Golf-One of Our Most Sustainable Human Activities

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This spring semester one of our graduating students, a young man with extensive golf course management experience, visited with me about his idea for a report on sustainable golf courses. It seems he'd suggested the topic to a professor in a class focused on organic and sustainable agricultural production. The professor had scoffed at the idea of a sustainable golf course, implying the student needed to realize golf courses are inherently unsustainable. I encouraged the student to think back to what he knew of the history of golf course management, beginning in the 12th century, and how golf course management has evolved to today's practices.

Sustainability is unquestionably in society's mindset today. If we think about it, virtually nothing about our society is truly sustainable. We mine minerals from the ground, we burn fossil fuels, and we cover the land with buildings. Our row crop agriculture, arguably the foundation of our nation's power, often depletes non-replenishing fossil groundwater and causes massive loss of irreplaceable topsoil.

Golf courses preserve soil with their complete and permanent vegetation. Golf courses also preserve land in urban environments which otherwise would be given over to buildings. We're just starting to realize the longer-term consequences of our construction process. Residents of New York City were victimized by toxic dust from New York City buildings destroyed during 9/11. Unusable wells exist on the east side of Madison, WI, contaminated from industrial pollutants. In Detroit, plans to utilize the vast acreage of vacant land in inner city Detroit for local food production, are thwarted by polluted soils as buildings sink into decay.

Starting at the beginning is the best place to think about what it means to have a sustainable golf course. The original courses were likely nothing more than holes in the ground (legend has it as rabbit burrows), perhaps with vegetation cropped by animals: one can't get more sustainable than that. Today's golf courses have morphed into architectural jewels of nature, care-

fully shaped and maintained by rather minimal crews aided by modern technology. Table 1 summarizes the most common inputs for golf course maintenance while showing that sustainability is mostly a matter of degree rather than absolute all-or-nothing actions.

The greatest and least sustainable aspect of most golf courses is mowing with internal combustion engines which use fossil fuels. The most sustainable practice of course is to use grazing animals, or not mow all, but this is unlikely to be acceptable to today's golfers. Hand mowing with a push reel-type mower is a close second but not likely to occur in today's society. A small number of courses have adopted electric mowers, which offer a range of sustainability based on how the electricity is generated. Most electricity is still generated from coal, but solar or wind power offer virtually sustainable power absent the cost of the infrastructure.

Water is the next greatest obstacle to achieve sustainability. In many regards, golf courses are ahead of much of the nation's agriculture west of the Mississippi, which relies on fossil water for crop production. Water used by golf courses comes from a variety of sources (Table 1). Some sources, such as on-site irrigation ponds filled by rainwater, are virtually sustainable. In many cases, golf course water use could be more sustainable than current practices if irrigation was based on evapotranspiration (ET) rates rather than by a preset routine or perceived needs. To a homeowner on a municipal supply line facing water restrictions, the only conceivable sustainable practice would be no irrigation.

Today's most commonly used fertilizers are synthesized using the Haber-Bosch process and rely on fossil fuels. In use for over 70 years, synthetic fertilizers such as IBDU and ammonia sulfate provide users with the ability to use small volumes of fertilizers with variable properties to give turf managers a range of options for specific situations. Historically of course, fertilizers have depended on animal waste, if used at all. Most natural-based fertilizers such as plant or animal waste compost tend to require relatively high inputs of labor, machine-processing, and time before they are ready for use. In addition, natural-based fertilizers have generally been considered as slow-release forms of nutrients which limited their applicability. However, Dr. Soldat (Soils Department at UW-Madison) has been researching various organic fertilizers and is finding that some indeed have a nice blend of water-soluble and slow-release characteristics which will open the door for additional uses. Currently we base nitrogen applications on a seasonal or "how the grass looks" basis. A more sustainable approach would be applying nitrogen only when and in the amounts needed by grass. As research shows differences in nitrogen requirements among grasses, and scientists work to develop a test for plant-available

Table 1. Sustainable golf course management is a sliding scale.

