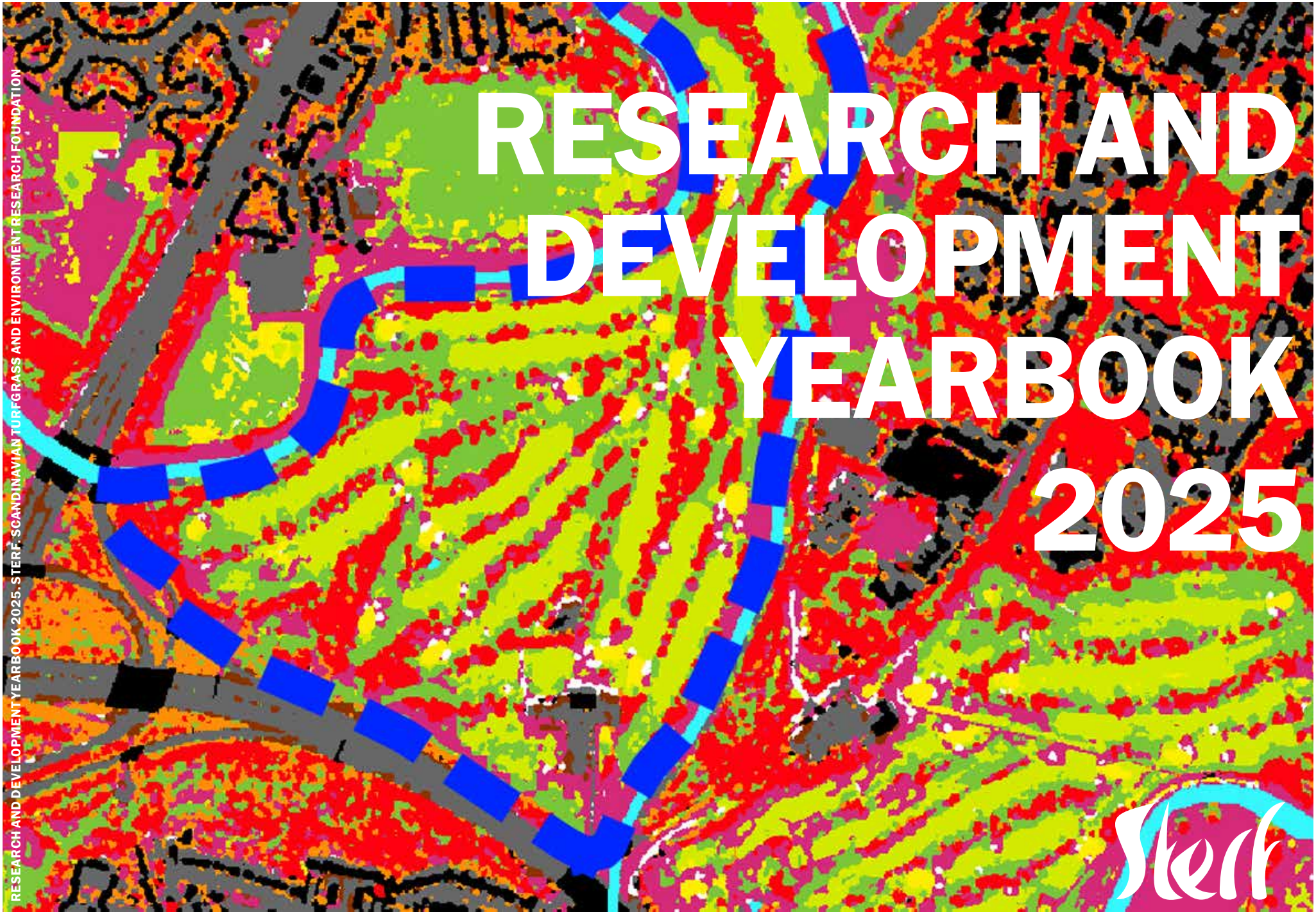

RESEARCH AND
DEVELOPMENT
YEARBOOK
2025
RESEARCH AND DEVELOPMENT YEARBOOK 2025. STERF. SCANDINAVIAN TURFGRASS AND ENVIRONMENT RESEARCH FOUNDATION
sterf

20 YEARS OF SUCCESS FOR STERF

STERF is a unique research and development collaboration and sustainability initiative for the turfgrass sector you will not find anywhere in the world.

Twenty years ago, we carried out solid background and foreground analysis and set the cornerstone strategies as:

- End user prioritised applied research, with ready to use results.
- Cooperative financing with contributions from golfers, industry, research councils, etc.
- The formation of innovative scientific environments through international cooperation and others.

A multitude of phone calls, meetings, seminars, conferences, and visits to research facilities around the world with golf associations and partners have been held to fulfil our strategies and meet our goals. STERF is now recognised as "a global centre of excellence in turf science" by golf and greenkeepers organisations, the turf industry, universities/turf scientists, and many more.

In 2025, we also fulfilled the last important strategy to "Increase cutting edge capacity in solving problems for the turf sector through global cooperation", by launching the International Turfgrass Research Initiative – ITRC together with USGA and the R&A.

Below you will find the timeline for STERF's first 20 years and Important events for 2025. We hope you will continue to follow our work for the coming 20 years!

Bruno Hedlund
STERF Chairman

2006: Statues for the foundation of STERF are approved. Strategies for the development of STERF are prepared and extensive contacts with the Nordic golf federations are held.

2007: Iceland joins STERF, fulfilling the vision of pan-Nordic research cooperation, and all the national federations accept a tax of € (IPM)0.5 per registered participant as a long-term strategy to fund research and competence building.

2008: STERF arranges its first innovation workshop, focusing on the challenge of climate change, which gathers more than 100 participants from all the Nordic countries, representing different stakeholders. As a result of discussions in the workshop, the first research programme is formulated.

2009: The Nordic greenskeepers' associations approach STERF with a proposal for strategic co-operation. An agreement on regular information about STERF projects in magazines, the prioritisation of meetings comprising cross communication between greenskeepers and researchers, the participation of greenskeepers in advisory groups for projects, etc. is reached.

2010: The project "Multifunctional golf facilities - an underutilised resource" is funded by the Nordic Council of Ministers. The main aim of the project is to create networks and allow the exchange of experiences between experts and groups in society with an interest in the land areas used by golf courses.

2011: STERF's open library on Integrated Pest Management (IPM) is set up, with support from the Swedish Board of Agriculture, to provide the park and golf sector with access to information and tools based on research and development for IPM. Information seminars, education materials, 20 factsheets and a large number of handbooks and other publications are launched.

2012: To strengthen the process of integrating strategic research and development all the way from producer to end-user, STERF's Industry Scientific Partner Programme is introduced. The partners contribute to funding STERF's open research programme. In addition, STERF recognises a need for international co-operation and signs an agreement of collaboration with the Canadian Turfgrass Research Foundation (CTRF).

2013: The second Innovation workshop is held, resulting in four new strategic research programmes with an international outlook, namely Integrated Pest Management, Sustainable water management, Winter stress management and Multifunctional golf facilities. STERF also invites club managers, greenskeepers and other representatives of 700 golf clubs in the five Nordic countries to

respond to an internet-based questionnaire about STERF's R&D priorities, and 510 clubs submit their priorities – highly valuable input!

2014: Seven industry partners contribute SEK 1.5 million to STERF's project portfolio, bringing the portfolio to a total volume of SEK 4.5 million, a 10-fold increase over 10 years. Four international R&D seminars are held by STERF, in Norway, Denmark, the Netherlands and China.

2015: STERF invites the Nordic authorities responsible for the implementation of the EU Directive on Sustainable Pesticide Use to a contact meeting in Copenhagen to inform them about STERF's present and planned Integrated Pest Management (IPM) projects and the digital IPM library. In this meeting, they also discuss the implementation of the newly revised procedures for the registration of plant protection products. The authorities and delegates agree on joint communication strategies and important R&D areas for the Nordic countries.

2016: To increase the accessibility and impact of STERF research for practitioners, national websites for all Nordic countries are launched. Handbooks, guidelines, fact sheets and other publications are now available in English, Norwegian, Finnish, Danish, Icelandic and Swedish. Despite 10 years of ongoing progress, the challenges are even greater today for the golf sector. The impact of climate change is exceeding the worst expectations; strong restrictions on the use of chemicals, fertilisers and energy are expected and there is an accelerating loss of urban green areas and biodiversity.

2017: STERF collaborates with Norwegian authorities on project examining pesticide fate and biodiversity. Almost 100 participants from 10 different countries, including scientists, superintendents, industry representatives and consultants, participated in the STERF seminar 'Winter Stress Management of Turfgrasses", where the new handbook was also introduced. STERF holds a seminar on "Multifunctional landscapes" and conducts a comprehensive study on "Multifunctional activities on Nordic golf facilities". Seven new projects are funded in the 2017 call.

2018: Two new instruction videos released, "From dense sward to biodiverse roughs" and "The golf course as an outdoor classroom". The first international irrigation workshop is held with theory and practice in "Engineering better irrigation in turf'. A new handbook on golf clubs as frontrunners for sustainable development is released. At the Sixth European Turfgrass Society conference, 25% of the papers presented were from STRF research.

2019: Around 100 greenskeepers, scientists, advisors and representatives from national authorities and the pesticide industry from 10 countries participated in the international seminar – "Leaching and surface runoff of pesticides". A meeting with Nordic golf and authorities was also arranged. Cooperation between R&A's GolfCourse 2030 and STERF is initiated. A handbook on Outdoor teaching, using the golf course as a classroom, is published.

2020: The Corona pandemic also hits STERF with the consequence that all seminars and meetings were carried out as webinars, Teams meetings, etc. We arranged an international webinar for the project "From dense swards to biodiverse roughs" with almost 100 participants from all over the world. The number of reports, publications and articles was one of the highest in STERF history. Two videos on how to control Dollar spot were released. During 2020, STERF started six new projects to ensure that we had the knowledge we needed to build and maintain sustainable golf courses and sports fields and meet global challenges.

2021: Based on preliminary results from four of ICE-BREAKER's subprojects (the largest R&D project in STERF history, 9.6 million SEK), an international webinar with more than one hundred participants from different countries was held. A new experimental green was built at Smörum GC in Denmark. The SUSFOS project resulted in a thorough revision of STERF's fertiliser handbook and an international webinar about the more environmentally and economically sustainable fertilisation of golf courses. The STERF-project ROBO-GOLF arranged a greenskeepers' meeting at Grenå GC, Denmark to discuss the trials and discuss the latest in robotic technology. More videos than ever were also produced during 2021, an effect of the pandemic.

2022: At last, after years of delay caused by the global Covid-19 pandemic, the world's top brains in turfgrass science and technology gathered in Copenhagen for the 14th International Turfgrass Research Conference, hosted by STERF. Expectations were high and you could feel that the delegates were really delighted to meet after the long involuntary break from close contact. The conference week was really fantastic, with large volumes of scientific results, innovative discussions and technology transfer. The conference was ranked as the best turfgrass event ever by the participants and sponsors.

2023: The symposium 'Sustainable golf course management- Integrated turf management', a joint R&A and STERF initiative and part of the Golf Course 2030 programme, was held in Sigtuna. Representatives from STERF, USGA and the R&A met in May 2023 to discuss approaches to further develop a global initiative for financing and organising turfgrass research. The scientific and practical conclusions from ICE-BREAKER, one of STERF's largest ever projects, which was co-funded by the Norwegian Research Council over the past four years, were highlighted in a final seminar held in Oslo.

2024: A new website, sterf.org, with a user-friendly interface and support for videos and films, is launched. Now, all factsheets, articles and handbooks are published in English and all Nordic languages. In May 2024, the International Turfgrass Research Initiative was launched and the three partners (STERF, USGA and the R&A) have invested SEK eight million for a three-year period. we invited scientists to submit pre-proposals, and in 2024, the initiative received 25 pre-proposals.

The most important events of 2025 can be found in the following pages.

IMPORTANT EVENTS IN 2025

NEW RESEARCH PROGRAMMES

The future challenges for golf and the larger turfgrass industry are many and diverse when aiming to provide high quality golf courses and other sport fields. Climate change is transforming abiotic stress patterns, pest life cycles, and basic turfgrass selection and management. Strong restrictions on the use of chemicals and fertilizers, increasing pressure on natural resources (notably water, energy and land) and rising opera¬ting costs for turfgrass maintenance are expected. Development is accelerating the loss of ecosystem services and biodiversity. All this calls for more research and innovation for a sustainable future.

