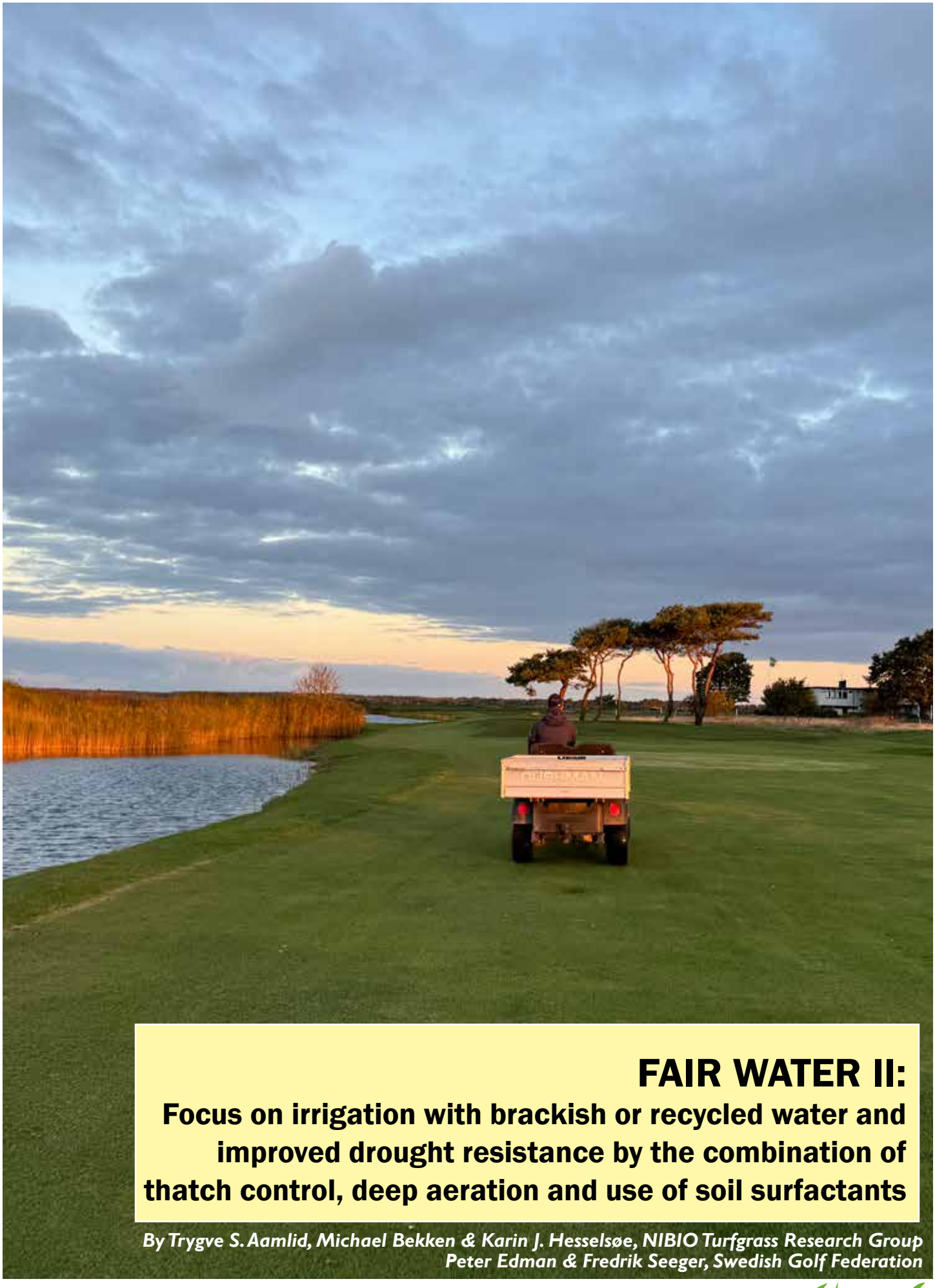

FAIR WATER II:

Focus on irrigation with brackish or recycled water and improved drought resistance by the combination of thatch control, deep aeration and use of soil surfactants

By Trygve S. Aamlid, Michael Bekken & Karin J. Hesselsøe, NIBIO Turfgrass Research Group
Peter Edman & Fredrik Seeger, Swedish Golf Federation

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FAIR WATER II:

Focus on irrigation with brackish or recycled water and improved drought resistance by the combination of thatch control, deep aeration and use of soil surfactants.

