GRASS really is green

Working toward sustainable sports fields

Set-up, results, and conclusions of research into the environmental impact of grass sports fields

PRODUCTSCHAP AKKERBOUW

Plantum

BLONK MILIEUADVIES
giving shape to sustainability

The sustainability of grass sports fields mapped out

Society has an ever-increasing desire to take steps towards a more sustainable future: a green, clean and beautiful world offering good quality of life now and for generations to come. Government bodies have therefore made agreements with regard to sustainable purchasing in order to lead the way. Following the Dutch national government's example, the aim is for all provincial and local governments in the Netherlands to implement 100% sustainable purchasing policies from 2015, making environmental aspects a decisive factor in addition to price and quality.

Having been confronted with their carbon footprints, many municipal councils and sports associations are currently holding internal consultations to see what they can do to limit emissions of greenhouse gases and to operate in a carbon-neutral manner. As a collective grass seed sector brought together in Plantum, we see it as our responsibility to offer relevant information within this framework about the type, construction, and management of sports fields.

Plantum asked the renowned consultancy, Blonk Milieuadvies, to perform a life cycle analysis (LCA) for natural grass sports fields. A life cycle analysis is a method for determining the total environmental impact of a product throughout its usable life. Emissions are mapped out for every stage of the life cycle, from the production and processing of grass seed right through to the construction, maintenance and replacement of the sports field.

Well maintained grass is shown to be a sustainable, environmentally-friendly and carbon-friendly product. A football pitch fixes a great deal of carbon from the air, for instance. These outcomes are of particular relevance for sports field managers and policy-makers in their argumentation and decision-making regarding the choice between artificial and natural grass. Possibilities for the further minimisation of the environmental impact of a grass sports field must be primarily sought in maintenance activities: reducing the use of mineral fertilisers and fuel.

This brochure summarises the most important results, conclusions, and recommendations of the research.

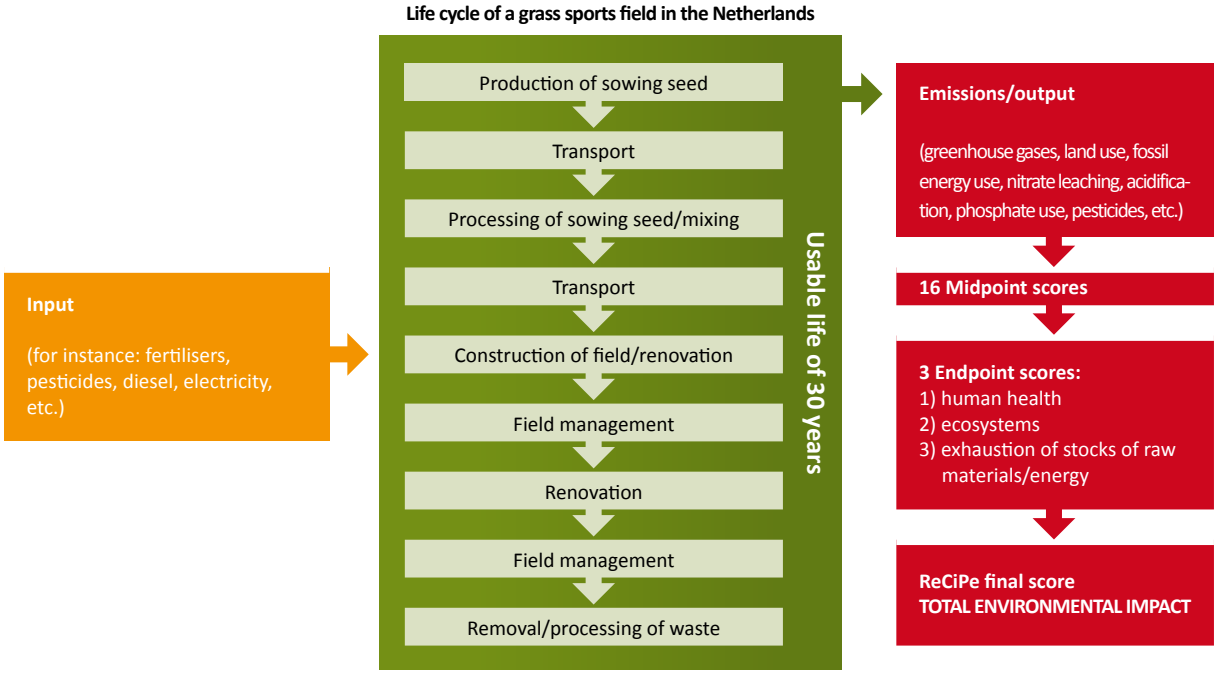
The research into the environmental impact of grass sports fields was carried out by Blonk Milieuadvies in Gouda in the first half of 2012, on the instructions of Plantum and jointly financed by the Productschap Akkerbouw (Arable farming commodity board). A steering group with representatives from the chain supervised the project under the auspices of two experts from research institutions outside the Netherlands.
The summary is also available in digital form at www.plantum.nl and www.kennisakker.nl.