To meet these challenges, STERF has created and launched four international and trans-disciplinary R&D programs, including:

- Winter stress and integrated pest management
- The sustainable use of natural resources in golf course management
- Multifunctional golf courses and ecosystem services from a landscape perspective
- New technology for a sustainable future

The programmes are presented on page 10.

THREE NEW RESEARCH PROJECTS

In autumn 2025, STERF issued an open call for proposals to meet the challenges our sector must face. In its 2025 call for proposals, STERF decided to prioritise research and development within STERF´s four new R&D programmes.

In response to the call, STERF received 15 high quality project proposals within all four R&D programmes. The STERF Advisory Committee and committee subgroups then carried out a thorough evaluation of the proposals. The sub-group coordinators (Nilla Nilsdotter-Linde, SLU, and Karin Normann, Turf House) were especially important in the evaluation process. The total amount sought from STERF was €2,500,000. Based on the Advisory Committee´s recommendations, the STERF board decided to fund three new projects, corresponding to a total investment by STERF of €650,000 over four years. These new projects are presented on pages 26-31.

ITRI FIRST FUNDED PROJECTS

STERF, the R&A and the USGA have selected three projects for funding under the International Turfgrass Research Initiative (ITRI), a global programme designed to advance sustainable golf course and sports turf management.

The announcement of the new projects was the culmination of a rigorous two-phase application process. Of the 25 proposals received at Phase 1, nine high-quality projects were invited to submit full proposals at Phase 2. Following expert peer review and joint evaluation, three outstanding projects have been awarded funding. These projects address critical priorities shared by STERF, the R&A and the USGA:

- Integrated pest management and the reduction of inputs
- Water conservation and efficiency
- Biodiversity, ecosystem services, and landscape values
- Climate adaptation and carbon balance

The funded projects are:

- Pathways to a climate positive future for golf, *Robert Kempster, Ph.D., Norwegian Institute of Bioeconomy Research (NIBIO)*
- Integrating alternative strategies to improve the sustainable management of dollar spot, *Paul Koch Ph. D., University of Wisconsin-Madison*
- Leveraging Satellite Data for Water Conservation on Golf Course Fairway, *Qiyu Zhou, Ph.D., North Carolina State University*

More information about the projects can be found on pages 32-37.

FAIR WATER AND FAIRWAYS4FUTURE FIELD DAYS IN FINLAND AND GERMANY

In addition to irrigation water quality and demo trials with thatch control/aeration and the use of soil surfactants, the STERF project FAIR WATER II, funded by R&A's program GC2030, has a strong focus on technology transfer and dissemination of results. Two well-attended fields days were held in 2025, the first at Hirsala GC near Helsinki, Finland, on June 26th and the second at St.Diony's GC, near Hamburg, Germany, on September 24th. Both events were held in collaboration with the national greenekeeper associations, and the field at St.Diony's was also supported by the German Golf Federation. The field days started with lectures presenting preliminary results from the on-going FAIR WATER projects, and at Hirsala also about from the STERF project FAIRWAYS4FUTURE focusing on robotic mowers. After that, participants visited and discussed the large-scale demo trials at both sites.

15TH INTERNATIONAL TURFGRASS RESEARCH CONFERENCE

The International Turfgrass Research Conference (ITRC) is held every four years and is the world's leading conference within golf and turfgrass management. At ITRC, the latest research is presented to help the golf and turfgrass sector address

Participants at St.Diony field day listening to Trygve S. Aamlid in FAIR WATER II demo triiche mechanical aeration treatments and the soil surfactants ProWet Evolve and Qualibra are tested for their ability to improve fairway drought tolerance.

Nordic representatives at the 15th International Turfgrass Research Conference in Kuruizawa, Japan

key challenges and drive necessary change. The conference brings together researchers, advisors, practitioners and industry representatives. It serves as an important platform for building collaboration and discussing how to generate the new knowledge that is needed.

This year's conference was held in Karuizawa, Japan. Key highlights and future trends included: new technologies to advance the golf and turfgrass sector; the need to increase the sector's contribution to essential ecosystem services; an unusually high number of young researchers presenting important findings; and the need to strengthen international research collaboration. In this context, STERF's initiative, the International Turfgrass Research Initiative, a research collaboration between STERF, USGA, and the R&A, received considerable attention. The conference in Japan gathered 421 participants from 27 countries. More than 180 scientific papers were presented, and we are proud that more than ten of these were based on various STERF projects. To hear more voices from the conference through recorded interviews, please visit STERF's YouTube channel.

REVISED HANDBOOK: TURFGRASS WINTER STRESS MANAGEMENT

STERFs handbook 'Turfgrass Winter Stress Management' was first published by NIBIO Turfgrass Research Group in 2017. The new version has been updated by Trygve S. Aamlid and Tatsiana Espevig and includes ready-to use knowledge from projects completed during the last seven years, including the STERF funded projects 'ICE-BREAKER' and 'Integrated management of turfgrass diseases', and the USDA-funded project 'WINTER TURF'. For those who want to dive deeper into the subject, the handbook includes 173 references, mostly recently published research articles.
The updated handbook is divided in the following chapters:

- An overview of the risk for turfgrass winter damage stress in the Nordic countries

- Turfgrass hardening (acclimation) and de-hardening (de-acclimation)
- Grass species for northern climates: Winter stress tolerance species by species
- Turfgrass winter diseases, including integrated management approaches
- Abiotic winter stresses, including low temperature freezing stress, frost heave, desiccation, and damage from ice encasement and melt water.
- Spring stresses: Desiccation, photoinhibition, and oxidative stress
- Reestablishment of dead turf in spring

The new handbook can be downloaded here.

NIBIO INTERNATIONAL TURFGRASS FIELD DAY 2025

The 2025 NIBIO International Turfgrass Field Day took place on September 9th at Landvik, Grimstad, gathering more than one hundred participants from eleven countries- a new record for the event. The main theme this year was sustainable water management, a timely topic following an unusually dry spring and summer in southern Norway.

Three international speakers highlighted challenges and solutions for turf management in warm and dry climates. Chase Straw, Penn State University, presented advances in precision irrigation, showing how sensors and satellite data help reduce water use significantly. Trygve S. Aamlid, NIBIO, shared early results from FAIR WATER projects, demonstrating how soil surfactants and drought tolerant grass species can improve both drought resistance and recovery. Bernd Leinauer, New Mexico State University, outlined strategies for water savings, including alternative water sources, drought tolerant species, and improved irrigation efficiency- along with the more controversial idea of using artificial turf in selected areas.

Participants also joined a guided field walk featuring twelve ongoing trials, from variety testing and robotic mowing to new concepts such as reflected light ("Second Sun") and precision weed spraying. The day concluded with presentations by STERF leaders Maria Strandberg and Bruno Hedlund, who introduced new research programs and highlighted major international projects recently funded by USGA, R&A, and STERF. Videos / interviews with speakers at NIBIO's international field day are available here.

Participants at NIBIO Turfgrass Field Day. Photo: Lars Sandved Dalen.

STERF ON LINKEDIN AND YOUTUBE

STERF established a presence on LinkedIn and YouTube in 2025. All produced videos are published on YouTube, including podcasts. LinkedIn is used for continuous updates on new content available on YouTube and the website, as well as for sharing other material of relevance to our target audience, such as webinars.

Over the year, 21 videos were published on YouTube, generating a total of 641 views. On LinkedIn, STERF published 46 posts, which received 1,160 reactions.

ABOUT STERF

SCANDINAVIAN TURFGRASS AND ENVIRONMENT RESEARCH FOUNDATION, STERF

STERF is an independent research foundation that supports existing and future R&D efforts and delivers 'ready-to-use' research results that benefit the golf and turfgrass sector. STERF was set up in 2006 by the golf federations in Sweden, Denmark, Norway, Finland and Iceland and the Nordic Greenkeepers' Associations. Research funded by STERF is carried out at universities or research institutes (or equivalent), where the majority of relevant research capacity is concentrated. STERF helps to strengthen research capacity by encouraging and supporting networks and collaborating actively with key international organisations in the field of turfgrass management. STERF also arranges innovation workshops to help identify the golf and turfgrass industry´s future research needs in which researchers and industry representatives contribute to the planning process. STERF receives funding from participating golf associations, complemented by funding from other sources.

STERF's vision is to be the leading international centre of expertise in sustainable golf course management.

To achieve this vision, STERF focuses on:

- Making the turfgrass industry in the Nordic countries a role model of responsibility for sustainable societal development, i.e. in the production of managed turfgrass areas of a high standard while ensuring the sustainable use of natural resources, contributing to functioning ecosystems, and providing recreation areas that are open to the public and to outdoor activities.

- Ensuring that Nordic turfgrass research and development focuses on internationally important areas where concerted research and industrial efforts are required. These include the pressures generated by government demands for greater environmental regulation, increasing pressure on natural resources (notably water, energy and land), the emerging role of turf management in supporting

ecosystem services and enhancing biodiversity, the continued need to promote integrated pest management, and the looming challenges posed by a changing climate and the urgent need to adapt. Activities within the focus areas must contribute to the fulfilment of eight of the 17 sustainable development goals (SDGs) set in the United Nations Agenda 2030.

- Establishing successful international research and development collaboration, including research facilities and expertise from all five Nordic countries. STERF will continue to initiate inter-disciplinary and multi-disciplinary research and support collaboration in Europe, Canada and USA, involving researchers and stakeholders interested in land used for managed turfgrass areas.

- Developing and expanding the STERF industrial scientific partner programme by collaborating with leading international companies within the sector to further strengthen the strategy of research and development integration from producer to end-user.

- Taking a lead in making research results and new knowledge easily accessible to end-users and providing support to implement changes, a prerequisite for achieving progress in the sustainable management of golf courses and other turfgrass areas.

STERF´s activities must contribute to the fulfilment of eight of the 17 SDGs set out in Agenda 2030. STERF has divided these into six categories:

1. Sustainable use of natural resources and chemicals (SDGs 6, 11, 12, 14, 15).
2. Ecosystem services and enhanced biodiversity (SDGs 14,15).
3. Adapting to a changing climate and minimising factors affecting climate change (SDG 13).
4. Sustainable cities and communities (SDG 11).
5. Healthy lives and well-being for people of all ages (SDG 3).
6. Partnership for sustainable development and for new regulations (SDG 17).

These categories and goals are closely related to the golf and turfgrass industry´s everyday challenges and to STERF's programmes, projects and dissemination efforts.

BACKGROUND

Managed turfgrass areas, such as golf courses, sports fields, landscaped amenity areas and public parks, act as an important social, environmental and economic resource for both urban and rural communities. These areas serve a multifunctional purpose by offering valuable open spaces for recreation, helping to improve the health and quality of life for individuals and, when designed and managed appropriately, enhancing biodiversity and supporting regulatory targets for environmental protection. Conversely, where turfgrass management practices are inadequate or inappropriate, their services to society are reduced and their impacts on the natural environment can be damaging and costly.

The future challenges for turfgrass and golf course management are many and diverse. They include increasing demands on natural resources (notably land use, water resources and energy) driven by economic development and population growth, coupled with government demands for greater environmental protection, which are creating conflicts at the interface between land management (including turfgrass) and the environment. The situation is particularly acute in peri-urban areas, where the majority of managed turfgrass facilities are concentrated. Population growth, migration and climate change will exacerbate the current situation by increasing competition for resources between individual sectors, including agriculture, urban development, tourism and the environment. Many golf courses, sports facilities and stadiums are under economic pressure due to economic recession in many parts of the world.

The key to success in future golf course and turfgrass management will be to increase resource use efficiency, reduce maintenance costs and minimise environmental impacts. In this context, the protection and enhancement of ecosystem services will need to be fully integrated into the planning, design, construction and management of all golf and turfgrass facilities.

Nordic Golf Federations have approximately 1.1 million members, playing golf on more than 1,100 courses, which occupy a total area of more than 70,000 hectares. Any societal activity as significant as golf must take responsibility for building knowledge through research and development (R&D). There are several important reasons why Nordic R&D is necessary. In Central Scandinavia, Oslo, Stockholm and Helsinki lie at the same latitude as the southern tip of Greenland (~60oN). This creates a unique climate, with distinct light, temperature and precipitation patterns during the playing season and particularly during the winter season. The Nordic climate creates conditions for plant growth and the construction and management of golf courses, sports fields, etc. that are not found anywhere else in the world.

R&D will continue to be a necessary and strategically important investment for the golf sector to achieve economically and environmentally sustainable golf facilities of a high standard and to establish the credibility of golf as an environmentally friendly sport. Golf facilities that are already using new knowledge are achieving cost savings through more efficient management strategies, while also enhancing their golf courses, raising the profile of their golf facility, and improving the environment.

