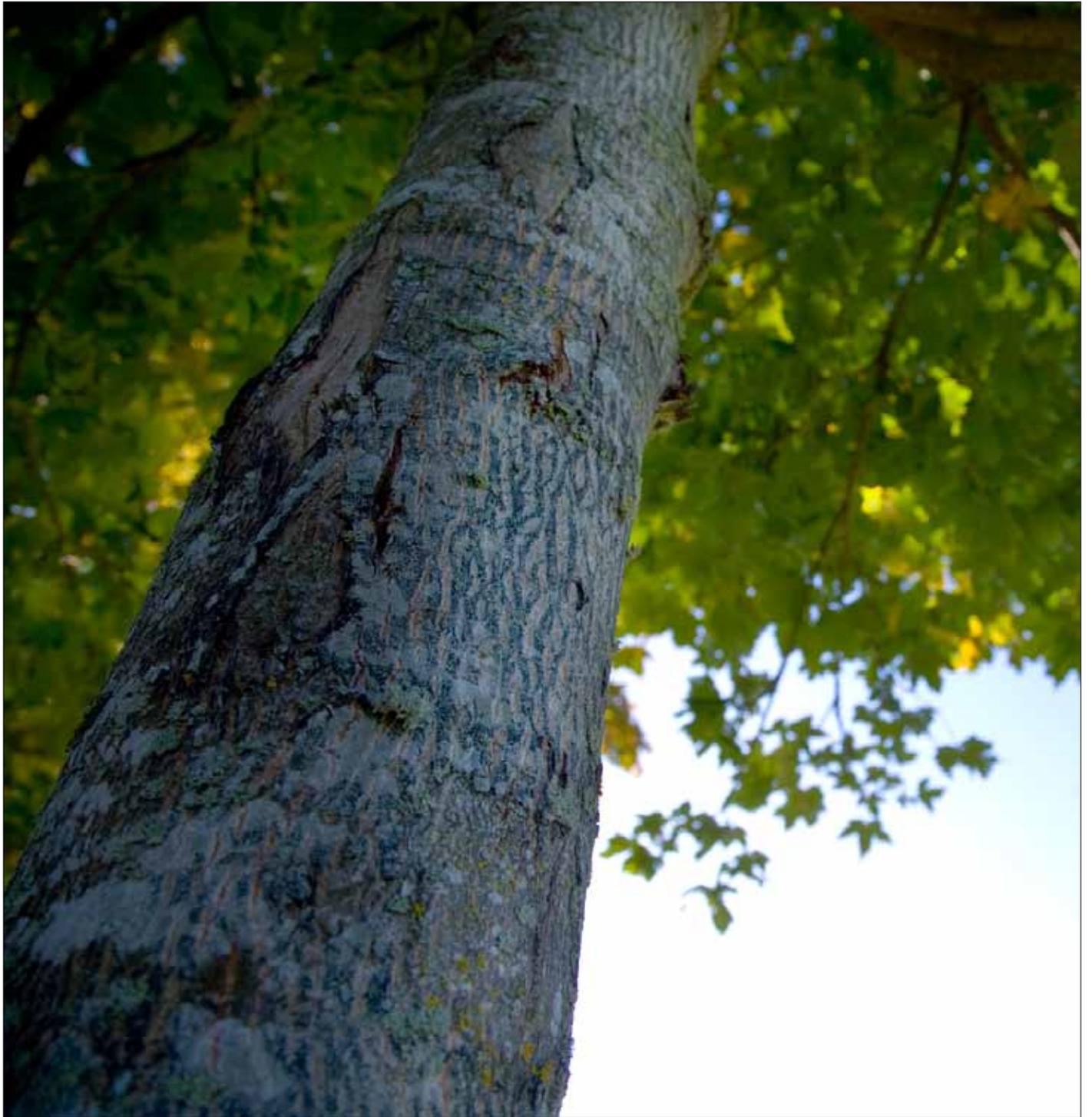


**GOLF'S RESEARCH AND DEVELOPMENT
PROGRAMME WITHIN**

**INTEGRATED
PEST MANAGEMENT**

Steris



SUMMARY AND CONCLUSIONS

In this programme we describe the current situation and present the research, development and communication needed in order for Nordic golf to carry out the measures needed to achieve sustainable use of pesticides according to EU Council Directive 2009/128/EG, dated 21 October 2009. STERF considers that the Swedish authorities together with the golf sector can play a leading role in the Nordic area as regards implementation of the new Directive for integrated pest management within parks and golf.

