How sports turf helps reduce **the carbon footprint**

IT MIGHT TURN OUT THAT GOLF FAIRWAYS, football fields and other sports turf areas are the "good guys" when it comes to the earth's carbon footprint.

Although sports turf has been much maligned in the general press recently, researchers at Colorado State University, Fort Collins have proved that established turf does great things for carbon sequestration. The next step in their research is to develop metrics that predict the impact of carbon sequestration in turfgrass.

Early results are eye-opening. For starters, undisturbed turf will lock up one metric ton of carbon per hectare per year. In English, that is about 0.44 tons of carbon per acre annually.

"The strength of this research is that it covers multiple years and is based on very good data," says Yaling Qian, professor of horticulture and landscape architecture at Colorado State. She notes that some other studies, a few of which do not have nice things to say about recreational turf, are based on far fewer data sets.

Recent global concerns over increased atmospheric CO_2, which can potentially alter the earth's climate systems, have resulted in rising interest in studying soil organic matter (SOM) dynamics and carbon sequestration capacity in various ecosystems.

WHAT IT IS

Carbon sequestration is simply the long-term storage of carbon dioxide. CO_2 storage is necessary as a part of controlling climate change. CO_2 can be stored either geologically or in terrestrial ecosystems, according to the National Energy Technology Laboratory. NETL is part of the U.S. Department of Energy's national laboratory system and is operated by the DOE. NETL supports DOE's mission to advance the national, economic, and energy security of the United States.

"This is the kind of information turf managers need to broadcast," says Tony Koski, professor and extension turf specialist at Colorado State.

Determination of carbon pools in urban turfgrass soils will shed light on the role of turfgrass systems in contributing to terrestrial carbon, Koski says.

Koski says the results of this research support a better understanding of the roles carbon sequestration and carbon emissions play in the management of sports turf and what impact operational activities have on the environment.

At present, Qian is looking for research funding to support graduate students who will establish models for determining carbon sequestration. "We need to be able to project the impact of land use," she says.

The models would weigh climate, soil type, management style and prior land use—among other variables—in a database file. The results would not only help turf managers see the impact of what they do but also would help lawmakers determine the value of keeping open green areas open and green.

A one-acre soccer field removes carbon equivalent to driving a car OVER 3,000 MILES.

Qian notes there was no hard data for turf when the Colorado State group started its research in 2000. It was tough even to find carbon data on farmland. "On turf, there was no data at all," she says.

Golf courses figure most heavily in the Colorado State research. That is because turf management records were available for years, even decades on the sites the CSU researchers studied. Critical benchmarks identified during the project provide information that will allow the golf course management community to improve resource use efficiencies and bolster environmental performance.

"Carbon sequestration as only one side of the equation. The other side is carbon emissions." – Qian

One reason the CSU study focuses so heavily on golf courses as a function of sports turf is the number of acres golf courses keep green. According to the World Golf Foundation's "The Golf 20/20 Industry Report," there are about 15,000 golf courses in the United States. The GCSAA (Golf Course Superintendents Association of America, www.gcsaa.org) puts the size of a typical 18-hole golf facility at 150-200 acres total, including water bodies, hard structures, and out-of-play areas. A typical urban golf course might be only 110-120 acres, and courses in resort areas may be 170-190 acres. While not all of this is managed turf, all of the green areas can absorb carbon.

On the other hand, a typical soccer or football field is about one acre in size. Even a college complex with a dozen or more fields would represent only a fraction of the managed turf area of the typical golf course. But keep in mind that all sports turf can contribute positively to carbon sequestration.

The Colorado State study is only one of many studies that point up the value of sports turf for carbon sequestration. The biology departments at such diverse spots as Cornell University; Bradley University, Peoria, Illinois; and Missouri Southern State University in Joplin have done similar work on a somewhat smaller scale. No matter the geography, these studies point in the same direction.

Because of high productivity and lack of soil disturbance, turfgrass may be making substantial contributions to sequester atmospheric carbon. To determine the rate and capacity of soil carbon sequestration, Yaling Qian and Ronald Follett at the USDA-ARS, Soil-Plant-Nutrient Research Unit in Fort Collins compiled historic soil-testing data from parts of 15 golf courses that were near Denver and Fort Collins, and one golf course near Saratoga, WY.

In addition, they compiled 690 data sets on previous land use, soil texture, grass species and type, fertilization rate, irrigation, and other management practices. The oldest golf course was 45 years old when the project was initiated, and the newest golf course was just over a year old. Nonlinear regression analysis of compiled historic data indicated strong pattern of SOM response to decades of turfgrass culture.

"The strength of our project was based on having 690 data points," Qian notes.

The study shows that total carbon sequestration continued to increase for up to 31 years in fairways and 45 years in putting greens. However, the most rapid increase occurred during the first 25 to 30 years after turfgrass establishment. Past land use imparted a strong control of SOM baseline: in fact, fairways converted from farm lands exhibited 24% lower SOM than fairways converted from native grasslands.

