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SUSTAINABILITY

TEEB for Business – The Netherlands

The Economics of Ecosystems & Biodiversity

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TEEB for Business – The Netherlands

Contents

Foreword

Many companies are dependent on ecosystems, and the loss of biodiversity and ecosystem degradation is one of the greatest risks facing business today (World Economic Forum, 2010).

This study, 'The Economics of Ecosystems and Biodiversity for Business – The Netherlands' (further referred to as TEEB for Business), shows that in addition to the risks, there are also opportunities for the business sector. By anticipating the growing pressure on biodiversity, businesses can not only safeguard their survival in the longer term, but also gain a competitive edge through innovation or by reducing the dependence on ecosystem services. This applies not only to provisioning services, such as fish, food crops, clean water and medicinal plants, but also to regulating services, such as the filtering of contaminated water by wetlands, and cultural services, such as the benefits for recreation and tourism.

The question of the economic value of biodiversity attained international political prominence in 2007 with the publication of the first in a series of international studies entitled The Economics of Ecosystems and Biodiversity (TEEB).

Since then, a number of studies have been launched to identify the economic value of biodiversity for the Netherlands, to demonstrate the rewards of investment in and sensible management of biodiversity, to encourage us to consider nature in the decisions we make, and to incorporate nature in the solutions we find for social problems.

The TEEB for Business study is one of six studies being carried out as part of the national government's TEEB programme. The other studies cover public health, spatial planning, Dutch supply chains, the Netherlands' Caribbean region and cities (for the municipality of Apeldoorn with the support of the Ministry of Economic Affairs, Agriculture and Innovation and the Ministry of Infrastructure and the Environment).

I would like to thank the members of civil-society organisations and academics who took part in the focus groups and I hope that this study will mark the beginning of a new partnership between all the stakeholders – one that is in the interests of business and of nature itself.

Annemie Burger
Director-General for Nature and Regional Policy
Ministry of Economic Affairs, Agriculture and Innovation

Summary

Biodiversity: Today's first movers are tomorrow's winners

There is a lot at stake for business. The conservation of freely available ecosystem services is essential to ensure the profitability of companies over the long term. The nine sectors studied in TEEB for Business show that there are actions that companies can take, and there are opportunities for companies that anticipate the growing pressure on biodiversity. In addition to safeguarding their future survival, they will enjoy first-mover advantages. To trump their competitors, companies must quickly analyse their risks and opportunities in relation to biodiversity and assess their financial impact. This study provides tips on how to perform such an analysis.

Many companies depend heavily on ecosystems – through their suppliers or otherwise – and that dependency is particularly great in non-Western countries. This is directly connected with a number of megatrends, such as rising food prices (especially in relation to the expected growth of the world's population), changing patterns of consumption, the growing demand for biofuels and soya, water shortages and climate change.

Understandably, the World Economic Forum concluded in 2010 that the loss of biodiversity and ecosystem services is one of the major risks facing business. Where there are risks, however, there are also opportunities, for example in the form of cost savings, product innovation and, above all, the creation of first-mover advantage.

To seize these opportunities, companies must adopt a contemporary attitude to how they create value for society. After all, the public increasingly holds companies responsible for environmental and economic problems and expects them to take steps to resolve those problems. Companies that wait until they are left with no other choice will pay the price by incurring costs that are many times greater than those they would have faced if they had adapted their behaviour in time. Sometimes, it might even be too late to make the transformation and these companies will lose their 'licence to operate'.
In short, today's first movers are tomorrow's winners.

Prospective actions by different sectors

This study highlights some of the actions that can be taken. The horticultural sector, for example, has shown that biological pest control is possible, while Nutreco, a producer of fish feed, has demonstrated that plant-based feed can be used in the aquaculture sector as an alternative to animal-based feed. This move has helped to preserve wild fish stocks and created a strategic position for the company in a world where 80% of fish species are threatened by overfishing. To give another example, a number of companies in the Netherlands have made enormous strides in the development of bioplastics.

While the first-mover advantage is more difficult to pinpoint in other sectors, the enormous economic importance of biodiversity and ecosystem services is nevertheless perfectly obvious. In the agricultural sector, for example, it is difficult to grow tomatoes without bees. Although manual or mechanical pollination is possible, it could cost up to € 40 million euro annually. Drinking water is another example. As long as the dunes retain their capacity to purify the groundwater, it will not be necessary to make huge investments in storage facilities in order to guarantee a 100-day supply of drinking water.

Obviously, many chemical companies can only be assured of a supply of natural raw materials in the longer term with properly functioning ecosystems. But the relationship is a very complex issue and there are a great many uncertainties. In such a context, any attempt to calculate the risks and opportunities that biodiversity creates for an individual company is difficult and can also lead to false assurances.
This study shows that while 'second-generation bioplastics', in particular, can

Summary

solve a great many of the dilemmas surrounding the choice between the use of fossil fuels and crops that require the large-scale use of land in competition with food crops. With the strong position it already holds in terms of knowledge and innovation, the Netherlands can play an important role in finding solutions to these dilemmas.

What can companies do?
The first important step is for companies to realise the economic value of using ecosystem services smartly, with benefits that include lower costs, gaining a strategic advantage over competitors, creating new markets, stimulating product innovation and improving their reputation among consumers.

The next step is to understand the dependencies and impacts on ecosystem services and to weigh up the associated opportunities and risks for the bottom line in the short and longer term. There are no straightforward models for calculating these variables or to calculate the net effect of the measures taken by a company.
The economic value will therefore always have to be analysed from various perspectives: opportunities, risks, the ecosystem balance sheet, operating results, and higher costs due to scarcity in the future.

A possible third step is to calculate the full value of all the ecosystem services and biodiversity for a company, or to calculate the entire negative 'ecological footprint' and discount it in the operating result. This requires a tailored analysis that will differ greatly from one company to another and will force a company to make a fundamental assessment of the sustainability of its current operations.

Conclusion
In time, changes are inevitable.
The pressure of public opinion has increased in recent years, and companies that show that they are grasping the opportunities that nature offers and/or anticipating risks can gain an edge over their competitors. Doing nothing is also an option, but probably the worst possible one, since evolution has shown that it is not the strongest that survive but those that are best able to adapt to changing circumstances. That is an important lesson for every company.

Ecosystem services
Ecosystem services represent economic value for companies.
They are divided into four categories:

- Provisioning services deliver various products, such as fish, food crops, clean water and medicinal plants.
- Regulating services manage processes in ecosystems, such as the purification of contaminated water by 'wetlands' and climate regulation through carbon sequestration.
- Cultural services are benefits from ecosystems, for example through recreation and tourism.
- Supporting services, such as habitats and the conservation of biodiversity, underpin almost every other ecosystem service.

Introduction

Introduction
Background

Biodiversity and ecosystem services: the economy's 'green engine'
Biodiversity and ecosystem services are the 'green engine' of our economy. One of the objectives set out in the government's Sustainability Agenda is 'to highlight the economic value of biodiversity for society and business and so make clear to all stakeholders the rewards of investment in and sustainable management of biodiversity'.

TEEB International
The international study 'The Economics of Ecosystems & Biodiversity' (TEEB) was published by Germany and the European Commission in response to a proposal by the ministers of the environment of the G8+5 group of countries in Potsdam, Germany in 2007 for a worldwide study of the economic costs of the loss of biodiversity.
The second phase of the TEEB study was hosted by the United Nations Environmental Program (UNEP) with the support of a number of other organisations.

The TEEB study has drawn a lot of attention to the issue of the economic value of biodiversity and ecosystem services. However, it has not yet delivered the specific information that companies in the Netherlands need to inspire them to take the next step and actually incorporate the economics of ecosystem services and biodiversity in their business strategy.

TEEB for the Netherlands
With the study 'TEEB for the Netherlands', the government's intention is to provide insight into the economic value of biodiversity and ecosystem services – in terms of costs and benefits – for Dutch public authorities, the business sector and the general public.

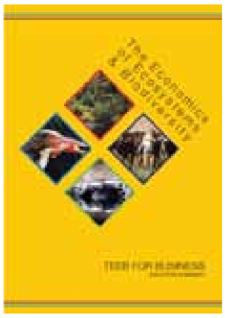
As part of this comprehensive study, in TEEB for Business KPMG identifies the economic value of ecosystem services for the Dutch business sector. Why? Because knowledge of how companies and sectors depend on and have an impact on ecosystem services and biodiversity is the key to taking appropriate action. A company's ability to respond at the right time to the opportunities that nature offers – or to anticipate risks – can make all the difference in a competitive business environment.

On the next page we describe the remit and scope of the study.

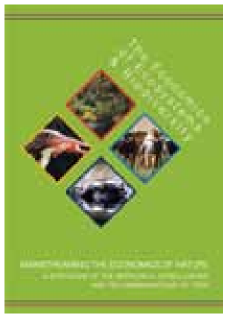
What are ecosystem services and biodiversity?
In this study we use the following definitions:

- *Ecosystem services* are the direct and indirect benefits people gain from ecosystems (e.g. pollination by bees in the horticultural sector or purification of water by forests and wetlands) and from nature within managed ecosystems (e.g. microclimate regulation by city parks) (Millennium Ecosystem Assessment, 2005; TEEB, 2010).

- *Biodiversity* is the variability among living organisms, within species, between species and between ecosystems (Convention for Biological Diversity; TEEB, 2010).



TEEB for business



Mainstreaming the economics of nature

Introduction

Objectives, terms of reference and scope

Objectives

The TEEB for Business project has the following objectives:

- Representative picture: to provide a clear impression of the economic value, in financial terms, of eco-system services and biodiversity for the Dutch business sector.
- Inspiration and specific actions that can be taken: to create awareness, provide inspiration and identify specific actions that individual companies in the Netherlands can take, not only to integrate the eco-nomics of ecosystem services and biodiversity in commercial decision-making in relation to risk mangement, but also to optimise their current business operations and invest in mitigating measures, new solutions and/or new products and markets.

Terms of reference

The terms of reference for this study are to 'identify the economic value of relevant dependencies and impacts on biodiversity and ecosystem services and opportunities for Dutch business.'

Scope

The study focuses on the Dutch business sector, and primarily on com-panies' dependencies and impacts on biodiversity and ecosystem services in the Netherlands. Dutch businesses can have an indirect impact on biodiversity and ecosystem services in other countries by buying commodities and other materials from abroad. Where that impact is substantial, it is considered in the global context.

Figure 1: Size of top sectors

Top sector[1]	%GDP[2]	Number of companies[3]
Agro & food	4.4%	59,500
Horticulture and propagation materials	1.4%	13,500
Creative industry	1.6%	33,000
Life Sciences	3.4%	17,000
Water	1.6%	33,000
Chemicals	2.2%	4,100
High-tech materials and systems	6.7%	3,900
Energy	3.4%	475
Logistics	3.4%	17,000

[1] 23% of the working population is employed in the top sectors.
[2] Source: Ministry of Economic Affairs, Agriculture and Innovation (2011)
[3] Source: MT - De 9 Topsectoren onder de loep, 8 February 2011.

The above data do not always correspond with the data shown in the sector analyses because different sources were consulted.

In this study, the economic value of biodiversity and ecosystem services is investigated for eight 'top sectors' in the government's innovation policy: agro & food (broken down into livestock farming, arable farming and fisheries), horticulture (with a special emphasis on greenhouse horticulture) , life sciences, water, the chemical industry and the creative industry, as well as the tourism sector.

The selected sectors and the accom-panying case studies provide a wide range of examples of the value of ecosystem services in the Netherlands.

The study devotes special attention to the agro & food top sector because this sector has the greatest dependency and impact on ecosystem services in the Netherlands through its direct use of ecosystem services for food production (crops, meat, dairy products). The high-tech, logistics and energy sectors are not covered in this study because their relationship with ecosystem services is covered in depth in studies for other policy areas.

The case studies in this report provide insight into the value of ecosystem services for individual farmers, SMEs, family-owned companies and business units of smaller multinationals in various sectors.

Introduction

Importance for business and public authorities

Why is the subject so important for companies and the government?
As Michael Porter argued in his article 'Shared Value' in the Harvard Business Review (2011), in recent years business has increasingly been seen as responsible for environmental and economic problems. In Porter's view, the legitimacy of business has fallen to levels not seen in recent history.

This diminished trust in business prompts politicians and policymakers to formulate policies that undermine competitiveness and sap economic growth.

Part of the blame lies with the companies themselves. In their strategies, many companies regard the environment and the social context largely as a given. Solving environmental and social problems has been ceded to the government and non-governmental organisations (NGOs). Corporate social responsibility programmes are driven mainly by a desire to improve a company's reputation, in response to external pressure, and are regarded as a necessary expense. Governments, meanwhile, have often regulated in a way that makes it difficult for companies to create 'value' both for themselves and for society. Implicitly, each has assumed that the other is an obstacle to achieving their objectives, and they have acted accordingly.

Sustainable enterprise will be a prerequisite for survival in 2020
However, companies that do not operate sustainably are undermining their own survival in the long term. Environmental problems (as well as the emergence of the BRIC countries and the rapid growth in the use of farmland to produce raw materials for biofuels and chemicals) compel companies to reconsider their strategies in order to reduce their dependence on natural raw materials and to safeguard a continuous supply of these materials at affordable prices.

This is why a growing number of major multinationals known for their profit drive, including GE, Unilever and Nestlé, have taken serious initiatives to make their business operations more sustainable. An important feature of these initiatives is that they have resulted not only in a substantial reduction of their negative impact on the environment, but also an improvement in their business operations (for example, by guaranteeing a continuous supply of raw materials or reducing energy consumption). The steep rise in external 'environmental costs' of companies in the period 2002-2010 highlights the need for this (KPMG, 2012).

Growing role of the financial sector
Consideration for people and the environment also gives companies access to the capital market. Institutional investors, such as pension funds, insurance companies and banks, increasingly use sustainability as a criterion in their decisions on financing and investment. After all, they assume that (Eurosif European SRI study, 2010):

- Over time a company's record on sustainability will have a positive effect on its risk-return profile.
- The potential return on investments is greater with sustainable companies.
- There is less of a risk that investments will deprciate with these companies.

Michael Porter spoke at the second International Supply Management Congress in the RAI in Amsterdam in December 2011, remarking that by 2020, companies that society does not regard as sufficiently sustainable will face the risk of losing their licence to operate. At the time of writing, Kodak, which lost its near-monopoly in just a decade because it could not compete against new technologies, had applied for Chapter 11 bankruptcy protection, illustrating the ultimate consequences for a company that is unable to adapt to changing circumstances adequately and in time. There are a number of reasons why it is essential for a company to understand its dependency on natural resources, the processes that make those resources available (referred to here as 'ecosystem services') and its impact on those ecosystem services and biodiversity. It is not just because of the risks to the company's reputation or business operations or the threat of legislation but, above all, to safeguard the survival of the company, to stimulate innovation (which enables a company to strengthen its competitive advantage by supplying products or services with greater value for society) and to improve its processes (which leads to better results for the company and enhances the well-being of society – by improving the environment or socio-economic conditions, for example).

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The CEOs of major multinationals are also increasingly emphasising the importance of biodiversity and ecosystem services. In a study of major business risks in 2010, the World Economic Forum (WEF) concluded that the consequences of the loss of biodiversity and ecosystem services must not be underestimated and would particularly affect the ambitions for growth of the emerging economies (WEF, 2010). The loss of ecosystem services and forests are two of the ten 'mega forces' that will have the greatest impact on businesses. Earlier research by KPMG showed that 44% of CEOs already regard sustainability as a source of innovation and 39% see new opportunities for their company (KPMG, 2011).

This is also relevant for governments and policymakers in formulating policies that will help companies to strengthen their competitiveness without compromising the environment.

Approach and methodology

Approach and methodology
The different ecosystem services

The relationship between ecosystem services and business
Ecosystem services provide a variety of economic benefits for companies, depending on their location, sector and position in the chain. In the Millennium Ecosystem Assessment, ecosystem services were described as follows:

- Provisioning services are the products obtained from ecosystems, such as fish, clean water and genetic resources (e.g. medicinal plants).

- Regulating services are the benefits obtained from the regulation of ecosystem processes, such as pest control and purification of contaminated water by 'wetlands'.

- Cultural services are non-material benefits obtained from ecosystems, such as recreation and cultural heritage.

- Supporting services, such as nutrient cycling and soil formation, are the services that are necessary for the production of practically every other ecosystem service.

The analysis of the financial and economic value of ecosystem services is primarily concerned with the provisioning services, where businesses directly use the goods and products that nature provides, such as fuel, food, building materials, clean and sufficient water and genetic resources.

Although it is often more difficult to assign an economic value to indirect services (regulating, supporting or cultural) – such as climate regulation, transport of water, natural pollination and recreation – from a business perspective, they are included where relevant.

Focus on dependencies, impacts, risks and opportunities
In this study, we value ecosystem services on the basis of a distinction between the dependencies and impacts on ecosystem services and the risks and opportunities they create for a company.

