ROBO-GOLF

Better grass quality, reduced fertilizer costs and less use of fossil energy when using fairway and semi-rough robotic mowers

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	Overall impression (1-9,9 is best)	Mean leaf fineness, mm	Tillers/cm^2	Mean diameter of weed plants, cm	
				White clover (*Trifolium repens*)	Daisies (*Bellis perennis*)
Robot mower	7,3	2,1	3,2	24,0	6,6
Manual rotary mower	6,4	2,7	2,1	7,0	4,3
Least significant difference (LSD)	0,2	0,3	0,5	2,2	2,2

Table 1. *Results from the Italian trials comparing robotic mowers and manual rotary mowers in lawn/semi-rough (Pirchio et al. 2019).*

Over the past five years, the use of robotic mowers in private gardens has increased significantly, but so far only a few Nordic golf courses have started to use this new technology. One of the exceptions is Bærheim Golf Club, Norway, which has around 70 robotic mowers to do the cutting of the semi-roughs. In December 2019, STERF decided to fund the new project ROBO-GOLF, where the aim is to study agronomic, environmental and economic consequences by switching to robotic mowers. The project is a collaboration with the company Husqvarna, the ”world leader in robotic mowing”.

A robotic mower is more than a driverless mower

A robotic mower is a small and light electric mower that is programmed to mow a specific area according to a random pattern. (There are also robotic mowers that can be programmed for systematic mowing, but these will not be used in this project). It is important to distinguish the robotic mowers in the ROBO-GOLF-project from the fairway or rough mowers which, using advanced technology, can be remotely controlled just like driverless cars or buses, but which, apart from reduced labor consumption, do not represent special advantages in the turfgrass management.

Inspiration from Italy

At Pisa University in Italy, the researchers Michel Pirchio and Nicola Grossi have worked for several years with robotic mowers in tall fescue dominated lawns and semi-roughs. Tall fescue (*Festuca arundinacea*) is a coarse and drought-tolerant grass species, which is not used on golf courses in the Nordic countries, but the results from Italy can be transferred to other grass species. Pirchio & Grossi found that the overall impression of the grass, rated on a scale of 1-9, increased from 6,4 on plots with manual rotor mowing to 7,3 on plots with robotic mowing (Table 1). This increase in grass quality was due to the fact that the lawn became denser and the leaves got finer. A denser lawn is related to the fact that the grass on the robotic mown plots were cut at 3-3,5 cm, which was lower than on the manually mown plots, which was mown at 3-5 cm. If the leaf area does not become so small that it will repress the photosynthesis, a lower cutting height leads to that more and qualitatively better light reach the soil surface, and tillering will be stimulated.

When it comes to weeds, the Italian results were not in favour for the robotic mowers. Robotic mowing led to more daisies (*Bellis perennis*) and especially white clover (*Trifolium repens*) in the lawn (Table 1). The Italian researchers pointed out that this could be a problem when robotic mowers are used at lower cutting heights, e.g. on fairways.

Pirchio & Grossi also measured the consumption of electrical energy at the charging stations for the robotic mowers, as well as the fuel consumption by manual mowing. They found that switching to robotic mowers

Photo 1. *Golfers and robotic mowers «living together in peace» at Bærheim GC, Norway. Photo: Atle R. Hansen.*

led to a reduction of 60 to 70 % in energy consumption. This was a pure energy calculation that did not take into account the type of energy used or whether it was renewable or not. Benefits such as less CO_2 emissions and less noise thus come in addition to this.

We are very pleased that Michel Pirchio and Nicola Grossi have agreed to join the reference group for our new project and hereby share their experiences with us.

Experiences from Bærheim Golf Club

According to course manager Atle R. Hansen at Bærheim GC it was a big challenge when they bought 67 robotic mowers from Husqvarna in 2017. They had a goal that the investment should pay off within five years. Now after three years they are on track to reach that goal, and Atle can't imagine returning to manual mowing of about 25 ha of semi-rough.