It is important to balance the competitive ability of the golf sector against the environmental quality objectives, just as in other sectors affected by the Directive. With the introduction of integrated pest management, there is also a need for equally high expertise within the golf sector as within other sectors, e.g. agriculture. This applies to advisory, training and information activities, as well as research and development (R&D).

The training modules that the authorities require to be developed for the park and golf sector must be filled with information and new knowledge based on R&D and tried and tested experience that is relevant for the golf sector. Therefore it is important that R&D activities and the communication of new knowledge within the golf sector be given space and a high priority.

STERF together with the Nordic golf sector, universities and research institutions and authorities can take responsibility for ensuring that R&D activities that are important for integrated pest management are coordi-

nated and executed and that new knowledge is delivered. STERF can contribute to the development of expertise within integrated pest management through communicating new knowledge and tried and tested experience in an integrated pest management perspective. STERF in partnership with consultants and good practitioners can take responsibility for ensuring that a Nordic model for systematic documentation of golf course maintenance is developed.

This R&D programme is intended to act as data support that allows the golf sector to access the funding set aside by the authorities for R&D and communication to facilitate the implementation of integrated pest management.

The aims of the programme are to:

- Allow the golf sector to take responsibility for and influence the implementation of the new EU Directive on the sustainable use of pesticides.
- Provide golf with access to information and tools based on research and development for integrated pest management.
- Encourage more researchers to work on issues relating to integrated pest management within golf in the Nordic countries.
- Act as support in applications for funding for R&D, communication and expertise development from the Nordic authorities in conjunction with implementation of the new EU Directive on sustainable use of pesticides.



BACKGROUND

Golf is a land-demanding sport that occupies more than 60 000 ha in the Nordic countries. The Nordic golf federations have around 900 000 members who play on more than 900 golf courses. An eighteen-hole golf course covers an average of 65-70 ha, of which approx. 20 ha are intensively managed and utilised playing surfaces and approx. 50 ha extensively managed nature areas.

Like other land-based industries, golf has to take responsibility for sustainable societal development, i.e. produce golf courses of a high standard while at the same time ensuring the sustainable use of natural resources and contributing to functioning ecosystems. When golf takes responsibility for sustainable development, this creates a range of positive effects that are in demand in society. Examples of this include alternative employment to work in agriculture and forestry, increased opportunities for recreation and encounters with nature, increased natural and cultural values in the cultivated landscape, increased biological diversity in urban regions and purification of urban wastewater and surplus water.

Nordic golf is facing a number of major environmen-

tal and societal challenges, for example climate change, new legislation and restrictions, limited access to natural resources, public ignorance and currently weak support from the authorities, politicians and society.

In order to deal with these challenges, there is a need for new knowledge within a number of areas and structured, efficient work on the environment and sustainable development. In order to secure essential new knowledge, the golf sector is investing in research and development (R&D) through STERF (Scandinavian Turfgrass and Environment Research Foundation). STERF is the Nordic golf federations' joint research body (see description of STERF in Appendix 2). STERF's complete research programme and information on all its current research projects can be found at sterf.golf.se

Directive 2009/128/EG of the European Parliament and of the Council from 21 October 2009, on establishing a framework for Community action on achieving a sustainable use of pesticides, contains regulations establishing a framework for achieving such sustainable use. This is to be achieved through e.g. decreasing the risks and consequences posed by the use of pesticides



for human health and the environment and through the development and introduction of integrated pest management.

The general principles for integrated pest management according to Annex III of EU Directive 2009/128/EG state that:

- Preventive measures must be used or supported.
- Forecasting and early warning methods must be used where available.
- Decisions on pest management measures must be preceded by monitoring in the field.
- The use of pest management measures must be tailored to requirements – in the first instance non-chemical methods must be preferred to chemical. When chemical methods are used, the use of chemicals must be limited, the most target-specific pesticide must be selected and account must be taken of the risk of resistance.
- The success of the pest management measures implemented should be monitored on the basis of the documentation carried out.

