FEATURE ARTICLE

NRCS Adopts Holistic Management

The United States Department of Agriculture Natural Resources Conservation (USDA-NRCS) Service is changing the way they do business by adopting the holistic management concept to help land managers improve soil health and reduce input costs.

Holistic management is a system that utilizes natural resources to reap sustainable environmental, economic and social benefits. Through holistic management land can be returned to a healthy condition so productivity is greatly increased without large infusions of cash, equipment or technology. Relationships between land, water and plants are managed in ways that mimic nature.

NRCS launched their new holistic management program to Texas landowners through one-day soil health workshops held across the state from September 18 through September 26. Principles of agro-ecology, basic soil function, ecosystem processes, adaptive nutrient management and adaptive grazing principles were taught in the workshops. The theme was to facilitate a holistic understanding on how the soil functions.

"By learning how to farm in nature's image we can improve soil health function," said Conservation Agronomists Ray Archuleta and Willie Durham of NRCS. "When we understand the different components that contribute to soil health, we can increase infiltration rate and add organic matter, all of which can improve the bottom line."

"When we improve soil health, we address the majority of our natural resource concerns," says Archuleta. "The problem is that we have become detached from our land and no longer understand it. We need to be able to diagnose soil health and design management strategies for improvement."

SOIL STABILITY

During the workshops, Archuleta demonstrated soil stability. Four air-dried clumps of soil or clods were placed on screens positioned on top of four separate large glass cylinders. Water was poured over each of the clumps and allowed to flow into the cylinders.

Archuleta explained, "If the water immediately dissolves a clump and carries soil into the cylinder that particular soil is very unstable and is subject to water and wind erosion. The rapid dissolving soil is carbon depleted – it lacks organic matter. Organic matter is 58 percent carbon.

Two of the soils used in the demonstration were Cecil clay loam from North Carolina – one from a field that had been in no-till crops for 40 years and a conventionally tilled soil. The second pair of soils was obtained from fields near Temple, Texas – one from a field that has been no-tilled for two years, and a conventionally tilled soil. The soil clumps from the conventionally tilled fields disintegrated immediately and washed into the cylinder. Soil that had been no-tilled for two years only partially came apart. The 40-year no-till soil stayed intact meaning it is very stable.

No-till soil remains open to the surface; thus, water can filtrate through its pores without destroying aggregate integrity. There is organic matter in no-till soils that allow them to absorb and hold water.

Many indicators can help determine soil health, but the soil stability test is the most visual demonstration.

AVOID TILLAGE

One of the keys to restoring soil health is to let nature do its work by avoiding tillage. A healthy soil is full of organic matter, earthworms and micro-organisms that include bacteria, fungi and protozoa.

"Eighty percent of our plants are mycorrhizal, meaning they have a mutualistic relationship with fungi," said Archuleta. "Carbohydrates are translocated by plants to their fungal partners and in return, the plant gains benefits from the fungi's higher absorptive capacity for water and minerals. Through the absorption process, the fungi coats soil particles with a glomalin protein.

"Fungi are made of a mass or network of threadlike tubes called mycelium. The individual thread-like mycelium parts are hyphae. Mycorrhizal fungi produce glomalin protein to coat hyphae to aid in absorption of water and nutrients."

"Hyphae act as a frame upon which soil particles may collect while glomalin glues them together and protects them," says Kris Nichols, United States Agricultural Research Service (USDA-ARS). "This is similar to walls in a house, where 2 X 4s are used to frame the wall, insulation fills in spaces between walls, wall board help keep every thing in place, and finally it is all coated with a protective layer of paint. In a soil profile hyhae are the 2 X 4s; soil particles are the insulation; microbial glues like glomalin and fungal and bacterial polysaccharides are the wall board; and glomalin is the paint."

"Glomalin is an important molecule in soil aggregate stabilization," continues Nichols. "When aggregates are not stabilized, they break apart with rainfall. Organic matter and nutrients within disrupted aggregates may be lost to rain and wind erosion. High glomalin concentrations are related to the formation and stabilization of aggregates in undisturbed and no-till systems compared to nearby conventionally tilled sites."

When soil contains organic matter, it is normally inhabited with earthworms. They are major decomposers of dead and decomposing organic matter and derive their nutrition from bacteria and fungi that grow on it.

"Earthworms dramatically alter soil structure, water movement, nutrient

dynamics and plant growth," says Clive Edwards of The Ohio State University. "They are not essential to all healthy soils, but their presence is usually an indicator of a healthy system. Earthworms perform several beneficial functions:

• Mix and aggregate soil. As they consume organic matter and mineral particles, earthworms excrete wastes in the form of casts, a type of soil aggregate.

• Stimulate microbial activity. Although earthworms derive their nutrition from microorganisms, many more are present in their feces or casts than in the organic matter they consume. As organic matter passes through their intestines, it is fragmented and inoculated with microorganisms. Increased microbial activity facilitates the cycling of nutrients from organic matter and their conversion into forms readily taken up by plants.

• Increase infiltration. Earthworms enhance porosity as they move through the soil. Some species make permanent burrows deep into the soil. These burrows can persist long after the inhabitant has died, and can be a major conduit for soil drainage, particularly under heavy rainfall. At the same time, the burrows minimize surface water erosion.

• Improve water-holding capacity. By fragmenting organic matter, and increasing soil porosity and aggregation, earthworms can significantly increase the water-holding capacity of soils.

• Provide channels for root growth. Channels made by deep-burrowing earthworms are lined with readily available nutrients and make it easier for roots to penetrated deep into soil.

• Bury and shred plant residue. Plant and crop residue are gradually buried by cast material deposited on the surface and by earthworms pulling surface residue into their burrows."

"Under normal no-till soil conditions, certain types of bacteria decompose plant residue material, organic matter and manure," Archuleta said. "These bacteria are part of the natural decomposition process – they convert organic material into available plant nutrients. Tillage exposes organic

matter and the biotic cementing agents to consuming bacteria. These bacteria have incredible ability to digest lots of carbon and multiply rapidly. It is decomposition gone wrong, just like cancer devours the human body and causes it to malfunction. Tillage stimulates the soil bacteria to feed on the body (the soil structure) and aggregation is diminished. When this happens, soils do not store water and nutrients efficiently and function is diminished."

MAINTAIN A COVER CROP

"Even no-till soils will erode," Archuleta continued. "A cover crop is needed on the soil 24 hours a day, 7 days a week to build organic matter, hold water and stop erosion. Continuous live or dead cover helps maintain soil health and protects it from heat and raindrop impact. Soil needs armor."

"Organic matter retains soil nutrients and when there is little or no organic matter, nitrogen is leached from the soil as nitrate," Durham said. "The nitrates are leached into ground water or carried into ponds, lakes and streams by run-off water."

"Organic matter retains nutrients as well as soil water," Archuleta added. "For every one percent organic matter added to soil, water is increased by 19,000 gallons."

Archuleta outlined three principles of soil management that need to be followed:

• Understand your context – treat soil as a living ecosystem. Plants and soil are one. In ecology, everything is connected.

• Keep the soil covered with a diversity of plants. Soil organisms are like people. They like a variety of food.

• Quit trying to manipulate or force nature; instead, work with her.

Many NRCS personnel attended the workshops for training on holistic management and they in turn will train other employees. In the future NRCS will offer holistic approaches as alternatives in conservation plans for lands used for farming, grazing or wildlife habitat. A number of holistic land managers across the state have already proven that production can be increased and inputs decreased when natural ecosystems are allowed to function.

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