Holdrege
Nebraska State Soil

Soil Science Society of America

Introduction

Many states have a designated state bird, flower, fish, tree, soil, rock, etc. And, many states also have a state soil - one that has significance or is important to the state. The Holdrege is the official state soil of Nebraska. Let's explore how the Holdrege is important to Nebraska.

History

The Holdrege Soil was first described as separate from surrounding soils in 1917 in Phelps County, NE and named for the nearby community of Holdrege. It was selected by the state legislature in 1979 to represent the soil resources of the state as the Official State Soil. Agriculture and soil are very important aspects of Nebraska's economy.

What is Holdrege Soil?

The Holdrege soils are very deep with small and medium (*clay* and *silt*) sized soil particles that result in excellent water storage but may restrict water movement through the soil. Every soil can be separated into three separate size fractions called *sand*, *silt*, and *clay*, which makes up the *soil texture*. They are present in all soils in different proportions and say a lot about the character of the soil.

The soil particles were originally deposited by wind and stabilized by tall- and mixed-grass prairie. Lands that have been cleared for agriculture have great potential for wind *erosion*. The soil is generally found on flat (less than 4%) slopes and has high natural fertility making it excellent for use in agriculture when conservation practices are observed.

Where to dig a Holdrege

Yes, you can dig a soil. It is called a soil pit and it shows you the *soil profile* **(Figure 1)**. The different horizontal layers of the soil are actually called *soil horizons*. Holdrege soils occur on about 1.8 million acres in south-central Nebraska. The Holdrege is most often found in the highlighted region of the below map **(Figure 2)**. This does not mean that other types of soil are not found in that portion of the state, just that Holdrege is very common.

Importance

The south-central region of the state, where Holdrege is common, has the greatest concentration of high yielding irrigated corn production in Nebraska **(Figure 4)**. Nebraska ranks third in the U.S. production of corn grain, and Holdrege is one of the many healthy soils that allow this high yield production because of its high natural fertility and high water storage capacity.

Photo: Chip Clark/Smithsonian Institution

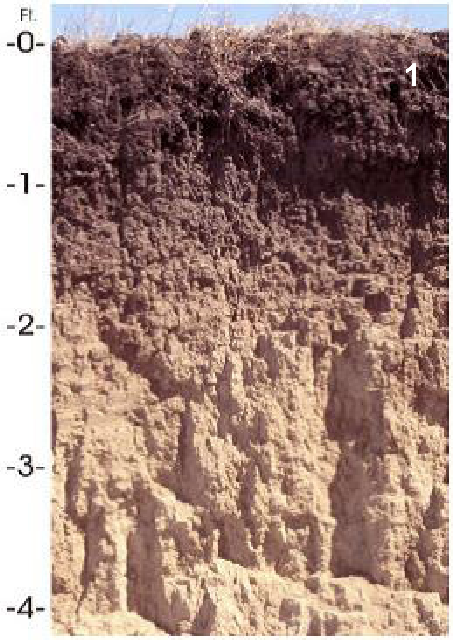
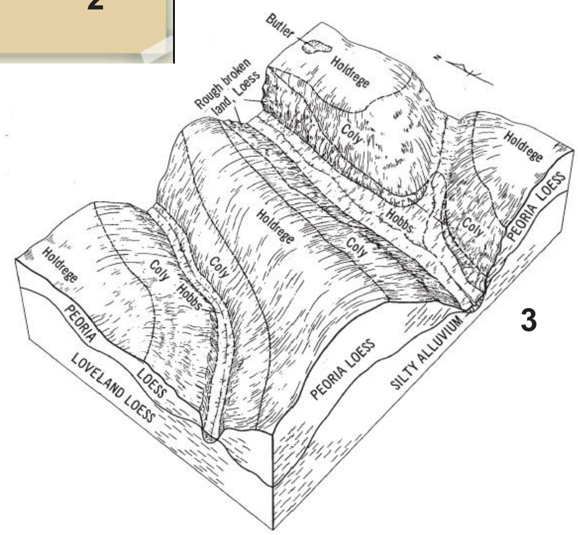


Fig. 1 Holdrege soil profile showing dark top layer due to addition of organic matter from prairie grasses. Source: http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=stelprdb1236841

Fig. 2 Holdrege soil series are the most common in the south central part of Nebraska. Source:http://forces.si.edu/soils/interactive/statesoils/index.html

Fig. 3 Holdrege soil is formed on flat upland portion of the landscape which is stable and promotes soil development. Source: NRCS. Soil Survey of Phelps County, Nebraska..