Sustainable water use on golf courses has been a priority research area for STERF for many years. Since 2023, the foundation has funded the FAIR WATER project, which aims to make fairways more drought-resistant by selecting drought-tolerant grass seed mixtures and optimizing the use of soil surfactants (see earlier articles at www.sterf.org).

FAIR WATER has now been expanded and extended until 31 December 2026, thanks to additional funding from the R&A's Golf Course 2030 program and the German Greenkeepers' Association. In addition to continuing activities from the first FAIR WATER project, FAIR WATER II will investigate the opportunities and limitations of irrigating with brackish or recycled water on Swedish golf courses.

FAIR WATER II began on 1 September 2024, and consists of two sub-projects in addition to the experiments already underway in FAIR WATER.

Photo 1. *Thatch development at the start of the project at a) Romerike Golf Club in Norway and b) Kalundborg Golf Club in Denmark. Photos: Trygve S. Aamlid (a) and Karin J. Hesselsøe (b).*

Sub-project 1:

Effects of thatch control and deep aeration in the fall, combined with soil surfactants in spring and summer, on the quality of non-irrigated fairways

In this sub-project, we take our experience from the small-scale trials with different surfactants at the NIBIO Turfgrass Research Center Landvik, one step further into large-scale trials on one drought-sensitive fairway at each of the following golf courses:

- Hirsala, near Helsinki, Finland
- Romerike, near Oslo, Norway
- Kalundborg, in West Zealand, Denmark
- St. Diony's, near Hamburg, Germany

The experiment at Romerike is on a silty loam soil, while the other trials are on sandy soils (Kalundborg and St. Diony's) or on a sand-capped fairway (Hirsala). Penetrometer measurements at the start of the project in September showed that the soil/sand at all sites

was hard and compacted, which hinders root development and makes the grass more vulnerable to drought. The thatch layer varied in thickness from 30 to 50 mm, making the grass more sensitive to both water deficits and excessive rainfall.

The dominant grass species varied from Kentucky bluegrass (*Poa pratensis*) at Romerike to perennial ryegrass (*Lolium perenne*) at St. Diony's, but all courses also had significant amounts of annual bluegrass (*Poa annua*). Loss-on-ignition tests showed that the organic matter content in the thatch layer was in the range 20-30% at Romerike, Kalundborg, and St. Diony's, while the sand-capped fairway at Hirsala stood out with only 9%.

Experimental Design

In September 2024, a uniform section of each fairway was divided into 3 × 3 = 9 plots, where the following treatments are being tested:

Factor 1: Mechanical treatments in the fall to reduce thatch and promote root development

A. Untreated control
B. Scarification (verticutting) to a depth of 2 cm
C. Scarification to 2 cm + deep aeration to 20 cm

Factor 2: Monthly application of soil surfactants in summer 2025 and 2026

1. Untreated control
2. Soil surfactant 1
3. Soil surfactant 2

The final decision on which surfactants to include in the experiment will be made at a project meeting in March 2025. Based on a comparison of eight soil surfactants in small-scale trials under a rainout shelter at NIBIO Landvik in 2023 and 2024, the most promising products are:

- **H2Pro Trismart**: Highest percentage of green grass cover after prolonged drought
- **Qualibra**: Best overall visual appearance after prolonged drought
- **Magnum 357 Calibre**: Highest green cover and best overall appearance during the first half of the drought period
- **ProWet Evolve**: Highest volumetric water content in the soil during the drought period

Photo 2. *Scarifying with 'Graden' at St. Diony's Golf Club on 11 September 2024. Photo: Thomas Fischer.*

With the exception of Kalundborg, where the nine treatment combinations are arranged sequentially along a narrow fairway, the mechanical treatments and soil surfactants will be applied in a crosswise pattern using the golf course's own equipment. In summer 2025, course managers will measure soil moisture using TDR sensors and take photos (preferably drone images) every two weeks. Results will be published on www.sterf.org and in Nordic and German greenkeeping magazines.

Since the experiments are being conducted on fairways in regular play and without any rainout shelters, there is no guarantee that drought stress will occur in 2025 and/or 2026. However, with two years of trials on four golf courses in different climate zones, we are reasonably confident of obtaining practical results useful for Nordic greenkeepers.

In collaboration with the national greenkeeping associations, field days and knowledge-sharing events will be held at all trial sites. The first event has been scheduled at Hirsala Golf Club in late June 2025.

