7			
01P02751	99-122	Btk3	N															sil	7.3	67.1	25.6	7.8			
01P02752	122-145	Btk3	N															sil	6.1	70.0	23.9	7.8			
01P02753	145-180	Btk4	N															sil	6.6	68.9	24.5	7.9			

*** Taxonomy Characterization Data ***

Pedon ID: (Finney County, Kansas) Print Date: Apr 11 2004 1:40PM

Sampled as : ;

Revised to :

United States Department of Agriculture

Natural Resources Conservation Service

National Soil Survey Center

Soil Survey Laboratory

Lincoln, Nebraska 68508-3866

SSL - Project

- Site ID

- Pedon No.

- General Methods 1B1A, 2A1, 2B

Taxonomy Tier 1

				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-
					Fine	$CaCO_3$	1500		.1-75	Bulk	Cole	Vol	Resist
				Clay	Clay	Clay	kPa	Clay	mm	Den	Whole	% of	Min
	Depth			<.002	<.0002	<.002	/Clay	Est	Frac	33 kPa	Soil	Whole	%
Layer	(cm)	Horz	Prep	(---------% of <2 mm-------)				(-------- % --------)		g cm^{-3}	cm cm^{-1}		
				3A1	3A1	3A1	8D1						
01P02745	0-12	Ap1	S				0.42		--				
01P02745	0-12	Ap1	N	32.3	18.8								
01P02746	12-23	Ap2	S				0.45		--				
01P02746	12-23	Ap2	N	34.1	23.8								
01P02747	23-35	Bt1	S				0.46		--				
01P02747	23-35	Bt1	N	40.2	27.3								
01P02748	35-53	Bt2	S				0.46		--				
01P02748	35-53	Bt2	N	42.4	22.9								
01P02749	53-72	Btk1	S				0.46		--				
01P02749	53-72	Btk1	N	41.9	10.9	2.1							
01P02750	72-99	Btk2	S				0.48		--				

01P02750	72-99	Btk2	N	31.2	5.6	6.3		
01P02751	99-122	Btk3	S				0.53	--
01P02751	99-122	Btk3	N	25.6	3.4	5.1		
01P02752	122-145	Btk3	S				0.54	--
01P02752	122-145	Btk3	N	23.9	3.6	3.2		
01P02753	145-180	Btk4	S				0.53	--
01P02753	145-180	Btk4	N	24.5	3.9	3.0		

Taxonomy Tier 2				-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-10-	-11-	-12-	-13-	-14-	-15-	-15-
				pH	pH	Org	Tot	Al+½ Fe		CO_3 as	(--- Base Sat ---)		NZ	ECEC	CEC7	ECEC	Al		
	Depth			H_2O	NaF	C	C	Oxal	ODOE	$CaCO_3$	NH_4	Bases	P Ret	cmol(+)	/Clay	/Clay	Sat	E C	ESP
Layer	(cm)	Horz	Prep			(-- % --)								kg $^{-1}$			%	dS m^{-1}	%
				8C1f			6A2f			6E1h	5C1	5C3							5D2
01P02745	0-12	Ap1	S			2					100*	92							3
01P02745	0-12	Ap1	N	7.6			1.67			--									
01P02746	12-23	Ap2	S			1					100*	91							2
01P02746	12-23	Ap2	N	7.2			0.99												
01P02747	23-35	Bt1	S			1					100*	93							1
01P02747	23-35	Bt1	N	7.7			0.71			tr									
01P02748	35-53	Bt2	S			1					100*	98							2
01P02748	35-53	Bt2	N	7.9			0.61			tr									
01P02749	53-72	Btk1	S			tr					100*	100							3
01P02749	53-72	Btk1	N	8.1			0.82			3									
01P02750	72-99	Btk2	S			tr					100*	100							5
01P02750	72-99	Btk2	N	8.4			1.91			14									
01P02751	99-122	Btk3	S			tr					100*	100							5
01P02751	99-122	Btk3	N	8.4			1.67			12									
01P02752	122-145	Btk3	S			tr					100*	100							6
01P02752	122-145	Btk3	N	8.3			1.26			8									
01P02753	145-180	Btk4	S			tr					100*	100							8
01P02753	145-180	Btk4	N	8.1			1.17			8									

*Extractable Ca may contain Ca from calcium carbonate or gypsum.