In contrast to e.g. agriculture and horticulture, the golf industry is covered by Article 12 of the EU Directive:

‘Reduction of pesticide use or risks in specific areas

Member States shall, having due regard for the necessary hygiene and public health requirements and biodiversity, or the results of relevant risk assessments, ensure that the use of pesticides is minimised or prohibited in certain specific areas. Appropriate risk management measures shall be taken and the use of low-risk plant protection products as defined in Regulation (EC) No 1107/2009 and biological control measures shall be considered in the first place. The specific areas in question are:

(a) areas used by the general public or by vulnerable groups as defined in Article 3 of Regulation (EC) No 1107/2009, such as public parks and gardens, sports and recreation grounds, school grounds and children’s playgrounds and in the close vicinity of healthcare facilities,

b) protected areas as defined in Directive 2000/60/EC or other areas identified for the purposes of establishing the necessary conservation measures in accordance with the provisions of Directives 79/409/EEC and 92/43/EEC’.



SOCIETY'S BENEFITS AND RESPONSIBILITIES

The development of integrated pest management within the golf sector contributes to achievement of the Swedish government's environmental quality target 'A toxin-free environment'. Integrated pest management also provides a better work environment and a good environment for active outdoor recreation. STERF considers that the Swedish authorities together with the Nordic golf sector can play a leading role in the Nordic countries as regards the introduction of the new EU Directive on the sustainable use of pesticides within parks and golf.

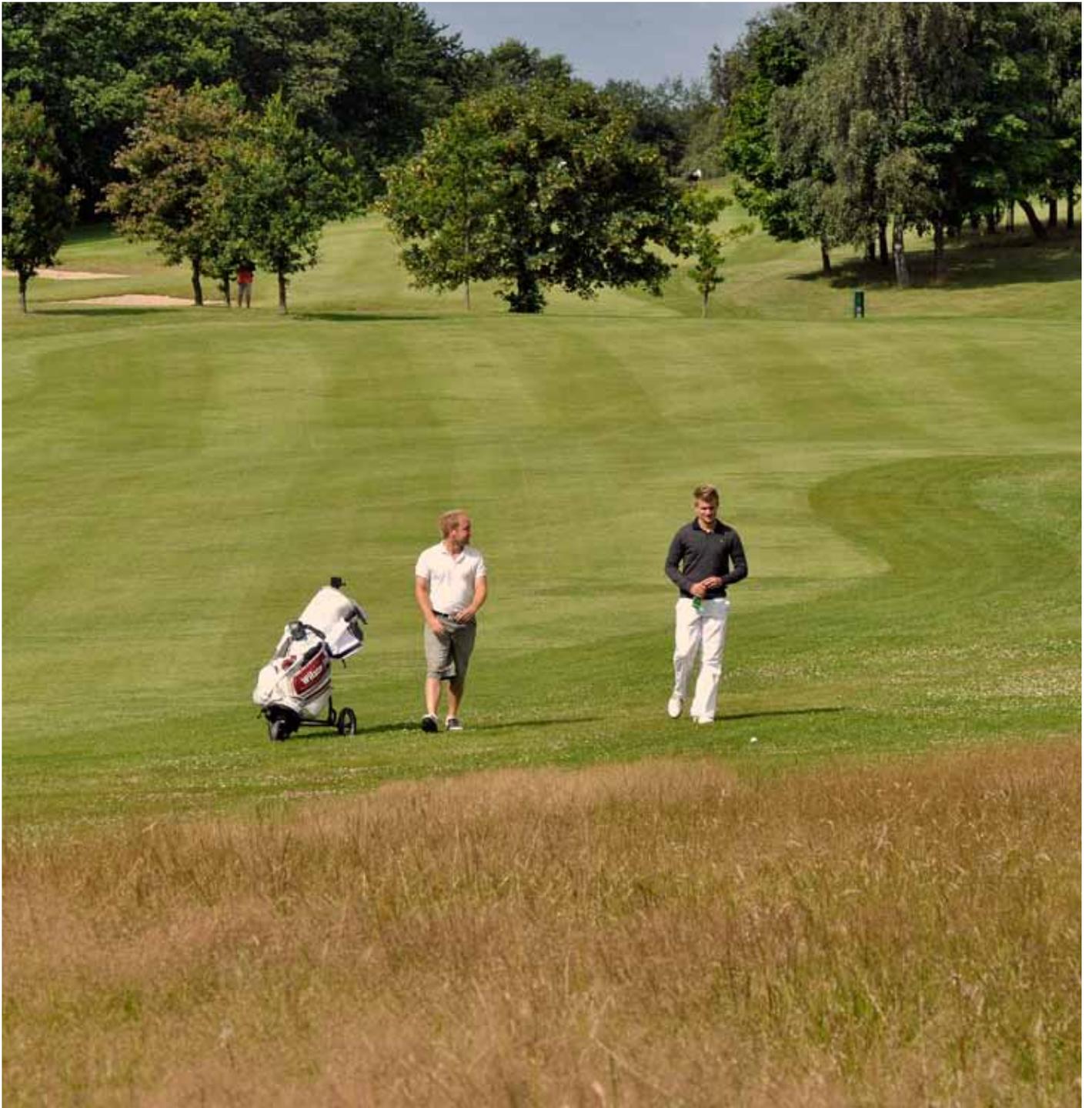
The Swedish Ministry of the Environment has commissioned the Swedish Environmental Protection Agency, in consultation with the Swedish Board of Agriculture, the Swedish Chemicals Agency and other relevant authorities, to draw up a proposal on introduction of the EU Directive on sustainable use of pesticides. In February 2010, the golf sector in Sweden was consulted on the content of 'Proposal on Swedish Implementation of Directive 2009/128/EG' (Naturvårdsverket, 2010).