The financial resources allocated to R&D in each country are very limited, and the number of scientists actively working within each priority R&D area is also quite limited compared with agricultural and forestry research. The financial resources and efforts of these researchers should therefore be coordinated through STERF to optimise R&D within the golf and turfgrass sector.

RESEARCH OBJECTIVES AND R&D PROGRAMMES

STRATEGIC RESEARCH OBJECTIVES

The golf and turfgrass industry, like other land-based industries, must take responsibility for sustainable societal development, i.e., it must produce golf courses and other turfgrass areas of a high standard while also ensuring the sustainable use of natural resources and contributing to functioning ecosystems.

The aim of STERF is to support R&D that can help the golf industry to fulfil these ambitions. The activities of STERF are intended to lead to improvements in the quality of golf courses, as well as supporting economic and environmental gains for the industry and society.

The strategic objectives for STERF-funded R&D activities are that:

- The design, construction, management and administration of golf courses provide optimal conditions for playing quality, the utilisation of the course and management inputs.
- The design, construction, management and administration of golf courses are economically and environmentally sustainable, for example, with respect to plant nutrient requirements, water and energy use, drainage, and the control of weeds and plant diseases.
- Golf courses contribute to the production of biological diversity, the conservation of natural and cultural envi¬ronments, the retention and expansion of ecosystem services, and to improving the conditions for high quality of life and health, for example, by providing a broa¬der active outdoor life, experiences of nature, and better climate adaptation in the everyday landscape.

R&D PROGRAMMES

The golf sector faces several challenges, including the need to provide high-quality playing surfaces while adhering to strict environmental regulations, addressing climate change, and managing rising operational costs. There is growing pressure on natural resources like land, water, sand, and energy, creating a need for their efficient use to reduce costs and environmental impact. Climate change further complicates matters, with unpredictable weather impacting turf growth and management. Additionally, golf courses must play a role in preserving biodiversity and ecosystem services, offering opportunities for multifunctional use, such as the promotion of health and recreation. Research and development are crucial to addressing these challenges, with a focus

needed on sustainable practices and efficient resource management.

To meet these challenges, STERF has created and launched four international and trans-disciplinary R&D programmes. The programmes are based on a current state analysis, including the needs of golf clubs and society for new knowledge, and research and development related to golf. Creating these programmes was an extensive effort that involved many actors, including the golf sector, authorities, Nordic and international researchers, and NGOs.

The new programmes are:

- Winter stress and integrated pest management
- The sustainable use of natural resources in golf course management
- Multifunctional golf courses and ecosystem services from a landscape perspective
- New technology for a sustainable future

Progress in these programme areas will collectively lead to improvements in the quality of managed turfgrass areas, as well as economic and environmental gains for the industry. The key objectives of the programmes are to coordinate the design and running of R&D activities and to ensure the effective dissemination of outputs (new knowledge) through channels and formats which are easily accessible to end-users. STERF will play a key role in expanding the programmes to an international level.

Winter stress and integrated pest management

Winter damage is the foremost reason for dead grass, reducing the aesthetic and functional value of turf. UN-IPCC climate scenarios predict that, due to high precipitation and unstable temperatures, ice and water damage will become the major cause of winter damage in the future. This is a complex but high-priority area for STERF, as an estimated 70% of Nordic golf courses suffer from winter damage each year.

New diseases, weeds and insects caused by a warmer climate are an important challenge for the turfgrass industry. At the same time, governments, society and the general public are continuously seeking to achieve greater levels of environmental protection. Because of this, new and existing regulations on national and international levels related to the turfgrass industry are becoming stricter.

The aim of this programme is to promote high quality and environmentally friendly golf courses through the integrated management of weeds, insect pests and diseases, with high resistance against abiotic and biotic winter damage, including fast recovery whenever such damages occur.

The sustainable use of natural resources in golf course management

Golf courses often utilize significant inputs of natural resources, including water, agrochemicals, fertilizers, sand, and energy. The growing recognition of society's responsibility to reduce resource consumption necessitates the development of methods to minimize resource use on golf courses and their associated environmental impacts.

This research program aims to promote the sustainable use of natural resources in golf course management by developing innovative methods to reduce environmental impact while maintaining functionality and the aesthetics of playing surfaces. The program focuses on five key areas: water management, soil management, sand use, plant nutrition, and energy efficiency. By addressing these areas through targeted research, educational outreach and practical implementation, the program seeks to enhance the sustainability of golf courses for the benefit of the environment, the golfing community, and society.

Multifunctional use of golf facilities and ecosystem services

Multifunctional golf courses are an untapped resource that have the potential to contribute to a diversity of societal and environmental benefits. In addition to offering a high-quality arena for golf, these facilities can contribute to the achievement of important international and national environmental quality objectives, improving people's health and quality of life. The potential for this is particularly great in peri-urban environments and in the cultivated landscapes, where many golf courses are located, as there is an increasing deficit of green areas, and competition for land is high.

Framed by a holistic, social-ecological system approach and resilience thinking to address sustainable development and the ever-changing nature of our landscapes, this research program constitutes three research areas of relevance to the future of golf courses:

- Landscape resilience: Supporting biodiversity, climate change adaptation and soil quality.
- Accessibility: Connecting to and learning from the nature and culture of the surrounding landscape.
- Collaborative partnerships: With whom and about what?

New technology for a sustainable future

Golf courses represent complex ecosystems that require a detailed and considered maintenance strategy to maintain optimal care and playing quality. This requires continuous and careful management of playing surfaces, landscape design and resource use that harmonizes with the game of golf and the environmental conditions.

This research initiative addresses challenges and opportunities in the golf sector through the integration of technologies, aiming to promote sustainability in golf course management. By adopting a multidisciplinary approach that incorporates collaboration between research communities, technology developers and golf clubs, the program aspires towards the development and application of innovative technologies, such as autonomous mowers, sensor technology, artificial intelligence, and the implementation of renewable energy sources.

INTERNATIONAL TURFGRASS RESEARCH INITIATIVE

A COOPERATIVE EFFORT BY STERF, THE R&A, AND USGA

The challenges for the future of the golf and the larger turfgrass industry are many and varied. Climate change is transforming abiotic stress patterns, pest life cycles, and basic turfgrass selection and management. Strong restrictions on the use of chemicals and fertilizers and increasing pressure on natural resources (notably water, energy and land) are expected. Development is accelerating the loss of ecosystem services and biodiversity. All this calls for more research and innovation for a sustaina¬ble future. Development and sustainability were the theme of the 14th International Turfgrass Research Conference (ITRC 2022) hosted by STERF in Copenhagen, Denmark in July 2022. Global challenges and challenges within the turfgrass industry related to the sustainable development goals set out in Agenda 2030 were the focus of many presentations and were discussed by delegates. STERF feels that investing in turfgrass research would be the most appropriate legacy from ITRC 2022, and the STERF board have decided to reserve future funds to support global turfgrass research. Therefore, STERF, together with the R&A and USGA, have created the International Turfgrass Research Initiative to develop research projects with global significance. The aims of the International Turfgrass Research Initiative are:

1. To agree on the most important global research topics for turfgrass management.
2. To solicit and select research proposals to advance these topics through a competitive request for proposals (RFP).
3. To begin two to three globally cooperative and applicable projects with international research teams.
4. To model global research cooperation and learn from the initiative for even greater future efforts.

Research Priorities

Sustainable agronomy is the most prevalent area of interest. Considering increasing pesticide regulations, warmer weather patterns, and more frequent droughts and irrigation restrictions in many parts of the world, all parties agreed that integrated pest management (IPM) and water conservation are key subjects for the initiative. Another important focus is biodiversity research in turfgrass management, which is essential to foster an ecological balance by understanding and preserving diverse ecosystems within turfgrass and golf course landscapes. A better understanding of the carbon balance in turfgrass management globally is crucial for understanding the impact of turfgrass on greenhouse gas emissions and net carbon sequestration.

The following specific topics have been agreed on and prioritized:

- Integrated pest/turfgrass management
- Water conservation
- Biodiversity and landscape perspective
- Climate (carbon balance)

Committees

The initiative has two important committees. First, the steering committee is comprised of representatives from the funding organizations (STERF, USGA and the R&A), who plan and execute the initiative, appropriately representing the interests of the organizations funding the initiative. The steering committee has nominated, selected, and is overseeing the work of 10 to 12 people to serve on the proposal review committee. The review committee will in-

clude 8 to 10 scientists and 2 to 4 industry practitioners.

Call for proposals and new projects

STERF, the R&A and USGA have together reserved approximately €250,000 per year for three years for research projects with global significance. Collaboration and joint projects between international research organizations are an important aim of the initiative and a requirement for project funding. We also recognize that industrial engagement and support is a critical component of research.

STERF, The R&A and the USGA were pleased to announce three research projects selected for funding at the 15th International Turfgrass and Research Conference in Japan.

The announcement marked the culmination of a rigorous two-phase application process. Of the 25 proposals received at Phase 1, nine high-quality projects were invited to submit full proposals at Phase 2.

Following expert peer review and joint evaluation, three outstanding projects were awarded funding:

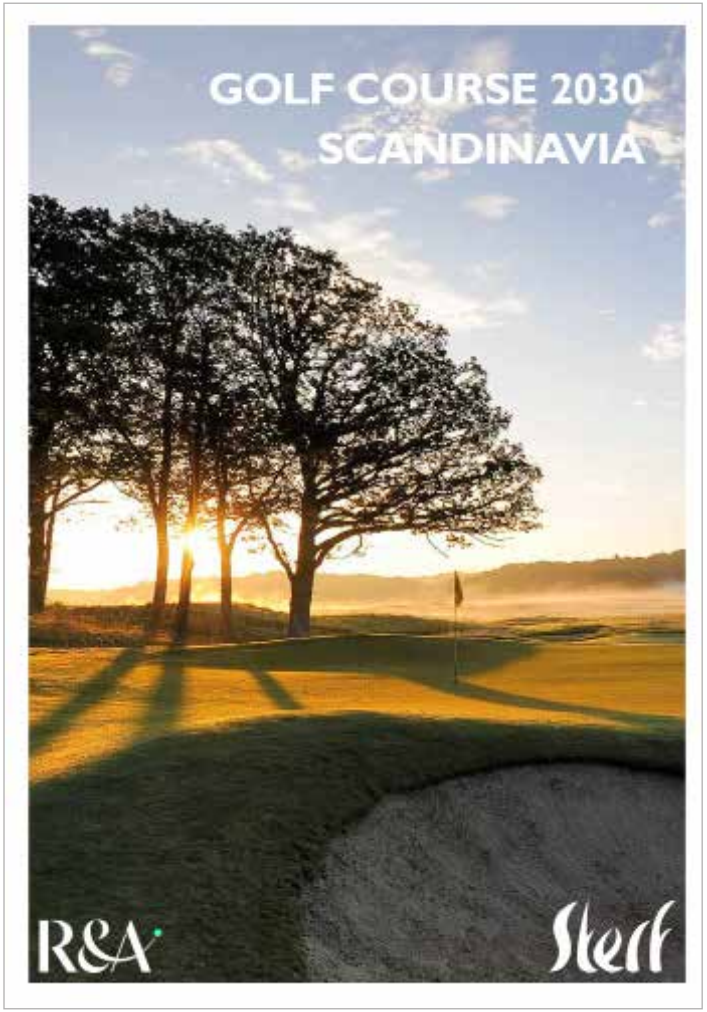
- Pathways to a climate positive future for golf, *Robert Kempster, Ph.D., Norwegian Institute of Bioeconomy Research (NIBIO)*
- Integrating alternative strategies to improve the sustainable management of dollar spot, *Paul Koch Ph. D., University of Wisconsin-Madison*
- Leveraging Satellite Data for Water Conservation on Golf Course Fairway, *Qiyu Zhou, Ph.D., North Carolina State University*

Maria Strandberg, STERF Director, said, "Climate change is driving significant shifts in natural ecosystems and environmental conditions, which affects the golf industry worldwide, and international collaboration is the only viable strategy to meet these challenges."

"All three ITRI projects are globally relevant and mobilize teams of qualified researchers representing different parts of the world. This collaboration will lead to new important knowledge and tools, and to a more efficient use of expertise and resources."

Read about the projects on pages 32-37.

GOLF COURSE 2030 SCANDINAVIA



To achieve the maximum future impact from the turfgrass sector´s sustainability work, it is of the utmost importance to establish international, interdisciplinary collaboration in which all stakeholders work to cooperate and align their resources and efforts using the United Nations 2030 Agenda for Sustainable Development, with its 17 sustainable development goals (SDGs) as a steering document.