Figure 2: Overview of ecosystem services

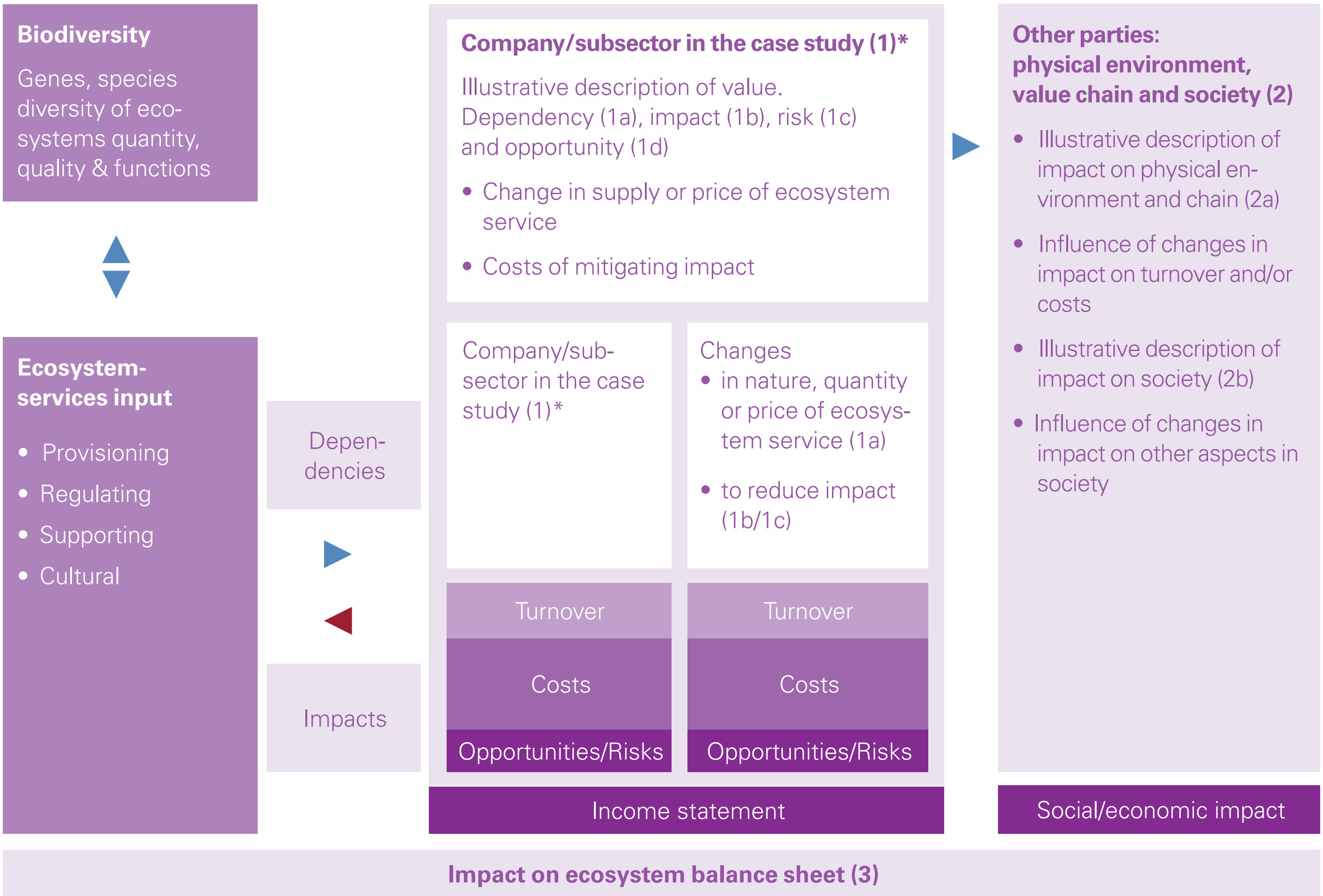
Provisioning services	Regulating services	Cultural services
• Food (crops, meat, fish) • Raw materials (wood) • Freshwater • Medicinal materials	• Climate and air-quality regulation • Carbon sequestration • Mitigation of extreme weather conditions • Water purification and waste treatment • Erosion prevention and preservation of soil fertility • Pollination • Pest control	• Recreation and mental and physical health • Tourism • Aesthetic values and inspiration for culture, art and design • Spirituality and the intrinsic character of the location
Supporting services	• Habitat for flora and fauna (nutrient cycling, soil formation, primary production) • Preservation of genetic diversity (biodiversity)	

Source: TEEB (2010) The Economics of Ecosystems & Biodiversity: Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB.

Approach and methodology

Analytical framework

Figure 3: Relationship between biodiversity, ecosystem services, companies and the environment



Based on Ten Brink and Gantioler, IEEP, 2011

*) See next page for an explanation of each number.

Approach and methodology

The value of ecosystem services

Focus on the company (1), with reference also to the physical environment, supply chain and society (2)

In the case studies, we focus primarily on the value of ecosystem services for a company within a specific sector, with specific reference to dependencies, impacts, risks and opportunities. Where possible, we express these aspects in monetary terms, particularly with regard to dependence on an ecosystem service and the costs of mitigating any negative impact. We also review the impact on the business environment (other organisations/citizens in the vicinity of the company, partners in the supply chain and society in general) and on the ecosystem balance sheet.

Dependencies on ecosystem services (1a)

In the case studies, we value the dependencies on an ecosystem service by calculating the cost of the relevant service in actual amounts and as a percentage of the company's costs and turnover. Where the use of the ecosystem service is not sustainable, we also assign a value to the consequences for the company of a change in its availability, price, etc.

This can affect a company's income statement in the following ways:

- an increase in the costs of factors of production over time
  - costs of more expensive raw materials/production of ecosystem services as a result of (growing) scarcity
  - costs of more expensive raw materials/production of ecosystem services as a result of replacement
- an increase in production costs over time
  - costs of necessary investments
  - costs of a more expensive production process
- lower income over time, due to
  - lower sales and turnover
  - lower prices because of poorer quality output
- increase in direct losses
  - costs caused by increased flooding, extreme hail storms or animal and plant diseases, for example

Value of the impacts on ecosystem services for other actors (2)

Companies not only depend on the availability of ecosystem services, they also have a direct impact on their availability for themselves and for others. We assess the impact on ecosystem services from two perspectives: the consequences for the company (which is explained in the case studies) and the impact on the physical environment and other parties in the value chain.

Consequences for the company of reducing the impacts (1b/1c)

The first analysis is made from the company's perspective and relates to changes in the costs and benefits arising from measures taken to mitigate the negative impact on ecosystem services and biodiversity. In practice, the possibilities are the same as those outlined for dependencies.

Impacts on the physical environment and other parties in the value chain (2a)

The second analysis takes the perspective of the physical environment and partners in the chain and is mainly concerned with identifying the financial impact on other companies. We analyse, in qualitative terms, which parties are affected financially and how.

This involves the so-called 'allocation issue' and addresses questions such as:

- Who profits or sustains loss in the basic alternative (no change in the behaviour of the company in the case study)?
- What is the financial value of the profit and/or loss?
- What is the change in terms of profit and loss once the company in the case study changes its behaviour?

Wherever possible within the scope of this study, when there is a significant financial impact, wherever we make an estimate of that impact on other companies. We do not make social cost-benefit analyses; the focus is always on the 'average' company at the centre of the case study.

Approach and methodology

Risks related to ecosystem services (1c)
We also identify the major risks in the medium term (5-10 years), focusing on:

- Operational risks. These are risks for the operations of the company in the case study, for example as a result of a scarcity of ecosystem services, but also from the impact caused by third parties.

- Legislative and regulatory risks. These are risks connected with statutory rules imposed on companies with a view to protecting the public from adverse effects. Such rules could force a company to change its business operations.

We also address other potential threats where they are relevant for the case studies:

- Reputational risk. Companies can suffer negative publicity because of their impact on nature, which can damage their reputation or affect the company's turnover.

- Risk of liability. Companies could be sued by NGOs, competitors or other parties for any damage they cause to the environment. This risk relates to the financial consequences of being sued rather than constraints imposed by legislation.

Opportunities (1d)
It is more difficult to assign a price to business opportunities, but they could provide inspiration for other companies. In this report, therefore, we analyse examples of good practices that have yielded a tangible increase in profits, a reduction of costs or a reduction of impact and risks as a result of the prudent management of ecosystem services.

Impact on society (2b)
Besides the impact on direct stakeholders (physical environment) or on the value chain, a business can also have a positive or negative impact on society in general: increasing scarcity, for example, by causing a decline in the availability of ecosystem services and raw materials, causing pollution or impairing social well-being through social abuses. Where the literature provides information to support it, we briefly sketch the impact on the 'social profit-and-loss account' and social well-being, in purely qualitative terms.

Changes in the ecosystem balance sheet (3)
For each case study, on one page there is a table showing what changes in the quality and/or availability of the various types of ecosystem services would ensue from an alternative use of raw materials, different production processes or entirely different activities.

Because ecosystem services are so complex, no quantitative calculations have been made, but the situation is described on the basis of the body of literature and the interviews with relevant stakeholders in the case study.

Approach and methodology

Research method

Method (by sector)

The following method was adopted to illustrate the economic value of ecosystem services and biodiversity for Dutch business:

- The key figures for the top sectors were analysed.
- A literature study. A survey of the relationship between ecosystem services and biodiversity and the selected sectors was made on the basis of Dutch and international literature. For each sector, an analysis was made of:
    - Dependencies. On which ecosystem services does the sector largely depend?
    - Impacts. On which ecosystem services does the sector have a significant impact?
    - Risks. What are the major risks with regard to the availability of ecosystem services or in terms of regulation to curb negative impacts?
    - Opportunities. What major opportunities are there for the business sector in relation to ecosystem services?
- We quantified the level of dependency and impact in a working document using various sources. This provided the underpinning for the initial findings on the relevant/material dependencies and impacts per sector. Those findings were used to guide the search for case studies. In this report, the most important findings from this interim step are integrated into the overviews of dependencies, impacts, opportunities and risks for each sector.
- In consultation with the client, case studies that provide insights into the value of ecosystem services for business were then selected. No attempt was made to produce a complete picture, merely to identify illustrative examples. The case studies concern a standard individual company or sector. The key aspects that need to be addressed as they emerged from the case studies were then fleshed out with a targeted search of the literature and through interviews. In the concluding chapter, we present the various perspectives at the heart of the case studies.

Contents per sector

To give an idea of the economic value of biodiversity and ecosystem services for Dutch business, we present the following aspects for dairy farming, arable farming, greenhouse horticulture and the chemical industry:

- For the sector:
    - a brief description of the sector in terms of turnover, number of companies and employment;
    - a survey of the sector's dependencies and impacts on biodiversity and ecosystem services, as well as the risks and opportunities they create.
- For the company and/or the sector in the case study:
    - a brief description of the company and the risks or opportunities that were identified;
    - a description of the case study;
    - an assessment of the economic value of ecosystem services and biodiversity for the company, in terms of its income statement or the effect on the cost price of a particular product;
    - changes in the ecosystem balance sheet (in qualitative terms) as a result of the measures described in the case study;
    - a summary of significant costs and benefits for other parties (chain effects, indirect effects) and society (effect on the community) as a result of changes in the company's procurement policy, production processes and activities;
    - a summary of strategic issues that need to be addressed by companies and policymakers. We also discuss some long-term trends, partly on the basis of the case studies.

For the other sectors, we describe the sector and present a survey of its dependencies and impacts on biodiversity and ecosystem services, as well as the risks and opportunities they create. This is followed by a case study in which key figures are used to describe the economic value of biodiversity and ecosystem services in narrative form.

Dairy farming

Dairy farming

Description of the sector

Dairy farming

Dairy farming is the largest subsector of livestock farming in the Netherlands and, together with arable farming and horticulture, occupies an area of more than 2 million ha, which corresponds with approximately 60% of the country's total surface area. The dairy farming (pasture) sector itself uses approximately 43% of the total area devoted to agriculture (CBS, 2011, on the basis of total area in 2008). Consequently, the sector is crucial to the character of the countryside (Melman & Van der Heide, 2011).

Dairy farming is very much a land-based sector. Dairy farming and the dairy industry, together with suppliers and distributors in the agribusiness sector, together form the land-bound livestock farming complex, which accounts for 30% of the added value and almost 35% of the employment in the overall national agricultural complex (Van Leeuwen et al., 2010).

The main products of the dairy sector are milk, cheese, cream, yoghurt and butter, and it also produces beef. The total volume of milk supplied to dairy factories was approximately 11.6 million tons in 2010. Almost 54% of the milk produced is processed into cheese (approximately 710,000 tons), much of which is sold in the main export markets of Germany (42%), France and Belgium (Van der Knijf et al., 2011).

The dairy farming industry in the Netherlands

Given the large amount of space the sector occupies, the distinctive influence it has on the character of the Dutch landscape and its great dependence and impact on ecosystem services and biodiversity, we focus mainly on dairy farming in our analysis of the livestock sector.

The average annual milk production per cow rose from 6,000 to 8,000 litres between 1990 and 2008 as a result of improvements in the quality of feed, breeding and business management.

Figure 4: Key figures for dairy farming

	Numbers
Added value of the land-bound livestock sector (in EUR million) (2008) [4]	7,700
Gross production value (in EUR million) (estimate 2010) [5]	4,086
Number of businesses [6]	23,440
Total land area (ha) [6]	1,030,000
Total milk supplies to dairy factories (in '000 kg) (2010) [7]	11,626,123

[4] Melman & Van der Heide (2011), [5] CBS (2011), [6] LEI, (2010), [7] LEI/Binternet (2011)

With this growth of output, the total number of cows in the Netherlands has declined by a third since 1985 (LEI, 2010).

As a land-bound sector, dairy farming depends heavily on the grasslands in the Netherlands and on maize, with the Dutch grasslands accounting for 51% of milk production (Aarts et al., 2005). In addition to grass and corn, the sector also depends on other feed (including soy), although to a lesser extent than the intensive livestock sector.

The dairy farming sector faces a number of challenges, due in part to the Common Agricultural Poicy (CAP) and the abolition of milk quotas. Dairy farmers are also affected, at least to some extent, by the trend in the food industry to intensify efforts to make the production chain more sustainable. For example, companies in the food industry are increasingly concerned that the ingredients in the mixed feed, such as soy, are produced sustainably.

Accordingly, as well as analysing the dependencies, impacts, risks and opportunities with respect to Dutch ecosystem services, this case study also discusses the use of certified soy, or the use of rapeseed meal as a substitute, to make the sector more sustainable.

Use of space in the Netherlands

Dairy farming relies heavily on the ecosystem service provided by grass. More than half of all agricultural land is used for milk production: 830,000 ha of grasslands and 200,000 ha of land devoted to maize.

Dairy farming

The table in Figure 5 presents a number of key figures for an average dairy farm in the period 2005-2009.

Agricultural land guarantees a substantial supply of raw materials for dairy farmers. Figure 6 shows the value of pasture and land cultivated with maize for the average dairy farm.

Figure 7 shows the areas in the Netherlands where milk is produced, based on the location of parcels of grasslands and feed crops. The principal areas are in the north of the Netherlands, the so-called Green Heart of the country, the province of Overijssel and around the IJssel (Melman & Van der Heide, 2011).

Figure 5: Key figures per average dairy farm

	Numbers
Number of cows	72
Area of cultivated land (in ha)	49.0
Average milk production per cow (in kg/year)	7,912

Source: LEI/Binternet (2011)

Figure 6: Key figures per average dairy farm

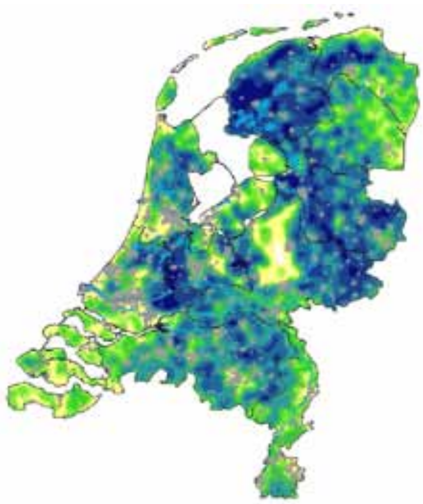
	Unit	Grass	Maize	Grass and Maize
Area of land8	ha	35.9	8.0	43.9
Economic yield per annum [9]	EUR/ha	1,260	1,050	
Value of grassland per annum [8]	EUR	45,234	8,400	53,634

[8] LEI/Binternet (2011), [9] Witteveen & Bos (2006)

Figure 7: Geographic spread of milk production

Milk production in tons per km^2

- 5 - 30
- 31 - 60
- 61 - 120
- 121 - 180
- 181 - 240
- 241 - 400
- 401 - 600
- 601 - 800
- 801 - 1.315
- Inland water
- Built-up area



Source: Melman & Van der Heide

Dairy farming

Description of business

Grass is the principal source of protein for a cow. Dairy farmers depend on land for grazing and to grow grass and maize, but they also depend heavily on mixed feed for milk production. Animal feed accounts for approximately 20% of the dairy farmer's total costs, making it the major expenditure, apart from tangible assets, as the income statement (figure 9) shows.