That led the researchers to conclude that carbon sequestration in turf soils occurs at a significant rate that is comparable to the rate of carbon sequestration reported for land that was placed in the Conservation Reserve Program.

Translated into everyday terms, the typical fairway (between 1.5 and 2 acres) will sequester three-quarters of a ton of carbon each year. That is the rough equivalent of removing the carbon caused by driving a car 6,500 miles.

A one-acre soccer field removes carbon equivalent to driving a car over 3,000 miles.

Disturbing such soil for any reason will add more oxygen to the soil, Qian notes. "The more disturbance the more you degrade the organic matter," she says. A renovation will put some carbon back into the atmosphere. But tearing the golf course up and building on the land will release great quantities of carbon to the atmosphere and destroy the valuable carbon sink.

This is one of the first studies of turfgrass that received strong cooperation from USDA-ARS. While USDA did not provide financial support, the research was a collaborative effort. Sports turf is less competitive when it comes to grabbing a part of the USDA research-dollar pie. This usually is credited to the fact that sports turf is seen as non-essential when compared to food and fiber research. So the big money normally goes to grasses like corn and wheat – and not Kentucky blue or turf-type fescues.

This time, USDA-ARS was interested in the carbon sequestration work. The reason has roots in the need to establish just what is happening to carbon in the environment in an era when the term "climate change" has gone well beyond research labs and into the halls of Congress and the front pages of the New York Times.

The Colorado State study is doubly important to the sports turf industry because sports turf got slammed in reports, some done in California, which painted a bleak picture of the value of sports turf when it comes to carbon sequestration.

Terrestrial carbon sequestration is defined by NETL as the net removal of CO_2 from the atmosphere by plants and microorganisms in the soil and the prevention of CO_2 net emissions from terrestrial ecosystems into the atmosphere.

"There is significant opportunity to use terrestrial sequestration both to reduce CO_2 emissions and to secure additional benefits, such as habitat and water quality improvements that often result from such projects," NETL scientists say.

In principle, terrestrial sequestration is the enhancement of the CO_2 uptake by plants that grow on land and in freshwater and, importantly, the enhancement of carbon storage in soils where it may remain more permanently stored. Part of NETL's interest in terrestrial sequestration is that it provides an opportunity for low-cost CO_2 emissions offsets.

Early efforts had included tree plantings, no-till farming, and forest preservation. More-advanced research includes the development of fast-growing trees and grasses and deciphering the genomes of carbon-storing soil microbes.

Rather than sports turf, NETL's terrestrial sequestration R&D is focused on reforesting and amending mine lands and other damaged soils and analyzing various land management techniques, including no-till farming, reforestation, rangeland improvement, wetlands recovery, and riparian restoration. There is a heavy agricultural and forestry bent to the NETL program. While ag research is important, it leaves out the contribution of sports turf. Taken together, however, natural areas will help reduce CO_2 emissions.

This is no easy task. Roughly speaking, NETL figures it would take about 220,000 acres to offset emissions from a single, average-sized coal-fired power plant. That is a lot of soccer fields, golf courses and baseball diamonds. The NETL figure assumes an average coal power plant from the existing fleet and a forest uptake rate of three tons of carbon per acre per year. Terrestrial sequestration is conceptualized for use in conjunction with CO_2 capture and storage to provide fossil-fired power generation with zero net greenhouse gas emissions. It is expensive to capture the last 5-10% of CO_2 emissions from a fossil fuel conversion plant, due to the law of diminishing returns.

Sports turf and trees are not the final answer. NETL figures a cost-effective approach for zero emissions is to capture 90% of emissions and offset the remaining 10% with terrestrial sequestration. NETL does point out the many collateral benefits of this kind of program, including flood protection, wildlife/endangered species habitat, restored ecosystems, and the like.

Soil carbon is both organic and inorganic carbon contained in soil. During photosynthesis, plants convert CO_2 into organic carbon, which then is deposited in the soil through their roots and as plant residue. Organic carbon is found in the top layer of soil, the A horizon. Inorganic soil carbon comprises carbonates that form through non-biological interactions. They are a minor amount compared with organic carbon, but are considered more permanent. Large plant roots, such as those of trees, are considered biomass and not part of the soil, but the organic matter, if you look closely, includes many fine root hairs, where much of the CO_2 exchange from the plant to the soil occurs.

But Qian sees ways sports managers can help with carbon in ways that go beyond carbon sequestration. "Turf managers should look at carbon sequestration as only one side of the equation," Qian says. "The other side is carbon emissions."

By this, she means managers have to look at ways to minimize their carbon footprint…whether from chemical use, from vehicle use, or other carbon-generating uses.

"Some vehicles are more fuel-efficient," she says. "It's another area of the carbon question that needs work." ■

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