Carbon Sequestration in Agricultural and Forest Soils

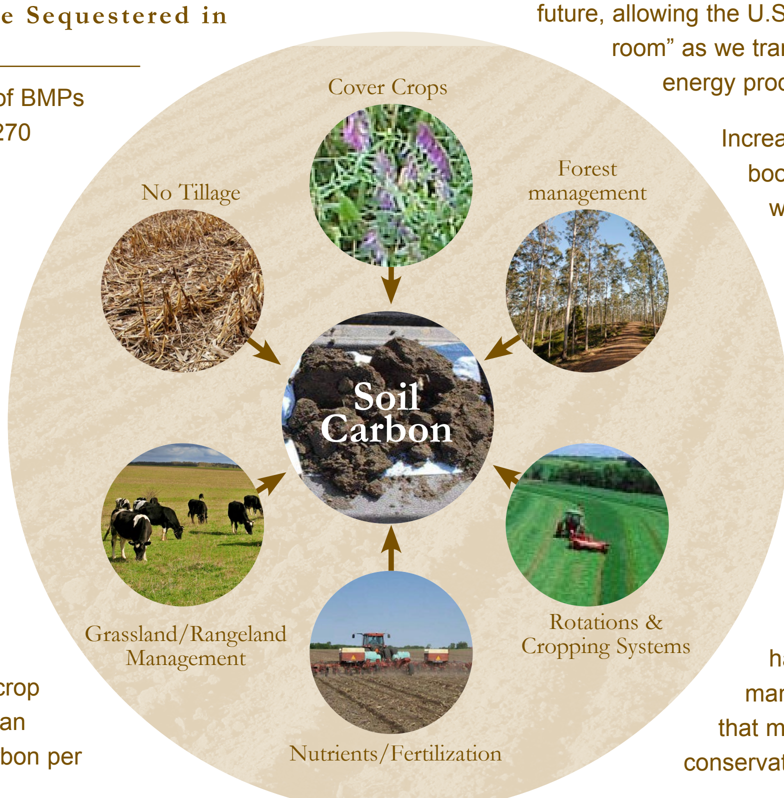
Agricultural land in the United States has the capacity to sequester about 650 million metric tons of carbon dioxide (CO_2) every year, offsetting up to 11 % of U.S. greenhouse gas (GHG) emissions annually (Lal et al., 2003). Of this amount, cropland accounts for about 41%, grazing land 24% and forest lands 36%. Farmers, ranchers, and foresters, implementing best management practices (BMPs) such as cover crops, no-tillage, and nutrient management, play an important role in sequestering carbon. Voluntary carbon trading markets like the Chicago Climate Exchange (CCX) currently pay these land managers between $2 and $3 per acre for adopting proven technologies (conservation tillage and grass and tree planting) for sequestering CO_2. In addition to providing farmers with another source of income, carbon sequestration increases soil organic carbon which improves productivity, reduces soil erosion and nutrient runoff, and enhances water quantity and quality. Soil carbon sequestration is a win-win solution for agriculture and the environment.

How is Carbon Sequestered?

Plants cultivated to produce food, feed, fiber, and fuel, use CO_2 from the atmosphere in photosynthesis to grow. Upon harvest, decomposing plant residues (including roots) are, in addition to being a source of nutrients for subsequent crops, a sink for atmospheric carbon. Soil carbon sequestration occurs when the carbon from decomposing residues is converted in the soil to humus or soil organic carbon (SOC). Farmers, ranchers and foresters can employ carbon-sequestering BMPs, including cover crops, buffer strips, conservation tillage, no-tillage, selective harvesting, and planting of grasses, to ensure sustainable yields and protect land and water resources while, at the same time, offsetting GHG emissions.

How much Carbon Can be Sequestered in the Soil by Agriculture?

In the U.S. each year, adoption of BMPs can lead to sequestration of 83-270 million metric tons of carbon (or a mean of about 650 million metric tons of CO_2). From the cropland portion totaling 72 million metric tons of carbon (264 million metric tons of CO_2), 50% can be due to conservation tillage and surface residue management, 25% to adoption of improved cropping systems and other BMPs, 6% to supplemental irrigation and the remainder to other practices. No-till farming, an especially promising method which leaves the soil intact and crop residues in the field, sequesters an average of 0.3 metric tons of carbon per acre per year.