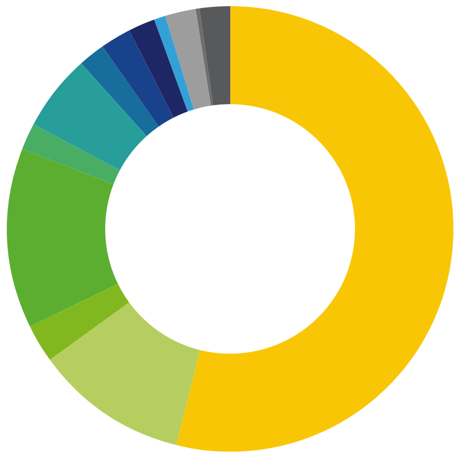
Many different ingredients are either incorporated in the feed for dairy cattle or fed to the cows separately.
The quality of feed is judged on the balance between its protein and energy content and the amino acids it contains. The best composition of the feed depends on the age of the animal and what the farmer is producing (milk, meat or eggs) (Hoste and Bolhuis, 2010).

Raw feed (grass, silage maize, etc.) can be grown by the farmer or purchasd from other farmers. Maize intended for silage is harvested in October and then stored in a silo.

Farmers also buy mixed feed. The manufacturer and the livestock farmer determine the composition of the mixed feed for the animals on the basis of factors such as the relative prices of the feed components, taking into account the nutritional requirements of the animals concerned (LEI, 2011). Crops from South America, such as soybean meal, palm oil and citrus pulp, are increasingly used in mixed feed.

Soybean meal is an important component of feed because of its relatively high protein content. There is, however, a downside to soybean cultivation, as it is one of the driving forces behind the deforestation of the Amazon region. Consequently, it has an indirect impact on the supply of ecosystem services (Van Berkum and Bindraban, 2008). In the two case studies for this sector, therefore, we discuss how the sustainability of the sector could be improved by replacing regular soy with certified soya (case study 1A) or by replacing soy with substitute products (case 1B).

Figure 8: Raw materials used in the mixed-feed industry in 2010 (%)



- Grain and grain by-products (54%)
- Soy (products) (11%)
- Palm pit (products) (3%)
- Cole seed, rapeseed and sunflower (products) (13%)
- Potato by-products (2%)
- By-products of the sugar industry (5.5%)
- Premixes (2%)
- Fats and oils (2%)
- Citrus pulp (2%)
- Waste streams from the food industry (1%)
- Dairy products (2%)
- Legumes (0.5%)
- Other (2%)

Source: The Dutch Feed Industry Association (Nevedi), 2010.

Dairy farming

Figure 9: Income statement of an average dairy farmer

Income (in EUR)			
Arable farming			3,960
Flower bulbs and tubers			233
Vegetables			380
Flowers			100
Other horticulture			200
Beef cattle			203,640
Intensive livestock farming			2,600
Other income			42,300
incl.	income allowances and subsidies	26,340	
	sale of energy	433	
Total income			**253,413**
Expenditures and depreciation (in EUR)			
Animal- and vegetable-based assets			74,920
incl.	incl. feed	42,620	
	fertilisers	6,440	
	seed	2,440	
	crop protection agents	1,940	
	costs of manure disposal	1,025	
Energy			5,480
Intangible assets			6,340
Tangible assets			62,420
Paid labour			3,240
Work by third parties			13,580
Financial costs			27,220
Overhead			12,560
Total costs and depreciation			**205,760**
Income from normal business operations			**47,653**

Source: LEI/BINternet (2011), the data are averages over the period 2005-2009.

Dairy farming

Dependencies, impacts, risks and opportunities

Input: Dependencies on ecosystem services

- **Food:** The dairy farming industry depends on a combination of forage and concentrated feed:
  - Grass contains proteins, minerals and vitamins. A Dutch cow eats an average of 60 kg of grass a day.
  - Maize: The total area devoted to maize is just over 250,000 ha, with 99.1% of this area devoted to crops for animal feed (CBS, 2011). Forage maize mainly provides the starch needed by beef cattle; it is supplemented by protein from the relatively protein–rich grass or soy/alfalfa and similar products.
  - Soybean meal (as well as other foreign crops such as palm oil and citrus pulp) is mixed in the feed for dairy cattle. Because of its high protein content, soybean meal is an important raw material in the feed, but it is imported mainly from Argentina and Brazil, and contributes indirectly to deforestation in the Amazon region.
- **Fresh water:** Dairy farming is a major consumer of water. Irrigation (primarily using groundwater) is used during periods when there is not enough precipitation to replenish the moisture in the soil. Approximately 10% of the land used for livestock farming is irrigated. Dairy farmers account for roughly 60%-70% of the water used by agriculture for irrigation (Melman & Van der Heide, 2011); approximately 80-240 million m3 per year (Hoogeveen et al., 2003).
- **Medicinal plants:** Antibiotics and other medicinal products are still frequently used to prevent animal diseases.

Output: Impact on ecosystem services

- **Food (+):** Milk and beef. The most important ecosystem service produced by this sector is milk. A total of 11.6 million tons of milk were produced in 2010.
- **Climate regulation (-):** Negative impact from emissions of the greenhouse gas, methane (CH4). There are emissions of CO_2 and N2O, but to a lesser extent (Boone et al., 2010).
- **Air quality (-):** Acidification due to ammonia in the air can damage ecosystems and crops (LEI, 2011). This occurs if emissions are higher than the ecosystem's regulating capacity.
- **Aesthetic value (+ and -):** Covering an area of more than 1 million ha, dairy farming greatly influences the look of the Dutch countryside, but the cultivation of maize can spoil the view and farm consolidation affects traditional elements of the landscape.
- **Preservation of genetic diversity (+ and -):** The livestock sector is crucial for meadow birds in the Netherlands and also for the lifecycle of migrating species, but intensive production and high water levels constitute a threat to meadow birds.
  - Soybean cultivation contributes indirectly to the deforestation of the Amazon rain forest.
  - The genetic diversity of the livestock herd itself is declining because of the very small number of breeds (particularly Holstein-Frisians) and the use of only a few bulls from those breeds (e.g., Sunny Boy) for insemination.

Dairy farming

Risks in relation to ecosystem services

- **Operational risks:**
  - Pressure from rising land prices and from urban spread in the Randstad and other urban concentrations in the provinces of Zuid-Holland and Noord-Holland (Vogelzang et al., 2010).
  - There is a risk that markets will be lost if the demand for sustainable production and the use of sustainable feed, including soy, cannot be met.
  - Prices for mixed feed are rising because of competition with production for biofuels (e.g., bio-ethanol) and growing demand in emerging countries.
- **Regulatory risk:** Restrictions on the use of fertilisers or production in relation to phosphates and the accumulation of metals in the soil (due to the metal content in mixed feed) are possible, as well as restrictions on the use of antibiotics.
- **Reputational risk:** Production curbs and the culling of cattle could be implemented as a result of infectious diseases, such as foot-and-mouth disease.

Opportunities in relation to ecosystem services

- **Ecological intensification:** 'Ecological intensification' of land use in the Netherlands, whereby even more nutritional value is retrieved from the land used, thus reducing the dependence on imported raw materials.
- **Aesthetic value:** The livestock sector could help to enhance the quality of the landscape through agricultural nature management.
- **Markets for ecosystem services:** Farmers could provide 'blue services' by helping to make water cleaner through more extensive land use along waterways and by storing water during wet periods.

Dairy farming

Case study: the use of soy

Replacing regular soy with certified soy or rapeseed

The agro & food top sector recently committed itself to increasing the share of certified products in the major import streams (such as soy, palm oil, coffee and cacao) to 90% by 2020 (Top Sector Agro & Food, 2011). This is in line with the growing trend among food companies and food retailers to buy only products for which they can guarantee the sustainability of the entire chain.

As already mentioned, dairy farmers depend in part on mixed feed with the correct composition, because it can increase production. The chain approach means that the demands concerning sustainability are also likely to have consequences for the mixed-feed industry.

In the two case studies for this sector, we describe the dairy farmers' financial dependence on soy and the impact of the transition to certified sustainable soybean and rapeseed meal.

Use of soy in the Netherlands

Soybean is an annual crop that produces an edible bean with a high protein (40%-50%) and oil (20%) content. Soy is a good source of protein for both human consumption and animal feed.

Soybean oil is the most widely consumed vegetable oil in the world, and soybean meal is by far the most important source of vegetable protein for animal feed. In 2008, the soybean accounted for 68% of the protein for animal feed in the EU (Bouxin, 2009). For every kilogram of milk produced, eleven grams of soybean product (excluding soybean hulls) are used (Hoste and Bolhuis, 2010).

The production of vegetable protein in Europe is unable to fully meet the demand (LEI, 2010), so much of it is imported and a large share of the imports comes through the Netherlands. After China, the Netherlands is the largest importer of soybeans in world. In 2008, this country accounted for 27% of EU imports of soybeans (3.9 million tons) and 22% of EU imports of soybean meal (5 million tons). A substantial proportion of the imported soybeans are not intended for domestic consumption but are forwarded to the intensive livestock sector in Northern Europe.

The bulk of the soybeans produced in the world are used for animal feed. Because of its high protein yield per hectare (0.8-1.55 ton/ha) and good fatty-acid composition, the price-quality ratio of soybeans is far better than other sources of protein. Soy is a good supplement in a maize ration and increases milk production as well as the protein content in milk.

The total land area devoted to soybeans globally increased from 50 million ha to 103 million ha in the period 1980-2009. The United States, Brazil and Argentina are the largest producers and exporters of soybeans (Kamphuis et al., 2011). The link with deforestation is evident: when trees are felled for timber, the cleared land is first used as pasture for livestock, and later for arable farming, including the cultivation of soy.

Soybean meal is a by-product from the preparation of soybean oil. After the beans are crushed, the fat/oil is removed by dissolving it in a liquid. The meal then contains more protein and less energy than soybean expeller and soybean cake (for which the fat/oil is removed mechanically and more fat is retained).

Consumption of soybean products in mixed feed

In the Netherlands, 93% of the soybeans consumed are used in animal feed, only 6.5% in food for human consumption, and 0.5% in technical applications.

The average consumption of soybean products for animal feed was almost 1.8 million tons in the period 2008-2010, of which 1.7 million tons was used in mixed feed. Figure 10 shows the consumption of soybean products in mixed feed for each segment in the livestock sector. Pig and poultry farms are the largest consumers of soyabean products because of their high demand for soybean equivalents (sbeq).
The dairy farming sector consumes an average of 195,000 tons of soybean equivalent per year, and in 2007 and 2008 also consumed an average of 70,000 tons of soybean meal and 6,000 tons of soybean hulls as separate raw materials (Hoste and Bolhuis, 2010).

Dairy farming

The soybean chain

The three major suppliers of soybeans are Brazil, Argentina and the United States. In 2010, the production of soy on the basis of genetic modification represented 100%, 75% and 93% of the total production in Argentina, Brazil and the United States, respectively (Soystats, 2011). Whereas there is opposition to genetic engineering in Europe, it is far less controversial in the South American countries (Franke et al., 2011).

At the same time, the demand for soy in emerging countries is growing rapidly. In the last 10 years, China has started importing more soybeans than Europe (ICONE, 2011), and in 2010 the country imported 56.6 million tons, or approximately 61% of worldwide imports of soybeans. The demand for soybeans in China is expected to climb to 73.1 million tons in 2020 (FAPRI, 2011). China does not employ sustainability criteria for purchases of soybeans, which removes some of the incentive for soy producers to comply with the standards of the Round Table on Responsible Soy (RTRS) (ICONE, 2011).

Soybean meal is no longer a by-product but a primary product

The oil determines roughly 40%-55% of the value of a soybean, and the meal approximately 45%-60% (Hoste et al., 2010).

Figure 10: Consumption of soybean products for mixed feed, by segment
(in 1,000 tons/year)

	Meal	Hulls	Oil	Beans	Total	Sbeq[10]
Dairy	139	221	0	0	359	195
Beef	23	13	0	0	36	32
Pig fattening	159	71	13	21	264	245
Pigs for consumption	300	6	2	0	307	423
Laying hens	199	0	7	7	213	286
Poultry	350	0	5	34	388	527
Miscellaneous	57	28	0	0	85	80
Total	**1,226**	**339**	**27**	**62**	**1,654**	**1,788**

[10] One soybean equivalent (sbeq) is equal to the cultivation required for a particular weight in soybeans, to meet the demand for meal and/or oil.

Source: Hoste and Bolhuis (2010)

Because of various examples of genetic modification, however, the soybean is not uncontroversial in Europe. For this reason, the use of soybean oil in the European food industry has declined sharply, but animal feed does still contain high percentages of genetically modified soy. Consequently, soybean meal is regarded less as a by-product of soybean oil, and its economic importance is growing.

Consequences for dairy farming

The growing demand for soy from emerging countries and the debate about the sustainability of soy cultivation in Argentina and Brazil has two important implications for dairy farming.

First, there is a growing threat of upward pressure on prices and a risk that certification will become less important because the soybean can still be sold to emerging countries, which creates a risk for the security of supply.

A second risk is that the sales channels will actually start demanding guarantees that only sustainable raw materials are used and, therefore, that only certified soy is used in feed.

Dairy farming
Case study 1A: Certified soy

In this case study, we calculate the financial consequences of replacing regular soybeans with certified soybeans. In particular, we look at the costs of switching feed for the average dairy farmer.

There are various initiatives to promote sustainable soybean production, not only in the dairy farming industry but throughout the dairy chain. The Dutch Feed Industry Association (Nevedi), Koninklijke FrieslandCampina, VION, Gebr. van Beek Group, Storteboom and Ahold are members of the Round Table on Responsible Soy (RTRS), the most prominent initiative to promote the use of sustainable soy in food and animal feed. The RTRS has developed a standard for responsible soybean production, which includes requirements designed to reduce the conversion of land with a high value in terms of biodiversity, to promote best practices in the management of arable land and to ensure fair working conditions and respect for indigenous land-tenure claims.

RTRS has also established a certification scheme for the production of soybeans and has implemented it in the chain. The first RTRS certification of a soybean farm was in June 2011.

A platform for certificate trading has been created to facilitate transactions with certified producers. The maximum price per certificate is currently between USD 2 and USD 5 per ton of soy. Future prices will depend on further developments, but it is expected that the gap between the prices of uncertified and certified soy will disappear if the volumes become substantial (RTRS interview, 2011).

In the Netherlands, the Netherlands Dairy Association (NZO) and the Dutch Federation of Agriculture and Horticulture (LTO Nederland) have established the Sustainable Dairy Chain. The aim of this initiative is to make the Dutch dairy sector a world leader in sustainability through collaboration between the dairy industry and dairy farmers. One of the objectives is 100% use of RTRS-certified soy and sustainable palm-kernel expeller by 2015.

Dutch dairy farms use 359,000 tons of 'residual products' from soybeans (soybean meal and hulls) as concentrated cattle feed every year. Koninklijke FrieslandCampina, a multinational dairy cooperative with 14,800 member farms in the Netherlands, Germany and Belgium, is a major player in the dairy chain. FrieslandCampina works with producers and civil-society organisations to actively promote socially responsible soybean production and to make the soy chain more sustainable.

Another programme launched in the last few years is the Dutch Initiative Sustainable Soy (IDS), which promotes the purchase of responsibly produced soybeans for the Dutch market. Because the IDS has not yet implemented its own system of certification, it has launched a pilot programme to accelerate the adoption of the RTRS process and build a mainstream market for responsibly produced soy. The idea is that every year a predetermined volume of certified soybeans will be purchased for animal feed in the Netherlands. In 2009 the target was 50,000 tons, rising to 100,000 tons in 2010 and 150,000 tons in 2011.

Dairy farming

Impact on the income statement

Calculations show that the impact of the transition to certified soybean meal on the costs of animal feed is minimal. The cost price of feed with uncertified soybeans is EUR 42,620. If certified soy is used, the cost of rises by approximately 0.1% (a total cost of between EUR 42,644 and EUR 42,680), assuming that the costs of certification only have an effect on the price of feed (and not on the price of soybean oil or concentrated soy protein used in the production of vegetarian burgers, for example).

For a successful transition to certified soy, however, the entire value chain for animal feed has to be involved because the transition could affect the trade balance of other parties. To illustrate, dealers have a fundamental impact on the trade volume of raw materials. In their search for the ideal composition of feed (in terms of cost), a minor intervention in the prices could prompt major shifts in their demand for soy.

Figure 11: Impact of certified soy on the income statement of dairy farmers (in EUR)

	Uncertified soya (in EUR)	**Certified soya** (in EUR)
Production value	203,640	203,640
Cost of feed	42,620	42,644 – 42,680
Operating income	**47,673**	**47,629 – 47,592**

Explanation of calculation: The cost price of feed in the scenario for certified soya is calculated on the basis of price x volume.It is assumed that the price of certified soya is USD 2-5 (= EUR 1.53 – 3.82) higher. The volume (i.e., soya consumption per dairy farmer) is assumed to be 15,720 kg. based on the total soya consumption in the dairy farming sector (in the Netherlands), divided by the total number of dairy cows in the Netherlands.

