Management summary

Study of the environmental impact of natural grass sports fields

This report describes the environmental impact of natural grass sports fields and how this environmental impact can be reduced. The environmental impacts of the various stages in the lifespan of natural grass sports fields (from the production and processing of the grass seed to the construction, maintenance and renovation of the field) were determined by carrying out a life cycle assessment (LCA). The study shows that the biggest contribution to the environmental impact (80–90%) is made by the annual maintenance activities, mainly from the use of diesel fuel and synthetic fertilisers. The study shows that the environmental impact of natural grass sports fields can be considerably improved by reducing the use of synthetic fertilisers, switching to other types of fertiliser, and using different machinery, such as electric mowers. This summary describes the methods, results, conclusions and main recommendations of the study. The full report is not publicly available.

The project was carried out by Blonk Milieu Advies (Blonk Environmental Consultants) for Plantum and was partly financed by the Dutch Commodity Board for Arable Products (Productschap Akkerbouw). The study was supervised by a steering committee of representatives from the grass sports fields sector and reviewed by two experts. A further output of the study is a calculation tool for use by Plantum members to calculate the environmental impact of the life cycle of a grass sports field and determine the effects of measures taken to improve the environmental impact.

Methodology

The life cycle assessment (LCA) was carried out in accordance with international guidelines (ISO standards) and additional LCA specifications for the agriculture and food sectors (e.g. PAS 2050). The environmental impact was analysed using the ReCiPe methodology, in which the impacts were determined for 16 midpoint impact categories[1] and then these were weighted and aggregated to three endpoint categories: human health, ecosystems and resource depletion. The total environmental impact is the sum of those three endpoint categories and is expressed as a score without units, enabling comparison of scenarios.

Soil carbon sequestration was not taken into account in the LCA. Because there is no standardized method to calculate it and because there is too little reliable data on carbon sequestration and the fate of the fixed carbon following disposal and renewal of the field remains uncertain. Nevertheless, a separate calculation was made to give an indication of the possible effect of carbon sequestration on the total environmental impact.

The life cycle of natural grass sports fields consists of the production and processing of grass seed, the construction of the field, annual maintenance, renovation and disposal.

For the purposes of this study it was assumed that the seed is cultivated and processed in the Netherlands, the natural grass sports field is also located in the Netherlands, and it is used as a football field with a lifespan of 30

[1] The 16 impact categories are: climate change, ozone depletion, terrestrial acidification, freshwater eutrophication, marine eutrophication, human toxicity, photochemical oxidant formation, particulate matter formation, terrestrial ecotoxicity, marine ecotoxicity, ionising radiation, land occupation (agricultural and urban), water depletion, metal/mineral depletion and fossil energy depletion.

years. To give an impression of the consequences of differences in intensity of use and between management regimes, environmental impacts were calculated for four scenarios – LOW, AVERAGE, AVERAGE HIGH and HIGH – with different intensities of use, ranging from 250 to 500 hours/year. The synthetic fertiliser inputs and maintenance regimes (such as mowing and sand spreading) for the four scenarios are summarised in Table A.

The results of an LCA always contain a certain degree of uncertainty resulting, among other things, from differences in the reliability of the input data (e.g. because of limited available information) and uncertainties in the emission factors used. These uncertainties were not quantified in this study.

Data

The grass seed used for natural grass sports fields is a mixture of perennial rye grass (*Lolium perenne*) and smooth-stalked meadow grass (*Poa pretensis*). The data on the cultivation and processing of the grass seed were obtained mostly from companies in the grass seed sector, supplemented with data from published sources. The information on the construction, maintenance and renovation of natural grass sports fields is based on day-to-day practice, supplemented with research results and advice. The fertilisation regime for annual maintenance in the AVERAGE scenario is based on the recommended standard application rates for natural grass sports fields; the fertilisation regimes for the other scenarios reflect actual practice based on the field management survey. Table A shows the key data for the four scenarios.