PEDON DESCRIPTION

Print Date: 04/11/2004

Country:

Description Date: 11/27/2000

State: Kansas

Describer: DeAnn Ricks

County: Finney

Site ID:

MLRA: 72 -- Central High Tableland

Site Note: NE /4 of Section 17, T 22S, R 24W. Finney County Irrigated since 1969 by a center-pivot sprinkler. The irrigated crop is always corn and the dryland crop is either wheat or milo. No manure has ever been applied to this field (important because most fields in this area get a lot of manure applied on them). Information comes from a telephone conversation with Andy Larson Jr. on November 16, 2000. I have requested information in writing twice now but haven't received anything yet.

Soil Survey Area: KS055 -- Finney County, Kansas

Pedon ID:

Map Unit:

Pedon Note: Krotovina is in profile at 1m. It was 25 cm in diameter and 50 cm long. Dry color was 10YR 5/4, moist color was 10YR 4/3. There was also a horizontal krotovina present at 160 cm. It was 5 cm in diameter and 60 cm long, moved up to the left side of the profile. It was filled with surface material, moist color 10YR 3/2.

Quad Name:

Lab Source ID: KSU

Location Description:

Lab Pedon #:

Legal Description: NE1/4 of Section 17, Township 22S, Range 24W

Soil Name as Described/Sampled:

Latitude: 38 degrees 8 minutes 36 seconds north

Soil Name as Correlated:

Longitude: 101 degrees 4 minutes 2 seconds west

Classification:

Datum: NAD83

Pedon Type: modal pedon for series

UTM Zone: 14

Pedon Purpose: research site

UTM Easting: 318840 meters

Taxon Kind: series

UTM Northing: 4223752 meters

Physiographic Division:

Primary Earth Cover: Crop

cover

Physiographic Province:

Secondary Earth Cover: Row crop

Physiographic Section:

Existing Vegetation:

State Physiographic Area:

Parent Material: silty calcareous loess

Local Physiographic Area:

Bedrock Kind:

Geomorphic Setting: on flat plain on tableland

Bedrock Depth:

Upslope Shape: linear

Bedrock Hardness:

Cross Slope Shape: linear

Bedrock Fracture Interval:

Cont. Site ID:

Pedon ID:

Slope (%)	Elevation (meters)	Aspect (deg)	MAAT (C)	MSAT (C)	MWAT (C)	MAP (mm)	Frost-Free Days	Drainage Class	Slope Length (meters)	Upslope Length (meters)
0.0								well		

Ap1--0 to 12 centimeters; silty clay loam, very dark grayish brown (10YR 3/2), moist; 12 percent sand; 56 percent silt; 32 percent clay; weak fine subangular blocky structure; very friable, slightly hard; common medium roots and common coarse roots; 3.0 ESP; noneffervescent, by HCl, 1 normal; slightly alkaline, pH 7.6, pH meter 1:1 water; clear smooth boundary.

Ap2--12 to 23 centimeters; silty clay loam, very dark grayish brown (10YR 3/2), moist; 7 percent sand; 58 percent silt; 34 percent clay; moderate fine subangular blocky structure; friable, slightly hard; many fine roots and many medium roots; 2.0 ESP; noneffervescent, by HCl, 1 normal; neutral, pH 7.2, pH meter 1:1 water; clear smooth boundary.

Bt1--23 to 35 centimeters; silty clay, very dark grayish brown (10YR 3/2), moist; 8 percent sand; 52 percent silt; 40 percent clay; moderate medium subangular blocky structure; friable, hard; many fine roots; 10 percent continuous faint , moist, clay films on all faces of peds; 1.0 ESP; noneffervescent, by HCl, 1 normal; slightly alkaline, pH 7.7, pH meter 1:1 water; clear smooth boundary.