The R&A Golf Course 2030, established by the Royal & Ancient (R&A) in 2018, is a significant initiative to support golf industry stakeholders to agree on a roadmap that secures optimal golf course conditions and playability for current and future generations. The roadmap is also intended to highlight the potential for golf courses to be designed and managed to promote critical ecosystem services, and to restore and enhance biodiversity in ecologically simplified landscapes.

Golf Course 2030 focuses on broad themes of sustainable golf course management. As part of the R&A Golf Course 2030 initiative, STERF has created Golf Course 2030 Scandinavia. This collaboration between STERF and the R&A focuses on ready-to-use research as an important tool to help prevent negative impacts on the planet.

It aims to develop new knowledge that is necessary to change the mindsets and attitudes of people worldwide.

Three joint R&A and STERF projects within the Golf Course 2030 programme:

- The IPM-project "*Integrated management of important turfgrass diseases and insect pests on European golf courses*" was completed in 2023. Research results and new knowledge have been presented in scientific publications and as practical advice and recommendations provided in demonstration videos, fact sheets, popular scientific articles, and presentations at seminars and workshops (for example, at the symposium '*Sustainable golf course management Integrated turf management*' held in Sigtuna in September 2023 by STERF and R&A).
- The ongoing "*GOLF LANDSCAPES: Biodiversity and multifunctionality of golf landscapes*", was started in 2023 and is progressing well. See page 24.
- In 2024, a third joint project started, named *FAIRWATER II*, focusing on maintenance strategies for more drought tolerant fairways and on irrigation water quality. See page 22.

IPM-project - Screening in vials of resistance of different turfgrass species to dollar spot isolates of different origin, spring 2019. Photo: Tatsiana Espevig.

SCANGREEN: TURFGRASS SPECIES AND VARIETIES FOR INTEGRATED PEST MANAGEMENT OF SCANDINAVIAN PUTTING GREENS, 2023-26

PROJECT PERIOD: JANUARY 2023 - MARCH 2027

FUNDING (kSEK)

	2023	2024	2025	2026	Total
STERF	529	669	635	510[1]	2343
Companies [2]	160			160	320
Smørum GC (in kind)	40	7	7	7	61
Reykjavik GC/Golf Union of Iceland (in kind)	7	15	15	15	52
Danish Golf Union (in kind)	25	25	25	25	100
Total	761	716	682	717	2876

1) Reserved, not granted;
2) Barenbrug (The Netherlands), DLF (Denmark), Landmark Seeds Company and Mountain View Seeds (Oregon, USA).

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Jørgen Hornslien, NIBIO Apelsvoll, Norway
Bjarni Hannesson, Reykjavik Golf Club, Iceland
Karin Normann, TurfHouse, Denmark
Per Rasmussen, Smørum Golf Club, Denmark.
Eric Watkins and **Andrew Hollmann,** University of Minnesota, USA*
*This collaboration includes a complete test site at University of Minnesota funded by US-project WinterTurf.

PROJECT OBJECTIVES
- To screen in the field and clarify which varieties of *Agrostis, Festuca, Poa* and *Lolium* are the most winter-hardy, most stress tolerant and most disease resistant on putting greens at four experimental sites representing the two major climatic zones in the Nordic countries.
- To create meeting places for discussions between plant breeders, seed companies and greenkeepers in order to encourage variety awareness, integrated pest management and continued effort in turfgrass breeding for northern environments.

TALKS AT CONFERENCES, SEMINARS, MEETINGS ETC. IN 2025
10 March, Scangreen project meeting, SCANGREEN results 2023-24, Karin J. Hesselsøe.
13 May, Reference group meeting, Scangreen 2023-26 update, Karin J. Hesselsøe.
5 June, Apelsvoll, Norway, Field Day, Mid-term results, Karin J. Hesselsøe.
13 July, Karuizawa, Japan, 15th ITRC, 'Optimal ratios between Chewings fescue and slender creeping red fescue in seed blends and mixtures for golf course putting greens' (poster), Trygve S. Aamlid.
9 Sept., Landvik, Norway, NIBIO International Field Day at NIBIO Landvik.
18 Sept., Field Day at Smørum GC.
21 Oct., Barsebäck GCC, Sweden, Berner Turf Launch 2025, Gräsarter och sortar för golfbanor i nordiskt klimat (online), Tatsiana Espevig and Trygve S. Aamlid.
23 Oct., Arlandastad Golf, Sweden, Berner Turf Launch 2025, Gräsarter och sortar för golfbanor i nordiskt klimat (online), Tatsiana Espevig and Trygve S. Aamlid.
27 Nov., SLU, Uppsala, Sweden, Greenkeeper Education Banskötsel, Gräsarter och sortar för golfbanor i nordiskt klimat (online), Tatsiana Espevig and Trygve S. Aamlid.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2026
The SCANGREEN project continues over 20 years of variety testing. In 2023-26, the varieties are assessed on sand-based greens at NIBIO-Landvik (Norway) and Smørum GC (Denmark) in the southern zone, and at NIBIO-Apelsvoll (Norway) and Reykjavik GC (Iceland) in the northern zone. The project also includes a test site at UMN, Minnesota, USA, funded by the WINTER-TURF project. SCANGREEN 2023-26 covers seven of the most common species and 20 new varieties for comparison with references. Mixtures of fescue and bentgrass are also tested.

Per Rasmussen presents results from the Scangreen 2023-26 under Field Day at Smørum GC on 18th of September 2025. Photo: Torben Kastrup Petersen.

Karin Hesselshøe presents results from the Scangreen 2023-26 under Field Day at NIBIO Apelsvoll on 5th of June 2025.Photo: Kristian Rindal.

In contrast to winter 2023-24, winter 2024–2025 was much milder, but visual differences in winter damage were still evident among the sites, particularly for creeping bentgrasses in early spring 2025. Overall, colonial bentgrass and creeping bentgrass showed the best winter survival and turfgrass quality across all sites, despite some snow mold during winter and early spring. The colonial bentgrass 'Saulsbury' showed weaker winter survival and higher disease susceptibility. Creeping bentgrass 'Oakley' had more snow mold and in-season disease in the northern zone and at Smørum.

Perennial ryegrass and Kentucky bluegrass were consistently weaker in winter performance. Kentucky bluegrass establishment was poor at several sites, contributing to low ratings, although 'Limousine' performed best in the southern zone and 'Yellowstone' matched it in the northern zone. Among perennial ryegrass, 'Barhodium' showed improved performance at Landvik.

Smaller cat's tail showed intermediate winter survival, performing best under a higher mowing height of 5 mm. It had little to no disease at southern sites but some snow mold in the north.

Among Chewings fescues, 'Barlineus', 'Bartico', and 'Euro Carina' showed the best winter hardiness, particularly in the northern zone, while 'Compass II' had favorable winter color and low snow mold in the south. For slender creeping red fescue, winter survival varied greatly by variety and site; 'LMG FRT-4631' and 'Sybille' performed best in the north, while 'Barnoustie' performed best in the south.

Dollar spot occurred only on Chewings and slender creeping red fescue at Smørum in 2024 (<1%). In 2025, it also appeared on creeping bentgrass but caused little damage; incidence remained highest on slender creeping red fescue.

In Minnesota, dollar spot pressure was very high in the summer and fall of 2025 and was especially damaging to all tested creeping bentgrass cultivars. Some fine fescue cultivars, especially Chewings fescues, performed better than others under high dollar spot pressure. The winter of 2024-2025 was very damaging to the perennial ryegrasses, all of which had to be reseeded due to winter kill; the only other entry that needed to be reseeded due to winter damage was 'Saulsbury' colonial bentgrass.

FAIRWAYS4FUTURE: MANAGING HIGH QUALITY GOLF COURSE FAIRWAYS AND SEMI ROUGHS WITHOUT HERBICIDES AND LESS EMISSION OF GREENHOUSE GASES

PROJECT PERIOD: MARCH 2023 - DECEMBER 2026

FUNDING (kSEK)

	2023	2024	2025	2026	Total
STERF	413	329	234	109	1085
Husqvarna (cash)	413	329	343	0	1085
Husqvarna (in kind)	0	1558	12	0	1570
Golf courses (in kind)	0	49	49	0	98
Total	826	2264	638	109	3837

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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 (**Christofer Andersson**), Sweden.
Sandnes GC (**Atle R. Hansen**), Norway.

PROJECT OBJECTIVES

- To study the long-term effects of robotic mowing on soil physical conditions on golf course fairways.
- To investigate how the combination of mowing system (robotic vs. traditional), mowing height and fertilizer rate affects the infestation of individual weed species and other aspects of turfgrass quality on fairways and semi-roughs.

TALKS AT CONFERENCES, SEMINARS, MEETINGS ETC. IN 2025

26 June, Hirsala Golf Club, Finland, Fairways 4 Future and Fairwater Field Day at Hirsala Golf Club, Finland, Karin Hesselsøe.
9 Sept., NIBIO Landvik, Norway, NIBIO Turfgrass Field Day, Karin Hesselsøe and Michael Bekken.
18 Sept., NIBIO Landvik, Norway, Lecture to Sandmoseskolen students, Michael Bekken.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2026

WP1: To evaluate the long-term impact of robotic mowing on soil physical properties, measurements were taken on fairways from two golf courses previously involved in the ROBO-GOLF project (2020-23). Soil testing was completed at Sandnes Golf Club (Norway) in 2023, and soil testing was completed at Grenå Golf Club in 2024. Soil compaction was lower in the robotically mown areas than in the traditionally mown areas at both golf courses. However, there were no significant differences in the infiltration rates between the two areas. For a full description of the results, please see the NIBIO report that we published.

WP2: At NIBIO Landvik, Norway the experimental area was seeded in spring 2024. After grow-in, a Ceora 546 EPOS robotic mower was installed. Starting in spring 2025, traditional rotary mowing has been compared with robotic mowing at two mowing heights to investigate turfgrass quality and the encroachment of white clover in roughs. Plugs of

Karin Hesselsøe showing the WP4 plots at Hirsala Golf Club. in June 2025. Photo: M.Bekken

A view of a fairway at Hirsala Golf Club at the F4F 2025 Field Day. Photo: M.Bekken

fairway-type white clover (*Trifolium repens*) were planted into the experimental area in mid-August 2024. After one year of data collection, clover coverage appears to be higher in the plots mown at the higher mowing height. At present, the differences between the mowing system are less clear.

WP3: Starting in spring 2025, a CEORA robotic mower has mown plots of two different fairway mowing heights at three nitrogen fertilizer levels (0, 60, and 120 kg/ha/yr). Plugs of white clover, daisies (*Bellis perennis*), dandelion (*Taraxacum officinale*), and yarrow (*Achillea millefolium*) were planted into subplots to study the combined effect of different mowing heights and fertilizer levels on the encroachment of broadleaved weed species. At present, it appears that a high mowing height and N rate allow for faster weed encroachment.

WP4: Demonstration trials on three golf courses concluded in 2025. In each of these trials Ceora EPOS robotic mowers were compared with traditional mowing on fairways and roughs, focussing on turfgrass quality and coverage of broadleaved weeds. On the fairways, the fertilizer levels were split into two: 'Common practice' (100%) and reduced (50%).

Preliminary results from some of the courses show a tendency towards higher turfgrass quality with robotic mowing compared to traditional mowing in plots with fertilizer levels at 'Common practice' (100%). At St. Eurach, the main benefit after one season with robotic mowing was visually apparent in the rough. Compared to the traditional rotary mower, the robotic mower left no clippings and created a clear definition to the edges.

FAIR-WATER I: TOWARDS BETTER DROUGHT RESISTANCE AND REDUCED WATER CONSUMPTION ON GOLF COURSE FAIRWAYS

PROJECT PERIOD: JANUARY 2023 - DECEMBER 2026

FUNDING (kSEK)

	2023	2024	2025	2026	Total
STERF	567	572	408	172	1719
Other sources	629	491	150	0	1270
Total	1196	1063	558	172	2989

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Peter Edman, Swedish Golf Federation
Martin Thieme-Hack & **Daniel Hunt,** Osnabruck University of Applied Sciences, Germany
Thomas Fischer, iNova Green, Germany
Bernd Leinauer, New Mexico State University

PROJECT OBJECTIVES

The principal objective of this proposal is to develop management strategies for resilient GC fairways that retain acceptable quality with no or strongly reduced consumption of potable irrigation water. This includes the following goals:

1. Identify the most drought resistant cultivars of the turfgrass species/subspecies commonly seeded on fairways in Northern Europe, including mixtures of these species.
2. Screen seven soil surfactants for their potential to prevent drought stress, reduce water consumption and enhance recovery after drought.
3. Validate through field trials in Norway and Germany the two most drought tolerant blends/mixtures (from goal 1) and the two best performing surfactants (from goal 2) to optimize fairway quality under drought conditions.