Table A. Key differences between the four scenarios in the intensity of use and management of a natural grass sports field

	Unit	**LOW**	**AVERAGE**	**AVERAGE HIGH**	**HIGH**
Playing intensity	hours/year	250	375	400	500
Fertilisation regime for annual maintenance	kg N/field	100	165	200	180
	kg P_2O_5/field	35	40	96	45
Sand/soil application for annual maintenance	m^3/ field	35	50	40	45
Annual maintenance operations	number of times mown	42	36	35	30
	number of times rolled/groomed	10	16	13	21

Results

The AVERAGE HIGH scenario (playing intensity 400 hours/year) has the highest impact, both in the 16 midpoint impact categories as well as the total environmental impact. For example, the impact on climate change (or carbon footprint) ranges from about 6000 kg CO_2 equivalents[2] per field in one year in the LOW scenario to about 8000 kg CO_2 eq./field*year in the AVERAGE HIGH scenario (see Figure 1). These impacts are equal to the carbon footprint of a car travelling 42,500 km and 58,000 km respectively. Of all the phases in the life cycle of a natural grass sports field, the annual maintenance makes the biggest contribution to the environmental impact, at 80–90% (e.g. in the impact category climate change shown in Figure 1).

[2] There are various greenhouse gases, each of which makes a specific contribution to the greenhouse effect. The term CO_2 equivalent (CO_2 eq.) is used to allow these contributions to be aggregated and compared. The emission of 1 kg CO_2 is equal to 1 CO_2 eq. One kg nitrogen oxide (N_2O) is equal to 298 CO_2 eq. and 1 kg methane is equal to 25 CO_2 eq.

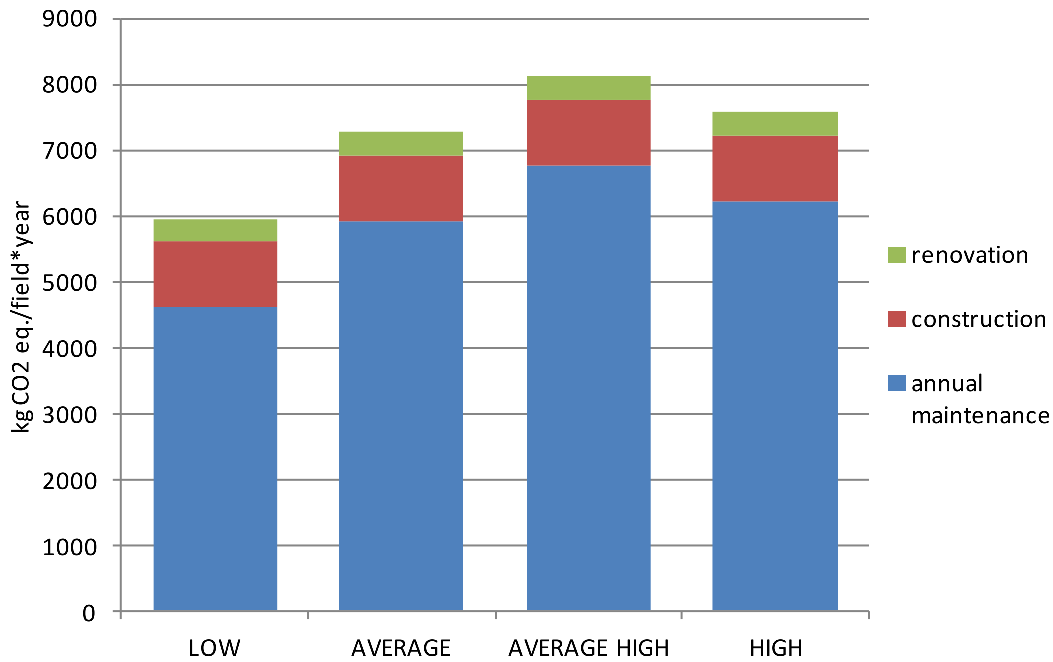

*Figure 1. Breakdown of the carbon footprint of a natural grass sports field (in kg CO_2 eq./field*year) by life cycle phase (construction means the construction of a new field and disposal of the old field)*