The golf sector in Sweden regards the proposal by the Swedish authorities on introduction of Directive 2009/128/EG of the European Parliament and of the Council as being good. The proposal can increase the long-term opportunities for increasing expertise in Nordic golf course management within e.g. integrated pest management. This is on condition that training, advisory and R&D activities linked to the Directive have a content that is relevant to the golf sector.

Article 4 (3 §), National action plans, emphasises the importance of balancing the competitive ability of Swedish agriculture against the environmental quality objectives. STERF considers that it is equally important to draw attention to the competitive ability of the golf sector in relation to these objectives.

Article 14 (18 §) of the proposal contains the views of the authorities on how integrated pest management should be introduced within all sectors. Integrated pest management within the golf sector requires equally high expertise as within other sectors, e.g. agriculture. In the proposal, the park and golf sector is given its own training module. It is important that this module is continuously supplemented with information and new knowledge based on research and development (R&D) and tried and tested experience that is relevant to the golf sector. Regardless of the form of study chosen, large parts of STERF's research results and new knowledge can be used in the training. Knowledge and experience from other sectors can be used, provided that this is tested and evaluated from a golf perspective.

It is also important that the supporting R&D activities and the communication of new knowledge be given space and a high priority within the park and golf sector. We regard this R&D programme as a concrete basis for the golf sector being given the same opportunities for accessing R&D and communication funding relating to integrated pest management as the other sectors concerned.



GOLF SECTOR GAINS AND RESPONSIBILITIES

The introduction of integrated pest management will help create a better knowledge base among greenkeepers through documentation of management practices and pest attacks. It will be possible to use it to analyse the effects of different methods and to create a foundation for more efficient golf course management. This forms part of the Nordic golf sector's vision of "producing golf courses of a high standard while also ensuring the sustainable use of natural resources and contributing to functioning ecosystems and a healthy environment".

In February 2010, STERF and SLU, with support from the Swedish Board of Agriculture, held a workshop on integrated pest management within golf in which greenkeepers, course consultants, lecturers and researchers from Sweden, Norway and Denmark participated. The conclusion from the workshop was that there is a major need for new communication strategies and R&D in order to create a good programme for integrated pest management within golf.

According to the participants in the workshop, integrated pest management for golf means the following:

- Integrated pest management is modern golf course management, i.e. greenkeeping strategies in which new knowledge and tried and tested experience are combined and reinforce each other.
- Integrated pest management increases the need for knowledge and places increasing demands on planning, documentation and administration. When integrated pest management is introduced, it is important to include the environmental consequences from a wider perspective, e.g. the consequences of energy consumption and carbon dioxide emissions.
- Integrated pest management involves a change in attitude that must permeate the entire system, with decisions taken by boards and managers reflecting this.
- Integrated pest management may mean golf players having to accept changes in the playing quality of courses in some cases. Providing information to players on what integrated pest management means will be very important.
- Integrated pest management must be included in the process of constructing and renovating playing surfaces. There should be specifications based on integrated pest management for construction and renovation.
- Integrated pest management means creating conditions that strengthen grass plants. A strong plant is more tolerant to disease. An essential prerequisite is the availability of grass species and varieties that are adapted to our Nordic conditions. Some important management practices to be optimised in creating strong plants are: irrigation, fertilisation, winter hardening, machinery in good condition and creation of dry playing surfaces.