Uses

Soils everywhere are used for agriculture (growing fibers, fuels, and foods for people and animals); support engineering (roads, buildings, tunnels); recreation (ball fields, playgrounds, and camping areas); natural ecosystems (wetlands); and more.

The Holdrege is extensively used for agriculture. Most of this for corn production, but also for other crops including wheat, soybean, sorghum, and alfalfa. Some areas are also used as pasture and rangelands for cattle production.

Some towns are settled on Holdrege soil. How would you feel if your house was built on the State Soil? Special, I think.

Limitations

While soil underlies nearly everything humans do, some soils are not as well suited for one or more of the uses discussed above. This is referred to as a "limitation". Soils with limitations required special management and adaptations in order to be able to carry out the intended use without damaging the soil.

Soil experts, called *Soil Scientists*, have studied the suitability of Holdrege soils for various uses and have determined that there are few limitations to restrict the use of Holdrege soils for construction, recreation, or crop production. The major limitation is that the fine grained particles at the soil surface easily dislodge creating *erosion* hazard and dusty conditions during use.

Holdrege soils have no limitations for support of buildings and homes with and without basements; however, those homes may not be able to use traditional septic systems because the fine textured soil restricts water movement.

The Holdrege soils are generally rated as class II and III for agricultural production. High potential for *erosion* and limited rainfall are the features that keep these flat, fertile soils from attaining the highest rating of class I.

Management

The primary limitation is also the main management concern for use of the Holdrege and other soils in Nebraska. It is critical to minimize *erosion* and preserve soil resources for a sustainable future. The keys to reducing *erosion* are to keep the soil surface covered and to reduce disturbance of the soil surface **(Figure 5)**. Keeping the soil surface covered can be accomplished by leaving more residue in the field after harvest or using mulches in gardens and construction sites. Soil disturbance can be reduced by reducing tillage in crop fields and only disturbing areas necessary during construction.

No-till is a practice for crop production where the field is not plowed between crops. This means the soil is not disturbed. It also leaves residue on the soil surface rather than bury it under ground. No-till has also been proven to allow more water to be stored in the *soil profile*. Since Nebraska is a state with limited natural rain and increasing groundwater use restrictions for *irrigation*, increasing the water storage of the soil profile is beneficial to crop production.

The region where Holdrege commonly experiences a good deal of wind *erosion* **(Figure 6)**. In addition to increasing ground cover and reducing disturbance, management practices that reduce wind access to soil are also beneficial for reducing *erosion*. One example of such a practice would be to plant tree wind breaks at field borders. Trees lift winds and protect the soil surface for a distance 10 times the height of the wind break. Reduced winds will also reduce evaporation and water losses from the soil (leaving more water for plant growth).

Fig. 4. Irrigation is a major source of water for growing corn on the Holdrege soil.Photo credit: Wale Adewunmi

Irrigation water management is an important concern in central Nebraska. Soil scientists recommend using low pressure sprinklers or other systems designed to increase water use efficiency and decrease water *erosion* caused by *irrigation* water.

Holdrege Soil Formation

Before there was soil, there were rocks, and in between, ClORPT. Without ClORPT, there will be no soil. So, what is ClORPT? It is the five major factors that are responsible for forming a soil like the Holdrege. These are **Cl**imate, **O**rganisms, **R**elief, **P**arent material, and **T**ime. The ClORPT is responsible for the development of soil profiles and chemical properties that differentiate soils. So, the characteristics of Holdrege soil (and all other soils) are determined by the influence of ClORPT. Weathering takes place when environmental processes such as rainfall, and freezing and thawing cycles act on rocks causing them to dissolve or break into pieces. After weathering, ClORPT acts on rock pieces, deposited sediments, and vegetative materials to form soils.

Climate – Temperature and precipitation influence the rate at which parent materials weather, and dead plants and animals decompose. They affect the chemical, physical and biological relationships in the soil. Holdrege soils formed in areas with relatively low annual rainfall, resulting in less horizon development than wetter regions, and therefore are considered young soils. There has been enough precipitation for *clays* and *carbonates* to move in the soil creating some horizon development.

Organisms – This refers to plants and animal life. In the soil, plant roots spread out, animals burrow in, and bacteria break down plant and animal tissue. These activities and others speed up the breakdown of large soil particles into smaller ones. Plants and animals also influence the formation and differentiation of *soil horizons*. Plants determine the kinds and amounts of *organic matter* that are added to a soil under normal conditions. Animals breakdown complex compounds into small ones and in so doing add *organic matter* to soil. Holdrege soils formed under prairie grasses, the extensive roots of which led to being high in *organic matter* (which increases its fertility) and excellent for crop production. Darker soil colors indicate greater *organic matter* content **(Figure 1)**.