Approach & research design

The starting point for the research is the life cycle of a grass sports field for football measuring 8,000 m^2 in the Netherlands. This life cycle begins with the production and processing of grass seed (within the Netherlands) and continues with the construction, annual maintenance, renovation, and eventual removal of the sward.

The life cycle analysis (LCA) of natural grass sports fields is performed in line with international guidelines (ISO standards) and additional LCA standards applicable within the agricultural and food sector (e.g. PAS 2050). The actual analysis of the environmental impact took place on the basis of the so-called ReCiPe methodology based on assessment firstly regarding environmental effects at midpoint level (see 1 for the 16 environmental topics addressed) and secondly regarding effects at endpoint level (human health, ecosystem diversity, and the availability of raw materials). Adding the figures and applying weighting results in a total score for environmental-impact that makes a comparison of the various scenarios with each other possible.

Figure 1: Diagrammatic impression of the research design;



[1] The sixteen environmental topics are: climate change, damage to ozone layer, acidification, eutrophication of fresh water (consequences of increase in quantity of nutrients in water), eutrophication of sea water, human toxicity, smog formation, particulate matter, soil toxicity, fresh water toxicity, sea water toxicity, radioactivity, land use (both agricultural and urban), water use, exhaustion of metals/minerals, and exhaustion of fossil energy resources.

Various sources were used for mapping out the input/output. The data relating to the production and processing of grass seed came largely from companies active within the sector, supplemented with information from public sources. The SV7 grass seed mix for sports fields, consisting of Perennial ryegrass (*Lolium perenne*) and Kentucky Bluegrass (*Poa pratensis*), was used as the standard. The data regarding the construction, maintenance, renovation, and replacement of grass sports fields is based on information drawn from practice, advice, and existing research results. Assuming a usable life of 30 years, and taking into account differences in use and management, the environmental impact is described in each case on the basis of four sports field scenarios. These feature usage intensities ranging from 250 to 500 playing hours per year.

Table 2: Sports field scenarios used, based on playing intensity;

Playing intensity	LOW	AVERAGE	AVERAGE, high N usage	HIGH
playing hours/annum	250	375	400	500

The four scenarios differ primarily in the use of mineral fertilisers and maintenance work carried out, such as mowing and topdressing. The scenario 'AVERAGE, high N usage' relates to a field with an average number of playing hours and a high level of usage of artificial fertiliser (nitrogen).

Grass has the best environmental credentials!

That is the conclusion drawn by Plantum, partly in response to the report 'Natural turf, why it remains the natural choice for football, sports and playing surfaces' by the European Seed Association (ESA). In particular, the required fossil resources involved in the manufacture of artificial grass and the removal (including transportation) of an artificial grass field that is no longer usable, place a heavy burden on the environment. The relatively short usable life (our calculations assume ten years, although in practice many such fields do not last that long) and the often underestimated maintenance that artificial fields require, increase that environmental burden. Although the heavy environmental impact decreases with a higher playing intensity as a result of it being spread over more hours of use, essentially artificial grass always represents more of a burden on the environment than natural grass.

Advanced natural grass solutions

In recent years, grass breeders have developed new and innovative natural grass solutions for sports fields. A number of examples are given below:

- According to figures published by Grasgids, Perennial ryegrass (the main grass variety used for sports facilities) has made great progress in its resistance to heavy wear, equivalent to one per cent per annum. This means that a sports field able to cope with an average of 330 playing hours a year in 1975 can tolerate an additional 117 hours of play a year today. A sports field sown today with the latest varieties is therefor equipped to cope with more than 450 playing hours each year.
- Advances in grass breeding have helped extend the growing season of grass. Varieties are now available that start to grow very soon after the end of the winter and that continue to grow well into autumn. The result is reduced damage in the winter, as well as improved winter colour.
- Shade is a problem on many sports fields, particularly in modern stadiums. Thanks to the introduction of shade tolerant grass varieties, the quality of fields grown and maintained in these environments has also improved greatly.
- The introduction of high-tech grass seed coatings has helped boost the germination and establishment of grass varieties.
- Ryegrasses can now germinate at lower temperatures (> 3.5°C) and can establish at a faster rate. This allows overseeding to take place on sports fields all year round, even in the cooler autumn and winter months. Ryegrasses were used for the pitches at the football World Cup in South Africa in 2010, and praised by independent sports grass experts from FIFA as being 'of an exceptionally high standard'.