Dairy farming

Figure 12: Effect on the ecosystem balance sheet: transition to certified soy

Ecosystem service	Location	Status	Comments
Provisioning services			
Food	Worldwide (the Netherlands and other countries)	▼	Because of stricter rules for land use and the use of chemicals and fertilisers for the production of certified soy, the volume of soybeans produced per hectare could be lower in the short term.*
Freshwater	South America	▲	Where there is irrigation, sound farming practices based on established procedures have to be followed, according to the RTRS. There are also guidelines for the use of water.
Regulating services			
Climate and air-quality regulation	South America	▲	The transition of land use from savannah and forests to soybean fields might lead to CO_2 emissions and eliminate the possibility of carbon sequestration. The Roundtable on Responsible Soy (RTRS) criteria are based on the use of existing farmland to grow soybeans. This could have a positive effect.
Purifying/treatment capacity	South America	▲	Certification implies that only legally permitted chemicals are used.
Supporting services			
Habitat for flora and fauna	South America (Argentina and Paraguay)	▲	The RTRS has adopted the criterion that all the land used by the farmer for certified soy must be land that was converted to farmland before 24 July 2006.
Preservation of genetic diversity	South America	▲	The RTRS has adopted the criterion that all the land used by the farmer for certified soy must be land that was converted to farmland before 24 July 2006. This principle is also laid down in the Soy Moratorium in Brazil, which represents an attempt to halt further clearance of rain forests by protecting biodiversity hotspots. They include the Cerrado, which is home to more than 11,000 plant species (44% of which are found nowhere else), and which accounts for 5% of the world's biodiversity. By forming an enormous water reservoir and with its substantial capacity to capture CO_2 in the vegetation and in the soil, the region is also known as 'Brazil's water tank' and is a key area for climate change. Although certified soy can contribute to the preservation of hotspots such as the Cerrado, the causal relationship between certification and preservation of biodiversity in general has not yet been shown (KPMG, 2012).

▲ Positive effect on the ecosystem ▼ Negative effect on the ecosystem

*) In this study, we assume that RTRS soy complies with the national legislation in each country. In Brazil, in particular, compliance with national legislation means restrictions on land use for soy production (particularly in sensitive areas).

Dairy farming

Figure 13: Impact on other parties and society: transition to certified soy

Other parties in the physical environment and the chain	**Physical environment** • The transition from regular to certified soy has no impact on the dairy farmer's physical environment in the Netherlands.	**Chain** • Foreign soy producers, dealers and mixed-feed producers see a growing demand for certified soy. • A demand-driven (from supermarkets/milk producers) transition to certified soy could contribute to scarcity and higher prices. It is not yet clear to what extent such an increase in price could be passed on to farmers and, in particular, to other parties in the food industry. • More expensive raw materials for animal feed could lead to higher milk prices for consumers.
Social gains and losses & general social effects	**The Netherlands** • Europe (including the Netherlands) imports roughly 35 million tons of soybean meal, primarily from Brazil and Argentina. The EU relies heavily on protein-rich crops and approximately 75% of the imports of protein-rich food is in the form of soy products (Netherlands Environmental Assessment Agency (PBL), 2011). • The transition to certified soy will enhance the reputation of the dairy sector and raise awareness among the general public.	**International** • There could be a positive impact on the social aspects of soybean cultivation, such as fewer land disputes, a reduction in the relocation of small farms, as well as better working conditions, fewer health problems and an improvement in local food security and employment (Kamphuis et al., 2010). • The RTRS stipulates that children and minors must not perform dangerous work or work that impairs their physical or mental well-being. • Another positive effect relates to the RTRS requirement that workers, leaseholders, contractors and subcontractors must have a written contract in a language that they understand. All workers must receive adequate and suitable training and receive comprehensible instructions. The transport and storage of agrochemicals must also be safe, and all relevant health, environmental and safety measures must be taken.

Dairy farming

Case study 1B: Soy replacement with rapeseed meal

In this case study, we calculate the financial consequences of replacing regular soy with rapeseed meal. We concentrate on rapeseed meal because of its ready availability in the EU and its high protein content, which makes it a realistic substitute for soy. However, the case study also illustrates the potential for replacement of soy with other raw materials.

Animals are given feed with a balanced composition of raw materials whose ingredients meet specific nutritional requirements in terms of raw protein, amino acids and fat. Soybean meal has a relatively high protein content. However, there are other products, such as rapeseed, sunflower pits (also sunflower meal) and palm pits, crops that could also provide the protein needed in feed (Hoste and Bolhuis, 2010). Legumes such as peas, lupines, lucerne and clover could also replace soy, at least partially. Figure 14 shows the levels of raw protein and lysine, methionine and cystine in some soy substitutes.

In terms of nutritional composition, studies have not identified any clear winner from among the potential soy substitutes. As a rule, if a component of feed, such as soybean meal, is scarce – for whatever reason (climate, politics, etc.) – the shortage can be made up by using other components, but this does have an impact on the price of the feed and, hence, on the farmer's costs.

The use of alternative crops also increases the pressure on land use, since more land is needed to produce the same quantity of protein that is obtained with soybean meal, which could cause land conversion.

Figure 14: Raw protein, lysine, methionine and cystine content of soy alternatives (in g/kg)

	Raw protein	Lysine	Methionine + Cystine
Soybean meal (46% protein)	487	28.5	13.3
Rapeseed meal	335	18.4	15.1
Sunflower meal	347	12.1	13.5
Peas	211	15.0	5.3
Lupines	314	15.1	6.9

Source: CVB (2007)

Apart from the raw protein content, the amino acids in the feed are also relevant. Amino acids are the building blocks of protein and are found in milk and meat in a specific, permanent ratio. A cow with a deficit of a particular amino acid has to produce it itself, but a cow cannot produce the so-called 'essential amino acids', such as lysine and methionine, itself. In other words, the cow must ingest them in its feed. A shortage of an essential amino acid will act as a constraint on milk production, and the production of milk protein will automatically decline. In practice, the amino acids methionine and lysine are most likely to be a constraint in a grass/maize ration and are therefore generally added to the feed.

Protein-rich crops are only grown on a modest scale in the EU (Hoste and Bolhuis, 2010), where the predominant alternative source of protein is rapeseed. Rapeseed meal is the by-product of the extraction of oil from rapeseed and is used as feed for cattle and pigs. The product is usually used as a protein supplement for low-protein grass and maize silage. The production of oil seeds in the EU is is dominated by rape and sunflower (based on data for 2007). Figure 15 shows the land use in the EU countries with the largest areas dedicated to three oil seeds (rapeseed, sunflower seed and soybeans) in 2007 (EUROSTAT, 2011). Twice as much rapeseed as sunflower seed is produced in the 27 EU countries (EUROSTAT, 2011). Most of the production is in North-West Europe.

Dairy farming

Impact on income

The protein yield per hectare declines with a shift from soy (960 kg/ha) to rape (792 kg/ha) (Vahl, 2009), which means that a mixed-feed manufacturer would have to formulate a new optimal composition for its animal feed. For the dairy farmer, it means that the cost of feed will rise in relation to the production value of the milk. On average, the price of feed would rise by EUR 0.12-0.15 per 100 kg of milk if soy were replaced by other raw materials, including rapeseed meal (De Boer et al., 2006). The ultimate impact of a transition to rapeseed meal on the farmer's income is limited, however; the operating income would decline by a maximum of 1.8% (see figure 16).

Shift in use of agricultural land

The transition to rapeseed meal could also have consequences for the use of agricultural land in North-West Europe.

Since practically all of the land suitable for farming in North-West Europe is already being used, this could lead to land conversion or the relocation of production to other parts of Europe. The oils extracted in the production of the meal can, in fact, also be used in food for human consumption and to produce biofuels and bioplastics.

In the short term, this probably means there will be additional pressure to increase the yield per hectare of domestic crops with the help of agro-ecological intensification.

Figure 15: Land use for oil seeds in EU countries (Area in 1,000 ha)

	Coleseed/Rapeseed[11]	Sunflower seed	Soy
Bulgaria	51	624	0
Czech Republic	331	24	7
Germany	1,550	19	0
France	1,588	506	32
Italy	8	89	105
Spain	18	620	1
Hungary	223	388	27
Poland	797	0	0
Romania	344	821	132
United Kingdom	679	0	0
Netherlands	3.4	0.4	0
Total	**5,592**	**3,091**	**304**

Source: Eurostat (2011)

[11] Sources do not always make a clear distinction between rapeseed and coleseed. We therefore include both under the same heading.

Figure 16: Impact of rapeseed meal on dairy farmer's income (in EUR)

	Uncertified soya	Rapeseed meal
Production value	203,640	203,640
Cost of feed	42,620	43,303 to 43,475
Operating income	**47,653**	**46,969 to 46,799**

Explanation of calculation: The cost of feed in the scenario with rapeseed meal is calculated on the basis of price x volume. It is assumed that the price will rise by 0.12 – 0.15 EUR per 100 kg of milk with replacement by rapeseed meal. The volume (i.e., milk production per dairy farmer) is assumed to be 569,664 kg, based on the average number of cows per farm multiplied by the average milk production per cow. Additional costs associated with the artificial addition of amino acids to the feed have not been calculated.

Dairy farming

Hopeful prospects
There are several possible scenarios.

- In the long term, other alternatives will emerge, such as oil-containing algae, cultivated in salt water, to produce biodiesel, with the protein residue being used for animal feed.

- The cultivation of sunflowers and soy in South-East Europe (Ukraine, South Russia, Romania) could increase. In principle, production there will not be at the expense of forests, but it will take time for these countries to reach an acceptable level of production. The land is currently used mainly to grow grain and, to a lesser extent, sunflowers. The yields per hectare on very fertile land are sometimes only half the usual yields in Western Europe. If the yield per hectare of these products increases, arable land that is already in use would be freed up for other crops. Soy can be grown at that latitude and would then be an attractive option. The FAO and OECD, among others, have confirmed this, and have been reporting for some time in their annual Outlooks that these regions have considerable potential that is not being fully exploited at the moment.

Dairy farming

Figure 17: Effect on the ecosystem balance sheet: replacement of soybean meal with rapeseed meal

Ecosystem service	Location	Status	Comments
Provisioning services			
Food	Netherlands and EU	▼	The protein yield per hectare would decline with a transition from soy (960 kg/ha) to rapeseed (792 kg/ha) (Vahl, 2009, p.33).
Food	Netherlands	▲ ▼	Feed is provided with a balanced composition of raw materials that meet specific nutritional requirements in terms of raw protein, amino acids and fat, among other ingredients (Vahl, 2009). It is not clear whether replacing soy with rapeseed meal would retard the growth of the cow and/or lead to lower milk production.
Regulating services			
Climate and air-quality regulation	Netherlands and EU	▼	A study in the dairy farming sector in France comparing the environmental effects of the use of rapeseed meal produced in France with soybean meal scrap from Brazil concluded that the cultivation of soybeans generates relatively fewer direct emissions (Lehuger et al., 2008).
Purifying/treatment capacity	Netherlands and EU	▼	A study in the dairy farming sector in France comparing the environmental effects of the use of rapeseed meal produced in France with soybean meal from Brazil concluded that relatively more chemical fertilisers are used in the production of rapeseed (Lehuger et al., 2008).
Supporting services			
Habitat for flora and fauna	South America	▲ ▼	Replacement with rapeseed meal produced in the EU might reduce the need for deforestation for soybean fields and, hence, the fragmentation of habitats.On the other hand, soybean meal has a relatively high protein content. An alternative crop (such as rapeseed meal) would require a relatively greater area of land to produce the same amount of protein. The transition to alternative crops could therefore intensify land use elsewhere.
Preservation of genetic diversity	South America	▲	Replacement with rapeseed meal produced in the EU by the dairy farming sector could (indirectly) reduce the pressure for deforestation in South America and the use of genetically modified organisms, which would preserve genetic diversity in this ecosystem.
Preservation of genetic diversity	Netherlands and EU	▼	As a result of Indirect Land Usage Changes (ILUC),fed by greater demand for rapeseed meal with relatively high claims on the land, land conversion could also occur in Europe.

▲ Positive effect on the ecosystem service   ▼ Negative effect on the ecosystem service

Dairy farming

Figure 18: Effect on other parties and society: replacement of soy with rapeseed meal

Other parties in the physical environment and the chain	**Physical environment** • The transition from soybean meal (mainly from Brazil and Argentina) to rapeseed meal (mainly from Europe) represents a shift in arable production in Europe. • It might encourage the cultivation of rapeseed around concentrations of livestock farms and/or lead to pressure on/conversion of the available natural areas in these regions, leading to a transformation of the landscape.	**Chain** • Arable farmers in the Netherlands would be affected because some of the rapeseed required could also be grown in the Netherlands. • International soy producers, dealers and mixed-feed companies could face a fall-off in demand for soy or demand for soy from other regions of the world. • Rapeseed is also used as a raw material for bio-diesel. The impact of the competition for use of land between production for food, animal feed and biodiesel is still unclear. • The impact on the price of other agricultural crops, such as grain, is unclear. The price of soy is linked to that of grain, because, besides being an energy carrier, it also contains protein (Hoste and Bolhuis, 2010). The replacement of soy would therefore exert downward pressure on the price of grain, but at the same time upward pressure due to competition for land.
Social gains and losses and general social effects	**Netherlands** • No other relevant effects	**International** • Substitution will create different trade flows, with associated effects.

Dairy farming

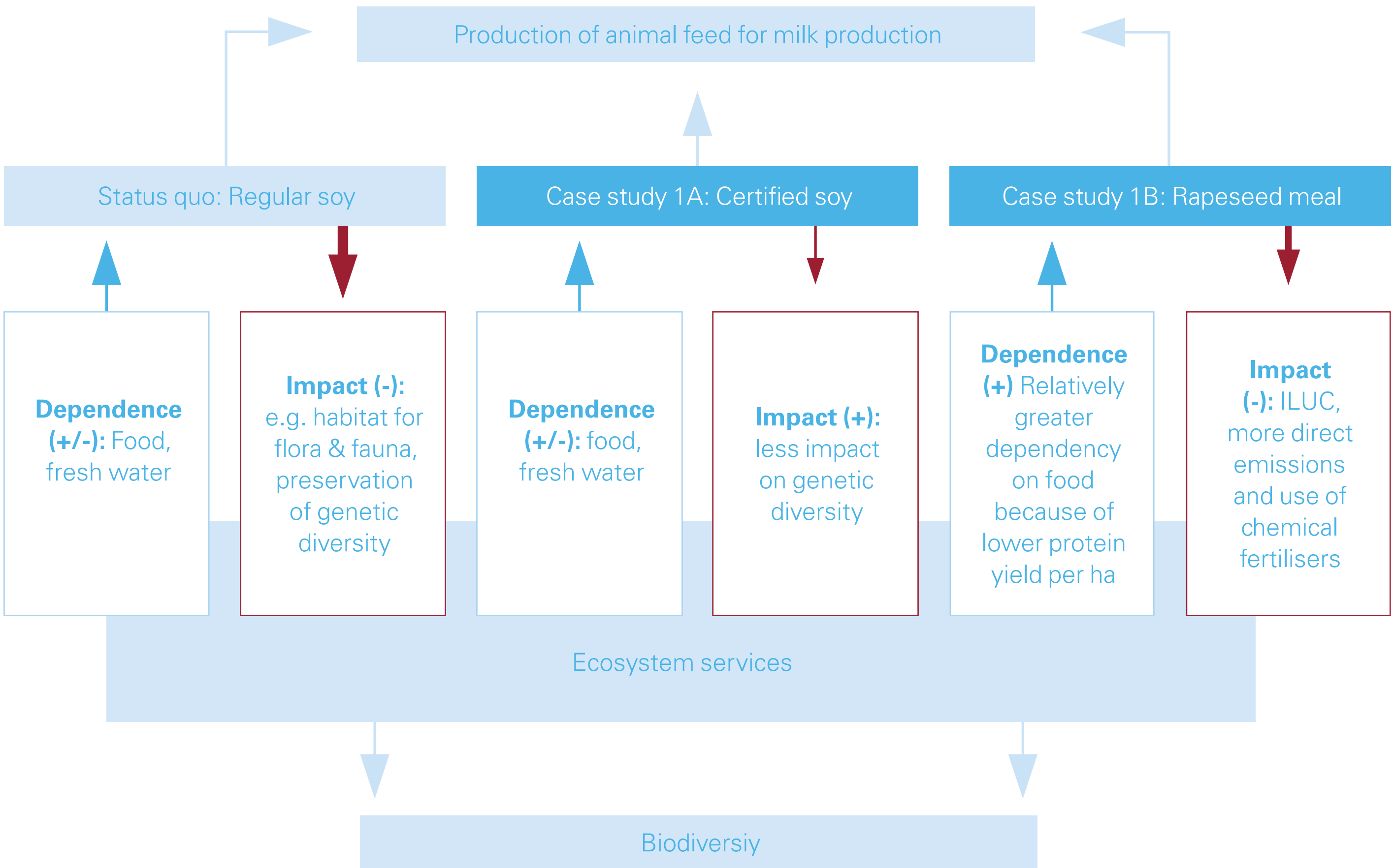
Issues and implications for companies and policymakers

De transitie naar gecertificeerde soja A diagrammatic overview of the importance of ecosystem services
The effects of a transition to certified soy and the use of rapeseed meal on ecosystem services vary. With certified soy, the dependencies remain the same, but there are fewer impacts. With the replacement of conventional soy with rapeseed meal, the dependence on the provisioning service, food, increases. At the same time, the impact in areas traditionally rich in soy will be reduced, which could lead to a decline in deforestation in the Amazon region; however, a larger area of agricultural ground will be required elsewhere for the production of rapeseed meal.

