

## AGRICULTURAL SYSTEMS THAT COULD SEQUESTER CARBON

Scientific interest in understanding what types of agricultural systems increase soil carbon and how has generated huge amounts of research on a variety of systems and on carbon dynamics in agricultural systems at different scales. Several agricultural systems have emerged as having the potential to increase soil carbon, although important details about the permanence of the carbon they sequester should be carefully considered.

### 1 CONVENTIONAL NO-TILL AND CONSERVATION TILLAGE

Among the most widely studied agricultural management strategies that can increase soil carbon are no-till systems. No-till is a system used on over a third of US crop acres that generally relies on specialized planting equipment, chemical herbicides, and genetically modified seed to reduce or eliminate the need for tillage equipment. Since soils in these systems remain undisturbed, soil aggregates remain intact, physically protecting carbon. Several studies have demonstrated that no-till can increase soil carbon rapidly, especially at the soil surface and several more detailed studies have found that this increase in carbon is linked to increases in aggregation.

Similar to no-till, conservation tillage utilizes tillage implements less aggressive than the classic moldboard plow and requires fewer tillage passes per season such that more residues are left on the surface and disruption of soil aggregates is reduced. This approach also generally relies on chemical herbicides and genetically modified seed to reduce weed pressure. Although conservation tillage comes in many forms, several studies have demonstrated that it also can increase soil carbon by increasing soil aggregation and physically protecting carbon, but sequestration generally occurs at rates lower than no-till.

### 2 COVER CROPS AND CROP ROTATIONS

While conservation tillage and no-till rely on protecting soil from disturbance by tillage, other approaches simply compensate for the loss of carbon due to tillage by increasing carbon inputs from plants. The use of periodic green fallows, winter cover crops, and crop rotations that utilize semipermanent crops, such as alfalfa, were practices long used in agriculture that fell out of use as

synthetic fertilizers and pesticides became more widely used. Such practices have demonstrated benefits for weed suppression and soil fertility, and some evidence suggests that they can also lead to carbon sequestration. Researchers found that more diverse crop rotations consistently have higher soil carbon and soil microbial biomass than less diverse systems, especially when cover crops were included in the rotation.

## 4. ROTATIONAL GRAZING

Recent research on grazing practices and production of meat animals, particularly cattle, has gained considerable attention for its carbon sequestration potential. When managed correctly, herds of grazing animals can maximize annual pasture biomass production and redistribute carbon throughout pastures in the more processed form of manure, leading to rapid increases in soil carbon. Methods such as Management Intensive Grazing emphasize frequently moving cattle to new pastures, high stocking densities, and preventing overgrazing such that pasture plants have continuously high biomass. In addition, this style of production generally does not require tillage, meaning soil aggregates are not disrupted and their carbon remains physically protected from disturbance.

Refers to NO. of animals that are kept on a given unit of area.

## 5. PERENNIAL CROPPING SYSTEMS

The majority of cropping systems are dominated by annual plants that rely on cycles of tillage and planting of seed to ensure sufficient productivity. By comparison, perennial plants that are capable of surviving several seasons require less disturbance. Perennial cropping systems have been recently proposed as systems that could protect soil carbon well, and since perennial plants often rely on more extensive roots systems to ensure longevity, they likely produce more belowground biomass.

## 6. LEY FARMING

Ley farming is a system in which grasses and/or legumes are grown in short-term rotation with crops and are grazed, thus intensifying the crop-fallow system.

## 7. AGROFORESTRY

Agroforestry is a collective name for land-use systems in which woody perennials (e.g., trees, shrubs, etc.) are grown in association with herbaceous plants (crops, pastures) or livestock, in a