Bt2--35 to 53 centimeters; silty clay, very dark grayish brown (10YR 3/2), moist; 7 percent sand; 50 percent silt; 42 percent clay; moderate medium prismatic parting to moderate medium subangular blocky structure; friable, hard; many fine roots and many very fine roots; 20 percent continuous faint , moist, clay films on all faces of peds; 1 percent carbonate masses; 2.0 ESP; noneffervescent, by HCl, 1 normal; moderately alkaline, pH 7.9, pH meter 1:1 water; gradual smooth boundary.

Btk1--53 to 72 centimeters; brown (10YR 5/3) silty clay, brown (10YR 4/3), moist; 7 percent sand; 52 percent silt; 42 percent clay; moderate medium prismatic parting to moderate medium subangular blocky structure; friable, hard; common fine roots and common very fine roots; 20 percent continuous faint very dark grayish brown (10YR 3/2), moist, clay films on all faces of peds; 1 percent carbonate masses; 3.0 ESP; strong effervescence, by HCl, 1 normal; moderately alkaline, pH 8.1, pH meter 1:1 water; clear wavy boundary.

Btk2--72 to 99 centimeters; pale brown (10YR 6/3) silty clay loam, pale brown (10YR 6/3), moist; 5 percent sand; 64 percent silt; 31 percent clay; strong coarse prismatic parting to moderate medium subangular blocky structure; friable, hard; very fine roots; 2 percent patchy faint brown (10YR 4/3), moist, clay films on vertical faces of peds; 3 percent carbonate masses and 2 percent fine carbonate nodules; 5.0 ESP; strong effervescence, by HCl, 1 normal; moderately alkaline, pH 8.4, pH meter 1:1 water; gradual smooth boundary.

Btk3--99 to 122 centimeters; light yellowish brown (10YR 6/4) silt loam, light yellowish brown (10YR 6/4), moist; 7 percent sand; 67 percent silt; 26 percent clay; strong coarse prismatic parting to moderate coarse subangular blocky structure; friable, slightly hard; common very fine roots; 1 percent patchy faint dark yellowish brown (10YR 4/4), moist, clay films on vertical faces of peds; 3 percent carbonate masses; 5.0 ESP; strong effervescence, by HCl, 1 normal; moderately alkaline, pH 8.4, pH meter 1:1 water; This horizon was split for sampling purposes..

Btk3--122 to 145 centimeters; light yellowish brown (10YR 6/4) silt loam, light yellowish brown (10YR 6/4), moist; 6 percent sand; 70 percent silt; 24 percent clay; strong coarse prismatic parting to moderate coarse subangular blocky structure; friable, slightly hard; common very fine roots; 1 percent patchy faint dark yellowish brown (10YR 4/4), moist, clay films on vertical faces of peds; 3 percent carbonate masses; 6.0 ESP; strong effervescence, by HCl, 1 normal; moderately alkaline, pH 8.3, pH meter 1:1 water; gradual smooth boundary.

Btk4--145 to 180 centimeters; light yellowish brown (10YR 6/4) silt loam, yellowish brown (10YR 5/4), moist; 7 percent sand; 69 percent silt; 24 percent clay; strong medium prismatic parting to moderate medium subangular blocky structure; friable, slightly hard; common very fine roots; 1 percent patchy faint dark yellowish brown (10YR 4/4), moist, clay films on vertical faces of peds; 2 percent carbonate masses; 8.0 ESP; strong effervescence, by HCl, 1 normal; moderately alkaline, pH 8.1, pH meter 1:1 water.

Appendix G - Homework 1 Assignment for AGRON 515 (Soil Genesis and Classification)

AGRON 515
Soil Genesis and Classification
Homework No. 1

1. Determine the diagnostic epipedon and diagnostic subsurface horizon or horizons for Pedons 1 - 10. In addition, list the important diagnostic soil characteristics (i.e., those that would affect classification) for Pedons 1, 3, and 7.

2. Each pedon can have only one diagnostic epipedon. A pedon can have one, more than one, or no diagnostic subsurface horizon(s).