Issues and strategic implications for companies
In the short term, the dairy farming sector will face growing pressure from supermarkets and the food industry for guarantees of the sustainability of the entire chain. This will have consequences for the dairy farming industry (and the mixed-feed industry), which will increasingly have to ensure that their operations and the feed they use comply with prevailing sustainability criteria. It is not unlikely that the consequences will be felt further down the chain. For soy, this could mean that only certified soy (from Brazil and Argentina) will be used in feed and/or that there will be a shift to alternative ingredients from the EU. In that context, the dealers and producers of mixed feed will have an important role in ensuring that the soy is actually certified.

In the long term, there are some impotant trends affecting the agricultural sector:

- The end of the current Common Agricultural Policy and milk quotas creates the risk of an increase in the volume of milk produced, which would exert downward pressure on prices (and reduce the possibility of implementing any measures to improve sustainability that might increase costs if they only apply in the Netherlands).



Dairy farming

- There is growing pressure on the availability of imported raw materials for dairy farming because of strong demand from emerging countries, on the one hand, and competition from the use of land to produce biofuels and raw materials for the chemical sector, on the other. In fact, industry mainly needs the hydrocarbons from the plants, while it is primarily the proteins that are used for animal feed.

- Innovation is becoming more important in the search for cheaper sources of protein for feed. An example would be the production of algae for oil, as a fuel and for use in chemical products, and for proteins for animal feed.

- There is growing competition with housing and business parks for the available space in the Randstad.

Companies and their trade associations will have to focus their strategies on guaranteeing that the business operations throughout the chain are sustainable. Otherwise, businesses in the chain face the risk of being suddenly confronted with a shift of demand to parties that can provide that guarantee.

Issues and policy implications for policymakers

For the transition to certified soy or sustainable raw materials grown in Europe, it is important for mixed-feed producers to switch to different raw materials and for dealers to base their procurement policy on specific sustainability criteria. To a certain extent, therefore, the dairy farmer is dependent on the other parties in the chain to meet the requirements of supermarkets and food producers. It is crucial for the competitiveness of the sector that it anticipates these requirements intime. However, a problem with the growing demand for assurances that the production chain is sustainable is that it is not entirely clear that every party in the chain will benefit sufficiently to justify the necessary effort and expense.

In that respect, the role of the Dutch government in the short and medium term is:

- to actively encourage the sector to perform chain analyses in order to identify the (financial) potential of substitution with other protein carriers;

- to support initiatives by the sector to make the chain more sustainable with a view to its future competitiveness, along with initiatives to introduce certification to help make the sector and the chain more sustainable;

- to accelerate fundamental research into new protein carriers, such as algae, for the Dutch dairy sector (and other agricultural sectors), such as algae.

- to make clear choices about what land is and will remain zoned for agriculture.

Arable Farming

Arable Farming

Description of the sector

Arable farming in the Netherlands
Tha largest user of land after dairy farming, covering approximately 461,000 ha (LEI & CBS 2011, p. 33), arable farming (grain, sugar beet and potatoes) accounted for 42% of the land used for agriculture in 2008 (CBS, 2008).

While in many other countries cultivation is dedicated mainly to grain, in the Netherlands the sector is dominated by root crops (potatoes, beets and vegetables). Grain is less important in economic terms and, because of the high moisture content of grain produced in the Netherlands, is not really suited to making bread and is used mainly for animal feed, in brewing and as a source of starch. It also plays a role in crop rotation. The rotation of grains with other crops – such as potatoes and maize – impairs the growth of bacteria and the impact of insect pests (Melman & Van der Heide, 2010).

In 2010, approximately 153,000 ha of arable land were devoted to grain, 118,000 ha to potatoes and 51,000 ha to sugar beets (LEI & CBS, 2011), generating production of approximately 6.8 million tons of potatoes and roughly 5.1 million tons of sugar beets (LEI, 2011). The increase in labour productivity and production per hectare over the last century in the Netherlands has been attributed to extensive mechanisation and growth in the size of the farms (consolidation) (Melman & Van der Heide, 2011).

The increase in crop production since 1975 has been modest compared with increases in the dairy farming sector, perhaps because, unlike milk production, crop production cannot be enhanced with raw materials from abroad (Melman & Van der Heide, 2011).

The negative external effects of modern food production include high energy inputs, the use of artificial fertiliser and the use of chemical agents to fight diseases and pests. Larger-scale farming can also impair the cultural-historical and aesthetic value of the landscape (Melman & Van der Heide, 2011).

Figure 19: Key figures for arable farming

	Numbers
Production value of potatoes (in EUR million) (in 2009) [12]	1,000
Production value of grain (in EUR million) (in 2009) [12]	204
Production value of sugar beets (in EUR million) (in 2009) [12]	275
Number of holdings with potatoes (in 2010) [13]	9,334
Number of holdings with grain (in 2010) [13]	14,992
Number of holdings with sugar beets (in 2010) [13]	8,785
Average annual income (in euro) per arable holding (2005-2009)[14]	70,840
Total area of arable crops (ha) (in 2010) [15]	

[12] LEI (2010), [13] CBS (2011), [14] LEI/Binternet (2011), [15] LEI (2011)

The following figures show the production capacity for grain and root crops (potatoes and beets) in 2008. The dark blue areas have the highest yields per hectare and are very similar for the two types of crops (crop rotation).

Figure 20a: Production of grain, 2008 (tons per km^2)

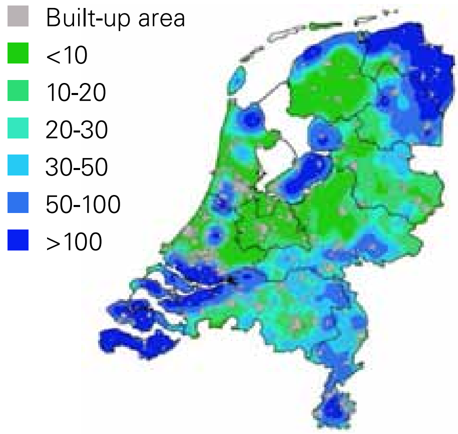
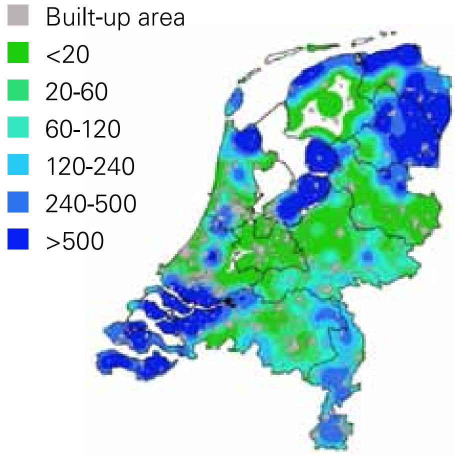


Figure 20b: Production of potatoes and beets, 2008 (tons per km^2)



Source: Melman & Van der Heide (2011)

Arable Farming

Description of business

The average area under cultivation on an arable farm is 60.8 ha, of which 58 ha was used for crops (in the period 2005-2009). Many arable farms use crop rotation to enhance the fertility of the soil.

On the following pages we discuss the opportunities that could arise from active management of field margins and the use of non-inversion tillage.

The table in Figure 21 presents the income statement for an average holding of 58 ha. The case study on 'field-margin management' (2a) describes how this income statement would change with the adoption of field-margin management.

In the case study on non-inversion tillage (2b), we describe the potential financial effects of this approach in general terms for the farmer.

Figure 21: Average income statement for an arable farmer

Income (in EUR)			
Arable Farming			166,220
	Wheat	23,660	
	Barley	5,240	
	seed potatoes	42,760	
	edible potatoes	31,780	
	starch potatoes	8,840	
	sugar beets	26.460	
	onions for sowing	13,860	
Vegetables			5,380
Other horticulture			180
Livestock farming			760
Intensive livestock farming			600
Other income			56,960
incl.	income allowances and subsidies	24,100	
	sale of energy	280	
Total income			**230,100**
Costs and depreciation (in EUR)			
Animal-based and vegetable-based assets			54,700
incl.	feed	460	
	fertiliser	10,760	
	seed	14,900	
	crop-protection agents	19,740	
Energy		3,560	3.560
Intangible assets (depreciation of milk quota)		180	180
Tangible assets		73,680	73.680
Paid labour		5,320	5.320
Work by third parties		10,720	10.720
Financial costs		18,620	18.620
Overhead		11,720	11.720
Total costs and depreciation		**178,500**	**178.500**
Income from normal business operations		**51,600**	**51.600**

Source: LEI/BINternet (2011). The data are averages over the period 2005-2009.

Arable Farming

Dependencies, impacts, risks and opportunities

Input: Dependence on ecosystem services

- **Fresh water:** Arable farming is a major consumer of water in the Netherlands. The sector uses precipitation, supplemented with irrigation during periods when the soil is not moist enough. Every year agriculture uses approximately 80-240 million m3 of water for irrigation (Hoogeveen et al., 2003; Melman & Van der Heide, 2010).
- **Raw materials:** Agriculture in Europe depends to a certain extent on imports of minerals for artificial fertiliser, phosphate in particular.

Output: Impact on ecosystem services

- **Food (+):** An increase in the yields per hectare for crops such as potatoes, grain and sugar beet.
- **Fresh water (-):** The large quantities of groundwater that are used for irrigation place a substantial strain on supplies of Freshwater, cause the groundwater level to decline and can result in the desertification of nearby nature areas (Melman & Van der Heide, 2011).
- **Purifying/treatment capacity (-):** Raising the groundwater level with water from elsewhere often increases the nutrient density in the water and reduces the ecological value of an area. Farming, itself, also releases nutrients into the runoff.
- **Erosion prevention and preservation of soil fertility (-):** Managing potato cultivation to maximise productivity ultimately reduces the natural fertility of the soil. Significant volumes of nutrients are removed from the field when the vegetables are harvested, while more nutrients are lost through erosion and leaching.

Arable Farming

Risks in relation to ecosystem services

- **Operational risks:**
  - Crop diseases: One of the diseases that still affect potatoes in Europe is Phytophtora infestans, the cause of potato blight.
  - Ground water: Excessive extraction of groundwater in coastal areas leads to salinisation, which results in additional costs because of lower yields per hectare and/or the need to secure a supply of Freshwater. Excessive salinisation will make crop production as we now know it impossible.
- **Regulatory risks:** The nitrogen/phosphate concentrations in roughly half of the regional surface waters in the Netherlands are still higher than the limits prescribed in the EU Water Framework Directive. The Netherlands' Fourth Action Programme on the Nitrate Directive, which runs from 2010 to 2013, includes policies on manure and minerals designed to improve the situation.
  The government has announced that the policies will be tightened further in the Fifth Action Programme, which will be implemented from 2014 (LEI, 2011).

Opportunities in relation to ecosystem services

- **Sustainable supply chains:** The arable sector can make greater use of the agricultural environment itself, by employing active field-margin and soil management, for example (Melman & Van der Heide, 2011).
- **Markets for ecosystem services:**
  - There are subsidy schemes for active field-margin management, where buffer strips are created between ditches and crops. Grass and flowers are grown in these strips to attract the natural enemies of pests, thereby avoiding the use of pesticides and chemical crop-protection agents and reducing water pollution.
    The method also reduces the loss of nutrients through runoff (case study 2A).
  - There are also subsidy schemes for non-inversion tillage, which protects soil organisms, particularly earthworms. Earthworms preserve the quality of the soil structure by breaking up organic matter and spreading it through the soil (case study 2B).
  - Although subsidies are being cut back severely at the moment, there are still markets for ecosystem services, usually in the form of payments for their conservation and maintenance as in case study 4A. But there are also payments for leaving land fallow to avoid grain surpluses at certain times, for example.

Arable Farming

Case study 2A: Active field-margin management

In this case study, we calculate the financial consequences of active field-margin management, giving special attention to the associated costs of constructing and managing field margins, the ensuing loss of profits and the income from subsidies. We also discuss other effects, positive and negative, in qualitative terms.

Field-margin management involves creating buffer strips between ditches and crops. No fertilisers or chemical crop-protection agents are used in the field margins. In addition, the grass cuttings from the ditch and the field margin are removed once or twice a year, thus reducing the run-off of harmful substances to the surface water.

This form of conservation management of field margins (standing overgrowth, dry and wet plot margins) allows indigenous plants to grow and enhances biological pest control, as well as helping to diminish the prevalence of pests in crops and vegetables.
The buffer strip can also provide a habitat for the natural enemies of insect pests (Melman & Van der Heide, 2011).

Field-margin management is already employed to a reasonably wide extent in the Netherlands. Approximately 700 farmers took part in the Field-Margin Management in Brabant (ARB I) project from 2002 to 2006, exploring how they could incorporate field-margin management into their production activites. The project was co-financed by the Association of River Water Supply Companies (RIWA), since companies that supply drinking water also benefit from improved water quality.

On the basis of the results of ARB I, a second phase (ARB II) was launched for the period 2007 to 2013. In addition to improving the quality of the environment and the water, ARB II focuses on increasing agrobiodiversity, increasing the efficiency of water management and creating additional functions related to water. The ultimate aim is:

- to construct 2,300 km of basic margins alongside water-transporting ditches (there is now a buffer strip stretching approximately 1,500 km along waterways in Brabant);
- to carry out two pilot projects to create an area of approximately 100 km with functional agrobiodiversity (field margins dedicated to natural pest control); and
- to carry out a pilot project with a package of water-related measures (additional functions for water, such as nature-friendly banks, marshy buffer strips or water storage).

For the construction of buffer strips between ditches and crops, participants in the ARB II project receive a payment of EUR 0.35 per metre along grassland and EUR 0.70 per metre along cultivated land. The project is an initiative of the four water boards in Brabant (Brabantse Delta, Rivierenland, Aa en Maas and De Dommel), the province of Noord-Brabant and the Southern Agricultural and Horticultural Organisation (Zuidelijke LTO).

The water boards in Brabant paid 25% of the subsidy for the ARB II project, with the other 75% being paid by the province from the Investment Budget for Rural Areas (ILG) scheme as part of its effort meet the targets for biodiversity.

Figure 22 shows the costs of field margins for the farmer (based on a margin 3.5 metres wide).

Figure 22: Costs of field margins

	Construction costs (in EUR/km)	**Management costs** (in EUR/km)	**Loss of profits** (in EUR/km/year)
Long-term field margin along ditch	427.38	235.26	120.25
Long-term field margin between fields	598.31	329.41	277.23

Source: Ecorys (2007) and FAB (2011). The figures have been corrected for price inflation between 2006 and 2011.

Arable Farming

Research in the Hoeksche Waard shows that it is most cost-effective to create field margins along ditches since less land has to be withdrawn from production.

Water boards benefit from improved water quality, particularly because of lower costs for maintaining ditches, although the average savings from the ARB II project (EUR 0.05 to EUR 0.09 per metre) are significantly lower than the subsidies provided. The principal savings arise from easier access for contractors (who can drive straight through the margin and do not have to guard against damaging crops). The drift of pesticides has also declined sharply, although the benefits of this for water boards are difficult to assess in financial terms, since the costs of water treatment are determined mainly by the basic investments and can only be reduced if there is no pollution at all.

Figure 23: Financial impact of field-margin management for a standard parcel of 150 x 300 metres (in EUR)

	1 year	3 years	6 years
Total costs/loss of profit	958	1899	3798
Construction costs: Machine, labour for tillage and seed	487	487	974
Management costs: Pesticides and herbicides, labour and machines for weeding and mowing	268	805	1609
Loss of profits	202	607	1214
Total income from ARB subsidy	630	1890	3780
Effect on results	**-328**	**-9**	**-18**
Savings for water board	45-81	135-243	270-486

Explanation of the calculation: it is assumed that the entire area is used for perennial field margins, with one long side along the ditch and the other sides between fields (in other words: 300 metres of arable land along the ditch, 600 metres of arable land between the fields). The field margin is assumed to be 3.5 metres wide.

Impact on income statement

Figure 23 shows the effects of managing field margins on the farmer's income statement, for a standard parcel, calculated on the basis of a subsidy of EUR 0.70 per metre. It also shows the effects of additional labour for sowing, mowing, raking and removing vegetation (construction and management costs). A new field margin has to be created every three years.

If an average holding is 58 ha, 12.9 standard parcels of 150 x 300 metres will fit into this land. In this case, there is no independent business case for field-margin management over a period of six years, but the associated costs are almost completely covered by the subsidy. However, the subsidy is a factor of 10 higher than the financial gains for the water boards.