CURRENT SITUATION

Golf courses in the Nordic countries currently require chemical pesticides to control various pests (fungi, weeds and insects) on grassed areas in order to create and maintain good playing quality. However, there is generally a lack of documentation on the amounts of chemical pesticides used.

Denmark is the Nordic country with the best documentation on its use of chemical pesticides on golf courses. This is thanks to the initiative Golf's Grønne Regnskab (Golf Green Accounts) which was introduced by the Danish Golf Union (DGU) in 2006. In addition, the DGU has carried out two surveys (in 1998 and 2002) on the use of chemical pesticides on Danish golf courses. The Green Accounts for 2009 show that the average pesticide use in Denmark is now at 0.24 kg/ha, calculated over the entire area of golf course. The corresponding figure for 2002 was 0.38 kg/ha, so there has been a decrease of 36% over seven years.

A survey carried out by the Norwegian golf association on the use of chemical pesticides in 2000 showed a very low level of use (13% of the average use in Norwegian agriculture per unit area) on the 82 golf courses (of 108) that responded. The results were presented as amount of pesticide used and type of area on the golf course. The survey found that very few chemical pesticides were used in 2000 and that the volume was well below that used on Danish golf courses. Norway only used 25% of the chemical pesticides applied per hectare in Denmark during the same year.

In Sweden there is no official monitoring of the use

of chemical pesticides on golf courses. However, the use of chemicals on golf courses in Sweden has been inventoried on the initiative of the Environmental Protection Agency, with the aim of evaluating the importance of golf courses in spreading chemical pesticides to the environment (Österås et al., 2009). Data on the compounds used, the doses, amounts and times of application and any measurement programmes in place were collected through contact with 27 supervisory authorities (municipalities) and eight greenkeepers. In the municipalities studied there were 117 golf courses, which represents around one-quarter of Sweden's golf courses. The use of chemical pesticides was reported by 62 of these. The conclusion was that ever year, more than 50% of golf courses use chemical pesticides, primarily fungicides, although according to Edman (2009), the proportion using pesticides is considerably higher than 50%.

The compounds used vary widely in ecotoxicity and persistence. Fungicides are applied according to requirements 1-3 times/year, mainly on greens and mainly during autumn and winter. Herbicides are mainly used during the summer as spot treatments on fairways and roughs and are applied 1-3 times/year. In general, the reported use agrees with the recommended doses, which in some cases are slightly greater than for the same compound within agriculture.

The investigation by the Environmental Protection Agency found that the total amount of chemical pesticides used within golf is considerably smaller than that used within agriculture. However, the areas concerned



DOCUMENTATION – A NEW STATUTORY REQUIREMENT

The introduction of integrated pest management into golf course management is no longer a voluntary option, it is now a statutory requirement. The EU Directive requires member countries to report their progress on the introduction of integrated pest management to the EU. This will probably also include a requirement on documentation from each individual golf course. Therefore it is important that the golf sector enters into this work with a positive attitude and acknowledges the advantages of systematic documentation rather than regarding it as just another laborious task.

For the individual greenkeeper, documentation can be an excellent tool for improving the efficiency of his or her work. In addition, it can act as continuous monitoring of golf course maintenance and can be used as support for management decisions. The statutory requirement on documentation will also involve the managers of golf courses and in this way the environmental message will be transmitted to a wider group.

With documentation at club level, the national golf federations have the opportunity to gain access to collective knowledge and detailed information that can be actively used, for example in contacts and dialogue with local parties or national authorities.

In order for this to work, there must be uniform, simple tools and procedures for systematic documentation that all greenkeepers and club managers are trained to understand and use. A Nordic model is preferable in order to provide scope for joint exchange

of experiences. Appendix 1 shows some examples of existing documentation systems within the golf sector.

There are golf courses in the Nordic countries that carry out their greenkeeping activities without any chemical pesticides or that do what they can to minimise their use. Various methods for sustainable use of chemical pesticides are being tested locally in golf course management. Meetings for exchange of experiences are organised by these clubs, but there is seldom any written documentation from these meetings, which means that experiences that could be used by others remain within the small group. Field observations can be good examples in devising procedures for documentation and exchange of experiences regarding greenkeeping practices, both at club and national level.

At present there is a lack of resources and procedures for identifying and documenting these good examples of the sustainable use of chemical pesticides in a structured manner, something that has long been requested by Nordic greenkeepers.