TALKS AT CONFERENCES, SEMINARS, MEETINGS ETC. IN 2025

18 March: FAIR-WATER I + II reference group meeting, Teams: Update of results from 2024 and plans for 2025. Trygve S. Aamlid
20 May: Slik vanner du plenen på en smart måte. Trygve S. Aamlid
26 June: Field Day, Hirsala GC, Finland: 'FAIR WATER I and II: Towards better drought resistance, reduced water consumption and alternative water sources for the irrigation of golf course fairways'. Trygve S. Aamlid
26 Aug. Fagforedrag Grimstad bibliotek. Smart vanning av plen. Trygve S. Aamlid.
9 Sep. NIBIO International Turfgrass Field Day, Landvik, Norway:
- Overview and results from the STERF and R&A projects FAIR-WATER I + II: Towards better drought resistance, reduced water consumption and alternative water sources for the irrigation of golf course fairways. Trygve S. Aamlid.
- Sustainable solutions for turfgrass irrigation. Chase Straw, Penn State University
- Maximizing turfgrass irrigation water savings: Ranking conservation impact. Bernd Leinauer, New Mexico State University.

18 Sep. Visit by the Danish Sandmose Greenkeeper School to NIBIO Landvik: Optimal vanding af fairways. Trygve S. Aamlid.
18 Sep. Inauguration ceremony Turfgrass competence center – Osnabrück University of Applied Sciences. Osnabrück, Germany. Martin Thieme-Hack
24 Sep.: Field Day, St. Diony's GC, Hamburg, Germany: FAIR WATER I and II Towards better drought resistance, reduced water consumption and alternative water sources for the irrigation of golf course fairways. Trygve S. Aamlid
1 Oct. The broadcaster Sat.1 Norddeutschland visited the Turfgrass competence center – Osnabrück University of Applied Sciences. Osnabrück, Germany. Daniel Hunt.
29 Oct. Sustainable Turfgrass Management. NIBIO Website. Trygve S. Aamlid.

FAIR-WATER collaborators visiting trial at Osnabrück University on 25 Sep. 2025. From left: Martin Thieme-Hack, Maximillian Karle, Thomas Fischer, Anne Borchert, Daniel Hunt and Trygve S. Aamlid. Photo: Levi Ellmers.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2026

The scarcity of potable water for irrigation has become an issue even in the Nordic countries. In the three work packages (WPs) of this project we study ways to reduce irrigation while retaining turfgrass quality on fairways mowed at 18-20 mm.

In WP1, we evaluated 42 varieties of 10 species for drought tolerance and recovery on sandy soil under a rain shelter at NIBIO Landvik. Three 8-wk drought periods were implemented in 2024 and 2025, each period followed by 3 wks recovery under irrigation. Turfgrass quality, soil water content (SWC) and turfgrass coverage were determined twice a week, the latter from digital images analyzed using https:// turfanalyzer.com. On average, for the varieties and three experimental runs, results showed that the ability to retain green coverage during prolonged drought deceased in the order: Tall fescue>>sheep fescue>perennial ryegrass>hard fescue>Kentucky bluegrass>strong and slender creeping red fescue>colonial bentgrass>Chewings fescue>creeping bentgrass. Among the species with less than average drought tolerance, creeping bentgrass, colonial bentgrass, strong creeping red fescue and Kentucky bluegrass had the fasted recovery once irrigation was resumed.

In WP2, the field trials testing seven soil surfactants for their ability to retain turfgrass quality and coverage under drought conditions were finished in 2024. In spring 2025, the following surfactants were selected for further testing in WP3 and in the parallel project FAIR WATER II: H_2PRO Trismart (the best compromise between green coverage and water usage), Magnum 357 Calibre and Qualibra (the highest turfgrass quality during the entire 8 week drought period or during the last 2 weeks, respectively), and ProWet Evolve (the greatest increase in SWC).

In WP3, the first-year comparison of three seed mixtures seeded in Aug.-Sept. 2024 at Landvik, Norway and Osnabrück, Germany did not show the same convincing results for a mixture of 65% tall fescue, 15% perennial ryegrass and 20% Kentucky bluegrass as expected from WP1. In Germany, there were no differences among seed mixtures, while in Norway, the highest green coverage and turfgrass quality under drought was found with a mixture of five fine fescue species/subspecies with the highest proportion of slender creeping red fescue. We believe that the poor performance of the mixture of tall-fescue (65%, w/w), Kentucky bluegrass (20%) and perennial ryegrass (15%) was caused by the time period being too short for tall fescue to develop a mature stand with deep roots before the drought period started in May 2025. Tall fescue was overseeded in September 2025 to increase the proportion of tall fescue in the turfgrass canopy in these plots in 2026. Among surfactants, H_2Pro Trismart performed slightly better than Magnum 357 Calibre at both sites. The trials continue in 2026.

FAIR-WATER II: TOWARDS BETTER DROUGHT RESISTANCE AND REDUCED WATER CONSUMPTION ON GOLF COURSE FAIRWAYS

PROJECT PERIOD: SEPTEMBER 2024 - DECEMBER 2026

FUNDING (kSEK)

	2024	2025	2026	Total
STERF	0	0	0	0
R&A	242	403	403	1048
Other sources	143	277	285	705
Total	385	680	688	1753

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PROJECT OBJECTIVES

Principal objective: To develop management strategies for drought resistant and resilient GC fairways that retain acceptable turfgrass quality with no, or highly reduced, use of potable irrigation water.
Specific goals for FAIR WATER II:

- Validate in large-scale demo trial the combined effect of (1) soil surfactants and (2) mechanical treatments that control thatch and/or stimulate root development on fairway drought resitance
- Review literature, collect and analyse soil and water samples and assist Swedish GCs on how to handle problems resulting from the use of brackish water from the Baltic Sea or effluent water from sewage cleaning plants for irrigation

TALKS AT CONFERENCES, SEMINARS, MEETINGS ETC. IN 2025

18 March: FAIR-WATER I + II reference group meeting, Teams: Update of results from 2024 and plans for 2025. Trygve S. Aamlid & Michael Bekken
26 June: Field Day, Hirsala GC, Finland:
- 'FAIR WATER I and II: Towards better drought resistance, reduced water consumption and alternative water sources for the irrigation of golf course fairways'. Trygve S. Aamlid
- Next Generation soil surfactant chemistry for Greens, Fairways and Curative Applications. Nick Gadd, RhizoSolutions.
- Experiences with the soil surfactant Qualibra. Alex Cawley, Syngenta.

9 Sep.: NIBIO International Turfgrass Field Day, Landvik, Norway: Overview and results from the STERF and R&A projects FAIR-WATER I + II: Towards better drought resistance, reduced water consumption and alternative water sources for the irrigation of golf course fairways. Trygve S. Aamlid.
24 Sep.: Field Day, St. Diony's GC, Hamburg, Germany: FAIR WATER I and II Towards better drought resistance, reduced water consumption and alternative water sources for the irrigation of golf course fairways. Trygve S. Aamlid

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2026

FAIR WATER II (FW II) comprises two work packages (WPs) and is an R&A funded extension of FAIR WATER.

In WP1, methods to enhance fairway drought resistance are compared in large scale demo trials at Hirsala GC (Finland), Romerike GC (Norway), St. Dionys GC (Germany) and Jammerbugt GC (Denmark). The trials are being carried out on fairways that have a history of drying out during the summer. The fairways are split into 3x3 sections with the following treatments in factorial combination:

Information board at demo trial, St.Diony's GC, Hamburg. Photo: Trygve S. Aamlid.

Soil sampleing before mechanical treatments in new WP1 trials at Jammerbugt GC, Denmark, 23 October 2025. Photo: Karin J. Hesselsøe.

Factor 1: Mechanical treatments in the fall of 2024 and 2025 to remove thatch and enhance root development:

- Untreated control
- Scarification (Graden or similar) or coring (Procore) to a 2-3 cm depth1
- Scarification to a 2 cm depth1 + aerification with vertidrain or Vertiquake to a 20 cm depth.

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

1. Unsprayed control
2. Qualibra
3. ProWet Evolve

The most notable result in 2025 was at Hirsala GC, where both surfactants resulted in higher turgrass quality with better color retention during a dry period in the late summer. Mechanical treatments had minor effects, other than an improvement in the following year's quality at St.Diony's after scarification with Graden in September. The trials continue in 2026.

In WP2, the same seven golf courses (Emmaboda, Falsterbo, Flommen, Ljunghusen, Loftahammar, Ronneby and Vastervik) that were visited in October 2024, were revisited and new soil and water samples were taken in June and August 2025. The salinity of the water at all golf courses was higher in the summer of 2025 than in October 2024. Four of the seven golf courses had an electrical conductivity of irrigation water (ECw) exceeding the threshold of 0.75 ds m^{-1} , at which detrimental effects can be expected. One of the golf courses had a ECw value of 5 ds m^{-1}, a level where severe effects of salinity are common. We engaged in a dialogue with the course manager at this course and suggested several strategies for salt mitigation.

As of January 2025, we are in the process of writing up the results for 2025 in an article in the Scandinavian greenkeeper magazines. In addition, we will hold a webinar with all participating golf courses to share our results directly with each course and to assist with any questions they may have about managing cool season turfgrass with saline irrigation water and soils. In summary, for 2024 and 2025 five of the seven courses have been identified as having salinity or sodicity concerns that must be addressed.

GOLF LANDSCAPES: BIODIVERSITY AND MULTIFUNCTIONALITY OF GOLF LANDSCAPES

PROJECT PERIOD: APRIL 2023 - DECEMBER 2025

FUNDING (kSEK)

	2023	2024	2025	Total
STERF	300	300	300	900
The R&A	225	225	225	675
Other sources	0	100	100	200
Total	525	625	625	1775

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Johannes Kollmann, NIBIO and Technical University Munich, Germany
Tommy Lennartsson, Swedish Biodiversity Centre, SLU, Sweden
Christopher Marston, UK Centre for Ecology & Hydrology, UK.

PROJECT OBJECTIVES
- To provide knowledge of how golf courses can be designed and managed to improve their contributions to biodiversity and multifunctionality at the landscape scale.
- Identify approaches to assess and document existing qualities and biodiversity potential, prioritise approaches and recommend methods to monitor development based on GC potential and landscape context.
- Provide simple indicators of GC contributions to landscape functions to be used in design and management, such as connectivity, species pool, and structural and habitat diversity.
- Provide methods to estimate multifunctionality for the courses and landscapes.
- Prescribe principles of design to improve biodiversity and ecological functioning (both the quality of GC habitats for biodiversity and their contributions to biodiversity in the wider landscape), while retaining playability and the quality of the game.

TALKS AT CONFERENCES, SEMINARS, MEETINGS ETC. IN 2025
14 Jan.: Biodiversitätseffekte einer ökologischen Aufwertung von Golfanlagen. Seminar LBV-Naturschutzzentrum, München. Kollmann J.
11 Febr.: Golf Landscapes: Biodiversity and multifunctionality of golf landscapes. Participation in panel discussion. Fairways to Nature Conference: Driving golf's biodiversity future, Paris. Hanslin HM.
16 Okt.: Biodiversität auf Golfanlagen und Chancen für eine positive Weiterentwicklung. Herbstworkshop Leading Golf Clubs, GC Eichenried, Kollmann J.
7 Nov.: Biodiversität auf Golfanlagen: Vorurteile und Chancen für eine Aufwertung. Clubdinner Wittelsbacher GC, Neuburg, Kollmann J.