3. Save your answers on a separate sheet. These same pedon descriptions and laboratory data will be used for the other two homework assignments.

Pedon Number	Epipedon	Diagnostic Subsurface Horizon(s)	Diagnostic Soil Characteristics
1	Ochric	Argillic Fragipan	(1) Fragic soil properties (2) Lithic contact
2	Mollic	Argillic	(1) Secondary carbonates
3	Ochric	Calcic Petrocalcic	(1) Secondary carbonates
4	Ochric	Albic Argillic	(1) Plinthite
5			None
6			None
7			(1) Slickensides (2) (3)
8			None
9			(1) Aquic conditions (2) Abrupt textural change
10			None

Appendix H - Homework 2 Assignment for AGRON 515 (Soil Genesis and Classification)

AGRON 515

Soil Genesis and Classification

Homework No. 2

1. Use Chapter 4 of Soil Survey Staff (2010) to classify Pedons 1-4 and 6 to the order level. Use the Simplified Guide to Soil Taxonomy to classify Pedons 5 and 7-10 to the order level. Fill in the table below to complete your homework assignment.

2. You should also write down the order for each pedon on the pedon description. You will need this information for Homework No. 3 and for class discussion

Pedon Number	Order
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Appendix I - Homework 3 Assignment for AGRON 515 (Soil Genesis and Classification)

AGRON 515

Soil Genesis and Classification

Homework 3 and Quiz No. 1

1. Classify Pedons 1, 5, and 7 to the subgroup level. (Use simplified keys to classify to the great group level and 11 edition of keys to classify to the subgroup level.)
2. Classify Pedons 3, 4, and 6 to the family level. (Use 11 edition of keys to classify.)
3. The classification of Pedon 10 to the family level will be graded as Quiz No. 1.
4. You may classify Pedons 2, 8, and 9, but they will not be graded.
5. Include for each of these pedons a list of assumptions that you make that are in addition to the assumptions listed below.

Pedon 1

Assume: Udic moisture regime and thermic temperature regime
Siliceous mineralogy
Control section = 15 - 64 cm (note that many calculations useful for classification are already included in Taxonomy Tier 2 data)

Subgroup classification:____

Pedon 2

Assume: Ustic moisture regime that is transitional to aridic moisture regime
Mesic temperature regime
Smectitic mineralogy
Control section = 23 - 73 cm

Pedon 3

Assume: Aridic moisture regime
Thermic temperature regime
Mixed mineralogy
Control section = 25 - 79 cm (note that many calculations useful for classification are already included in Taxonomy Tier 2 data)

Family classification: ____

Pedon 4

Assume: Udic moisture regime and thermic temperature regime
Siliceous mineralogy
Control section = 25 - 75 cm (note that many calculations useful for classification are already included in Taxonomy Tier 2 data)

Family classification:____

Pedon 5

Assume: Ustic moisture regime and isohyperthermic temperature regime
Allitic mineralogy
Control section = 25 - 100 cm

Subgroup classification: ____

Pedon 6

Assume: Udic moisture regime and mesic temperature regime
Mixed mineralogy
Control section = 25 -100 cm

Family classification: ____

Pedon 7

Assume: Ustic moisture regime that is borderlne to udic moisture regime
Thermic temperature regime
Smectitic mineralogy
Cracks that open and close periodically
Control section = 25 - 100 cm (note that many calculations useful for classification are already included in Taxonomy Tier 2 data)

Subgroup classification: ____

Pedon 8

Assume: Udic moisture regime and mesic temperature regime
Mixed mineralogy
Control section = 23 - 73 cm (note that many calculations useful for classification are already included in Taxonomy Tier 2 data)

Pedon 9

Assume: Aquic conditions within 50 cm
Thermic temperature regime
Mixed mineralogy
Control section = 34 - 75 cm (note that many calculations useful for classification are already included in Taxonomy Tier 2 data)

Pedon 10 (Counts as Quiz No. 1)

Assume: Udic moisture regime and mesic temperature regime
Siliceous mineralogy
Control section = 25 - 100 cm