An American study involving the measurement of the average temperature on artificial and natural grass in a test location between 7:00am and 7:00pm demonstrated that the surface of artificial grass can heat up considerably. Temperatures on the artificial grass field reached 47°C to 69°C, whereas the measurements for the natural grass field read 26°C, reaching a peak of 32°C. When the artificial grass was watered, the temperature dropped, but then rose again sharply. Even in the shade, higher surface temperatures were recorded than on natural grass fields. Excessive temperatures can result in burn wounds, fatigue, and an increased risk of injury. Plantum is the sector association for companies active within the sector of plant-based raw materials. As a knowledge and network organisation, one of Plantum's tasks is to stimulate the development and application of natural grass because of the advantages that this offers for the environment and in terms of sustainability.

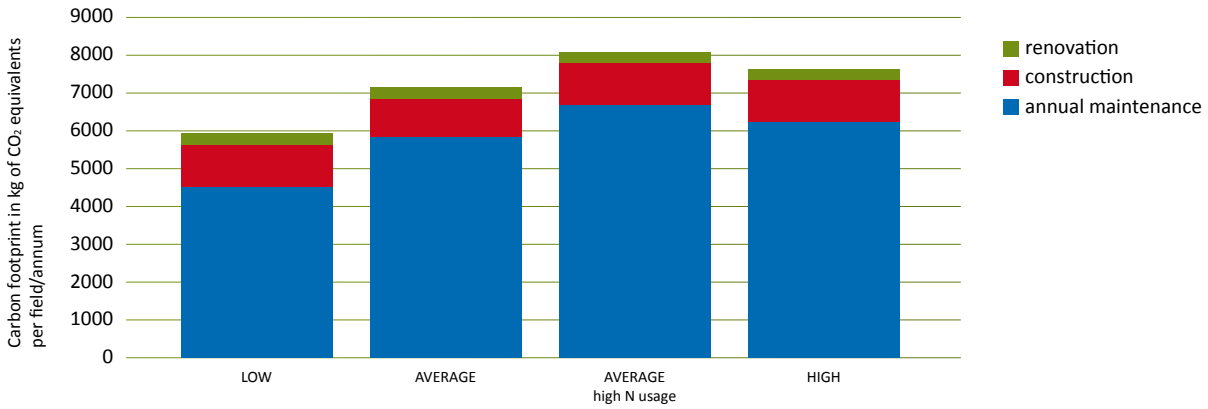
In short, natural grass has a good reputation where sustainability and reducing the environmental impact are concerned. With a playing intensity that has been extended to an average of 450 hours per year over the past few decades through the use of improved grass varieties, improved maintenance practices, and access to education for those who carry out the maintenance, natural grass is by far the best solution for the vast majority of Dutch sports fields, including in terms of costs. In addition, natural grass achieves something that artificial grass simply cannot: fixing greenhouse gases from the air in the soil, and providing oxygen in return. A more natural and environmentally-friendly option in this regard would seem to be impossible. Add to this the emotional value of grass - its feel, smell, the way it responds, its cooling effects in hot weather, and the considerably reduced risk of injury - the benefits are clear to see.

Results and consequences for the carbon footprint

Looking at the sixteen individual environmental topics and the total environmental effect, the scenario 'AVERAGE, high N usage' (400 playing hours/annum) has the greatest impact. The carbon footprint of such a sports field is more than a third greater than that of a field with 250 playing hours, with approximately 8,000 kg CO^2 equivalents per annum. That is equivalent to a car driving an additional 9,631 miles. The carbon footprint is the net total of greenhouse gases released that contribute to global warming (emissions minus fixation).

The differences between the carbon footprints, as well as with regard to the other environmental topics, can largely be traced back to the annual maintenance. Of all the stages in the life cycle of a grass sports field, these activities account for the largest share of the environmental impact at around 80 to 90% (see figure 3).