Relief –Landform position or relief describes the shape of the land (hills and valleys). The steepness of a location and the direction it faces make a difference in how much sunlight the soil gets and how much water it stores. Deeper soils form at the bottom of the hill rather than at the top because gravity and water move soil particles downhill. Holdrege soils formed on relatively flat *upland* landscapes **(Fig.3).** Soils on flat *upland* surfaces are more stable and therefore have more development than those found on slopes, which experience *erosion*, or lowlands, which experience *deposition*.

Fig. 5. Maintaining ground cover by leaving crop residue on the soil is one of the conservation practices to reduce soil loss by wind erosion. Photo credit: Wale Adewunmi

Fig. 6. Holdrege soil is prone to wind erosion of fine soil particles of silt size. Conservation management practices must be used to prevent this type of soil loss.

Parent material (C horizon) – Just like people inherit characteristics from their parents, every soil inherited some traits from the material from which it formed. Some soils form into bedrock but many have parent materials that were transported and deposited by glaciers, wind, water, or gravity. The Holdrege soil formed in *loess* (pronounced luss), which is fine grained (typically *silt* sized) material that has been deposited by blowing wind. Calcium *carbonates* present in these *loess* deposits can still be seen in the deeper, undeveloped part of the *soil profile* known as the C horizon.

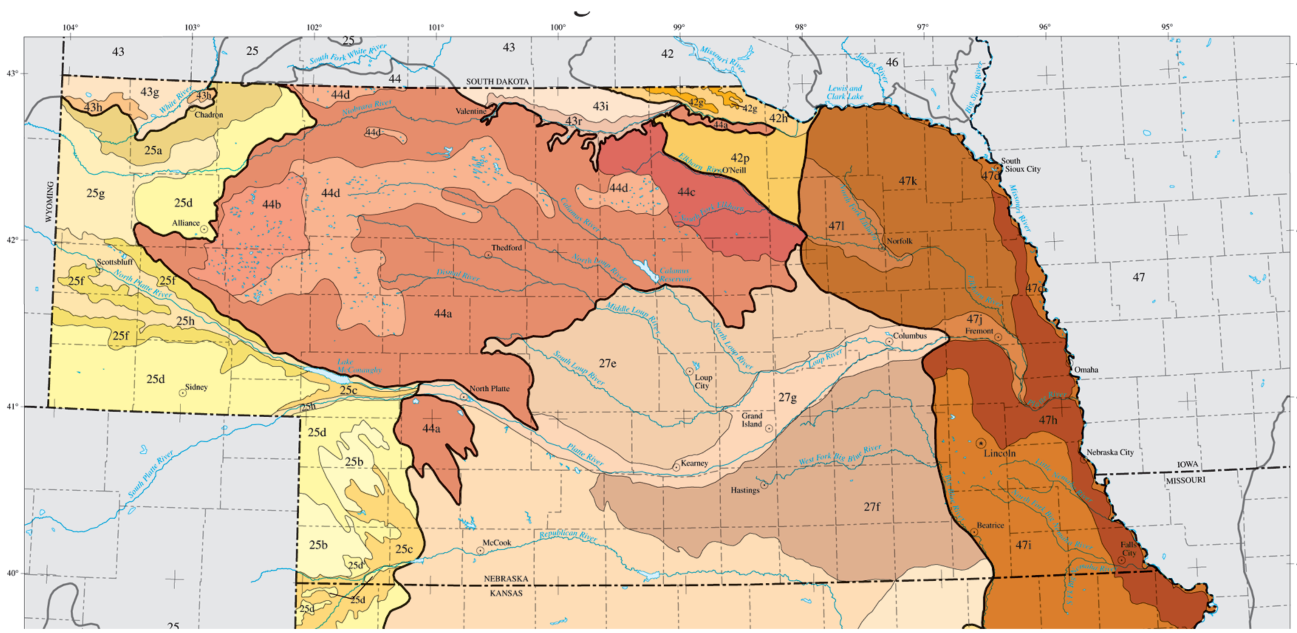
Time – All the factors act together over a very long time to produce soils. As a result, soils vary in age. The length of time that soil material has been exposed to the soil-forming processes makes older soils different from younger soils. Generally, older soils have better defined *horizons* than younger soils. Less time is needed for a soil profile to develop in a humid and warm area with dense vegetative cover than in a cold or dry area with sparse plant cover. More time is required for the formation of a well-defined *soil profile* in soils with fine textured material than in soils with coarse-textured soil material.