Family classification: ____

Appendix J - Evaluation Survey for AGRON 515 (Soil Genesis and Classification)

AGRON 515
Spring 2014 Evaluation Survey

Rate yourself on:
(1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high)

_____ your interest in learning about soil classification (soil classification has meaning to you)

_____ your prior knowledge of soil classification

_____ the amount you learned from the homeworks 1,2, and 3

______Your confidence in correctly classifying soils to the subgroup level using the simplified guide (it makes sense to you)

______Your confidence in correctly classifying soils to the subgroup level using *Keys to Soil Taxonomy* (it makes sense to you)

Answer the following statements with a Yes or No answer:
(Y=Yes, N=No)

______ I was able to determine the diagnostic subsurface horizons of the given pedons using the simplified guide (Homework 1)

______ I was able to determine the diagnostic subsurface horizons of the given pedons using *Keys to Soil Taxonomy* (Homework 1)

_______ Did the simplified guide help you identify the characteristics that differentiate the 12 different soil orders? (Homework 2)

______Did *Keys to Soil Taxonomy* help you identify the characteristics that differentiate the 12 different soil orders? (Homework 2)

______ Do you feel the *Simplified Guide to Soil Taxonomy* was useful in helping you classify soils to the subgroup level? (Homework 3)

______ Do you feel *Keys to Soil Taxonomy* was useful in helping you classify soils to the subgroup? (Homework 3)

Were there any features of the simplified guide that you found particularly useful? If yes, please explain which parts you found useful and how they helped you in classifying the pedons.

Did you find the terminology and vocabulary in the simplified guide easy or difficult to understand? Were the abbreviated definitions in parentheses after certain words helpful or did it make it the guide difficult to read?

Please comment or suggest any improvements that would help you in understanding how to classify soils using the *Simplified Guide to Soil Taxonomy*.

Did you find the terminology and vocabulary in *Keys to Soil Taxonomy* easy or difficult to understand? If it was difficult, what would help your understanding?

Please comment or suggest any improvements that would help you in understanding how to classify soils using *Keys to Soil Taxonomy*.

Which do you prefer to use to classify soils to the subgroup level, *Keys to Soil Taxonomy* or the *Simplified Guide to Soil Taxonomy?* Please explain your answer.

Appendix K - Supplemental Horizon Nomenclature Handout from Textbook for AGRON 305 (Soils)

Lowercase Letter Symbols to Designate Subordinate Distinctions Within Master Horizons

Letter	Distinction	Letter	Distinction
a	Organic matter, highly decomposed	n	Accumulation of sodium
b	Buried soil horizon	o	Accumulation of Fe and Al oxides– oxic
c	Concretions or nodules	p	Plowing or other disturbance
d	Dense unconsolidated materials	q	Accumulation of silica
e	Organic matter, intermediate decomposition	r	Weathered or soft bedrock
f	Frozen soil	s	Illuvial organic matter and Fe and Al oxides – Spodic
ff	Dry permafrost	ss	Slickensides (shiny clay wedges)
g	Strong gleying (mottling)	t	Accumulation of silicate clays– argillic
h	Illuvial accumulation of organic matter	u	Presence of human-manufactured materials (artifacts)
i	Organic matter, slightly decomposed	v	Plinthite (high iron, red material)
j	Jarosite (yellow sulfate mineral)	w	Distinctive color or structure without clay accumulation
jj	Cryoturbation (frost churning)	x	Fragipan (high bulk density, brittle)
k	Accumulation of carbonates	y	Accumulation of gypsum
m	Cementation or induration	z	Accumulation of soluble salts

Modified from Brady and Weil (2009).

Appendix L - Example Flow Chart, Maps, and Picture from the *Simplified Guide to Soil Taxonomy*

Mollisols – Suborders (KST 11th ed.)