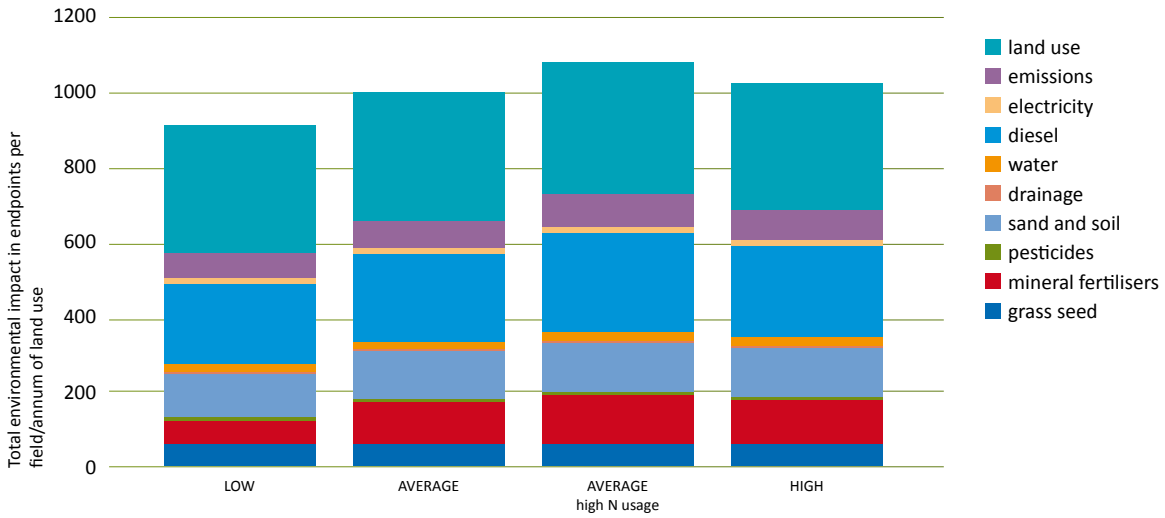
Figure 3: Carbon footprint per life cycle phase and sports field scenario;
(in kg of CO^2 equivalents per field/annum)



The scenario 'AVERAGE, high N usage' relates to a field with average playing frequency and a high maintenance level. If the amount of fertiliser used is more than the standardised amount, the CO^2 load for the field concerned will be greater. Construction refers to the creation of the new sports field, including the removal of the old sports field.

When looking at the use of the various elements during the life cycle of a grass sports field, it is striking that land use accounts for the largest proportion of the environmental impact - one third - due to the space occupied. This is inevitable, however, as it is inextricably linked with the nature of a sports complex. Of the items that can be influenced, diesel consumption for maintenance work on the grass sports field accounts for the largest share of the environmental impact (around 30%), followed by the emissions resulting from the use (around 20%) and the production (15% to 20%) of mineral fertilisers (see figure 4). There is a linear connection between diesel consumption and the environmental impact. If diesel consumption declines by 10%, for instance, then the total environmental impact will decline by more than 2.5%. The carbon footprint will in fact become around 3.5% smaller!
The amount of mineral fertilisers used in the scenario 'HIGH' (500 playing hours per annum) is almost 25% more than the recommended amount. If fertilisers were to be applied in line with the manufacturers' recommendations, the total environmental impact would be reduced by 4% and the carbon footprint reduced by 8.5%.

Figure 4: Share of various elements in the total environmental impact under various sports field scenarios;
(in endpoints per field/annum)



The total environmental impact ranges from around 900 to 1,070 points for the 'LOW' and AVERAGE, high N usage' scenarios respectively.