The calculation does not include all the positive effects. Planting more flowering plants in the buffer strips can increase the potential for pollination of crops that depend on pollination by bees and other insects, which can have a positive impact on the crop yield per hectare. Runoff to the ditch will decline, so soil fertility will be conserved and less artificial fertiliser will have to be used. The financial consequences of these aspects are unknown.

Figure 24 shows the consequences of field-margin management for the income statement of an average arable farmer compared with the current situation (without field-margin management). Once again, it is assumed that an average farmer owns 12.9 'standard parcels' of 150 x 300 metres. The calculation shows that the subsidy does not entirely cover the costs of managing field margins.

Arable Farming

Figure 24: Impact of field-margin management on farmer's income statement (in EUR)

		Current situation	Case: construction and management of field margins (after 1 year)	Case: construction and management of field edges (after 3 years)
Total income		228,172	236,299	708,897
incl.	Income allowances and subsidies	22,172[16]	30,299	90,897
Total costs		178,500	190,856	559,999
incl.	Construction and management costs of field margins and loss of profits	12,356	24,499	
Income from normal business operations		**49,672**	**45,443**	**148,898 (49,633 p/j)**

16 This is the amount received in income allowances and subsidies excluding payments for managing field margins. These payments are assumed to be 8% of the total (EUR 24,100), on the basis of the allocation of 1st pillar and 2nd pillar allowances and other payments.

The ARB II project officially ends in 2013. If the province of Brabant does not continue to support field-margin management, the project will be too expensive for the water boards to subsidise alone. The reform of the European Common Agricultural Policy (CAP) will be a factor in determing the future of field-margin management.

Reform of the Common Agricultural Policy

The European Union (EU) intends to amend the Common Agricultural Policy, with the new CAP scheduled to take effect on 1 January 2014 and run until 2020. According to draft texts, transitional policies may apply until 2019. The existing two pillars will remain in place.

Pillar I embraces direct measures for agricultural producers, without co-financing by the member states. The second pillar covers measures to promote rural development, with co-financing.

- Pillar I[17]: Under the first pillar, payments are made per hectare directly to the farmer. The basic subsidy for the average farmer is estimated at EUR 250-300 per ha. In addition, there will be a mandatory link between payments and 'greening' measures, whereby farmers could receive an additional subsidy of up to EUR 120 per ha for taking environmental measures relating to ecological focus areas: every farmer must devote at least 7% of the arable land to ecological purposes. The payment of EUR 120 is, in principle, only intended to cover loss of profits and does not cover active management measures. The water boards also want to encourage the construction of field margins and are considering providing ex ante payments, possibly with co-financing by the province.
- Pillar II[17]: The second pillar is related to rural development, with the emphasis on improving the environment and quality of life in the countryside. With co-financing by the EU and member states (the government, the provinces and/or the water boards), measures to enhance landscape elements, such as blue services, can be financed. It is possible that a package of measures for active management to promote the conservation of biodiversity will be introduced as part of the second pillar, to supplement the 'greening' subsidies. The amount of the allowance for active management will depend heavily on the criteria that are adopted for the quality of ecological focus areas. The amount could vary according to the field margin, the objective and the region. To illustrate, the payments for a brush area will obviously be lower than payments for a field margin rich in flora and fauna. No definitive quality criteria have been adopted yet. In this case study, therefore, we use indicative amounts from the Government Service for Land and Management (DLG): EUR 400/ha18 (interview with DLG, 2012).

Arable Farming

Figure 25: Financial impact of field-margin management for average farmer as a result of CAP reforms (in EUR)

	ARB construction		After CAP reforms [19]	
	(1 year)	(3 years)	(1 year)	(3 years)
Subsidies (for active field-margin management)	8,127	24,381	8,584	25,752
Costs (associated with active field-margin management)	12,356	24,499	12,345	24,477
Balance	**-4,229**	**-118**	**-3,761**	**1,275**

[17] These are indications based on draft texts. No decision has been made on the precise construction under the CAP new-style (European Commission, 2011).

[18] This amount was determined on the basis of the current national packages for land-management organisations. There are two management packages for arable farmers: high biodiversity (management package N12.05: EUR 762.73/ha) and almost fallow (management package N12.06: EUR 64.35/ha) (interview with DLG, 2012)

[19] Explanation of calculation: The amounts are indicative, based on draft texts and interviews with experts from DLG, the Ministry of Economic Affairs, Agriculture and Innovation's European Agricultural Policy and Food Security Department. The income is determined on the basis of a 'greening' subsidy of EUR 120 per hectare for the total area under cultivation, plus a payment of EUR 400 per hectare for active management over the surface area used as an ecological focus area (7%). The costs are determined on the basis of the same key figures as for the ARB construction (costs from findings in Hoeksche Waard translated to EUR/ha), on the assumption that one-third of the surface area of an ecological focus area is along ditches and two-thirds borders on fields.

Arable Farming

Figure 26: Effect on the ecosystem balance sheet: field-margin management

Ecosystem service	Location	Status	Comments
Provisioning services			
Food	Netherlands	▼	Loss of production because the area under cultivation declines.
Fresh water	Netherlands	▲	Parcel-specific storm water retention refers to the temporary retention of water after heavy showers. One possibility might be to retain the water a little longer in the buffer strip. How this can be incorporated in active field-margin management will have to be investigated. It might be a good solution for run-off, particularly of phosphate, into the ditch after heavy rainfall.
Regulating services			
Purifying/treatment capacity	Netherlands	▲	Creating a buffer strip of grass along the ditch reduces contamination of the surface water. The drift of pesticides to the ditch declines by 90%.
Preservation of soil fertility	Netherlands	▲	Buffer strips will reduce run-off of minerals by roughly a quarter, and the soil itself will be more stable.
Pest control	Netherlands	▲	The buffer strip can provide a habitat for natural enemies of pests.
		▼	On the other hand, a stable population of pests could nest in the buffer strip.
Pollination	Netherlands	▲	Planting more flowering plants in the buffer strips will increase the potential for pollination of crops that depend on pollination by bees and other insects.
Cultural services			
Aesthetic/landscape values	Netherlands	▲	Planting more flowering plants in the buffer strips will increase the potential for pollination of crops that depend on pollination by bees and other insects.
Recreation/tourism	Netherlands	▲	For farms with ancillary activities, such as care and tourism, attractive field margins are a promotional tool.
Supporting services			
Habitat for flora and fauna	Netherlands	▲	The buffer strip can provide a resting place for migrating species.
Preservation of genetic diversity	Netherlands	▲	Active conservation management of the strip (not using fertiliser) will produce greater biodiversity locally. Field margins form ecological corridors and shelter for fauna.

▲ Positive effect on the ecosystem ▼ Negative effect on the ecosystem

Arable Farming

Figure 27: Effect on other parties and society: active field-margin management

Other parties in the physical environment and the chain	**Physical environment** • A better habitat for pollinating insects and native plants. • Cost savings for water boards: - Lower costs for treatment of surface water due to lower runoff of chemicals. There are estimates that EUR 2.20 per kilogram of nitrogen and EUR 8.50 per kilogram of phosphorous can be avoided.[20] (Netherlands Commission for Integrated Water Management (CIW), 1999). - Fewer payments to farmers for damage to crops during maintenance to ditches, and lower costs for contractors because of easier access to and slower growth of grass on the slope of the bank.[21] • Stimulus for tourism: Margins around meadows and fields frame the parcel of land and beautify the landscape.	**Chain** • Field-margin management increases the market for businesses that specialise in green and blue services in the form of materials and labour. • Loss of arable land can lead to a reduction in crop production, although this effect will be relatively small with large parcels and when a field margin runs along a ditch. Consequently, the price of certain crops could rise or farmers could switch to crops with a higher yield per hectare.
Social gains and losses and general social affects	**Netherlands** • The Netherlands is famous for its sharply defined parcels and straight ditch edges. Field-margin management could enhance the aesthetic value of this landscape. • This could enhance the appreciation of the landscape among neighbouring residents, passers-by and recreationists.	**International** • No relevant international effects.

[20] These estimates assume that a decline in pollution will lead to a proportionate decline in the costs of water treatment, which is not the case; we therefore use the figures here purely for illustrative purposes.

[21] This will lead to an actual decline in the costs for water boards.

Arable Farming

Case study 2B: Non-inversion tillage

This case study focuses on the impact of non-inversion tillage and reasons for farmers to adopt the practice. In many countries, such as Argentina and the United States, non-inversion tillage is already employed on a large scale. With traditional ploughing, the earth is significantly distrurbed, but non-inversion tillage does not turn the soil beneath a depth of 12 cm, so crop residues are only superficially mixed with the soil. The subsoil can be turned without mixing it with other layers of soil.

Farming based on non-inversion, or minimum, tillage is said to have a number of (economic) advantages, including a reduction in the labour and fuel required to plough the land. For grain cultivation, for example, fewer operating cycles are required because combined sowing and ploughing equipment can be used.

Non-inversion tillage can also improve water infiltration, prevent erosion and preserve the natural fertility of the soil because nutrients are retained and there is an increase in soil organisms, such as earthworms, which play an important role in preserving the fertility of the soil (Melman & Van der Heide, 2011). Finally, non-inversion tillage facilitates the ploughing of rocky soil.

Possible disadvantages of non-inversion tillage are greater pressure from weeds (which leads to the use of more chemical herbicides) and pests (Ruebens et al, 2010), which is likely to lead to more problems with wireworms, black cutworms and the larvae of crane flies, as well as slugs and mice (Van der Weide et al., 2008). Another drawback of non-inversion tillage is that the soil's temperature is lower because the soil particles have less exposure to the air and therefore heat up and cool down less (Licht and Al-Kaisi, 2005). Cooler soils can slow the growth of crops and thus reduce yields.

Figure 28: The effects of non-inversion tillage on the income statement of a farmer

	Income/Costs	Financial impact
Subsidy for non-inversion	Higher income	+
Crops	Uncertain	?
Fuel	Lower costs (substantiated with grain)	+
Staff	Lower costs	+
Pest control	Higher costs	-
Herbicides	Higher costs	-
Machines for tilling and sowing	Investment costs	-

Various pilot studies are currently underway in the Netherlands into the effects of non-inversion tillage:

- In a pilot project in the Hoeksche Waard, non-inversion tillage is being compared with conventional tillage (ploughing). After the first year, when winter wheat was grown after potatoes, there were no negative effects in terms of yield, weed pressure or harm to geese. Non-inversion tillage had a distinctly positive effect on the earthworm population (SPADE).
- The BASIS (Broekemahoeve Applied Soil Innovation Systems) project is investigating the effect of non-inversion tillage on sugar beet, summer barley, summer wheat, carrots and seed potatoes grown in 2009 on parcels of 2.5 ha. After two years of research, it emerged that the yields of grain, sugar beet and potatoes under non-inversion tillage were similar to the yields with traditional ploughing, but yields of winter carrots and onions for sowing were lower. The weed pressure was found to be higher, there was more organic matter in the top soil layer (0-15 cm) but less in the soil layer beneath (15-30 cm), and changes in emissions of greenhouse gases, with a tendency towards lower emissions with non-inversion tillage (SPADE).

Arable Farming

The effects of non-inversion tillage on the income statement of a farmer in Limburg

Some farmers in the south of Limburg have been using non-inversion tillage for some time in order to curb erosion due to runoff and reduce the problem of flooding on ridges. The effect on the income statement of a farm in Limburg can be summed up as follows.

Non-inversion tillage can mitigate erosion from runoff and protect the physical environment from problems caused by mud. In 2011, the province of Limburg and the Roer en Maas water board financed an annual subsidy of EUR 50 per ha for non-inversion tillage. The subsidy that farmers can receive (together with any other allowances) is capped at EUR 7,500 for each period of three tax years; otherwise, it would be regarded as state aid. This is also known as the de minimis threshold.

The findings on how the crop yields perform under non-inversion tillage vary greatly (Melman & Van der Heide, 2011). The studies carried out by Applied Plant Research (PPO) in 2006 on the loess soil in the southern part of Limburg did not identify any clearly positive or negative trends in yields or the quality of potatoes, sugar beets, grain or forage maize.

When soil is simultaneously ploughed and sown with non-inversion tillage, fewer operating cycles are needed, which can reduce labour and fuel costs. The clay soil is normally ploughed during the winter and sown in the summer. There is usually sufficient labour available for the ploughing in the winter, but there can be a shortage of workers in the summer. If the sowing and ploughing are both carried out with non-inversion tillage in the summer, it can create a temporary peak in demand for labour, which is not always convenient.

A higher prevalence of pests and weeds can lead to an increase in the use of herbicides and pesticides. For example, in the south of Limburg, non-inversion tillage has led to greater use of glyphosphate, a non-selective herbicide that is used to eradicate weeds before ploughing. This is necessary because the weeds are not properly worked into the soil with non-inversion tillage and might require greater use of relatively more expensive herbicides later. Research does not clearly show whether more or less artificial fertiliser is used.

Special machines are used for non-inversion tillage, which demands an investment by the farmer. The machines for non-inversion tillage are better than they used to be and can break up the soil deeply and intensively, as with ploughing, but mix it on the surface, so there is less disturbance. This more intensive working is necessary in the Netherlands because of the relatively large volume of root crops. As a rule, these crops are harvested later than cereal crops, and sometimes under less favourable conditions. Deeper ploughing is then necessary to restore the soil structure. In the past, these tilling machines were not available or the farmers did not have tractors powerful enough to do this ploughing.

Too little is known about the effects on the income of the farmer to present a comprehensive overview here.

Hopeful international prospects

In numerous other countries, non-inversion tillage has proved extremely valuable and economically viable for a variety of reasons:

- United States: In this part of the world, non-inversion tillage has to be used because of problems with sand drift.

- Australia: Because of water scarcity and farms that are many times the size of farms in the Netherlands (1,000 ha up to as large as 10,000 ha), non-inversion tillage is mainly used to conserve water and reduce labour costs.

- Ukraine: Non-inversion tillage seems to be a realistic economic alternative here in view of the limited access to capital for ploughing equipment, artificial fertiliser and fuel.

- Argentina: Since the 1970s, because of the climate and the relatively large grain and maize harvests, non-inversion tillage is used on 70% of the land, although it takes around ten years before the soil in newly cleared areas is fully suited to it. The benefits are less use of fuel, prevention of erosion, water conservation and healthier soil life.

As these examples show, non-inversion tillage has proved to be an enduring and profitable option in some countries,

Arable Farming

mainly in light of the size of the farms (costs and capacity) and the climate (in order to conserve moisture). However, there is still no clear evidence that the positive results in other countries can also be achieved in the Netherlands because the issues in other countries – such as water scarcity, wind erosion and extremely high labour and fuel costs associated with large farms – are not always material issues in the Netherlands.

Also, while non-inversion tillage can be beneficial for crops whose roots depend heavily on soil organisms, it works less well on light soils because of the greater compaction (hard crust) after precipitation compared with heavier, moisture-retaining soils.

Figure 29: Effect on other parties and society: non-inversion tillage

Other parties in the physical environment and the chain	**Physical environment** • Non-inversion tillage can reduce erosion from runoff, thereby protecting the physical environment against problems with mud. This effect is particularly relevant in Limburg. Erosion, including wind erosion, is also a problem, also in potato cultivation in other parts of the country, so non-inversion tillage might provide benefits for nearby farms that are sensitive to dust.	**Chain** • With wider application of non-inversion tillage the tractor industry's market could change from ploughing machines to new, specialised machines with disks and teeth that break up deeper layers of soil and mix the organic residues near the surface. In practice, sowing machines fitted with seed discs can be used for non-inversion tillage. • There could be a niche market for these specialised machines in the Netherlands, although it is not known to what extent this would create opportunities for Dutch industry. For the time being, the export market is more interesting.
Social gains and losses and general social effects	**Netherlands** • A reduction of wind erosion (see above) also has benefits for a farm's neighbours.	**International** • No relevant impact found.

Arable Farming

Figure 30: Effect on the ecosystem balance sheet: non-inversion tillage for a farm in Limburg

Ecosystem service	Location	Status	Comments
Provisioning services			
Food	Netherlands	▲ ▼	The findings on crop yields under non-inversion tillage vary greatly (Melman & Van der Heide, 2011). Experts from the LEI who were consulted expect a significant decline in yields for potatoes and sugar beets because they need a lot of oxygen in the soil.
Fresh water	Netherlands	▲	By retaining the organic matter on the surface, the top layer of the soil is more porous, so water can infiltrate into the soil better; also, worm activity creates a structure that promotes the retention and storage of rainwater.
Regulating services			
Climate and air quality- control	Worldwide	▲	Less use of fuel leads to lower CO_2 emissions; there are also fewer emissions from earth that is not turned as deeply (Bodemacademie, 2012).
Purifying/treatment capacity (water purification, waste processing)	Netherlands	▼	In a number of pilot projects, the use of chemical agents (herbicides) increased. (Van der Weide et al., 2008).
Erosion prevention	Netherlands	▲	By retaining the organic matter on the surface, the top layer of the soil is more porous, reducing or eliminating compaction. With compaction, soil particles form a hard crust when the earth dries after a rain storm.
Preservation of soil fertility	Netherlands	▲	Non-inversion tillage preserves soil organisms; the organic residues of crops and fertilisers remain on the surface.
Pest control	Netherlands	▼	More nuisance from wireworms, black cutworms and the larvae of crane flies, as well as slugs and mice (Van der Weide et al., 2008).
Supporting services			
Habitat for flora and Fauna (nutrient cycling, soil formation)	Netherlands	▲	Some worms enhance the soil structure by burrowing through the soil from deeper layers to collect food at the surface. These vertical corridors create pores in the soil in which oxygen and water can collect and plants can form their roots.
Preservation of genetic diversity	Netherlands	▲	Increase in the quantity and variety of life in and on the soil (Melman & Van der Heide, 2011).