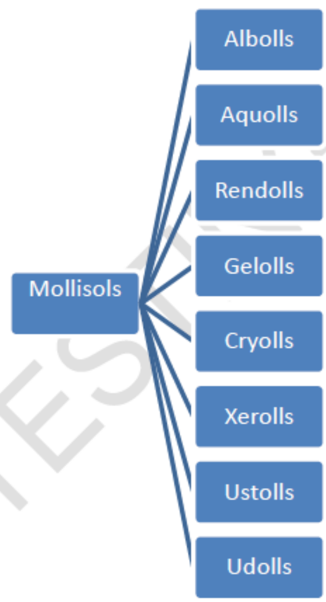
Classification of Mollisols

In the definitions of the suborders, emphasis is divided between the presence of a light-colored leached layer (albic horizon) with a fluctuating water table (Albolls), soil wetness (Aquolls), those formed in highly calcareous parent materials (Rendolls), cold soil temperature (Gelolls and Cryolls), and soil moisture regime (Xerolls, Ustolls, and Udolls).

The great groups reflect a combination of important soil properties including the presence of various diagnostic horizons in addition to the mollic epipedon, cold soil temperature, patterns of soil saturation, intense bioturbation from earthworms or other organisms, and those with morphology reflecting strong soil development on stable landforms.

The eight suborders are:

1. Albolls – Mollisols with a fluctuating water table and a light-colored zone of leaching (albic horizon).
2. Aquolls - wet Mollisols (Aquic conditions in upper part).
3. Rendolls – Mollisols formed in highly calcareous parent materials.
4. Gelolls – very cold Mollisols, but lacking permafrost (gelic temperature regime).
5. Cryolls – cold Mollisols (cryic temperature regime).
6. Xerolls – moderately dry Mollisols (limited moisture, supplied in winter “Mediterranean climate”).
7. Ustolls – moderately dry Mollisols (limited moisture).
8. Udolls – Mollisols of humid regions with well distributed rainfall.



DRAFT FOR TESTING

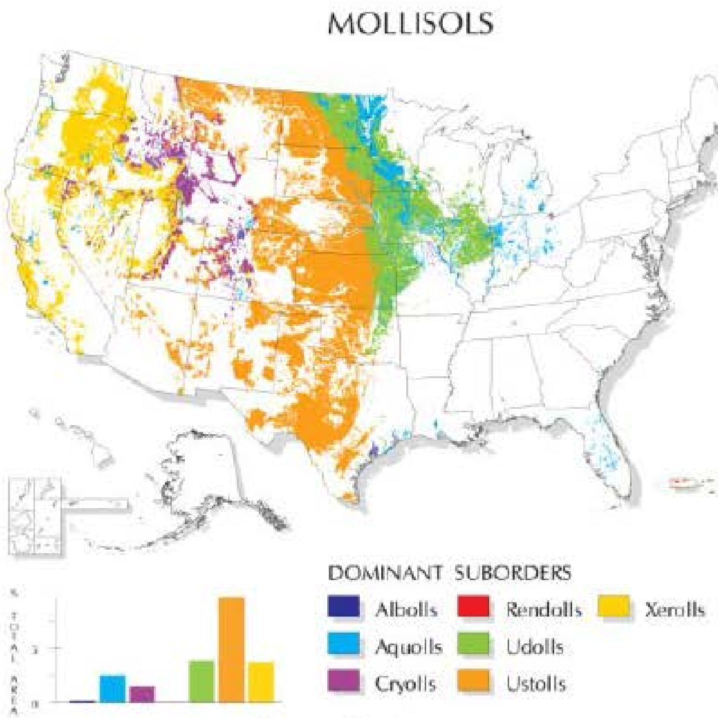
Keys to Suborders of Mollisols

Mollisols that have:

1. **A seasonally high water table within 100 cm, a light-colored leached layer (albic horizon), and an argillic (clay accumulation) or natric (high levels of illuvial clay and sodium) horizon** -- Albolls
   Note: See Keys to Soil Taxonomy for specific requirements for color, thickness, and location of the albic horizon. Artificially drained soils are included in Albolls. Redoximorphic features are evidence of a seasonal high water table. Albolls have a soil temperature regime warmer than cryic.

2. **A seasonally high water table within 50 cm** -- Aquolls
   (Note: Redoximorphic features are evidence of a seasonal high water table. However,

Mollisols – Order (KST 11th ed.)