Ecoregions, Soils, and Land Use in Nebraska

Nebraska is a large state with great soil diversity. It also has much more topography than it generally recieves credit for. The windy nature of the state has created topography from loess hill deposits and sand dunes. However, of the six recognized *ecoregions* of the state, five are considered plains and are made up of soil that is dominantly silty in nature **(Fig.7)**. The portion of the loess hills that are in Nebraska fall into the Western Corn Belt Plains *ecoregion*.

The three main plains areas (Western High Plains, Central Great Plains, Western Corn Belt Plains) can trace their separation to climate. The drier, western area was dominated by short grass prairie; the soils of this region are the least developed and have the shallowest *horizons*. The wetter, eastern plains (part of the Corn Belt) were dominated by tall grass prairie and have the deepest, most developed soils of the state. The central region was stabilized by mixed-grass prairie. These *ecoregions* are all suitable for and dominantly used for agriculture with higher water use crops (corn and soybeans) grown in the eastern portion of the state and lower water use crops (sunflower and dry beans) grown in the western portion of the state.

The sixth *ecoregion*, the Nebraska Sand Hills, is where Nebraska finds its greatest ecosystem diversity. The sand hills are both the largest sand dune complex in the Western Hemisphere and the largest wetland system in the United States with a number of seasonal and alkaline lakes also present to house great wildlife diversity. The Sand Hills are a fragile ecosystem that is laregely unsuitable for crop production or urban infrastucture but has proven very successful as rangeland for cattle production and habitat for wildlife and game.



25 Western High Plains
- 25a Pine Ridge Escarpment
- 25b Rolling Sand Plains
- 25c Moderate Relief Rangeland
- 25d Flat to Rolling Cropland
- 25e Rolling Cropland and Range
- 25f Scotts Bluff and Wildcat Hills
- 25g Sandy and Silty Tablelands
- 25h North and South Platte Valley and Terraces

26 Southwestern Tablelands
- 26a Cimarron Breaks
- 26b Flat Tablelands and Valleys

27 Central Great Plains
- 27a Smoky Hills
- 27b Rolling Plains and Breaks
- 27c Great Bend Sand Prairie
- 27d Wellington-McPherson Lowland
- 27e Central Nebraska Loess Plains
- 27f Rainwater Basin Plains
- 27g Platte River Valley

28 Flint Hills
- 28 Flint Hills

29 Central Oklahoma/Texas Plains
- 29a Cross Timbers

39 Ozark Highlands
- 39a Springfield Plateau

40 Central Irregular Plains
- 40b Osage Cuestas
- 40c Wooded Osage Plains
- 40d Cherokee Plains

42 Northwestern Glaciated Plains
- 42g Ponca Plains
- 42h Southern River Breaks
- 42p Holt Tablelands

43 Northwestern Great Plains
- 43g Semiarid Pierre Shale Plains
- 43h White River Badlands
- 43i Keya Paha Tablelands
- 43r Niobrara River Breaks

44 Nebraska Sand Hills
- 44a Sand Hills
- 44b Alkaline Lakes Area
- 44c Wet Meadow and Marsh Plain
- 44d Lakes Area

47 Western Corn Belt Plains
- 47d Missouri Alluvial Plain
- 47h Nebraska/Kansas Loess Hills
- 47i Loess and Glacial Drift Hills
- 47j Lower Platte Alluvial Plain
- 47k Northeastern Nebraska Loess Hills
- 47l Transitional Sandy Plain

Level III ecoregion
Level IV ecoregion
County boundary
State boundary

Fig. 7. Soil ecoregions in Nebraska.

Glossary

Carbonate: An accumulation of calcium carbonate (CaCO3) in the soil.

Clay: A soil particle that is less than 0.002 mm in diameter. Clay particles are so fine they have more surface area for reaction. They hold a lot of nutrients and water in the soil. A clay soil is a soil that has more than 40% clay, less than 45% sand and more than 60% silt.

Deposition: The process by which sediments, soil, and rocks are added to a landform or land mass. Wind, ice, and water, as well as sediment flowing via gravity, transport previously eroded sediment, which, at the loss of enough kinetic energy in the fluid, is deposited, building up layers of sediment.

Ecoregion: Represents areas with similar biotic and abiotic characteristics which determine the resource potential and likely responses to natural and man-made disturbances. Characteristics such as, climate, topography, geology, soils and natural vegetation define an ecoregion. They determine the type of land cover that can exist and influence the range of land use practices that are possible.

Erosion: The process of eroding or being eroded by wind, water, or other natural agents.

