SOILS ARE IMPORTANT TO SOUTH DAKOTA: (1) SOIL FORMING FACTORS

Douglas D. Malo[1], Cindy L. Piearson[2], Cheryl L. Reese[3]

INTRODUCTION

Soils in South Dakota (SD) may be thick or thin, stony or not stony, saline or non-saline, sandy, clayey, or have medium texture. The unique combinations of soil forming factors in South Dakota give rise to more than 560 different soils. A soil's characteristics influence suitability for various uses. When a state depends heavily upon agriculture for its livelihood, soil management becomes an especially important matter. Soil management depends upon a person's knowledge of the soil's characteristics and qualities.

South Dakota is an agricultural state with an area of 77,047 square miles and a population density of nine persons per square mile. In 1998 cash receipts, excluding government payments, from farming and ranching totaled more than $3.5 billion with 45% of the total coming from livestock and livestock product sales and 55% of the total coming directly from crop sales. In 1999, SD ranked nationally in agricultural production as follows: 2nd in flaxseed, grass hay, alfalfa hay, and sunflowers; 3rd in proso millet; 4th in oats, rye and spring wheat; 5th durum wheat; 7th in all other hay and in all wheat; 8th in soybeans; 9th in corn and winter wheat; 12th in grain sorghum; 15th in barley; 19th in potatoes; and 21st in cash receipts from crops. These crops and their products, along with forage, range and pasture grown in the state, provide feed for large numbers of livestock. This production is possible because SD has large areas of productive soils. However, not all soils are highly productive. The productivity of a soil is a function of climate, biological organism activity, parent material, topography and time. These five factors interact to produce the soil.

Climate: South Dakota is located in nearly the center of the North American continent. Because of SD's inland position, the climate varies with extremes of summer heat, winter cold, and rapid fluctuations of temperature. Annual precipitation ranges from 26 inches in the southeast to less than 14 inches in the northwest. Most precipitation is in spring and early summer. Approximately 75% of the total annual precipitation falls when temperatures are ideal for plant growth. Seasonal snowfall averages about 30 to 50 inches in the lower elevations of the State to over 100 inches in the Black Hills.

The average frost penetration depth ranges from 25 inches in southwestern SD to 50 inches in northeastern SD. Frost depth depends on amount of residue cover, soil moisture content, soil color, and, to a large degree, on amount and timing of snowfalls relative to temperature extremes.

The prevailing wind during cold seasons is from the northwest, and is from the southeast during warm seasons. Annual average surface wind velocity is 10 to 12 miles per hour.

Biological organisms: Climate controls the distribution of vegetation. Together climate and biological organisms often are called the "active factors" of soil formation.

The native vegetation of SD was originally grassland. Exceptions include the Black Hills that was forest and the river valleys were trees occurred. The tall grass prairie ranged from the eastern SD border to the eastern edge of the James River Valley. The principal vegetative were grasses of big bluestem, sand dropseed, and switchgrass and upland and lowland forbs.

Moving westward across the James River Valley, medium and short grasses assumed dominance throughout central SD. Important species of this area were needleandthread, green needlegrass, western wheatgrass, slender wheatgrass, blue grama, prairie junegrass, and buffalo grass.

In western SD, shorter grasses largely replaced medium grass species, because of decreased rainfall. Important grass species in western SD included blue grama, western wheatgrass, needleandthread, prairie junegrass, and little bluestem.

The flora (plant) and fauna (animal) life that occurs in the soil also affects soil formation. Decayed plant roots from previous years growth can provide channels for water and air to move through the soil profile. Earthworms also create channels for water and air movement through soil. Earthworms literally eat their way through soil and form burrows as they move through the soil. These burrows also allow water and air to move through the profile. Earthworms also enhance soil fertility and productivity by altering physical and chemical conditions in soils. For example, mineral availability to plants is increased when soil is passed through an earthworm’s digestive tract.

Soil microorganisms also affect soil structure. Microorganisms can break down decayed plant material and add organic compounds to the soil structure. Other microorganisms can take elemental nitrogen (N) gas from the air and ‘fix’ or change the N into a form that can be used by plants.

