RESEARCH PROJECT

Project title:	FAIRWAYS4FUTURE: Managing high-quality golf course fairways and semi-roughs without herbicides and with lower emissions of greenhouse gases.
Project start date: 1 March 2023	**Project completion date:** 31 December 2025
Principal investigator (PI): Name, institute/university, address and contact information	Karin Juul Hesselsøe, NIBIO Landvik, N-4886 Grimstad, Norway, Tel: + 47 413 96 851 E-mail: karin.hesselsoe@nibio.no
Co-applicants: Name and institute/university	Anne Friederike Borchert, Michael Bekken and Trygve S. Aamlid, NIBIO Landvik, Norway. Daniel Hahn, Hahn Turf Agronomy, Germany. Wolfgang Prämaßing, Hochschule Osnabrück, Germany. Golf courses (course managers): St. Eurach and Haus Bey, Germany. Brøndby GC (Gediminas Rudokas) and Grenå GC (Lasse Nielsen), Denmark. Hirsala GC (Janne Lehto), Finland. Hills GC, Sweden. Bærheim GC (Atle R. Hansen), Norway.

Funding, kSEK				
	2023	**2024**	**2025**	**Total**
STERF	413	329	343	1085
Husqvarna (cash)	413	329	343	1085
Husqvarna (in kind)	1558	12	12	1582
Golf courses (in kind)	73	33	33	139
Total	**2457**	**703**	**731**	**3891**

Project objectives

- To investigate management strategies for fairways and semi-roughs (robotic vs. manual mowing, mowing height and fertiliser level) that result in high turfgrass and playing quality with as low input of energy and fertiliser as possible.
- To elucidate the long-term effect of robotic mowing on soil physical conditions affecting greenhouse gas (GHG) emissions from golf course fairways and semi-roughs.
- To investigate how the combination of mowing system (robotic vs. manual), mowing height and fertiliser rate affects infestation by individual weed species and other aspects of turfgrass quality on fairways and semi-roughs.

Project summary and status January 2024

The long-term impact of robotic mowing on soil compaction and water infiltration rate, fairways, and roughs on golf courses in the ROBO-GOLF project (2020-23) (Bærheim (Norway), Grenå (Denmark) and Hirsala (Finland)) will be further examined. In September 2023, NIBIO started collecting soil samples to determine soil density, texture, and carbon content of the experimental fairways used in ROBO-GOLF at Bærheim. Penetrometer and soil moisture measurements were also made. In 2024, comparable samplings and measurements will be performed at Grenå and Hirsala.

At NIBIO-Landvik, Norway, conventional rotary mowing is being compared with systematic robotic mowing using the GPS-based Ceora EPOS system from Husqvarna. In the two mowing systems, two mowing heights 30 and 45 mm (which are believed to have an impact on weed encroachment) are compared. In 2024, plugs of fairway-type white clover (*Trifolium repens*) will be transplanted into subplots in the plots with different combinations of mowing height and mowing system. The following characters will be recorded monthly: Turfgrass overall impression, turfgrass colour and NDVI, turfgrass height and coverage of white clover using digital imaging.

The same Ceora robotic mower as used at NIBIO-Landvik will be programmed to mow different plots at the two mowing heights, 10 and 15 mm, in factorial combination with three fertiliser levels (0, 60 and 120 kg N/ha/yr). Plugs of white clover, daisies (*Bellis perennis*) and other broadleaved weeds will be transplanted into subplots to study the combined effect of different mowing heights and fertiliser levels on encroachment by the different weed species.

Demonstration trials will be established at five golf courses: Hills near Gothenburg in Sweden, Hirsala near Helsinki in Finland, Brøndby near Copenhagen in Denmark, Haus Bey near Düsseldorf, and St. Eurach near Munich in Germany. At each golf course, a Ceora robotic mower will be installed on a designated area including both fairway and semi-rough. Conventionally mown neighbouring fairways and semi-roughs of similar soil type will serve as control treatments. On fairways, two fertiliser levels will be assessed: 'Common practice' (100%) and reduced (50%). In Germany, course managers in collaboration with turfgrass agronomist Daniel Hahn and turfgrass scientist Wolfgang Prämaßing will be responsible for the trials. Golf playing quality of the turf will be assessed by Daniel Hahn.