What are the Economic and Environmental Benefits of Soil Carbon Sequestration?

Carbon markets offer farmers financial incentives while providing binding contracts to businesses that wish to voluntarily offset their CO_2 emissions. The CCX pays land managers between $2 and $3 per acre for sequestering CO_2 using certified conservation tillage practices and/or grass and tree planting. Voluntary carbon markets show great promise as a vehicle to improve stewardship and mitigate climate change.

Of the many mitigation options available to reduce greenhouse gases, SOC sequestration is the most readily deployable, environmentally beneficial and a low-cost means of reducing US GHG emissions. Soil carbon sequestration provides a bridge to the future, allowing the U.S. economy time and "breathing room" as we transition to less-GHG intensive energy production technologies.

Increasing SOC improves soil quality, boosting agricultural productivity while reducing atmospheric CO_2 concentrations. In addition, because carbon stored in agricultural soils can be easily quantified using well-accepted scientific practices, it can provide benefits to farmers through rental payments and to society by avoiding the cost of implementing expensive new technologies. More research is needed to ensure that farmers have access to improved carbon management technologies and that markets adequately reward their conservation efforts.

Best Management Practices

Cropland
- Reduced tillage
- Rotations
- Cover crops
- Fertility management
- Erosion control
- Irrigation management

Grasslands
- Grazing management
- Fire management
- Fertilization

Forest
- Selective harvesting
- Tree planting
- Diverse Species

Soil Carbon Sequestration is Greatest with:

Northwestern USA
- Conservation tillage
- Cropping systems without fallow periods

Northeastern USA
- Conservation tillage

Central USA
- Conservation tillage
- Complex cropping rotations

Southwestern USA
- Rangeland restoration
- Less intensive grazing

Southeastern USA
- Conservation tillage
- Cover crops
- Pasture management

Facts about Soil Carbon

- World wide, C in the surface meter of soil comprises about fl of the C on land.
- Best Management Practices (BMPs) vary due to climatic conditions and soil type.
- Carbon is found in diamonds, pencil lead, gasoline, and soil!
- In Western States, soil inorganic carbon is abundant in the parent material

Bios

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Dr. Rattan Lal is the current President of the Soil Science Society of America (SSSA). Lal served as a soil physicist from 1970 to 1987 at the IITA, Ibadan, Nigeria, conducting long-term experiments on land use, watershed management, methods of deforestation, erosion control, no-till farming, and agro-forestry. A world-renowned soil scientist, Lal received the prestigious World Congress of Soil Science Liebig Applied Soil Science Award, an honor bestowed upon recipients once every four years in conjunction with the World Congress of Soil Science conference.

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Professor Charles W. Rice has conducted research on the role of soils in mitigating, with a focus on C and N emissions in agricultural and grassland ecosystems. Rice's research has been supported by more than $15 million in grants from the U.S. Department of Agriculture, National Science Foundation, Department of Energy, and other agencies. He currently serves on the U.S. National Committee for Soil Science and the USDA Agricultural Air Quality Task Force. Internationally, he served on the UN Intergovernmental Panel on Climate Change (IPCC) to author a report on Climate Change and he serves as the chair of Commission on Soils, Food Security, and Public Health of the International Union of Soil Sciences.

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Dr. Brent Sohngen has been in the Department of Agricultural, Environmental, and Development Economics at the Ohio State University since 1996. His primary research interests lie in estimating the economic benefits of improving environmental resources, and estimating the costs of carbon sequestration in forests and agricultural soils. He leads an extension program in environmental and resource economics that provides resources on benefit cost analysis to Ohio policy-makers. Sohngen teaches a graduate course on micro-economic theory, and an undergraduate course on environmental and resource economics.

Merle Holle
M & K Farms near Marysville, KS

Mr. Merle Holle is a no-till grain and soybean farmer in Kansas's 1st Congressional district. Mr. Holle has farmed the land on M & K Farm since 1956, where it has been passed through the hands of two generations. He now grows corn, soybean, wheat, and grain sorghum with his son on the land in Marysville, KS and has practiced no-till for 16 of his 60 years of farming. After the first 5 years of no-till, Mr. Holle has never looked back to conventional, citing the many benefits of no-till. Mr. Holle participates in the Chicago Climate Exchange (CCX) program for soil offsets through the Kansas Coalition for Carbon Management.

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