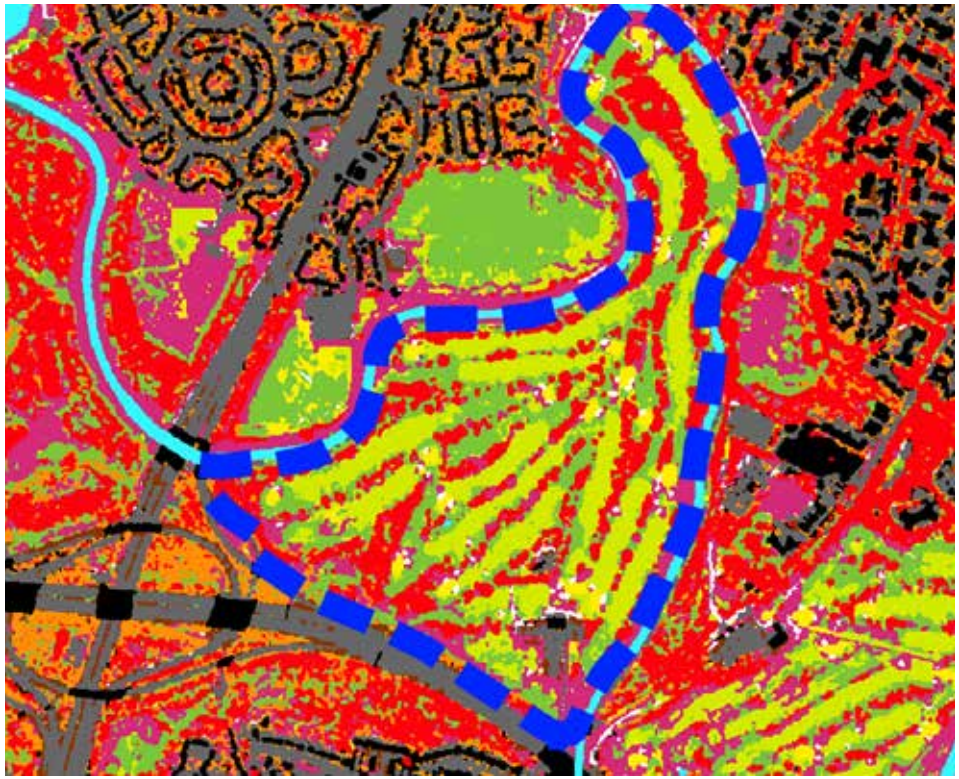
PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2026
Golf courses (GC) are often established in highly fragmented and at least partly degraded landscapes, resulting in positive effects on biodiversity and ecosystem functions. However, there are few studies on the ecological effects within and beyond GC.

The project carried out landscape ecological analysis of 40 courses along urbanization gradients in Munich (Germany), Manchester (UK), Stockholm (Sweden), Copenhagen (Denmark) and Oslo (Norway), including a 1 km buffer around each course with habitat mapping using GIS on high resolution satellite imagery, breeding bird surveys, and vegetation surveys.

We found that the species richness of birds and vegetation on golf courses was determined by a combination of landscape characteristics and course configuration. Habitat richness on courses was important for the species pool, and we found a higher richness of birds and plants in more urban landscapes. Aside from the urbanisation gradient, the habitat composition of the surrounding landscape had marginal effects on the species richness on the course.

Regional differences were evident and the total area of the course was important for the species pool, but the extent of rough and deciduous woodlands was also an important contributor to the species pool across courses. Interestingly, the overlap in species composition between habitats on courses was smaller than expected, and most habitats contributed additional species. For design and management, we recommend focussing on maintaining habitat richness on both small and large courses.

Hence, estimates of habitat richness and the Simpson diversity index are good candidate indicators for assessment and the monitoring of potential biodiversity support on golf courses. Also, the extent of rough and semi-rough, and deciduous woodland can be used more directly as indicators of habitats supporting biodiversity.



AURORA GREEN: MANAGING TURFGRASS PHOTOINHIBITION IN THE NORTHERN LIGHT

PROJECT PERIOD: MARCH 2026 - MARCH 2029

FUNDING (kSEK)

	2026	2027	2028	2029		Total
STERF	462	646	303	209*		1620
Other sources	228	331	129	64		752
Total	690	977	432	273		2372

** Reserved not granted*

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Dominic Petrella, University of Minnesota (UMN), USA
Anne F. Borchert, NIBIO, Norway
Håkan Blusi, Swedish Golf Federation, Sweden
Trygve S. Aamlid, NIBIO (Until 31 Dec. 2026), Norway

PROJECT OBJECTIVES
To clarify the impact of and ways to alleviate photoinhibition in turfgrass management at high latitudes.

Subgoals (corresponding to WPs)
1. Investigate the effect of light intensity/quality and temperature on the cold acclimation of turfgrass species commonly used on golf course putting greens (phytotron studies)

- study the impact of light intensity during cold acclimation on the freezing tolerance of creeping bentgrass and annual bluegrass (NIBIO Tromsø)
- Explore the effect of UV light during cold acclimation on the photosynthetic activity and freezing tolerance of creeping bentgrass, annual bluegrass and slender creeping red fescue (UMN)
- Investigate how interactions between different light and temperature treatments affect photosynthetic activity during the cold acclimation of 6 established golf grass species (UMass)

2. Examine the interactive effects of freezing temperatures and high light intensity on the photoinhibition and photoprotection mechanisms of creeping bentgrass, annual bluegrass and slender creeping red fescue at the seedling stage (UMass)

3. Test the use of cover and colorants to prevent photoinhibition in seedlings and established turf in field experiments. Screen a number of spring covers available on the Nordic market for their potential role in alleviating turfgrass photoinhibition (NIBIO Landvik)

- Screen a number of colorants available in the USA and in the Nordic countries for their potential role in alleviating turfgrass photoinhibition (UMN)
- Optimize the use of cover or colorants in early spring for the quicker recovery of established grass that is weak after winter stress (UMN)
- Optimize the use of cover and colorants when (re)establishing creeping bentgrass and red fescue from seed on putting greens in early spring. (NIBIO Landvik)

4. Validate the use of cover and colorants in demonstration trials on golf courses (Northern Sweden).

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2026

Grass on golf courses in the Nordic area exists under extreme conditions. At latitudes between 56 and 71 degrees north, daylight varies dramatically through the year, majorly impacting the ways in which turfgrass copes with winter and how quickly it recovers in spring.

Traditionally, poor grass growth in early spring has been blamed on cold temperatures or a lack of light. However, new research from the ICE-BREAKER and WINTER TURF projects shows that the problem may actually be the opposite: too much light at the wrong time. When strong light is combined with low temperatures, particularly after ice encasement, the grass can suffer from photoinhibition and oxidative stress. This weakens the grass's ability to carry out photosynthesis and makes it less tolerant to freezing and other stresses. Sensitive species such as annual bluegrass and creeping bentgrass, commonly used on golf greens, are particularly affected.

The goal of this project is to better understand how excess light damages turfgrass — and how that damage can be prevented. The work is organised into four main working packages. Experiments in Norway and the United States will study how different light levels and levels of UV radiation affect grass during autumn hardening. The researchers will also test how protective covers and special pigments can help grass recover faster in spring and improve the success of reseeding greens that have been damaged over winter.

Finally, the results from controlled growth chamber experiments and field trials will be tested under real conditions on golf courses in northern Sweden. The aim is to give greenkeepers practical tools to protect turfgrass through winter and achieve healthier, greener playing surfaces earlier in the season.

EXPLORING ALTERNATIVES TO QUARTZ-BASED SANDS IN GOLF COURSE MANAGEMENT

PROJECT PERIOD: 2027 - 2028

FUNDING (kSEK)

	2027	2028	Total
STERF	564	602	1166
Other sources	362	362	724
Total	926	964	1890

PRINCIPAL INVESTIGATOR / CONTACT PERSON
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CO-APPLICANTS AND COLLABORATORS
Michael Bekken and **Anne Borchert,** NIBIO Landvik, Norway

PROJECT OBJECTIVES

1. Assess putting green performance and soil physical and chemical characteristics when substituting quartz-based topdressing sand with dunite sand on a creeping bentgrass putting green under two different N rates at NIBIO Landvik, Norway.
2. Assess putting green performance and soil physical and chemical characteristics when substituting quartz-based topdressing sand with basaltic sand on creeping bentgrass and ultradwarf bermudagrass putting greens at NC State University, North Carolina, USA.
3. Quantify carbon emission reductions from replacing quartz sand with basalt and dunite.
4. Quantify the carbon sequestration rate of basalt and dunite sand at both study locations.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2026

Quartz-based topdressing sands are essential for maintaining firm, fast, and smooth putting surfaces on golf courses, yet their finite availability, rising costs, and high carbon footprint from mining present multiple sustainability challenges.

wwThis project will investigate basalt and dunite sand as alternative topdressing materials. These alternative sands have numerous advantages, including a darker color (assisting in higher soil temperatures, causing faster spring green up), lower cost, lower carbon footprint of production, and the potential for CO_2 sequestration via enhanced weathering.

A two-year field study in Norway and the USA will compare traditional quartz-based sand to these alternative sands for their effect on turfgrass performance, soil physical and chemical properties, organic matter management, and surface playability. In addition, the overall carbon footprint (including emissions and sequestration) of using conventional vs. alternative sand will be quantified.

David Toscano applying quartz and basaltic sand to a putting green, Lake Wheeler Turfgrass Field Lab at NC State University. Photo: Qiyu Zhou

H2MOW: NEXT STEPS TO DROUGHT RESISTANT FAIRWAYS WITH ROBOTIC MOWING

PROJECT PERIOD: MARCH 2026 - DECEMBER 2028

FUNDING (kSEK)

	2026	2027	2028	Total
STERF	550	426	519	2649
Other sources	1763	443	443	1495
Total	2313	869	962	4144

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Michael Bekken, NIBIO Landvik, Norway,
Martin Thieme-Hack and **Maximilian Karle,** Hochschule Osnabrück, Germany

PROJECT OBJECTIVES
The overarching objective of this study is to investigate how the management of robotically mown fairways can be optimized to enhance turfgrass drought resistance. The sub-objectives by work package are as follows:

- Work package 1: To compare and advance methods of cutting quality measurement and to conduct a field trial that investigates the relationship between turfgrass cutting quality and drought resistance on both pure species and fairway mixtures.
- Work package 2: WP 2a) To compare and advance methods of drought status measurement in turfgrass, and WP 2b) to conduct a field trial that quantifies the relationship between turfgrass cutting quality, cutting height, and the drought resistance of a fairway mixture.
- Work package 3: WP 3a) To compare the drought resistance of robotically mown and traditionally mown fairways, and WP 3b) to compare turfgrass performance under robotic mowing on a golf course fairway with and without precision irrigation implemented.
- Work package 4: To compare dollar spot occurrence after drought on a fairway mown with a robotic mower, and with a robotic mower followed by rolling.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2026
Even in Scandinavia, where water was once assumed to be plentiful, water resources are becoming increasingly scarce. As a result, many golf courses struggle to keep healthy turf stands during summer months. At the same time, robotic mowing is quickly being adopted on golf courses.

The goal of this project is to develop strategies to optimize robotic mowing under water limited conditions. Field trials will be conducted at turfgrass research stations in Norway and Germany to test how cutting quality, mowing height, and turfgrass species affect drought resistance. Golf course demonstration trials will be conducted in Sweden and Germany to explore management practices that may increase drought and dollar spot resistance on fairways managed with robotic mowers. The outcome of the project will provide greenkeepers with actionable guidance to maintain drought resistant fairways with high playing quality.

Severe drought stress on fairways has increased in Scandinavia during the last years. Photo: Trygve S. Aamlid

Robotic mowing needs to be adapted to the drought conditions. Photo: Karin J. Hesselsøe

INTEGRATING ALTERNATIVE STRATEGIES TO IMPROVE THE SUSTAINABLE MANAGEMENT OF DOLLAR SPOT

PROJECT PERIOD: MARCH 2026 - DECEMBER 2028

FUNDING (Euro)

	2026	2027	2028	Total
USGA	100 000	100 000	100 000	300 000
Other sources	-	-	-	-
Total	100 000	100 000	100 000	300 000

PRINCIPAL INVESTIGATOR / CONTACT PERSON

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Karin Juul Hesselsøe and **Tatsiana Espevig**, NIBIO, Landvik, Norway.
Daniel Hunt, and **Maximilian Karle,**. Faculty of Agricultural Sciences and Landscape Architecture (AuL), Hochschule Osnabrück – University of Applied Sciences, Osnabrück, Germany.

PROJECT OBJECTIVES

- Assess robotic mowers for their ability to suppress dollar spot.
- Validate the Smith-Kerns Dollar Spot Model for use across Europe, Scandinavia, and the UK.
- Evaluate alternative dollar spot management products across a broad geographic area.
- Determine the efficacy of integrating UVC light with alternative dollar spot management strategies

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2026

Dollar spot is a golf course disease with one of the greatest financial impacts in the world, and its severity has increased dramatically in recent years in parts of Europe, Scandinavia, and the UK due to climate change. At the same time, greater governmental restrictions have limited the fungicides available for dollar spot management, and increasing rates of fungicide resistance have resulted in decreased product efficacy.

This project brings together an experienced team of researchers from the US, UK, Norway, and Germany with the overall goal of developing more sustainable dollar spot management strategies. Specific research objectives include assessing the ability of robotic mowers to suppress dollar spot, validating the Smith-Kerns Dollar Spot Prediction Model for expanded use across Europe, evaluating a range of alternative and ecologically sensitive products for efficacy against dollar spot, and determining how to integrate UVC light into an effective dollar spot management program.