The total environmental impact varies from about 900 points for the LOW scenario to about 1070 points for the AVERAGE HIGH scenario (see Figure 2). The biggest contribution to the total environmental impact of a natural grass sports field (one third) is made by its land occupation, which is an unavoidable impact because it is in the very nature of a sports field. Of the emission sources that can be influenced, the use of diesel fuel for maintenance and other operation makes the biggest contribution to the environmental impact (30%), followed by emissions from synthetic fertiliser application (about 20%) and the production of fertilisers (15–20%) (see Figure 2). Diesel use has a linear relation with the environmental impact. For example, a 10% reduction in the use of diesel will lead to a reduction in the total environmental impact of just over 2.5%, while the carbon footprint will fall by about 3.5%.

The use of synthetic fertilisers in the HIGH scenario (500 playing hours/year) is almost 25% higher than the recommended standard dose. If the standard doses were applied, the total environmental impact would fall by 4% and the carbon footprint would be reduced by 8.5%.

Based on the scientific literature we assume that the average carbon sequestration in a grass sports field is 0.71 tonnes of carbon/ha*year. This estimation entails quite a high degree of uncertainty because the conditions in the reported studies are not entirely comparable with the parameters of this LCA (e.g. a different country and use as a golf course instead of a football field) and due to uncertainties about the fate of stored carbon following disposal of the field at the end of its lifespan of 30 years. Despite this uncertainty, this estimated figure for carbon sequestration does give an indication of the effect of carbon sequestration on the environmental impact. If all the carbon fixed in the soil is included in the calculation, the total environmental impact falls by 9%. If, in the worst case scenario, we assume that all the fixed carbon is emitted following disposal of the field after 30 years, this carbon accounts for a reduction of 625 kg CO_2 equivalents/field*year in the carbon footprint (a reduction of 8.6%). For comparison, this is equivalent to the emissions from a car travelling at least 4400 kilometres.

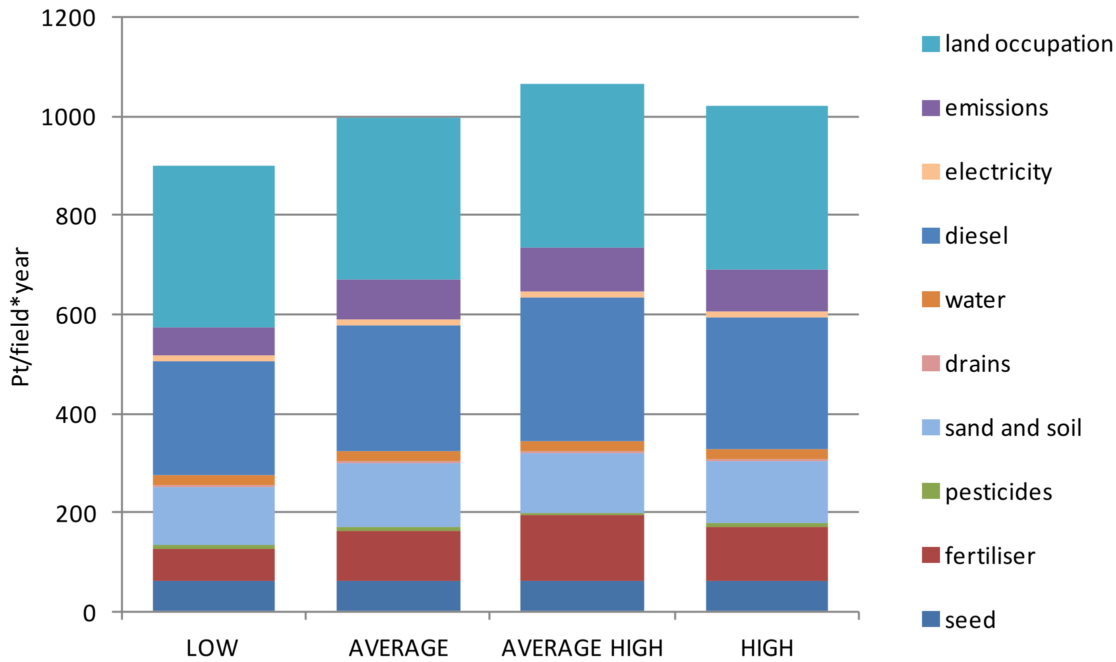

*Figure 2. Breakdown of total environmental impact by emission source (expressed as endpoints, Pt/field*year). The source 'emissions' represents the nitrous dioxide (N2O) emissions due to fertiliser application.*

