Quarterly Viewpoint

FROM THE DESK OF RATTAN LAL

31 December 2019

Soil Organic Matter and Water Retention

In many ancient civilizations, soil is considered one of the natural factors of importance to human wellbeing and nature. For example, soil, water, fire, air and space were considered important in India; soil, water, fire gold, and wood in China; and soil, water, fire, and air in Greece. Selman Waksman, the 1952 Nobel Prize Laureate for his discovery of streptomycin, stated that “Humus plays a leading part in the storage of energy of solar origin on the surface of the earth.” Indeed, several ancient cultures understood the beneficial impacts of humus, or soil organic matter (SOM), on soil health. For example, the English word “human” is derived from the Latin word “humus,” or the ground. Similarly, the Hebrew word Adamah (ground) is derived from the Hebrew word “Adam,” which means human. The Roman philosopher Virgil, about 1 A.D., used the terms “humus,” “terra,” “soil,” and “earth” interchangeably. Accordingly, Virgil called a loamy soil “pinguis humus.” The importance of humus as being dark in color is vividly depicted by Ibn-Al-Awam, a Moorish philosopher of the 12th century. In his book, Kitab-El-Felaha, he stated “One must also take into consideration the depth of the soil, for it often happens that its surface layer may be black.”

Among numerous mechanisms of making soils and agro-ecosystems climate-resilient is the hypothesis that increasing SOM content can enhance plant-available water capacity (PAWC) and mitigate the frequency and intensity of pedologic and agronomic drought. Increasing SOM in degraded and depleted soils can increase the retention of green water (PAWC) in the rootzone. Similar to most scientific issues, there are also two contrasting views about the impact of SOM on PAWC. One states that there is a strong increase in PAWC with increase in SOM content. For example, some argue that SOM can hold up to 20 times its weight in water. Others claim that with each one percent increase in SOM content, soil can hold 20,000 gallons more water per acre. In contrast, some believe that increasing SOM content has a limited if any effect on PAWC.

Expectedly, the truth lies somewhere in between these two contrasting views. The response of PAWC to an increase in SOM depends on numerous controls: soil properties such as the antecedent SOM content (depleted vs. adequate), texture (low or high clay control), clay minerology (2:1 expanding lattice versus 1:1 fixed lattice clay minerals), internal drainage (poor vs. excessive), effective rooting depth (shallow vs. deep), etc. Additionally, the response also depends on soil management (i.e., conservation agriculture with mulch versus plow-tillage without mulch, with or without input of organic amendments, etc.). Cropping/farming systems, crop rotations, crop species, and with or without integration of crops with trees and livestock are important controls.

Furthermore, there may be an optimal range of SOM content beyond which the PAWC does not increase with an increase in SOM content. Limits of such an optimal range may also depend on factors outlined above. Even if the increase in water retention with increase in SOM by 1% in the plow layer is merely 4,000 gallons/acre, yet it can make a strong impact on crop growth and production in a drought-prone environment. While some scientific information is available, credible data from replicated and properly designed field or laboratory experiments are indeed scanty. Thus, alleviation of drought stress by restoring SOM content is a researchable priority, especially in a changing and uncertain climate.

Sincerely,

Rattan Lal

Rattan Lal
Distinguished University Professor of Soil Science, SENR
Director, Carbon Management and Sequestration Center
Past President, International Union of Soil Sciences

International Decade of Soils 2015-2024