▲ Positive effect on the ecosystem ▼ Negative effect on the ecosystem

Arable Farming

Issues and implications for business and policymakers

A diagrammatic overview of the importance of ecosystem services

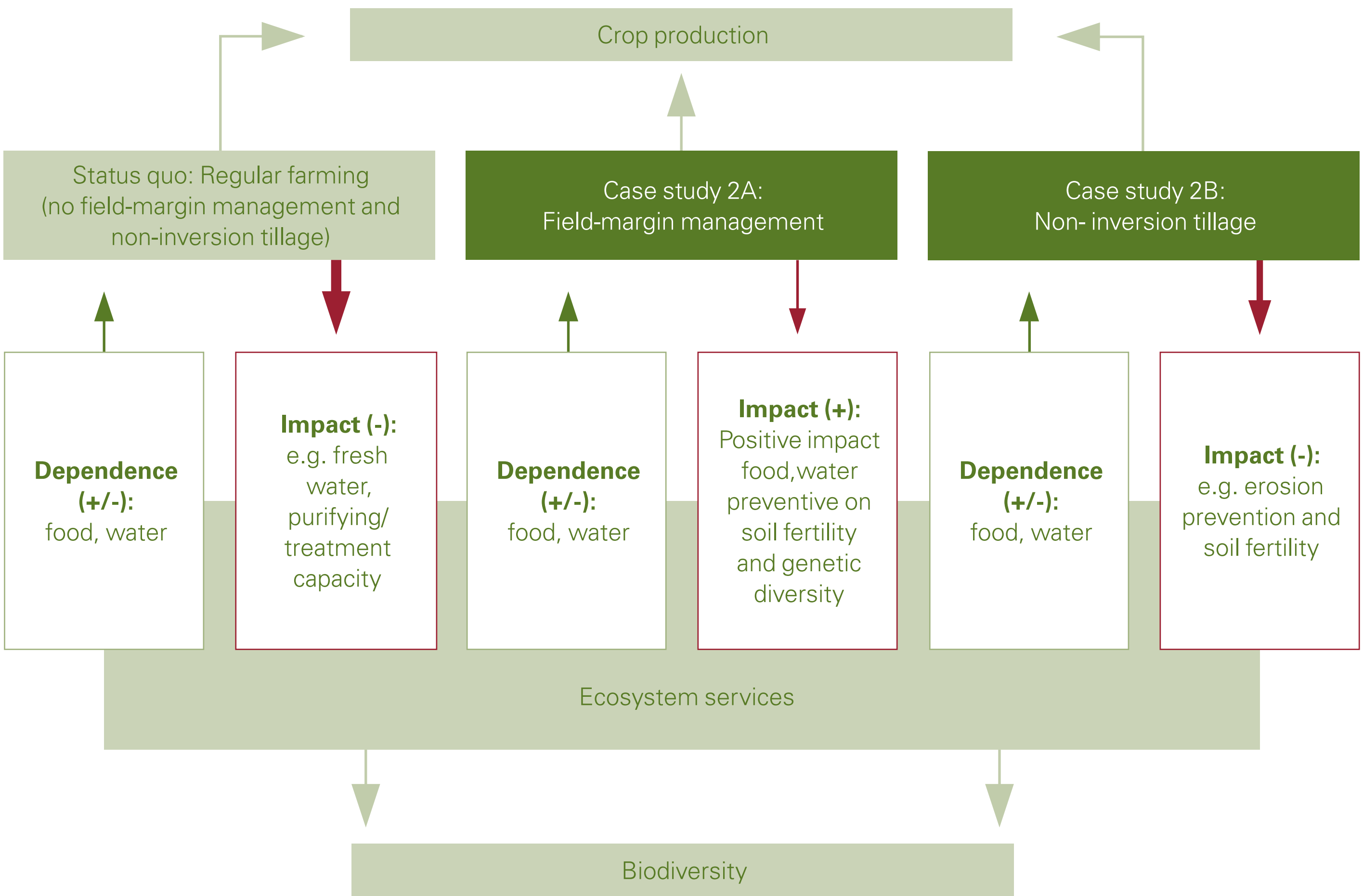
With field-margin management, the dependence on ecosystem services remains the same as it would be if nothing were done. However, the negative impact is diminished (e.g., less contamination of surface water) and, to a certain extent, the ecosystem services are better used (e.g., less runoff of minerals, natural pest control). Non-inversion tillage also contributes to the preservation of genetic diversity, uses relatively less fuel and prevents erosion.

Issues and strategic implications for business

Case study A Field-margin management

Field-margin management has positive effects for ecosystem services and biodiversity. However, there is no business case for adopting the process except where substantial subsidies or other forms of payment are provided by third parties, in which case, the costs of constructing and managing field margins and the loss of profit are almost identical to the income (in the form of subsidies). In other words, the existing financial structure relies to a certain extent on the willingness of the farmer to practice field-margin management without financial gain. Water boards seem to be the appropriate party to provide remuneration since they actually benefit financially from field-margin management.

In the longer term, the policy on subsidies for field-margin management is quite likely to change. In the new CAP, the emphasis on sustainable agriculture will increase. In the case study, the potential income and expenditure in relation to field-margin management



Arable Farming

was provisionally estimated on the basis of indicative amounts, showing that the average farmer would not be much better off than in the current situation. In light of these calculations, there is practically no financial incentive for farmers to practice field-margin management, either now or in the future. Further research is needed to discover whether there might be other potential financial returns (in areas such as natural pest control, soil fertility, etc.) that would justify those efforts by the farmer.

Case study B Non-inversion tillage
Farmers in hilly areas, in particular, would be advised to seriously consider non-inversion tillage and to make enquiries about ongoing pilot projects and possible subsidies. There are various short-term gains to be made, including lower fuel consumption, erosion prevention and the preservation of soil fertility. There are also specific examples of farmers who have already been benefiting from non-inversion tillage for years.

For farms in other areas of the Netherlands, non-inversion tillage is not a method that springs immediately to mind.

Issues and strategic implications for policymakers:

Case study A Field-margin management
The calculations show that there is still no independent business case for the farmer to adopt field-margin management. Too little is also known about the financial benefits for third parties, although water boards benefit directly through lower costs for the maintenance of dikes. The savings on the cost of water treatment are less evident, since fewer nutrients in the water does not automatically lead to proportionately lower treatment costs. Ultimately, the water still has to be treated and the quality of the treated water must be consistent. Positive effects, for example in relation to public well-being (e.g. increased tourism, aesthetic quality) are less direct or difficult to quantify. Further research to identify the benefits for other parties could help in raising additional financing in combination with the new CAP.

Case study B Non-inversion tillage
There is not enough known yet to determine how a business case could be made for non-inversion tillage by farmers in the Netherlands. Even if it can, it would probably only apply for a small, hilly area of the country. As far as we know, non-inversion tillage is only used in the Netherlands when there is a subsidy for it. Up to now, the positive effects on ecosystem services and biodiversity beyond the farm itself have not really been explored and/or have not proved very relevant. Further research is needed to establish the true potential of this method for individual farms in the Netherlands. In that context, farmers could learn from the experience with non-inversion tillage in other countries, such as the United Kingdom. Information from countries where non-inversion tillage is used on a large scale is not relevant to the situation in the Netherlands because the physical geography (climate, topology, soil) is too different.

Fisheries

Fisheries

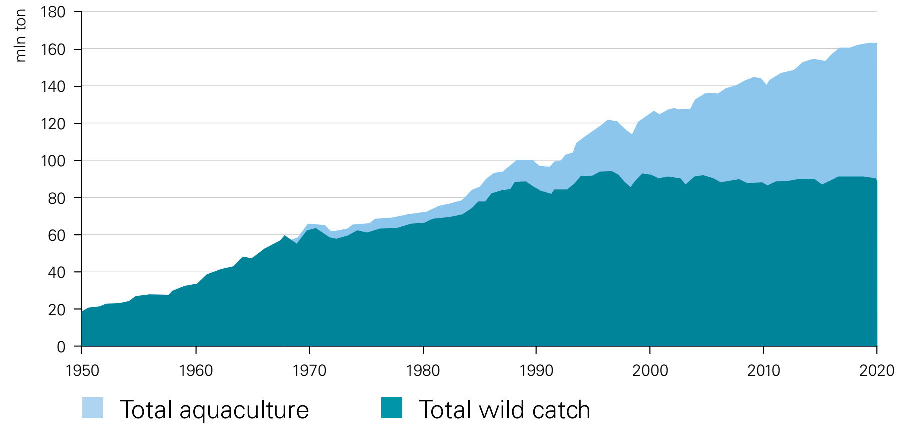
Description of the sector

The fisheries sector
Accounting for approximately 20,000 jobs, the fisheries sector provides substantial employment in the Netherlands. The value of imports by the sector is EUR 1.9 billion and its exports are worth EUR 2.3 billion. The Dutch fishing fleet consists of 14 trawlers, 295 North Sea cutters, 67 IJsselmeer cutters and 65 mussel cutters. In 2010, in addition to the wild fish catch, there were also 54 aquaculture companies producing eels, catfish, tilapia and pike perch (Dutch Fish Product Board, 2010).

In 2010, Dutch consumers ate more than 865 tons of fish (an increase of 1% compared with 2009) (Dutch Fish Product Board, 2010), half of which was produced through aquaculture (Dutch Fish Product Board, n.a.).

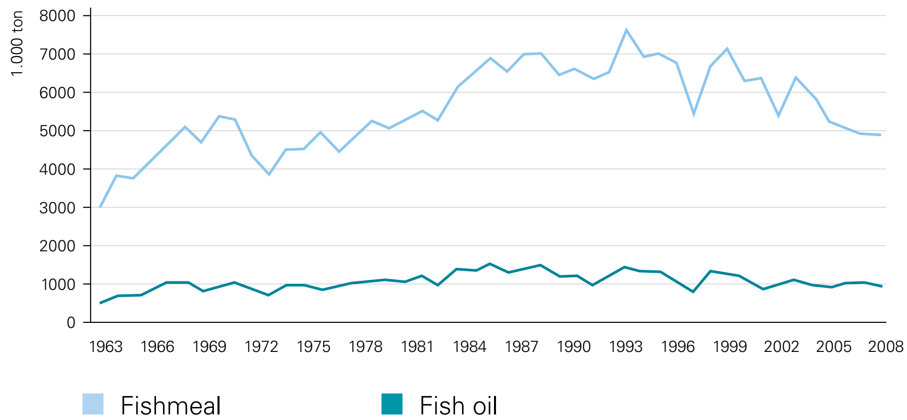
Worldwide market developments
The total worldwide fish production – both of wild fish and in aquaculture – has increased greatly since 1950 and is expected to continue growing.
The figure below illustrates the trend. In the period 2000-2010, the wild fish catch declined slightly, while the production in aquaculture grew strongly. The worldwide concerns about overfishing has led many countries to establish quotas for fish catches, and aquaculture now accounts for half of all fish production. As an alternative to the wild fish catch, aquaculture could meet the growing demand for fish, while conserving wild populations at the same time.

Figure 31: Worldwide fish production, 1950-2020 (in million tons)



Source: KPMG (2011), based on statistics from FAO

Figure 32: Worldwide fishmeal and fish oil production, 1963-2008 (in 1,000 tons)



Source: IFFO (2011)

Fisheries

Use of fish feed in aquaculture

The aquaculture sector mainly uses fishmeal and fish oil for fish breeding. Fishmeal is the brown flour obtained after cooking, pressing, drying and milling whole fish. As 'industrial fish catch', consisting almost exclusively of small, bony fish that generally live in the surface waters or middle depths of the sea, these fish are not intended for human consumption. According to the Food and Agriculture Organization of the United Nations (FAO), 90% of the fish used to make fishmeal and fish oil is unmarketable as human food, although some larger species of wild fish (such as trout and salmon) are dependent on the fish that are used in fishmeal.

Figure 32 shows the trend in global production of fishmeal. Although today less fishmeal is required for each kilo of growth of a fish (Skretting, 2011), the use of fishmeal and fish oil in the aquaculture sector and the volume of wild fish needed for fish farming is a serious issue (Aquaculture Europe, 2009).

Fisheries

Dependencies, impacts, risks and opportunities

Input: Dependence on ecosystem services

- **Food:** The fisheries sector depends on the variety and wide availability of wild fish.
  - For the catch of live fish at sea for human consumption. To illustrate, Dutch fisheries depend on live fish to catch eels, whose population has declined, particularly in the IJsselmeer.
  - For use as fish feed in aquaculture ("industrial fish").
- **Fresh water:** aquaculture needs a large quantity of clean water.
- **Pest control:** Farm-bred fish can cause damage to the wild fish around the fish farms (if both species live in the same water).

Output: Impact on ecosystem services

- **Food (Fish catch) (+):** 436,000 million kg of fish were caught and produced in the Netherlands in 2009.
- **Preservation of genetic diversity (-):** the depletion of fish and shrimp stocks threatens the survival and the habitat of wild fish.
- **Habitat (international) (-):** the use of space for aquaculture in coastal areas has encroached on the habitat of wild fish and has led to pollution, the introduction of non-native species and the uncontrolled depletion of fish stocks for fishmeal and fish oil production

Risks in relation to ecosystem services

- **Operational risks:**
  - In time, over-fishing will create a shortage of live wild fish ("tragedy of the commons"), which will initially lead to higher costs for the sector.
  - Extreme weather events in some years, such as El Niño, could cause a significant decline in supplies of fishmeal and fish oil from South America.
- **Reputational risks:** fisheries and their clients face a risk of damage to their reputation in association with large quantities of by-catch.

Opportunities in the area of ecosystem services

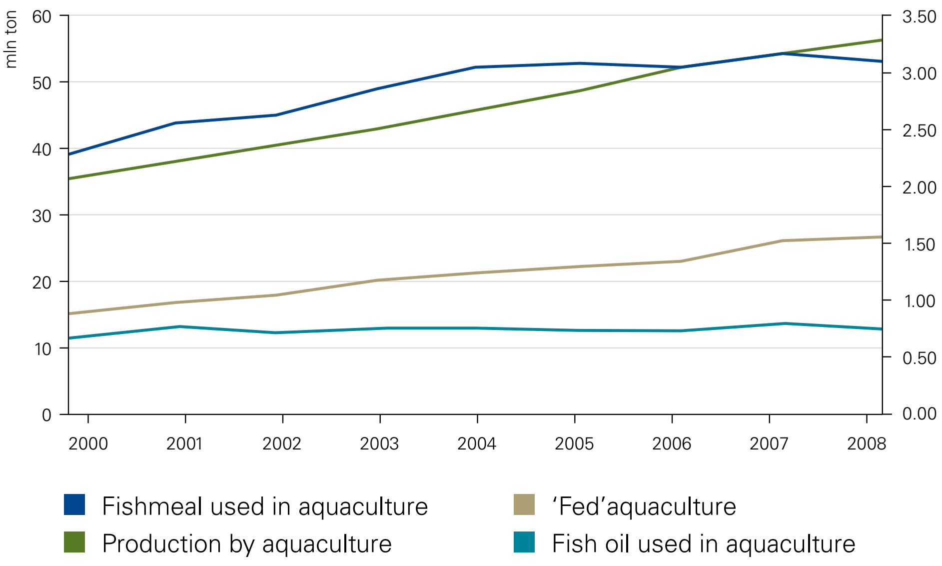
- **Markets for ecosystem services:**
  - The growing worldwide demand for farmed fish as a result of declining catches of wild fish and the demand for essential fats (Omega 3) from fish.
  - A transition from fish feed derived from raw marine materials to feed based on non-marine materials (e.g. vegetable proteins) (see the case study).
- **Certification:** The Marine Stewardship Council (MSC) and the 'Global Standard for the Responsible Supply of Fishmeal and Fish Oil' of the International Fishmeal and Fish Oil Organisation (IFFO).

Fisheries

Case study 3: Fish-feed production based in part on vegetable proteins

This case study looks at the production of fish feed on the basis of vegetable proteins to replace fish feed that is derived from wild catches. The impact on natural fisheries could be reduced with an alternative source of raw materials for fish feed.

Figure 33: Trends in production and consumption of fishmeal and fish oil, 2000-2008 (in million tons)



Source: IFFO (2011)

The IFFO has estimated that, in 2009, aquaculture accounted for 63% of the fishmeal production worldwide and that 81% of the worldwide fish oil production was used in aquaculture.
The remainder was used in the pig industry (25%), the poultry industry (8%) and for other purposes. Figure 33 shows steady growth in worldwide production by fish farms, while the consumption of fishmeal stagnated and the use of fish oil remained stable (IFFO, 2011).