***Photo 3**. Deep aeration with Verti-Drain at Kalundborg Golf Club on 28 October 2024. Photo: Micki Truelsen.*

***Photo 4.** Drone photo of experiment at Hirsala Golf Club, Finland, on 20 September 2024. The untreated control plot is in the center. In spring 2025, 10-meter-wide strips with different surfactants will be applied along the length of the fairway, perpendicular to these plots. Photo: Janne Lehto.*

Sub-project 2: Irrigation of fairways with brackish or recycled water

Around 70 golf courses in Sweden and Finland are located near the Baltic Sea, where the water typically contains 0.7% salt, i.e. only one-fifth of typical seawater (3.5%). For these courses, using brackish water for irrigation during dry periods may be an attractive option, especially on fairways.

Some courses have reported issues with seawater intrusion into groundwater wells, streams, or rivers used for irrigation. Others rely on runoff water from roads or parking lots, while some have access to treated wastewater from sewage plants.

In October 2024, we visited seven Swedish golf courses with known or potential problems with irrigation water quality: Ljunghusen (photo 5), Falsterbo, Flommen, Ronneby, Emmaboda (photo 6), Västervik and Loftahammar. The course managers were interviewed about their experiences with the use of brackish or recycled water and samples were taken of irrigation water and from the soil on fairways and greens where low quality irrigation water has been used or will most likely be used in the future.
The course managers at Ljunghusen, Fasterbo, Flommen and Ronnaby told that they often see yellowing turf and reduced growth as symptoms of salt stress / drought stress in July and August. Falsterbo and Flommen attempts to avoid such symptoms by regularly flushing the greens to leak out the salt, but these flushing treatments may not be sufficient to prevent salt damage during the most stressful parts of the growing season.

For the grass plant, a high salt concentration in the soil solution will normally be perceived as drought stress because the salt concentration inhibits root uptake of water. The total concentration of salts (ions) in irrigation water is expressed by the electrical conductivity (ECw), with higher conductivity meaning higher risk for salt damage. In the water samples taken at the Swedish golf courses in October, the highest ECw was 2.5 ds m^{-1} in the sample from Ljunghusen, whereas the other courses had conductivities varying from 0.2 to 0.5 ds m^{-1}.

According to US research, 4.0 ds m^{-1} is a critical threshold for cool-season grasses (Lui et al. 2023), but damage can occur even at 0.75 ds m^{-1} (Ayers & Westcot 1985).

Apart from the total salt content, it is also important to monitor the concentration of each ion independently. Of the major cations (positively charged), there is a particular risk that high concentrations of sodium (Na) will damage soil structure (collapse of micropores) and result in reduced water infiltration and percolation rates. The sodium adsorption ratio (SAR) is an expression for the ratio of sodium to calcium (Ca) + magnesium (Mg), with a critical value of 10 (Lui et al. 2023). Here, the water samples from the Swedish golf showed SAR values between 1.2 and 2.6 except for Ljunghusen which had 5.7.

To summarize, the samples taken in October 2024 show that Ljunghusen has a problem both with the total salt concentration ('salinity') and with the concentration of sodium ('sodicity') in the irrigation water. The other courses seem to be at less risk, which was confirmed also by the parallel soil samples (not shown in this article). But since the salt concentration in both irrigation water and soils are likely to vary significantly during the season, our sampling in October 2024 will be follow up with new samples taken when the need for irrigation water is at the highest in June and July 2025. At the same time, we will also make a review of relevant literature and establish field trials to evaluate which treatments are most effective to mitigate damage caused by irrigation with brackish or recycled water.

Photo 5. *From the work of collecting soil and water samples at Ljunghusen Golf Club in October. This course has issues with excessive salt in the irrigation water. Photo: Michael Bekken.*

Photo 6. *This irrigation pond at Emmaboda Golf Club is filled with wastewater from a local treatment plant. Fortunately, the wastewater passes through several ponds and channels before reaching the irrigation pond. Photo: Michael Bekken.*

Acknowledgments

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References

Ayers, R.S. & Westcot, D.W. (1985). Water quality for agriculture. FAO Irrigation and Drainage, Paper 29, Food and Agriculture Orga nization, Rome.

Lui, H., Todd, J.L. & Luo, H. (2023). Turfgrass Salinity Stress and Tolerance-A Review. Plants. https://doi.org/10.3390/plants12040925