STERF, in partnership with consultants and good practitioners, can take responsibility for:

- Developing a Nordic model for systematic documentation of greenkeeping procedures.
- Documenting tried and tested experience and field observations and making these available to the entire golf sector, e.g. in the form of good examples.



COMMUNICATION AND EXPERTISE DEVELOPMENT

STERF, in partnership with the Nordic golf federations, is already involved in producing and communicating new knowledge, with applications for the construction and upkeep of golf courses. The objective is to achieve golf courses of high quality with effective and credible environmental protection work. This takes place in dialogue with representatives of the golf sector, e.g. golf course personnel, course consultants, golf course architects, the authorities and environmental organisations.

Every Nordic golf federation is responsible for implementing the new knowledge through training, advisory and information work. This is carried out with varying results in the Nordic countries. Through communicating new knowledge in an integrated pest management perspective, STERF can facilitate and streamline the dissemination of new knowledge within the Nordic golf sector.

STERF, together with the Nordic golf federations, greenkeepers' organisations, universities and research institutions, can contribute to expertise development within integrated pest management through taking responsibility for:

- Producing fact sheets, e.g. based on experiences from other crops but adjusted to the conditions on golf courses, on the biology and control of major pests, including weeds.
- Produce teaching material on integrated pest management within the golf sector for certification courses.

- Produce teaching material on integrated pest management within the golf sector for greenkeeper training courses.
- Arrange seminars and courses with the focus on integrated pest management and thus create continuous interaction between researchers and practitioners.
- Develop a section on integrated pest management on the STERF website.
- Appoint contact individuals and ambassadors for integrated pest management.
- Organise meetings for exchanges of experiences - with the focus on communicating new knowledge and tried and tested experience
- Plan the spread of knowledge on integrated pest management within the golf sector.

STERF's work on expertise development regarding integrated pest management within the golf sector must be securely embedded among the different actors within the golf industry.

RESEARCH AND TRIALS



KNOWLEDGE GAPS ON INTEGRATED PEST MANAGEMENT WITHIN THE PARK AND GOLF SECTOR

The knowledge gaps identified are based on suggestions from the workshop arranged by STERF and SLU with the support of the Swedish Board of Agriculture in February 2010 and on continuous contacts with representatives of the industry in regular discussions during training courses and seminars.

- What grasses (species and varieties) are best suited to resist pathogenic microorganisms, pests or weed invasions under different climate conditions with optimal supply of water and plant nutrients?
- How can grass resistance to damage be enhanced through the use of management strategies in spring, summer, autumn and winter?
- What are the effects of different methods for green construction (Push up, California, USGA) and types of rootzone mixture (pure sand, sand with organic material, compost and soil inclusion) on disease development in integrated pest management?
- What non-chemical pest management methods can be used on weeds on fairways and roughs, and at what stage should these weeds be controlled (when they are most susceptible or in order to decrease their spread)?
- How can the spread of *Poa annua* into pure grass cultures be prevented?
- What irrigation strategies are most suitable for decreasing damage and diseases?
- What biological inputs (biostimulants, compost, various types of fertiliser) can be used to reduce diseases?
- What are the economic consequences of introducing integrated pest management?
- What are the environmental effects of introducing integrated pest management compared with the restrictive use of chemical pesticides as practised in the Nordic countries?
- What is required for various grasses (species and varieties) to achieve maximum hardening before winter and how fast is the hardening process?



SUGGESTED RESEARCH, TRIAL AREAS AND PROJECTS

There is a need for pure research projects and also for demonstration trials under different climate conditions in order to gain a fundamental understanding of the issues within integrated pest management.

STERF, together with the Nordic golf sector, universities, research institutions and authorities, can take responsibility for ensuring that R&D activities that are important for integrated pest management are coordinated and carried out and that new knowledge is delivered. Some suggestions for R&D areas are:

- 1. Variety testing – identifying varieties with high resistance and competitive ability under Nordic conditions**

What grass species and varieties have the best resistance to diseases and good competitive ability against weeds in the most northerly regions of the Nordic area (Iceland and the most northern parts of Sweden, Finland and Norway), in central areas (inland climate) and in coastal and southern regions (Denmark, the

coast of Sweden, Finland and Norway)?

Results from completed and current variety testing (Molteberg et al., 2007, 2008 & 2010) to be used to select grass species and varieties suitable for greens and fairways, for testing in at least three locations in the Nordic countries. New, promising plant breeding material may be included. Variety testing to be carried out on USGA-like rootzone mixture without the use of chemical pesticides. Some of the trials to be infected with the fungus that causes snow mould (*Microdochium nivale*).