The results from this research will be immediately applicable to turfgrass practitioners around the world and disseminated broadly through presentations at regional turfgrass education meetings, in regional and national trade journal articles, and in peer-reviewed scientific publications. Implementing the recommendations put forward by this proposal will enhance the sustainability of golf courses and help golf courses meet the United Nations sustainability goals outlined in Agenda 2030.


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LEVERAGING SATELLITE DATA FOR WATER CONSERVATION ON GOLF COURSE FAIRWAYS

PROJECT PERIOD: MARCH 2026 - DECEMBER 2028

FUNDING (Euro)

	2026	2027	2028	Total
The R&A	79 377	83 577	86 571	249 525
Other sources	74 405	73 405	53 968	200 778
Total	153 782	156 982	140 539	451 303

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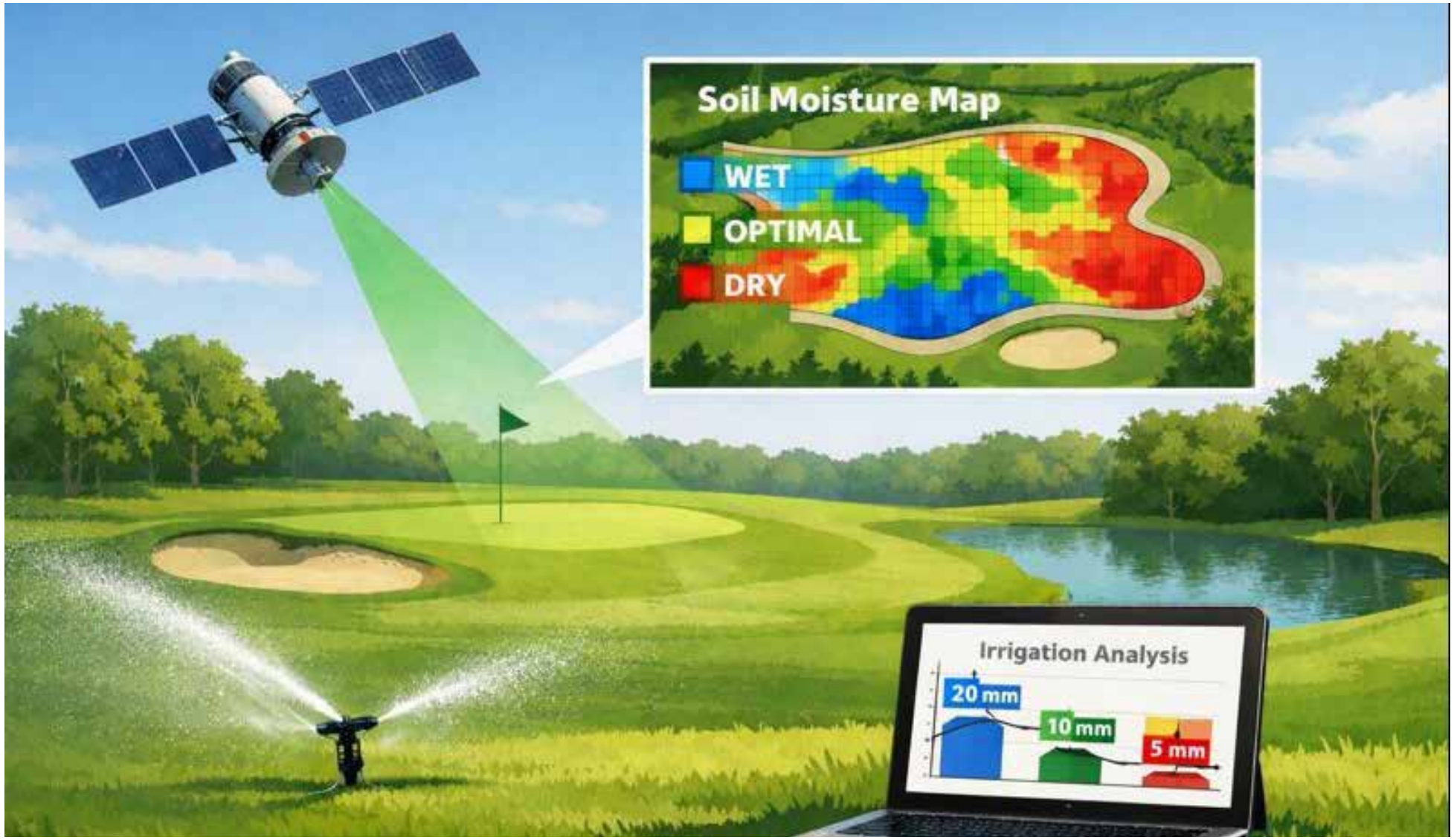
PROJECT OBJECTIVES
- Establish downscaled high spatial (3 m) and temporal (daily) resolution surface soil moisture maps for golf course fairways by fusing multiple sources of satellite imagery.
- Develop a pipeline for building a web application for daily soil moisture maps on fairways.
- Use downscaled soil moisture maps combined with a soil water balance model for irrigation scheduling on golf course fairways.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2026
Water scarcity remains a global challenge for the turfgrass industry, including golf courses. Precision irrigation, based on accurate soil moisture mapping, offers significant potential for water conservation. However, adoption remains low. This is mainly due to the limited use of soil moisture sensors, stemming from a lack of skilled labor for data collection and interpretation, the absence of standardized protocols for sensor placement, and high costs for large-scale sensor deployment. Using satellite imagery could be a cost-effective method for large-scale soil moisture mapping. However, a key challenge is the spatial and temporal resolution of current satellite imagery not meeting the needs of irrigation management in intensively maintained turfgrass systems. Additionally, no user-friendly decision support tool exists for turfgrass managers to easily use satellite data for timely irrigation planning.

Potential Benefits for the Turfgrass Industry: Precision irrigation with soil moisture sensors has been shown to reduce water use on golf greens. Expanding this approach to larger turfgrass areas, such as fairways, could lead to even greater water savings and reduce water budgets, and help address other site-specific cultural practices on turfgrass sites. This project aims to support the turfgrass industry, particularly on golf and other intensively managed turfgrass sites, by promoting the broader adoption of soil moisture maps and precision irrigation. Additionally, it addresses societal concerns about water consumption in intensively managed turfgrass systems, contributing to a more sustainable industry.

Deliverables:
1. Establishes a new strategy for developing high spatial and temporal soil moisture maps for large turfgrass sites, i.e. golf course fairways.
2. Creates a framework for developing a web application for daily soil moisture maps based on satellite data and soil water balance models for daily irrigation scheduling.
3. Presentations at state, regional, national, and international extension and scientific meetings; Publications in both peer-reviewed journals, trade magazines and webpages.


Soil Moisture Map
WET
OPTIMAL
DRY
Irrigation Analysis
20 mm
10 mm
5 mm

PATHWAYS TO A CLIMATE-POSITIVE FUTURE FOR GOLF

PROJECT PERIOD: MARCH 2026 - DECEMBER 2028

FUNDING (Euro)

	2026	2027	2028	Total
STERF	157 231	53 416	39 280	249 927
Other sources	-	-	-	-

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Josh Friell, The Toro Company
Daniel Hunt and **Maximilian Karle,** University of Applied Sciences Osnabrück
Hideaki Tonogi, Chiba University
Yo Toma, Hokkaido University
Bernhard Leinauer, New Mexico State University
Paul Nelson, James Cook University
Elena Koukouna, Merieux NutriSciences, Blonk Consulting

PROJECT OBJECTIVES

- WP1 of this project will deliver a globally validated soil sampling protocol for golf course SOC stock determination.
- WP2 will deliver a next generation LCA model for quantifying GHG emissions in golf course maintenance and provide a clear guide for the most effective GHG emission reduction pathways for golf course maintenance operations.
- This project will disseminate all findings as peer-reviewed papers, articles in trade magazines, presentations at scientific and industry conferences, and on industry podcasts.

PROJECT SUMMARY AND STATUS AS OF 1 JANUARY 2026

Climate change is the most urgent environmental crisis of our time, and the golf industry, as with all sectors of society, has a role and responsibility to address this crisis. It is imperative for the golf industry to have accurate knowledge of its current climate impact and invest in a climate-positive future. However, despite high levels of curiosity across the industry, our knowledge of the climate impact of golf courses around the world remains at a relatively low level of confidence.

The first work package (WP1) of this project will test soil carbon stocks on golf courses around the world in six different countries (Australia, Germany, Sweden, United Kingdom, United States, and Japan). The goal of the WP is to refine soil testing methodologies for quantifying golf course carbon stocks with high accuracy, while minimizing sampling time and costs. The WP will benefit the turfgrass industry by demonstrating how high confidence estimates of golf course carbon stocks, and ultimately carbon sequestration rates, can be determined.

In WP2, a next generation life cycle analysis (LCA) model for quantifying golf course greenhouse gas (GHG) emissions will be developed in consultation with LCA experts. A comprehensive resources and materials survey will be distributed to all golf courses in WP1, which together with the updated LCA model, will result in the high-resolution carbon emission estimates calculated for 21 golf courses around the world. In addition, through a collaboration with The Toro Company, this WP will incorporate the use of machinery energy, fuel, and activity tracking systems with the goal of characterizing the relative contribution of various types of equipment to the overall GHG footprint of maintenance operations. Altogether, this WP will benefit the turfgrass industry by identifying the most effective strategies that golf course maintenance operations can take to reduce GHG emissions.


Atmospheric carbon
Sequestration by photosynthesis
Emission by plant respiration
Emission from maintenance
Emission by soil respiration
Biomass carbon
Plant death and decomposition
Soil carbon
Pathways to a climate-positive future for golf
International Turfgrass Research Initiative

COMPLETED PROJECTS

The projects listed below were funded by STERF during the period 1999-2024. More information about the projects can be found on the STERF website www.sterf.org

1. The effects of soil organic matter, content, and quality on soil biological activity and turfgrass root development in sand dominated golf greens. Karin Blombäck, Swedish University of Agricultural Sciences (1999–2001)

2. Nitrogen utilisation efficiency in different golf green constructions of Creeping Bentgrass golf greens. Karin Blombäck, Swedish University of Agricultural Sciences (2001-2004).

3. Effects of demand-driven fertilisation on growth, appearance and nitrogen use efficiency of turfgrass. Tom Ericsson, Swedish University of Agricultural Sciences (2003-2004).

4. Leaching of fungicides from golf greens: Quantification and risk assessment. Nicholas Jarvis, Swedish University of Agricultural Sciences (2004-2005).

5. Benefits and environmental risks of fungicide use on Scandinavian golf greens. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2004-2005).

6. Evaluation of *Agrostis* and *Festuca* varieties for use on Scandinavian golf greens. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2004- 2007).

7. Environmental management programmes for golf facilities - a case study in the Stockholm golf district. Mårten Wallberg, Swedish Society of Nature Conservation, Stockholm (2005-2007)

8. Evaluation of Agrostis and Festuca varieties (Nordisk sortguide). Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2007).

9. Evaluation of biodiversity and nature conservation on golf courses in Scandinavia. Bente Mortensen, GreenProject (2006-2007).

10. Effects of organic amendments and surfactants on hydro-phobicity and fungicide leaching from ageing golf greens. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2006-2007).

11. The role of golf course management in the support of wetland-associated organisms in greater metropolitan Stockholm. Johan Colding, Beijer Institute of Ecological Economics, Royal Swedish Academy of Science (2006-2008).

12. Ageing of a sand-based rootzone. Karin Blombäck, Swedish University of Agricultural Sciences (2006-2008).

13. Turfgrass demonstration trials in Dalarna. Erik Svärd, Swedish Golf Federation (2006-2008).

14. Improved strategy for control of *Microdochium nivale* on golf courses. Anne Marte Tronsmo, Department of Plant and Environmental Sciences, Norwegian University of Life Sciences (2006-2008).

15. The influence of golf on nature and environment – analyses and evaluation of the environmental performance in Scandinavia. Bente Mortensen, GreenProject (2006-2008).

16. Evaluation of the plant growth regulator trinexapac-ethyl (Primo MAXX®) on Nordic golf courses. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2007-2009).

17. Development, evaluation and implementation of playing quality parameters in a continuous golf course evaluation concept – user survey. Anne Mette Dahl Jensen, Forest & Landscape, University of Copenhagen (2007-2009).

18. Prediction of turf growth as a function of light and temperature under Nordic conditions. Karin Blombäck, Swedish University of Agricultural Science (2007-2009)

19. Re-establishment of green turfgrass after winter damage, spring 2009. Agnar Kvalbein, Norwegian Greenkeepers' Association (2008-2009).

