Soil Management

Soil can be managed in ways that reduce the need for supplemental watering and increase the sustainability of the farm. This article details some of the strategies for soil management and some concepts to go with them.

Texture

Texture refers to the proportions of sand, silt, and clay present in a given soil. A *sandy loam*, for example, has much more sand and much less clay than does a *clay loam*. A *loam* soil is a more balanced blend of sand, silt, and clay. Most soils are some type of loam. Texture is an innate characteristic of the soil type. Unlike the other factors discussed here - aggregation, organic matter, and ground cover- texture cannot be changed through agronomic practice. By knowing the innate texture of the soil, however, the farmer can select and adjust practices that optimize moisture management.

Soil moisture-holding capacities corresponding to texture designations are found in Table 1.
Notice that although the plant-available water is highest in the loam to clay-loam textures, the *total* water goes up with increasing clay content. This is because clay has more total pore space to hold water, but some of these pores are so small that the water is held too tightly for plants to extract. Sand has less total pore space to hold water, but most of the water it can hold is available to plants. Finally, water evaporation from sandy soils is faster than from clay soils. As any farmer knows, sandy soils dry out more quickly after a rain and plants growing on them show drought signs sooner compared to finer-textured soils. Consequently, it is wise to put drought tolerant crops on the most drought-prone soils, and drought-sensitive crops on finer-textured soils.

Texture	Total Water	Available Water
Designation	Inches	Inches
Sand	1.2	0.9
Sandy loam	1.9	1.3
Fine sandly loam	2.5	1.7
Loam	3.2	2.0
Silt loam	3.5	2.1
Sandy clay loam	3.7	2.1
Clay loam	3.8	2.0
Silky clay loam	3.8	1.7
Clay	3.9	1.5

Table 1 Soil texture’s effects on soil moisture

Aggregation

Soil *aggregation* refers to how the sand, silt, and clay come together to form larger granules. Good aggregation is apparent in a crumbly soil with water-stable granules that do not disintegrate easily. Well-aggregated soil has greater water entry at the surface, better aeration, and more water-holding capacity than poorly aggregated soil. Plant roots occupy a larger volume of well-aggregated soil; better rooting increases the depth and area plants can reach for water. These are all positive attributes for drought resistance.

Well-aggregated soil also resists surface crusting. The impact of raindrops causes crusting on poorly aggregated soil by disbursing clay particles on the soil surface, clogging the pores immediately beneath, sealing them as the soil dries. Subsequent rainfall is much more likely to run off than to flow into the soil (Figure 1). In contrast, a well-aggregated soil resists crusting because the water-stable aggregates are less likely to break apart when a raindrop hits them. Take note, however, that *any* management practice that protects the soil from raindrop impact will decrease crusting and increase water flow into the soil. Mulches and cover crops serve this purpose well, as do no-till practices which allow the accumulation of surface residue.

A soil's texture and aggregation determine air and water circulation, erosion resistance, looseness, ease of tillage, and root penetration. However, while texture is an innate property of the native soil and does not change with agricultural activities, aggregation can be improved or destroyed readily through our choice and timing of farm practices.

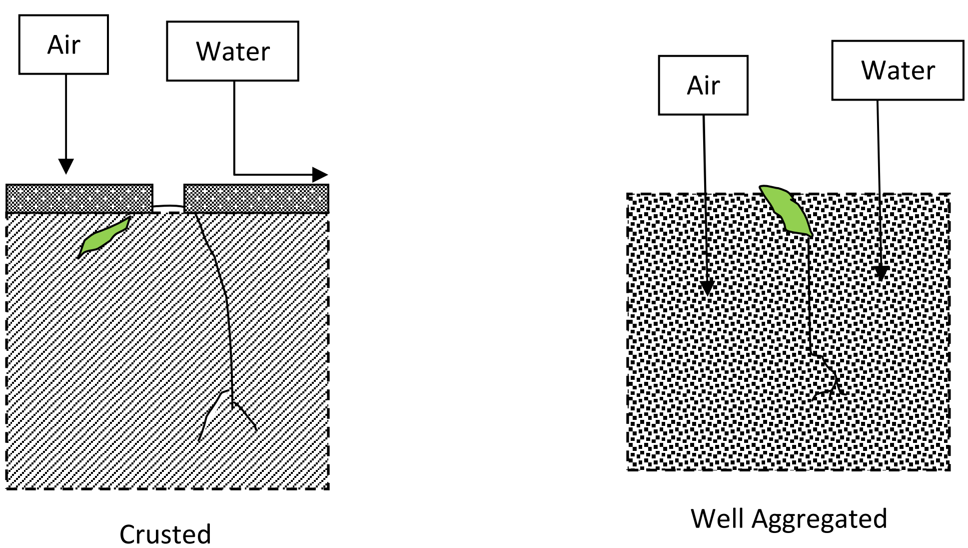

Figure 1. Effects of aggregation on water and air entry into the soil

Some practices that destroy or degrade soil aggregates are:

1. . Excessive tillage
2. . Tilling when the soil is too wet or too dry
3. . Using anhydrous ammonia, which speeds the decomposition of organic matter
4. . Excessive nitrogen fertilization
5. . Excessive sodium buildup from salty irrigation water or sodium-containing fertilizers

Aggregation is closely associated with biological activity and the level of organic matter in the soil. The gluey substances that bind components into aggregates are created largely by the various living organisms present in healthy soil. Therefore, aggregation is increased by practices that favor soil biota. Because the binding substances are themselves susceptible to microbial degradation, organic matter needs to be replenished to maintain aggregation. To conserve aggregates once they are formed, minimize the factors that degrade and destroy them.

The best-aggregated soils are those that have been cultivated with plants whose roots extend as a mass of fine roots throughout the topsoil, contributing to the physical processes that help form aggregates. Roots continually remove water from soil microsites, providing local wetting and drying effects that promotes aggregation. Roots also produce food for soil microorganisms and earthworms, thus generating the compounds that bind the aggregates into water-stable units. Additionally, a perennial grass sod provides protection from raindrops and erosion while these processes are occurring.

This combination of factors creates optimal conditions for establishing a well-aggregated soil under a perennial cover. Conversely, cropping sequences that involve annual plants in extensive cultivation provide less vegetative cover and organic matter, and usually result in a rapid decline in soil aggregation and organic matter. No till cropping requires less manipulation of the soil and retains surface mulch; it is quite successful at promoting good aggregation on annually cropped soils.

Organic Matter and Water-holdingCapacity

Soil holds water according to its texture, as shownin Table 1. However, the level of organic matteralso determines how much water a soil can hold. Soil scientists report that for every 1%of organic matter content, the soil can hold 16,500gallons of plant-available water per acre of soildown to one foot deep.In addition to holding water, organic matter alsoimproves aggregation. As soil organic matterbreaks down, large amounts of glues andslimes the cementing agents of aggregation.are produced by microbes in the decompositionprocess.

Ground Cover

The most apparent benefit of maintaining groundcover on soil is erosion resistance. However, ground cover is also associated with drought proofing. This has been well demonstrated and documented by scientist worldwide. Surface cover also reduces water evaporationfrom soil thus making more water available to the plants.

Tillage System

Tillage systems and equipment have enormous impacts on water infiltration, storage, and plant efficiency. These include mechanical stress on soil aggregates, effects on soil microorganisms, and the tendency to create hardpans. Deep tillage encourages deep rooting; sub soiling can increase rooting depth and impart increased drought protection. Before sub soiling, determine whether it is necessary. Push sharpened steel probe in the ground to test for compaction. If you are going to be planting on the same rows year after year probe on top of the rows.

Additionally, you can dig a 2-foot-deep hole and run a knife blade through the sidewall of the hole to check for resistance. Where the knife blade stops is where the hardpan is. When adjusting the depth of the subsoiler shank, you will wantto run it just under the compacted layer. For example,if the bottom of the layer is 9 inches deep,then run the shank at 10 or 11 inches, not 12 or13. Running as shallow as necessary will reducedraft requirements and cost. Subsoiling shankscan also be run in-row, leaving the surface largelyundisturbed.

No-till and reduced-tillage systems benefit soil. The advantages of a no-till system include superior soil conservation, moisture conservation, reduced water runoff, long-term buildup of organic matter, and increased water infiltration. A soil managed without tillage relies on soil organisms to take over the job of plant-residue incorporation formerly done by tillage. On the down side, no-till can foster a reliance on herbicides to control weeds and can lead to soil compaction from the traffic of heavy equipment. Pioneering development work on low-chemical conservation tillage farming is proceeding at the National Agriculture Research Institute (NARI).

Summary

High aggregation, abundant surface crop residue, and a biologically active soil are keys to drought-proofing a soil. All these qualities are advanced by reduced-tillage systems. In short, maintaining high residue and adding organic matter while minimizing or eliminating tillage promotes maximum water conservation.