- 2. Golf course maintenance strategies – reducing disease attacks**

Experiences from golf courses that do not use chemical pesticides to be collected and collated ('Golfens sønner' and the network 'Miljöoptimerad banskötsel' are good sources). These to form the basis for issues to be tested in trials laid out in experimental greens or golf courses.

3. Weed management on fairways with minimised use of chemical pesticides

In order to create good playing quality on fairway surfaces, it is necessary to limit the amount of weeds (dicots and *Poa annua*). Studies show that it is difficult to achieve good results using only mechanical weed control on large areas with many different weed species.

New experiments should focus on techniques for point application, plus species-specific treatments for different types of weeds on different parts of the golf course. This would require more information on the biology and physiology of the most important weeds under differing conditions as regards wear, mowing, addition of nutrients and water and mechanical weed control. Studies on weeds to be carried out in relation to the competitive power of weeds.

4. Effects of green construction and use of alternative chemical pesticides

An initial review to be made of disease problems on golf courses with different green structures but with comparable maintenance procedures and use of chemical pesticides. The golf courses to be located within three climate areas: (1) inland climate with variable snow cover, (2) inland climate with variable snow cover and bare ground and (3) southerly/coastal areas. An experimental plan to be drawn up from this starting point, with experiments laid out on golf courses or experimental greens.

Experimental treatments to consist of an untreated control, which is compared with e.g. treatment with iron sulphate and various biostimulants. Disease incidence to be assessed at least 3 times/season (March-April, August and October-November), as well as when the greenkeeper notices an attack.

5. Optimal irrigation and fertilisation of greens grasses

Inaccurate irrigation and fertilisation methods lead to the build-up of organic material (mats), disease attacks, etc. What is the optimal irrigation and fertilisation strategy for different species of grass used on golf greens? Experiences from current research projects on environmentally friendly and economical irrigation and fertilisation (Aamlid, 2008; Blombäck 2008) to be used as a basis for further studies.

6. Development of models for hardening and dehardening

Hardening is essential for good winter survival. The rate at which different species and varieties achieve optimal hardening and the ease with which they can be dehardened in Nordic climate conditions have not been determined. Trials under controlled conditions and in fields where the light conditions can be manipulated to be carried out to determine how quickly and well selected grasses harden (number of sunshine hours and light intensity) at low temperature and how stable they are to dehardening. The results to be used to develop models that can be used by greenkeepers to plan measures to be carried out in autumn and/or winter to reduce winter damage caused by fungi, water or ice.

7. Economic consequences and effects on the natural and work environment of introducing integrated pest management

Economic analyses to be carried out on differences in costs between conventional greenkeeping and greenkeeping with integrated pest management, and calculation of CO₂ emissions, based on data from golf courses included in the planned project. Exposure to toxic chemicals to be documented and the health risks arising from the use of chemical pesticides to be investigated. Lysimeter studies of leaching from approved and alternative chemical pesticides to be carried out for greens constructed from sand and soil. Experiences from previous projects on fungicide leaching from greens (Aamlid et al., 2008, 2009; Larsbo et al., 2008) to be used as the starting point for new, more comprehensive studies that also examine herbicides and insecticides.

8. Product development – of equipment and practices

Product development will provide the sector with access to the most modern technology relevant for integrated pest management. Practical trials to be established in collaboration with the suppliers and manufacturers of biological and chemical compounds, fertilisers, sprayers, mowers, aeration equipment, seed drills, etc. in order to identify the best golf course management practices and equipment for integrated pest management. An example of product development that can be of benefit in integrated pest management is the development of greenkeeping strategies for the use of PrimoMAXX (Aamlid, 2009).

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APPENDICES

Appendix 1: Existing documentation systems

Appendix 2: STERF

APPENDIX I

EXISTING DOCUMENTATION SYSTEMS

Golf Green Accounts - DGU

Since 2006 the Dansk Golf Union (DGU) has issued Golfen's Grønne Regnskab (Golf Green Accounts), which are based on voluntary reporting by Danish golf clubs. The accounts contain data on the use of chemical pesticides reported in relation to type of pesticide (herbicides, fungicides, insecticides) and type of area (greens, tees, fairways, etc.). In 2009, 120 golf courses (of 180) submitted their data.