20. Impact of mowing height and late autumn fertilisation on winter survival of golf greens in the Nordic countries. Agnar Kvalbein, Norwegian Greenkeepers' Association (2008 -2010)

21. Multifunctional golf course with unique natural and cultural values. Carina Wettemark, Kristianstads Vattenrike Biosphere Reserve, Kristianstads kommun (2008 – 2010)

22. Evaluation of turfgrass varieties for use on Scandinavian golf greens, 2007-2010. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2007-2010)

23. Demonstration trials with winter cover protection. Boel Sandström, Swedish Golf Federation (2007-2010)

24. Breeding of winterhardy turgrass varieties for central and northern Scandinavia. Petter Marum, Graminor AS, Bjørke Research Station (2007-2010)

25. VELVET GREEN: Winter hardiness and management of velvet bentgrass (*Agrostis canina*) on putting greens in northern environments. T. Espevig, Norwegian Institute for Agricultural and Environmental Research (2007-2011)

26. Fertiliser strategies for golf turf: Implications for physiology-driven fertilization. Tom Ericsson, Department of Urban and Rural Development. Swedish University of Agricultural Sciences. (2007- 2011)

27. Nordic cooperation between authorities and non-governmental organisations for creating multifunctional golf courses and healthy ecosystems. Maria Strandberg, Scandinavian Turfgrass and Environment Research FoundationJanuary (2010–2011)

28. The Nordic Turfgrass Guide 2012 and Variety Lists. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2011-2013)

29. Optimal maintenance for hardening and early spring growth of green turfgrass. Karin Blombäck, Department of Soil and Environment, Swedish University of Agricultural Sciences (2006-2013)

30. Development of methods for non-pesticide weed control on golf fairways. Anne Mette Dahl Jensen, Forest & Landscape, University of Copenhagen-LIFE (2008-2013)

31. Preservation of cultural landscapes and cultural heritage elements on golf courses. Ole R. Sandberg, Department of Landscape Architecture and Spatial Planning, Norwegian University of Life Sciences (2009-2013)

32. Interactive map with navigation to learn and understand environmental work and impacts at a golf course. Magnus Enell, Enell Sustainable Business AB (2011-2013)

33. Integrated pest management - communication project within the park and golf sector. Maria Strandberg, Scandinavian Turfgrass and Environment Research Foundation (2011-2013)

34. Evaporative demands and deficit irrigation on sand-based golf greens. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2008-2014)

35. Large-scale demonstration trials: Silvery thread moss on greens. Mikael Frisk, Swedish Golf Federation (2011-2014)

36. SCANGREEN: Turfgrass species and varieties for integrated pest management of Scandinavian putting greens. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2011-2015)

37. Increasing rates of the current and a new formulation of Primo MAXX® for plant growth regulation on greens and fairways. Ingunn M. Vågen, Norwegian Institute for Agricultural and Environmental Research (2013-2015)

38. Effects of mowing height, N-rate and P-rate/ mycorrhiza on quality and competition against annual meadowgrass on putting greens with red fescue as predominant species. Tatsiana Espevig, Norwegian Institute for Agriculture and Environmental Research (2011-2015)

39. Validation of the GreenCast prediction model for microdochium patch on golf greens in the Nordic region. Tatsiana Espevig, Norwegian Institute for Agricultural and Environmental Research (2012-2015)

40. Testing of alternative plant production products for the control of *Microdochium nivale* and other diseases on golf greens.Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2011-2015)

41. Better turfgrass survival in a changing winter climate Tatsiana Espevig, Norwegian Institute for Agriculture and Environmental Research (2011-2015)

42. A comparison of the soil surfactant Qualibra and Revolution on creeping bentgrass greens varying in water availability. Trygve S. Aamlid, Norwegian Institute for Agricultural and Environmental Research (2014-2015)

43. GreenCast validation of anthracnose (*Colletotrichum graminicola)* on golf greens in the Nordic region. Tatsiana Espevig, Norwegian Institute for Agricultural and Environmental Research (2014-2015)

44. FESCUE-GREEN: Best management of red fescue (Festuca rubra) golf greens for high sustainability and playability. Trygve Aamlid, NIBIO (2011-2016)

45. Overseeding of Fairways - A strategy for finer turf with less broad-leaved weeds and Poa annua. Anne-Mette Dahl Jensen, University of Copenhagen (2011-2016)

46. Identification and risk assessment for dollar spot on Scandinavian golf courses. Tanja Espevig, NIBIO (2014-2016)

47. Experience mapping and multifunctional golf course development - enhanced possibilities of increased and more varied use of golf courses. Ole Hjorth Caspersen, University of Copenhagen (2011-2016)

48. Multifunctionality in golf courses – effects of different management practices on the ecosystem services carbon sequestration and biodiversity. Thomas Kätterer and Jörgen Wissman, SLU (2014-2016)

49. Optimal application of nitrogen and sulfur in autumn for better winter survival. Agnar Kvalbein, NIBIO (2014-2017)

50. Successful reestablishment of golf greens following winter damages. Wendy Waalen, NIBIO (2014-2017)
51. Fairy rings and thatch collapse, Tatsiana Espevig, NIBIO (2016-2017)

52. Evaluation of the soil surfactant Qualibra on sand-based putting greens. Trygve S. Aamlid, NIBIO (2015-2016)

53. Evaluation of Aquatrols experimental biostimulant formulations on fine turfgrass subjected to wear, drought (nutrient) and winter stress. Agnar Kvalbein, NIBIO (2015-2016)

54. Sustainable fairway management. Trygve S. Aamlid, NIBIO (2014-2016)

55. Evaluation of fungicides for Nordic golf courses. Trygve S. Aamlid (2016-2017)

56. Evaluation of a phosphite pigment, alone and in combination with fungicides, for control of turfgrass winter diseases on green and fairway. Trygve S. Aamlid, (2016-2017)

57. Optimal application of nitrogen and sulphur in autumn for better winter survival of perennial grasses – with emphasis on turf. Bert Sandell, NIBIO, (2014-2017)

58. Dandelion management at Värpinge golf course Håkan Rasmusson, Värpinge golf course (2014-2018)

59. Engineering better irrigation in turf - Quantifying impacts of application uniformity on turf quality in golf. – Jerry Knox, Cranfield University (2014-2019)

60. Effect of fertiliser type, silicon and copper on turf quality and Microdochium infection on Poa annua putting greens. Tanja Espevig, NIBIO (2016-2019)

61. Effect of irrigation, fertiliser type and soil amendment on turf quality and organic matter accumulation/thatch control on creeping bentgrass greens. Bert Sandell, NIBIO (2017-2019)

62. Testing the effect of AlgeaGreen® on winter stress tolerance. Bert Sandell, NIBIO (2016-2019)

63. Selection and management of bentgrass cultivars for genetic and induced resistance to microdochium patch and pink snow mould. Trygve Aamlid, NIBIO (2014-2019)

64. Practical re-establishment of golf greens following winter damage – a field study. Carl-Johan Lönnberg, Swedish Golf Federation (2017-2019)

65. Winter damage to golf greens in the Nordic countries: Survey of causes and economic consequences (part II). Tatsiana Espevig, NIBIO (2017-2019)

66. Golf clubs as landscape players – Establishment of collaboration networks in the landscape for enhanced contribution to the 2030 Agenda on sustainable development. Anders Esselin, Man & Nature (2017-2019)

67. SCANGREEN: Turfgrass species, varieties and seed blends and mixtures for integrated pest management of Scandinavian putting greens, Trygve Aamlid, NIBIO (2015-2020)

68. Risks for surface runoff and leaching of fungicides from golf greens varying in rootzone composition and amount of thatch, Trygve Aamlid, NIBIO (2016-2020)

69. Invite the starling to help the greenkeeper, Henning Heldbjerg, DOF Birdlife Denmark (2018-2020)

70. Go outdoors and use the Golf area in a pedagogical way – creativity, learning and health in the unlimited classroom, Anders Szczepanski, Linköping University/ Spetsa (2017-2020)

71. From dense swards to biodiverse roughs. Hans Martin Hanslin, NIBIO, (2017-2020)

72. Risk assessment, management and control of dollar spot caused by *Clarireedia* spp. on Scandinavian golf courses. Tatsiana Espevig, NIBIO, (2017-2020)

73. SUSPHOS: Sustainable phosphorus (P) fertilization on golf courses. Trygve S. Aamlid, NIBIO, (2017-2022)

74. SCANGREEN: Turfgrass species and varieties for integrated pest management of Scandinavian putting greens, P. Heltoft and K. J. Hesselsøe, NIBIO (2019-2022)

75. ICE-BREAKER: Reducing the agronomic and economic impact of ice damage on golf courses and other grasslands, Trygve S. Aamlid, NIBIO (2020-2024)

76. Carbon Par: Estimating carbon status of land used by Icelandic golf Courses, Edwin Roald, Carbon Par ehf. (2020-2024)

77. ROBO-GOLF: Robotic mowers for better turf quality, reduced fertiliser cost and less use of fossil energy on golf course fairways and semi-roughs, T. S. Aamlid and K. J. Hesselsøe, NIBIO (2020-2024)

78. Integrated management of important turfgrass diseases and insect pests on European golf Courses, T. Espevig, NIBIO (2020-2024)

79. Practical measures to increase biodiversity on golf Courses, Peter Edman, Swedish Golf Federation (2020-2024)

80. Artificial Intelligence powered golf turf maintenance (ADORE), Claes Holmström, Nordic AI Technology AB (2024-2025)

STERF KEY INDICATORS 2006 - 2025

Year	Funding (kSEK)		Applications		Ongoing projects	Scientific publications		Popular publi-cations	Presen-tations at seminars, webinars, conferences	Handbooks, Fact sheets, videos Programmes	Subscribers to STERF newsletters		
	STERF	Match-funding	Received	Approved for funding									
2006	1 500		17	7	12	7		23	46				
2007	4 900		1	1	13	3		12	26	1			
2008	4 500		22	6	18	11		29	42	2			
2009	5 500		1	1	15	16		20	49	1			
2010	3 000		16	9	13	7		29	46	1			
2011	3 700				19	4		32	50	25			
						Peer-reviewed papers	Publications and reports				English	Swedish	Finnish
2012	3 400				18	9	12	24	98	25			
2013	4 100				14	2	11	36	71	11			
2014	6 300		19	8	22	13	18	33	84	12			
2015	4 400				17	6	7	23	77	9			
2016	4 100		15		19	14	6	25	86	126			
2017	4 700	3 682		7	18	10	3	50	92	16	893	1 233	
2018	3 300	4 711	3	1	15	10	7	48	114	19	898	1 238	
2019	2 412	4 129	17	6	7	2	4	49	122	5	1 303	1 271	
2020	2 900	5 952			9	7	1	88	85	13	1 374	1 293	
2021	2 900	5 467			7	5	8	57	103	26	1 452	1 397	
2022	1 321	4 224	9	4	6	6	5	44	106	35	1 465	1 428	250
2023	2 600	5 414	1	1	11	2	13	60	118	30	1 465	1 428	250
2024	2 345	3 291	27	2	6	2	7	42	87	24	718	1 614	125
2025	1 911	1 606	15	7	5	11	7	46	61	20	728	1 589	125

These key indicators are based on information in annual project reports. STERF issues an open call for proposals approximately every three years. If there are specific reasons, a project application in between the open call for proposals may be approved for funding by the STERF board.

FINANCIAL SUMMARY

INCOME STATEMENT	01/01/2024 12/31/2024	01/01/2025 12/31/2025
Revenue		
Net revenue	4 171 712	4 218 528
	4 171 712	4 218 528
Expenses		
Other external expenses	-103 452	-78 484
	4 068 260	**4 140 044**
Income from financial items		
Interest	365 134	210 244
Surplus	**4 433 394**	**4 350 288**

BALANCE SHEET	2024	2025
Other receivable	0	0
Cash and bank balances	**12 048 893**	**13 820 443**
Total assets	**12 048 893**	**13 820 443**
Liabilities and equity		
Equity		
Restricted reserves	262 719	262 719
Non restricted reserves	11 669 174	13 557 724
Total equity	**11 931 893**	**13 820 443**
Current liabilities		
Other current liabilities	117 000	0
Total current liabilities	**117 000**	**0**
Total liabilities and equity	**12 048 893**	**13 820 443**

LIST OF PUBLICATIONS 2025

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LAYOUT: KARIN SCHMIDT. **LINGUISTIC REVISION:** WILL COWLEY **COVER:** LAND COVER CLASSES, FROM THE GOLF LANDSCAPE PROJECT.

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