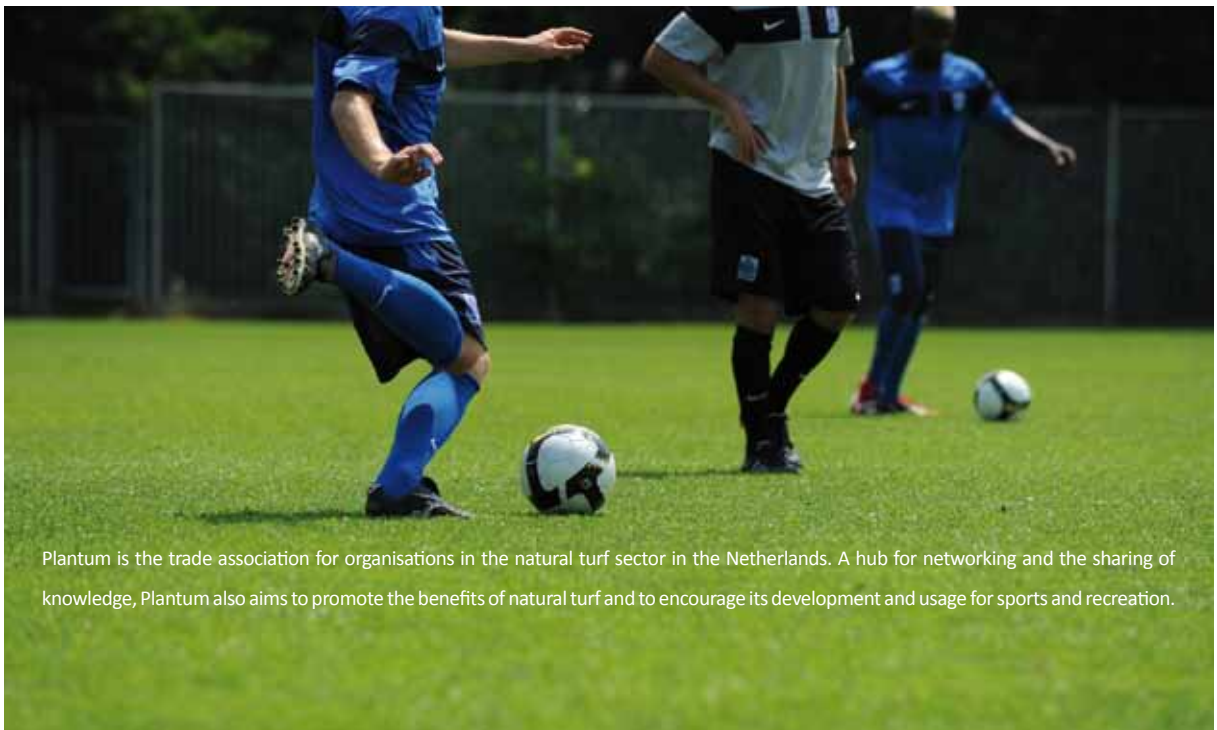
It is not yet entirely clear what happens to the carbon that is fixed within the soil when the sports field is removed after the usable life of 30 years. Despite this uncertainty, the research does give an indication of the contribution of the carbon fixation to the environmental impact: The CO^2 footprint declines by 29% if the carbon is stored permanently in the soil. Even if we assume the worst-case scenario - all the fixed carbon being released as CO^2 at the end of those 30 years - this still means a reduction of 625 kg CO^2 equivalents per sports field per annum (due to the temporary CO^2 storage), i.e. a 8.6% smaller carbon footprint. If we calculate this for all Dutch grass sports fields together (around 8,000), this amounts to a reduction in the environmental impact that is comparable with that of 21,747,991 miles driven in a car, and it's all thanks to the unique ability of grass to fix carbon.

Conclusions & recommendations

- Grass sports fields used intensively have a greater environmental impact than sports fields used less frequently. This is not just due to the increased use of diesel for maintenance work, but also the increased use of mineral fertilisers.
  - Through adherence to the manufacturers' recommended application rates, the relatively large quantities of mineral fertilisers which are typically applied to intensively used sports fields these days could be reduced by almost a quarter. The carbon footprint would then be reduced by 8.5% and the total environmental impact would decline by 4%.
  - Where the impact of nitrogen-based fertilisers is concerned, great improvements could be made in the production process. For instance, nitrous oxide emissions could be trapped and prevented from entering the environment, or nitrate could be replaced with another type of fertiliser such as urea. In the latter case, account should be taken of an increase of ammonia emissions during application.
  - The environment would also benefit from the use of more organic and controlled-release fertilisers with increased longevity. On an annual basis, less diesel would then be required for their application, and in comparison with mineral agricultural fertilisers the risk of leaching decreases.

- Over the entire life cycle, the annual maintenance of a grass sports field has by far the greatest impact on the environment. Of the emission sources that can be influenced, diesel consumption accounts for the largest share: 30%.
  - The use of slow-growing grass varieties and those requiring less mowing can reduce diesel consumption.
  - The use of fossil diesel could also be avoided through the use of mowers running on green energy, such as electric, possibly in combination with solar power, or through the use of LPG or renewable fuels.

- If the carbon fixed in the soil remains stored in it - even after the removal of the sports field at the end of its usable life - the carbon footprint can be reduced by 29%. If the fixed carbon is released through the oxidation of the organic matter when the sports field is removed, this percentage will be 9%.
  - If an old sports field is replaced, it is important to ensure that the fixed carbon is not released under the new one.



Plantum is the trade association for organisations in the natural turf sector in the Netherlands. A hub for networking and the sharing of knowledge, Plantum also aims to promote the benefits of natural turf and to encourage its development and usage for sports and recreation.