Least Sustainable						**Most Sustainable**	
Mowing type	Internal combustion using fossil-fuels	Internal combustion using biofuels	Electric[1]	Hydrogen		Solar or non-motorized reel	None/grazing animals (sheep)
Mowing height							
-Greens	≤ 0.125 inch	0.156 inch	0.25 inch				Any height
-Fairways/tees	≤ 0.4 inch	0.5 inch	0.75 inch	1 inch			Any height
-Roughs	Mowed > once weekly[2]	Once weekly	Monthly			Semi-annually	Not mowed
Fertilizer source	Synthetic, fossil-fuel based	Sewage sludge	Plant/animal compost				None or "At-will" from grazing animals
-Amount and timing	Calendar basis for optimum growth and quality		Based on soil availability and plant needs[3]				"At-will" from grazing animals
Irrigation	To point of runoff or leaching	ET-based[4]	Deficit irrigation				None
-Source	Fossil water[5]	Off-site lakes, streams or municipal	On-site ponds or shallow ground water				None
Pesticides	Synthetic, highly toxic general biocides	Natural, highly toxic general biocides	Biorational[6]		Bio-pesticides[7]		None
Pest Management	Calendar basis		IPM-high quality turf		IPM-low quality turf	Resistant grasses[8]	None
Cultivation and topdressing[9]	Biweekly	Monthly		Annually[10]			None
Golfer-Acceptability	High				Low		Not likely acceptable
Economics	Typical	Better		Break-even	Failure likely		

[1] Electric-powered mowers can be nearly completely sustainable depending on power source used for their operation, production, and transport to the golf facility.
[2] Assumes fossil-fuel based internal combustion engine.
[3] Not totally possible especially with nutrients like nitrogen.
[4] Assumes irrigation rate does not exceed soil infiltration rate.
[5] Fossil water is generally below bedrock and only replenished over thousands of years.
[6] Biorational pesticides are typically synthetic though may be based on naturally-occurring compounds, used at low rates, have low environmental/human toxicity, and rapid environmental degradation.
[7] Bio-pesticides are naturally-occurring biological compounds or organisms such as nematodes, bacteria, and fungi. They are generally not currently a viable option-most fail to provide a noticeable effect, others are too costly or illegal in the U.S. (e.g., Sarritor).
[8] Combined with other approaches, e.g., IPM, resistant grasses can greatly improve the desirability of virtually any management level
[9] Includes activities like vertical mowing and aeration.
[10] Insufficient topdressing unlikely to provide desired effect for high quality golf courses.

nitrogen in the soil, we should be able to improve sustainability efforts in fertilization, too.

I know superintendents have many other ways they already employ sustainability in their operations. One cannot avoid being fairly sustainable if the goal is to have a profitable operation. Environmental and economic sustainability readily go hand-in-hand.

Golf courses also provide tremendous social sustainability. Golf courses provide jobs for multiple skill and age levels. A tremendous number of high school students get their first job experience on a golf course. They learn responsibility by getting up early in the morning, the value of hard work, and decision-making skills across a combination of biological and mechanical systems. Many also learn personnel management skills along with customer relations. Employees include mid-career as well as highly skilled retirees, which further ads to the social network of a golf course.

Charitable organizations depend on golf for their sustainability. Look in the newspaper, or on your own schedules, to see the types of fundraising events at golf courses. Of the U.S. golf industry's annual $76 billion economic impact, an estimated $3 billion is for charity. Tim Votaw of the International Golf Foundation has stated that "No sport around the world contributes as much money to charity as golf" (http://www.sportsfeatures.com/olympicsnews/story/44457/charity-begins-with-golf). Even the dairy science department at UW-Madison uses a golf outing to raise about $30,000 annually for scholarships and departmental operations. Ultimately, of course, golf provides an important opportunity for recreation. Golf is one of the least discriminating forms of outdoor recreation in terms of gender, age, and some could argue (if they've seen me golf), ability. That's why nearly 29 million people in the U.S. play golf (NGF, 2010).

Ultimately golf may be one of the most sustainable types of operations we have going for us in terms of environmental, economic, and social sustainability. It's a good thing to keep in mind, given the pressures companies are feeling these days to show their sustainability to a questioning public.