Carbon Footprint and Agronomy Practices to Reduce Carbon Footprint of Golf Courses

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Objectives:

1. *Evaluate fuel and electricity uses associated with golf course maintenance activities (electricity used for irrigation, fuel and energy used for mowing, spraying, and aeration, vehicle and golf cart uses); and b) fuel and electricity use associated with clubhouse operations.*
2. *Determine the carbon sequestration rates for golf course native areas, roughs, fairways, and greens by computer modeling.*
3. *Measure trace gas fluxes on golf course fairways, roughs, native areas, and putting greens.*
4. *Evaluate the impact of different types of fertilizers on trace gas fluxes.*
5. *Identify agronomic practices that will increase carbon sequestration, reduce carbon foot print, and minimize greenhouse gas emissions using calibrated and validated CENTURY and DAYCENT models as a management support system.*

Research is in progress collaboratively at Colorado State University and with the GRACEnet (Greenhouse Gas Reduction through Agricultural Carbon Enhancement Network) program of USDA–ARS to evaluate golf course carbon footprint. To determine the impact of turfgrass and turfgrass management on the greenhouse gas (GHG) budget on golf courses, the project consists of 5 objectives stated above.

To address Objective 1, a survey was conducted to evaluate fuel, electricity, and natural gas uses associated with 17 golf course operations in Colorado for over 3 years. We are in progress of analyzing the survey data. Preliminary results suggest that the clubhouse and golf carts electricity use was the greatest energy consumption associated with golf course operation in Colorado.

To address Objectives 2 and 3, graduate student Ms. Katrina Gillette has measured N_2O, CH_3, and CO_2 fluxes on fairways, roughs, native areas and greens on a golf course in Colorado. About 85 vented chambers were installed on the various areas of the course, and gas samples were collected from inside the chambers. Measurements were taken once a week throughout the growing season and twice monthly in winter. Soil sensors measured soil water content and soil temperature. To evaluate the impact of different types of fertilizers on trace gas fluxes, 12 plots were used on a fairway and a rough, respectively, to accommodate 3 fertilization treatments (BCMU, UMAXX, and POLYON) and a control. Gas samples were collected from each plot. Current results showed that soil water content and soil temperature played a large role in N_2O emissions. Accumulative annual N_2O emission from the fairway site was significantly higher than the rough site. N2ON_2O emission from the putting green and native sites was only about 10% of the emissions from fairways. POLYON fertilizer had the lowest N_2O emissions.

To address Objectives 4 and 5, graduate student Mr. Yao Zhang has applied the DAYCENT model to turfgrass systems. Data from previous field experiment were used to calibrate and parameterize the DAYCENT model. Simulated clipping yields, evapotranspiration

The modified trace gas measurement chamber.

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Trace gas sampling chambers were installed on golf course fairways.

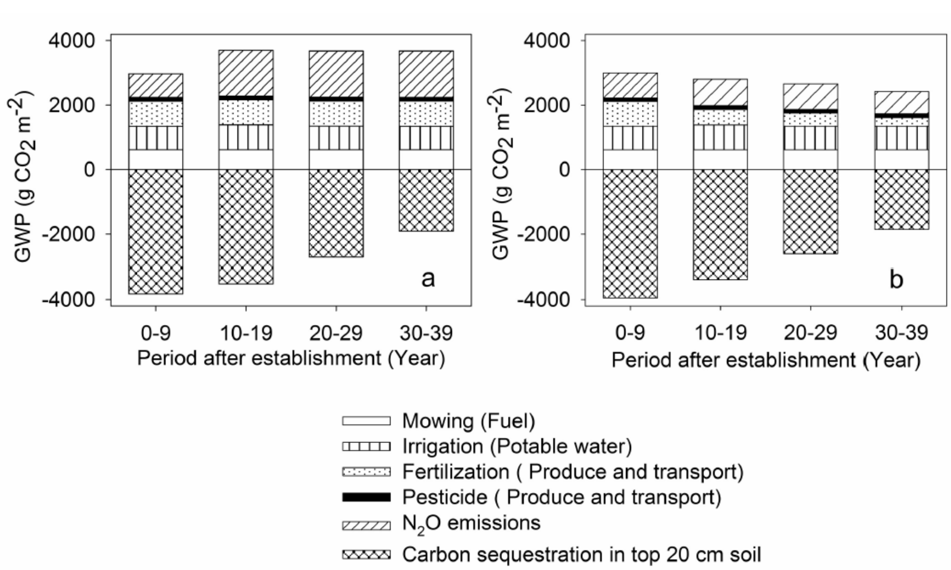
Graduate students collecting gas samples for trace gas analysis.

(ET), deep percolation, nitrate leaching, and soil temperature of Kentucky bluegrass turf compared well with the measured values with r value ranging from 0.6 to 0.87. Modeled N_2O emissions were validated for Kentucky bluegrass turf. The annual cumulative N_2O emissions predicted by the DAYCENT model were close to the measured emission rates of Kentucky bluegrass (within 16% of the observed values). After calibration and validation, the DAYCENT model was further used to predict best management practices (best irrigation and nitrogen fertilization rates) for Kentucky bluegrass turf. Irrigation that decreases from 100% potential evapotranspiration (PET) to 60% PET is predicted to reduce 50-percent of annual net production in the semi-arid region. The model simulation suggested that gradually reducing fertilization as the lawn ages from 0 to 50 years would significantly reduce long-term nitrate leaching and N_2O emissions when compared to applying nitrogen at a constant rate (at 150 kg N ha^{-1} yr^{-1}). Our simulation indicates that Kentucky bluegrass turf could change from a sink to a weak source of GHG emissions about 20 to 30 years after establishment as soil carbon sequestration is reduced (Figure 1).

Summary Points

- Clubhouse and golf cart electricity use was the greatest energy consumption associated with golf course operation in Colorado.
- Nearly 15,000 data points of trace gas fluxes have been collected over a two-year period.
- N_2O emissions were greatest from the fairway site.
- Compared with BCMU and UMAXX fertilizers, POLYON had the lowest loss of N_2O.
- The DAYCENT model can be properly used as a supporting tool to estimate greenhouse gas budget in turfgrass systems; it can be used to develop the best irrigation & fertilization management practices;
- Gradually reducing fertilization as turf stand ages from 0 to 50 years would reduce approximately 40% long-term N_2O emissions.

Figure 1: Estimated i.e. greenhouse gas budget for high quality Kentucky bluegrass roughs using (a) conventional management and (b) BMPs generated by the DAYCENT model.



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