Potential improvement options

The improvement options with the highest potential for reducing the environmental impact of the life cycle of a natural grass sports field concern the use of synthetic fertiliser and diesel fuel.

- Synthetic fertiliser: Switching to a synthetic nitrogen fertiliser that has a much lower environmental impact during production would improve the environmental impact of natural grass sports fields. Examples are nitrogen fertilisers produced with recovery of N_2O emissions, and replacing nitrate fertilisers with another type, such as urea. In the latter option, account should be taken of higher ammonia emissions during application. Using organic fertilisers instead of synthetic fertilisers would also reduce the environmental impact.
- Diesel: The use of diesel as a fuel for mowing and other operations can be reduced by planting slow growing grass species. Switching to electric mowers running on green electricity (possibly in combination with solar energy) would also limit the use of fossil diesel.

Other potential improvement options:

- Fertilisation according to the recommended standard application rates will deliver savings compared with current practice, certainly for intensively used fields.
- The use of 100% perennial rye grass instead of a mixture of perennial rye grass and smooth-stalked meadow grass would deliver a small reduction in the environmental impact, because the cultivation of perennial rye grass has a lower environmental impact.

- Carbon sequestration: A considerable reduction in the environmental impact could be achieved if the carbon stored in an 'old' field is not released when a new field is laid, but is retained by incorporating it into the soil under the new field.
- A potential option which was not investigated in this study is replacing diesel with other fuels, such as LPG or renewable fuels.

Conclusions and recommendations

The main conclusions and recommendations (*in italics*) are given below.

- Over the life cycle of a natural grass sports field in the Netherlands by far the biggest share of the total environmental impact is from the annual maintenance activities, at 80–90%. Of the emission sources that can be influenced, the use of diesel for construction, maintenance and renovation operations makes the biggest contribution to the environmental impact, at about 30%.

  Given that the use of diesel accounts for a large share of the total environmental impact, we recommend investigating measures to reduce the use of diesel fuel, such as using slow growing grass species (which require less frequent mowing) or using more fuel efficient machinery.

- The greater environmental impact of more intensively used natural grass sports fields can be attributed mainly to higher inputs of synthetic fertilisers and diesel for maintenance and other operations.

  The relatively higher fertiliser inputs to intensively used natural grass sports fields common in current Dutch practice exceed the standard application rates. If the recommended standard application rates were followed, the inputs of synthetic fertilisers to intensively used fields would be reduced by almost 25%, reducing the carbon footprint by 8.5% and the total environmental impact by 4%.

  For natural grass sports fields under high intensity use we recommend complying with the standard fertiliser application rates to reduce unnecessary environmental impacts (and costs!).

  We highly recommend investigating the degree to which organic fertilisers and advanced synthetic fertilisers (slow release) can be used to replace traditional synthetic fertilisers, and by how much that would reduce the environmental impact.

- Based on an average value for carbon sequestration in the soil organic matter of a natural grass sports field, retaining all the fixed carbon after disposal of the field will reduce the carbon footprint by 29%. If after the 30 year lifespan of a field, all the fixed carbon is released through oxidation of the soil organic matter, the carbon footprint is reduced by 9%.

  The use of an average value for carbon sequestration is not consistent with the expected differences in sequestration rates resulting from differences between management regimes (e.g. in fertiliser doses). We therefore recommend calculating the carbon sequestration more accurately by taking account of important parameters such as fertiliser use, mowing intensity, etc.