Geology: The study of earth, the materials (rocks) it is made of, and the physical and chemical processes that change it over time.

Geologic formation: Is a body of rock of considerable extent with distinctive characteristics that allow geologists to map, describe, and name it.

Horizon: see Soil horizons

Infiltration: The process by which water on the ground surface enters the soil.

Irrigation: The practice of supplementing natural rainfall with additional water to improve crop production. Irrigation may use groundwater or surface water sources, such as rivers.

Leaching: The removal of soluble material from soil or other material by percolating water.

Loess: A loosely compacted deposit of windblown silt-sized sediment. Also a soil parent material transported to and deposited in current location by wind.

Organic matter: Material derived from the decay of plants and animals. Always contains compounds of carbon and hydrogen.

Permeability: The ease to which gases, liquids or plant roots penetrate or pass through a layer of soil.

Sand: A soil particle between 0.05 and 2.0 mm in diameter. Sand is also used to describe soil texture according to the soil textural triangle, for example, loamy sand.

Soil Series: The lowest category of U.S. system of soil classification. It is commonly used to name the dominant soil units on detailed soil maps.

Silt: A soil particle between 0.002 and 0.05 mm diameter. It is also used to describe a soil textural class.

Soil Forming Factors: The surrounding environment that leads to differences in soil properties. The factors include Parent Material, Climate, Relief (Topography), Biological Activity, Time, and in some cases, Human Activity.

Soil Horizon: A layer of soil with properties that differ from the layers above or below it.

Soil Management: The sum total of how we prepare and nurture soil, select type of crops that suitable for a type of soil, tend the crop and the soil together, type of fertilizer and other materials added to soil so as to maintain productive and preserve soil.

Soil Profile: The sequence of natural layers, or horizons, in a soil. It extends from the surface downward to unconsolidated material. Most soils have three major horizons, called the surface horizon, the subsoil, and the substratum.

Soil Scientist: A soil scientist studies the upper few meters of the Earth's crust in terms of its physical and chemical properties; distribution, genesis and morphology; and biological components. A soil scientist needs a strong background in the physical and biological sciences and mathematics.

Soil Texture: The relative proportion of sand, slit, and clay particles that make up a soil. Sand particles are the largest and clay particles the smallest. Learn more about soil texture at www.soils4teachers.org/physical-properties

Subsoil: (B horizon) The soil horizon rich in minerals that eluviated, or leached down, from the horizons above it. Not present in all soils.

Topography: The shape of the land surface. (Relief: refers to differences in elevation of different points in a region.)

Topsoil: (A horizon) –Mostly weathered minerals from parent material with a little organic matter added. The horizon that formed at the land surface.

Upland: The higher ground of a region or an area of land lying above the level where water flows or where flooding occur.

Well-drained: One of several drainage classes used by soil scientist to indicate the depth to the water table during the growing season. Well drained means the water table is below 122 cm or 4 ft during the growing season.

Additional Resources

Lindbo, D. et al. 2008. *Soil! Get the Inside Scoop*. Soil Science Society of America, Madison, WI.

Lindbo, D. L., D. A. Kozlowski, and C. Robinson (ed.) 2012. *Know Soil, Know Life*. Soil Science Society of America, Madison, WI.

Web links for more information | Soil Links

Resources for Teachers, www.soils4teachers.org

Have Questions? Ask a Soil Scientist,https://www.soils.org/ask

Soil Science Society of America, https://www.soils.org/

Natural Resources Conservation Service, State Soils Homepage http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=stelprdb1236841

NRCS Links

Natural Resources Conservation Service, http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/soils/

Natural Resources Conservation Service, Educational Resources, http://soils.usda.gov/education/resources/k_6/

Nebraska NRCS, http://www.nrcs.usda.gov/wps/portal/nrcs/main/ne/soils/

UNL CropWatch Youth Innovation, http://cropwatch.unl.edu/cropwatch-youth

UNL CropWatch Soil Management, http://cropwatch.unl.edu/soils

References

National Cooperative Soil Survey, Official Series Description-Holdrege Series. https://soilseries.sc.egov.usda.gov/OSD_Docs/H/HOLDREGE.html

Natural Resources Conservation Service, USDA. *Holdrege – Nebraska State Soil*. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/?cid=stelprdb1236841#list

University of Nebraska at Lincoln, School of Natural Resources, Conservation and Survey Division – http://snr.unl.edu/data/publications/HoldregeSoil.asp

US Environmental Protection Agency, Ecoregions of Kansas and Nebraska. http://www.epa.gov/wed/pages/ecoregions/ksne_eco.htm

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