These Green Accounts were created as a result of the voluntary pesticide agreements entered into in 2005 by DGU, the Danish Ministry of Environment and Kommunernas Landsorganisation. According to this agreement, Danish golf courses undertook to decrease their pesticide use by 75% compared with that prior to 2008. The Green Accounts have been DGU's way of documenting their use of pesticides in accordance with the pesticide agreement.

R&A golf course management and benchmarking

The R&A promotes sustainable course development and management; encouraging facilities to adopt strategies that will produce excellent playing performance and strong economic performance, whilst providing a high level of environmental stewardship and social responsibility. To help golf facilities work towards this goal, The R&A has developed a system of data management so that performance across these areas can be monitored over time. It also enables an exchange of experiences (benchmarking) whereby individual golf courses are able to compare their own results, successes and changes with those of others. Participation in the scheme is free of charge, data entered is secure and anonymous. The system is based on registering the golf course (basic data on the course, use of fertiliser, pesticides, water and energy, the costs of machinery, labour and materials, playing quality etc.). Some of those details lie outside those that need to be documented in integrated pest management or sustainable

use of pesticides. Golf courses participating in the system can use it to document whether they are applying integrated pest management in their greenkeeping plans.

GEO certification

The Golf Environment Organisation (GEO) has launched a certification model that aims to support continuous improvement in environmental protection work on golf courses. Clubs register their activities and documents within the environmental protection area in a joint database. The long-term objective is environmental certification. Some of the criteria concern upkeep procedures for grassed areas, where there can be a risk of emissions, pollution of water or incorrect use of chemical pesticides. When it is time for certification, an independent inspector visits the golf club. At that time a certification fee is paid, but prior to that participation is free of charge.

The forms of recording and documentation used by GEO can be good tools for the coming documentation of integrated pest management and the sustainable use of pesticides. Golf courses that are GEO-certified will be able to document their use of integrated pest management. At the present time there are three certified golf courses in the Nordic region, but others are well on the way to achieving certification.

APPENDIX 2

SCANDINAVIAN TURFGRASS AND ENVIRONMENT RESEARCH FOUNDATION

In order to achieve golf's environmental vision of 'producing golf courses of a high standard while at the same time ensuring the sustainable use of natural resources and contributing to functioning ecosystems and a healthy environment' and meeting the challenges golf is facing, the Nordic golf federations are investing in research and development (R&D) through STERF (Scandinavian Turfgrass and Environment Research Foundation). STERF is the Nordic golf federations' joint research body.

STERF supplies new knowledge that is essential for modern golf course management, knowledge that is of practical benefit and ready for use, for example directly on golf courses or in dialogue with the authorities and the public and in credible environmental protection work. STERF is currently regarded as one of Europe's most important centres for research on the construction and upkeep of golf courses. STERF's complete research programme, annual report for 2009 and descriptions of current and completed research projects can be found at sterf.golf.se

STERF works according to the following strategies:

- **Approach:** All research funded by STERF is carried out at Nordic universities, research institutions or equivalent where the majority of the research expertise is based. The approach is user-driven and project-orientated.
- **Expertise:** STERF accumulates scientific expertise through various networks and works actively with leading organisations within its area of operations
- **Applications:** STERF analyses and supplies research results that can be applied in various management programmes, actions and recommendations. The results are intended to provide the best playing quality and sustainable operations – in terms of both economics and the environment.
- **Resources:** The STERF concept involves accep-

ting annual contributions of resources from the various participating golf associations and using these funds together with other available research funding from businesses and organisations.

STERF, together with the Nordic golf sector, has decided to prioritise the following R&D areas:

1. Grasses for Nordic conditions

Research allowing us to continuously assess the grasses we import and to identify grasses that can cope with the Nordic climate and expected climate change, in combination with stricter laws and restrictions regarding the use of resources such as water, fertiliser and pesticides.

2. Winter survival

Research providing management strategies for ensuring the winter survival of grasses at the present time and the scope to prepare ourselves for how future climate change will affect winter survival in the future.

3. Nutrition, water and energy

Research providing recommendations on saving energy and on how to irrigate and fertilise our Nordic greens and fairways optimally while also improving playing quality.

4. Control of diseases and weeds

Research that in the short term provides us with access to modern chemical pesticides and in the long term to efficient and financially viable alternatives to these.

5. Nature and biological diversity

With the help of research, we can improve our upkeep and conservation of golf's natural and cultural values and develop good relations to the authorities, environmental organisations and the public at large.

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