Parent material: Parent material is the inorganic material from which the soil was derived. In eastern SD, the parent material for most soils resulted from glacier activity that occurred during the Pleistocene Epoch (1.8 million to 11,000 years ago). The Pleistocene Epoch witnessed a continued cooling, culminating in a series of ice ages. Glaciers entered SD from the northeast or north and flowed south and west. The western margin of glaciation was the Missouri River. Today, glacial deposits cover most of SD east of the Missouri River. West of the Missouri River, the soil parent material is primarily sedimentary rock. Soil west of the Missouri River was derived primarily from sedimentary rock.

Eastern SD contains many productive soils that were derived from glacial deposits. Glacial deposits are divided physically into main four groups:

1. Till;
2. Outwash;
3. Glacial lake deposits;
4. Ice contact stratified drift.

Till: Glacial till deposits are a mixture of all sized particles, boulders to *clay*. Till is thought to have been deposited the flowing ice shield.

Outwash: Glacial outwash consists mostly of gravel and sand. Outwash was deposited by glacial melt water as it flowed away from the ice.

Glacial lake deposits: When the ice front movement slowed to almost a standstill, there was no ready escape for water and ponding occurred. Soil deposits formed in lake deposits are called lacustrine. The lacustrine deposits that occurred from these lakes range from sand deposits near old shorelines to deposits of clay and silt materials from the deeper more still waters in the center of the lake. The deposits in the Red River Valley along the North Dakota and Minnesota state borders were formed from material settling out of Glacial Lake Agassiz. The deposits in most of Brown and part of Spink counties in SD were formed in sediments from Glacial Lake Dakota. These deposits usually produce soils with high fertility and somewhat poor drainage.

Ice contact stratified drift: Undifferentiated sediments deposited by glaciers is called drift. Ice contact stratified drift was formed when a glacier was melting. These deposits occur as knobs or small hills often in rough terrain. These deposits are called kames which are short, steep sided hills and eskers which are serpentine-shaped ridges.

Soils may form from actions other than glaciers as well. Factors that can carry and deposit soil from one place to another include the wind, waterways and gravity. Loess is a deposit of wind blown silt. Sandy and clay materials may also be carried and deposited by the wind, eolian sand and eolian clay, respectively. They also are important SD soil parent materials.

Alluvium is a deposit that occurs when gravel, sand, silt, and/or clay, settle out of flowing water. Generally, alluvial deposits west of the Missouri River have a clayey texture while deposits east of the Missouri River are have a loam texture. Local alluvium is a water-laid deposit along upland swales and depressions. It is usually finer textured than surrounding soils.

Colluvium is a deposit of rock fragments and unconsolidated earth materials accumulated at the base of slopes as a result of gravity and runoff. The deposit is usually unsorted because gravity can move all sizes. The soils can have textures ranging from sands to extremely bouldery clay.

A variety of factors created the landscape that occurs in SD today. Up-lifting and warping in the west created the Black Hills and wind and water erosion created the badlands and buttes. Glacier movement formed coteaus (low hills or divides) and plains in the east. The rocks and soils that make up these regions provide a wealth of resources upon which life in the state is based.

Topography and Time:

Topography refers to the lay-of-the-land. The land may be level, undulating, rolling, hilly, rough broken, or mountainous. It may be smooth with a network of small streams, or it may be choppy with many closed basins dotting the landscape.

Topography determines what drainage a soil will have. Steep slopes have excessively drained, thin soils; flat or depressed topographic areas usually have poorly drained, thick soils. The factor of time (the age of soil stability) can be illustrated by comparing a soil on a flood plain that receives annual deposits of alluvium with a soil on a stable upland ridge. The floodplain soil has few developed horizons, while the soil on the stable upland ridge has a well-developed soil profile with many horizons.

For additional information on geology in South Dakota, this website may be helpful: http://www.sdgs.usd.edu/.

Author Information:

[1] Distinguished Professor, South Dakota State University, Brookings, SD

[2] 6th grade science teacher, Mickelson Middle School, Brookings, SD, South Dakota State University, Brookings, SD

[3] Research Associate, South Dakota State University, Brookings, SD

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