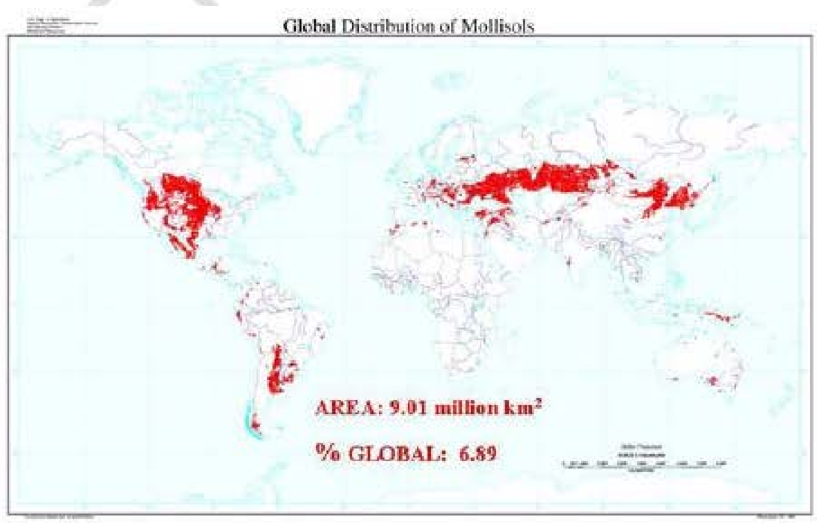


Mollisols by Suborder in the United States (above).

Note that this map was produced before the introduction of the Gelolls suborder. Some areas shown as Cryolls in Alaska are now Gelolls.

Global distribution of Mollisols (below).

Maps provided by USDA-NRCS Soil Survey Staff



Mollisols – Order (KST 11th ed.)

Mollisols are very dark-colored, naturally very fertile soils of grasslands.

General Characteristics

Mollisols are soils with a thick, friable, very dark-colored, organic-rich, surface layer (mollic epipedon). In addition, they are naturally very fertile, having a high base saturation throughout the soil. Depending on their environmental setting, Mollisols may have a variety of subsoil horizons, especially those on older, relatively stable geomorphic surfaces. In relatively dry areas where leaching is not intense, calcic (calcium carbonate accumulation), petrocalcic (calcium carbonate cementation), and duripan (silica cementation) horizons are known to occur. In more humid environments it is common for argillic (clay accumulation), or natric (high levels of illuvial clay and sodium) horizons to form. A few Mollisols in wet areas have a light-colored, leached albic horizon.

Environment and Processes

Mollisols have formed predominantly in temperate grasslands at mid-latitudes in many parts of the world. To a lesser degree they can be found in the tropics or at high latitudes or high mountain elevations. Mollisols have formed as the result of deep inputs of organic matter and nutrients from decaying roots, especially short, mid, and tall grasses common to prairie and steppe areas where there is a high below ground biomass production and deep cycling of nutrients. Less commonly, Mollisols have formed under forest vegetation, often from calcareous parent materials. Also contributing to the deep inputs and cycling of organic matter and nutrients are the activity of microbes, earthworms, ants, rodents, and other organisms.

In addition to the accumulation of organic matter, Mollisols have high contents of base nutrients distributed throughout their profile, making them naturally highly fertile. This characteristic is, in general, the result of their formation over mostly non-acid parent materials that supply bases to the soil as they weather and their setting in environments (subhumid to semiarid) that are not subject to intense leaching of nutrients from the profile.

Location

Globally, Mollisols occupy about 7% of the ice-free land area. They are commonly located between the Aridisols of very dry areas and the Alfisols and Spodosols of more humid environments. In the United States and Canada they are common throughout the Great Plains and Prairie regions. World-wide they are common in the subhumid to semiarid prairie and steppe regions of Europe, Asia and South America.

Mollisol profile (Calciustoll)
(USDA-NRCS Soil Survey Staff)

Back to Key to Orders

From Soil Survey Staff (2013).