- The robotic mowers have developed a new work life for the greenkeepers, says Atle. Now we finally have the time to work on playing quality instead of just mowing grass. The robotic mowers have released time, so we can put more work into the care of the greens, and now we are praised for faster and smoother ball roll. Surveys among the players on Bærheim GC show far greater customer satisfaction now, and the greenkeepers are less stressed and have a better work life balance. In 2019 we did not have a single hour overtime, says Atle.

Have there been any teething problems at all?
- Yes, absolutely!! Remember that the robotic mower itself is just one part of it. The most important thing is the management of all the mowers. We control the entire fleet from the PC and in some cases it has been a challenge to get each mower to cover the predicted area. But we have a good dialogue with Husqvarna and are constantly working on improvements.

What about the grass quality?
- That's what we should find out through the ROBO-GOLF-project! So far we have tried robotic mowers only on one single fairway, and the experience here is that we have to roll the fairway to avoid castings. However, so far we have not seen more weeds. This may be due to the fact that we normally mow the fairways at 11 mm, while the robotic mowers cut at 15 mm.
So far the experiences from Atle R. Hansen at Bærheim GC, who will be one of the key figures in the ROBO-GOLF-project. The first project meeting will be arranged here on August 27th.

What will be investigated in the ROBO-GOLF-project?

The project consists of three sub-projects. The first two will be conducted at NIBIO Landvik, and the third will take place on a golf course in each of the five Nordic countries.

In sub-project 1 we will investigate the effect of robotic mowing on density, leaf fineness, diseases, weeds (including *Poa annua*), repair of divots and soil packing on newly established fairway plots. They will be established with pure Kentucky bluegrass (*Poa pratensis*), red fescue (*Festuca rubra*) and colonial bentgrass (*Agrostis capillaris*) as well as a mixture of these three species. Control plots will be mown manually two to three times a week with a standard triplex cylinder mower. Both robotic and manual mowers will be set at a cutting height of 15 mm, and emphasis will be placed on regular backlapping/grinding of the cylinder mowers as well as replacement of the knives on the robotic mowers to achieve the best mowing quality.

In sub-project 1, there will also be carried out experiments on a semi-rough established with Kentucky bluegrass (*Poa pratensis*), red fescue (*Festuca rubra*) and ryegrass (*Lolium perenne*) at a 30 mm cutting height. Here, the control plots will be mown once or twice a week with a manual rotary mower.

Sub-project 2 aims to study if the transition to robotic mowers has consequences for the demand for fertilizer on the fairways. We want to test the hypothesis that mowing with robotic mowers several times a day provides better recycling of the nutrients (e.g. less loss of ammonia gas?) than regular mowing twice a week. To measure this, small plots with different fertilizer levels will be constructed within both robotic and manual mown plots.

Sub-project 3 is a field trial that is going to start up on five Nordic golf courses in the spring of 2020, where robotic mowers will be installed on one semi-rough and one fairway at each course. The experiment will compare grass quality, weeds and diseases between robotic and manual mown areas. In collaboration with a researcher from Landvik, the greenkeepers on the five courses will assess grass quality, weeds and diseases in the experimental areas during the growing season. In addition, the energy consumption of both robotic mowers and ordinary mowers will be measured and CO_2 emissions will be calculated. The time consumed for manual mowing will also be registered.

In August, a survey will be conducted on the five courses, among members, green fee players and greenkeepers. They will be asked how satisfied they are with the robotic mowers and with the playing quality. The five golf courses included in the project are: Bærheim (Norway), Jönköping (Sweden), Ikaalisten (Finland), Ness (Iceland) and Grenå (Denmark).

Reference:

Pichio, M., Volterrani, M., Grossi, N., Fontanelli, M. 2019. Autonomous mower saves energy and improves quality of lawns. Foredrag ved European Turfgrass Conference, Padova, Italia, 27-28.mai 2019.

Photo 2. *The whole fleet of robotic mowers at Bærheim GC. Photo: Atle R. Hansen*