The growing demand for fishmeal and fish oil is driven by the growth of the aquaculture sector, on the one hand, and greater demand from the animal feed sector because of higher meat consumption in developing countries, on the other (Skretting, 2011). The intensive livestock sector in Europe uses fish feed with a high fishmeal and fish oil content. The sector's annual consumption comes to approximately 615,000 tons of fishmeal and 317,000 tons of fish oil, for which approximately 1.9 million tons of fish feed is required (Huntington, 2009).

In 2008, 33% of the fishmeal production was based on trimmings from the fish-processing sector. These trimmings

Fisheries

could create additional costs for the environment and the consumer if they were disposed of as waste instead of being recycled. Most of the fishmeal produced in Spain, France, Germany, Ireland and the United Kingdom is based in fish trimmings, with the proportion worldwide being around 24% (Sea Fish, 2012).

Because of present concerns about the sustainability of the fisheries worldwide, there are also reservations about the origin of the fishmeal and fish oil used in aquaculture. It is becoming increasingly important for fishmeal producers to show that they source their 'industrial fish' responsibly and that the fish were caught legally.

In November 2010, the IFFO developed a Global Standard and Certification Programme for the Responsible Supply of Fishmeal and Fish Oil to combat illegal and unregulated sourcing of raw materials for fish feed (IFFO, 2010).

Non-marine raw materials

Some fish species, such as tilapia, also consume feed with a relatively high vegetable content. Skretting, a division of Nutreco, has gradually reduced the use of fish protein in the production of feed by using vegetable proteins, vegetable oils and by-products from the production of food for human consumption, such as poultry meal and poultry oils (Skretting). This is its response to the potential business risk of becoming too dependent on an increasingly scarce raw material.
By taking the lead in developing alternatives, the company is creating new market opportunities for itself.

An increase in the share of vegetable components might even lead to less fishing with a dragnet for fish protein, which would slow the rate of decline of wild fish populations, and perhaps even allow them to grow again in time, since industrial fishing (using a dragnet, for example) damages the natural habitat of wild fish and has a negative impact on genetic diversity.

Dilemma

Growing demand for vegetable proteins for fish feed could also lead to higher demand for soya and other protein-rich crops, which will create a demand for land to grow these crops with possible implications for the associated ecosystem services.

Greenhouse horticulture

Greenhouse horticulture

Description of the sector

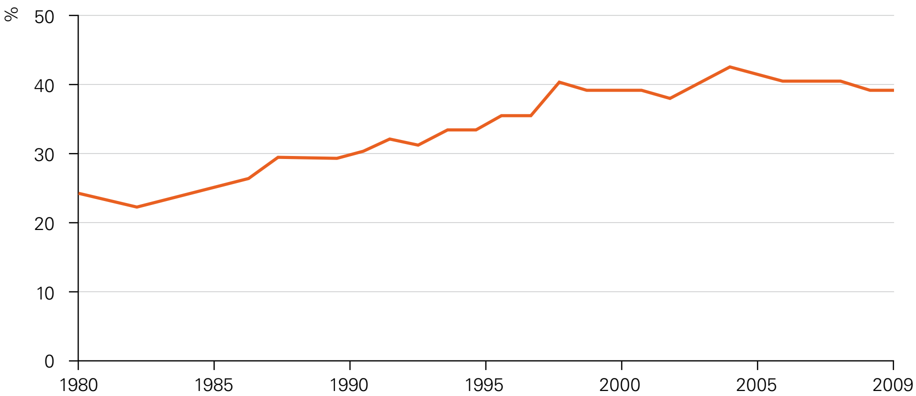
Horticulture in the Netherlands
With 39% of the total production value, the Dutch horticulture sector is the highest earner of all the agricultural sub-sectors in the Netherlands.
In 2009, the Netherlands accounted for 28% of EU horticultural exports (Dutch Product Board for Horticulture, 2010).

The output consists of ornamental flowers and plants (flowers, bulbs and trees) and food (fresh vegetables grown under glass, root vegetables, onions, mushrooms and fresh fruit). In 2010, ornamentals, particularly flowers, accounted for EUR 5,235 million of the sector's total production value, followed by fresh vegetables grown under glass with EUR 1,455 million.

The total area devoted to greenhouse horticulture expanded by 16% in the period 1985-2008 (Melman & Van der Heide, 2011).

Greenhouse horticulture in the Netherlands
Since the tomato crisis (the sudden fall-off in demand because Dutch tomatoes acquired the reputation of being tasteless among German consumers; the so-called 'Wasser-bombe' crisis), the greenhouse horticulture sector has undergone a radical transformation from being a relatively pollution-intensive sector to 'green' production.

Figure 34: Share of horticulture in agricultural output in the Netherlands, 1980-2009 (% production value)



Source: Dutch Product Board for Horticulture (2011)

Figure 35: Key figures for horticulture

	Number
Total production value of horticulture (in EUR million) (2010)[22]	7,895
Production value of vegetables grown under glass (in EUR million) (2010)[22]	1,455
Number of businesses - field cultivation[23]	11,037
Number of businesses - horticulture under glass[23]	5,782
Average annual income (in EUR) per greenhouse horticulture business (2005-2009)[24]	21,740
Total area – field cultivation (ha) (2010)[24]	87,073
Total area - horticulture under glass (ha) (2010)[24]	10,307

[22] Dutch Product Board for Horticulture, [23] Statistics Netherlands (CBS), [24] LEI/Binternet

Greenhouse horticulture

Greenhouse horticulture has become a closed system, with many greenhouses now even capable of producing energy efficiently. The biggest challenges in terms of further improvement in relation to dependencies and impacts on ecosystem services lie in field cultivation.

This analysis focuses exclusively on greenhouse horticulture, but the knowledge gained from that sector could also provide inspiration for field horticulture.

Energy consumption in greenhouse horticulture

Fossil fuels are not categorised as provisioning ecosystem services and are therefore not included as a case in this study. Nonetheless, the greenhouse horticulture sector in the Netherlands uses a lot of energy to create the optimal climate in the greenhouses and the CO_2 emissions contribute to global climate change and so have an impact on ecosystems.

Features of greenhouse horticulture are the high production levels and high energy costs per square metre of greenhouse. On average, the energy costs of a greenhouse horticulture business are 20% to 25% of the total operating costs. The Netherlands' moderate climate with mild winters and not overly warm summers is ideal for greenhouse horticulture.

The sector supplies high-quality products with the help of optimal growing conditions created by active management of the indoor temperature, the use of light to foster growth and intensive CO_2 dosing.

The Greenhouse Horticulture Energy Monitor researched trends in energy consumption and CO_2 emissions in the sector over the period 2000-2009 and its findings revealed a number of significant changes:

- The energy-efficiency index improved by 44% and total energy consumption declined.
- With the substantial increase in the use of combined heat and power (CHP) installations, in addition to growing crops, the sector is now a producer of electricity, which it supplies to the grid. The total consumption of natural gas has risen as a result, while the use of gas for growing has declined.
- The sector has also invested in sustainable energy, using solar heat, bio-energy and geothermal energy. The share of sustainable energy has also increased.
- With the emergence of CHP plants and the sale of electricity, the consumption of fossil fuels and total CO_2 emissions by the greenhouse horticulture sector have increased (7.0 Mton in 2009). While this has been offset by a reduction of national CO_2 emissions, the Intergovernmental Panel on Climate Changer (IPCC) method of calculating greenhouse gas does not include energy transactions. CO_2 emissions caused during growing by the greenhouse horticulture sector totalled 5.3 Mton in 2009.

Because fossil fuels are not a provisioning service of ecosystems, the measures taken to increase energy efficiency and reduce CO_2 emissions will not be considered in a specific case study.

Greenhouse horticulture

Figure 36: Energy use and supply in the greenhouse

	2000	2005	2009
Energy-efficiency index (1990 = 100)	84	68	47
CO_2 emissions, incl. supply of electricity	6.7 Mton	6.5 Mton	7.0 Mton
CO_2 emissions, cultivation	6.6 Mton	6.1 Mton	5.3 Mton
Share of sustainable energy	0.1%	0.4%	1.3%
Total energy use	137 PJ per year	128 PJ per year	117 PJ per year
Use of gas, total	3.7 billion m^3	3.6 billion m^3	3.9 billion m^3
(incl. electricity production through CHP)			
Use of gas for cultivation	3.7 billion m^3	3.4 billion m^3	2.9 billion m^3
Area with (ha):			
CHP	1300	2500	6400
Geothermal	0	0	15
Solar heat (semi-closed greenhouse)	0	22	187
Bio-energy	0	0	66
Total supply of electricity by greenhouse horticulture	0.2 billion kWh	1.3 billion kWh	6.2 billion kWh
Net electricity supply (= sales – purchases)	-1.2 billion kWh	-1.3 billion kWh	3.7 billion kWh
Net electricity supply as % of household consumption in the			15%
Total area of greenhouse horticulture	10,500 ha	10,500 ha	10,300 ha
Production value	EUR 4.5 billion	EUR 4.9 billion	EUR 4.9 billion
Energy costs as % of operating costs		20 - 25 %	

Source: LEI (2010)Binternet

Greenhouse horticulture

Description of business

In the period 2005-2009, the average area under cultivation by a horticulture business was 2.46 ha (LEI/Binternet, 2011). The area devoted to growing under glass was 1.67 ha.

The crops depend on pollination and pest control. Pollination by insects is a vital element in food production and is provided to a large extent by the honey bee, but also by bumblebees and wild pollinating species, such as wild bees and hover flies (Melman & Van der Heide, 2011). Pollination is also important for the survival of a number of wild plant species in the Netherlands.

All bees and other pollinating insects are important for natural pollination (Blacquiere, 2009), but honey bees are, without question, the most important pollinators of food crops. Domestic honey bees and bumblebees are the main pollinators in the greenhouse horticulture sector, although an alternative is to use other pollinating insects, such as wild bees and hover flies. Bumblebees have a crucial function in the pollination of some crops, including tomatoes. Case study 6A considers various alternative methods of pollination in tomato cultivation.

Pests represent a threat to food production and are generally treated with pesticides, but pesticides can pollute the water, affect pollination and impair biological pest control. Some pests can be controlled biologically, by using insects such as the ichneumon wasp as an alternative to chemical pest control. In case study 6B, different methods of pest control are compared.

Figure 37 shows the average income for a greenhouse horticulture business. The highlighted figures are those that will change if alternative methods of pollination and pest control are used.

Greenhouse horticulture

Figure 37: Average income of a greenhouse horticulture business

Income (in EUR)			
Arable farming			420
Flower and vegetable bulbs			3,280
Vegetables			239,280
incl.	tomato	70,960	
	cucumber	59,860	
	pepper	73,040	
	strawberry	11,360	
	lettuce	3,480	
	other vegetables	20,440	
Flowers			342,080
incl.	rose	95,300	
	chrysantium	69,660	
	freesia	35,280	
Other horticulture			179,380
Other income			93,660
incl.	income allowances and subsidies	4,980	
	sale of energy	43,780	
Total income			**858,100**
Cost and depreciation (in EUR)			
Animal and vegetable assets			229,680
incl.	fertilisers	11,040	
	seed	107,700	
	crop-protection agents	11,200	
	unspecified	99,740	
Energy			199,460
Tangible assets			153,940
Paid labour			153,420
Work by third parties			16,720
Financial costs			42,460
Overhead			39,220
Total costs and depreciation			**834,900**
Income from normal business operations			**23,200**

Source: LEI/BINternet (2011). The data are averages over the period 2005-2009.

Greenhouse horticulture

Dependencies, impacts, risks and opportunities

Input: Dependence on ecosystem services

- **Fresh water:** The vast majority of the water used in the greenhouse horticulture sector is rainwater, which is collected and stored. The sector also uses groundwater (the use differs by region), surface water (treated or otherwise) and mains water (LEI interview, 2011).
- **Pollination:** In the Netherlands, a substantial share of the production of hard fruit, soft fruit, strawberries, tomatoes, etc., depends on natural pollination by honey bees, wild bees and hover flies (Melman & Van der Heide, 2011). Bees are used almost exclusively for vegetables, more specifically tomatoes (LEI interview, 2011).
- **Pest control:** In 2008, biological pest control was used in more than 3,400 ha of greenhouses for vegetables (more than 90% of the total area); it was employed in more than 95% of the area devoted to growing peppers and tomatoes.
- **Preservation of soil fertility:** A small percentage of vegetables and cut flowers are grown in the ground; the majority (including all pot plants) are grown on a substrate such as peat, which is the most important raw material used for the growing medium (LEI interview, 2011).

Output: Impact on ecosystem services

- **Food (+):** The production value of vegetables grown under glass is EUR 1,455 million (CBS, 2010).
- **Climate regulation (-):** In 2009, the use of fossil fuels increased due to the rise of CHP plants and the sale of electricity, resulting in an increase in CO_2 emissions from the greenhouse horticulture sector by 7.0 Mton. This was offset by a decline in national carbon emissions, but, as mentioned above, the IPCC method of calculating greenhouse gases does not include energy transactions.
- **Purifying/treatment capacity (-):** In addition to nutrients, crop-protection agents also have an impact on water quality, particularly in terms of pollution of surface water, a large proportion of which is accounted for by the cultivation in substrate (LEI interview, 2011).

Greenhouse horticulture

Risks in relation to ecosystem services

- **Operationeel risks:**
  - Death of bees: Honey bees are essential for the food supply because of the service they provide as pollinators. The bee population is dying off, however, and no clear reason has been found for this. Researchers suspect that one reason, at least in the Netherlands and neighbouring countries, might be the growing prevalence of the varroa mite (Blacquiere, 2009). The possibility that pesticides are a factor, directly or indirectly, has not been ruled out.
  - Diseases : The EHEC crisis had enormous consequences for horticultural businesses, severly affecting the prices of tomatoes, peppers, cucumbers and lettuce (LTO Noord, 2011).
  - Water: Climate change will affect the balance of fresh/salt water in coastal areas in the Netherlands. Horticultural businesses depend on freshwater and could be affected in those areas (TNO, 2010).
- **Reputational risks:** The sector's image is determined in part by the environmental burden caused by the businesses in the sector.

Opportunities in the area of ecosystem services

- **Sustainable supply chain:**
  - Growth in the use of honey bees for pollination in greenhouses.
  - Use of biological pest control to reduce the impact on ecosystem services, particularly water purification.
- **Cost savings:** Increased production and cost savings through the use of CO_2 (via capture from CHP and pipelines from Pernis).
- **Markets for ecosystem services:** Organic waste as a raw material for bio-based products (energy generation, ingredients, etc.) (LEI interview, 2011).

Greenhouse horticulture

Case study 4A: Alternative pollination for tomatoes

In this case study, we consider the value of pollination as an ecosystem service in tomato growing. The costs of alternative methods of pollination are calculated to give an indication of its value.

The total value of the harvest of agricultural crops that depends on pollination is estimated at approximately EUR 1.1 billion a year for the Netherlands, on the basis of international studies. The value of pollination by wild species is estimated at 17% of the total value of pollination, which would be EUR 187 million for the Netherlands (Melman & Van der Heide, 2011).

Honey bees are the main pollinators of agricultural crops. Other solitary pollinators include bumblebees and ants. The honey bee is endangered, however. Of the 300-plus species of wild bee, approximately 10% have disappeared and 50% are threatened. The honey bee scarcely exists any longer as a separate wild species in this country; it depends entirely on the efforts of beekeepers. There are 8,000 beekeepers in the Netherlands, keeping 40,000-80,000 colonies, but their number is declining (Blacquiere, 2009).

The main causes of the death of bees are believed to include the intensification of agriculture (including the use of pesticides and decline of weeds), the deterioration of natural areas, the growth of the global human population and the introduction of non-native parasites, such as the varroa mite (Blacquiere, 2009). It is therefore uncertain whether the honey bee can be preserved in the Netherlands. It is likely to fare better if fewer pesticides are used and it has a continuous and varied supply of food (Melman & Van der Heide, 2011).

Plants that require pollination for their production are not entirely dependent on pollination by insects; they can also be pollinated by wind or by self-pollination, but that varies depending on the species (Blacquiere, 2009).

The fruit, greenhouse-vegetable and seed sub-sectors are the most dependent on pollination. For tomatoes, the bumblebee is the most important pollinator, but the disappearance of honey bees could also have direct consequences for the bumblebee, because of the dependence on the pollen collected by honey bees (Blacquiere, 2009). If bees die out, hand pollination might be a last resort.

Figure 38 shows the costs of pollination in the tomato-growing sector in 2010. The total area of greenhouses devoted to growing tomatoes is assumed to be 1,676 ha. The costs of pollination by bumblebees are EUR 0.23 per m^2.

Figure 38: Financial impact of alternative methods of pollination

Formerly: wild honey bees	**Today:** domesticated honey bees and bumblebees in tomato cultivation	**Opportunity seized:** fromhand pollination to bumblebee pollination of tomato crop
Few if any costs in open horticulture	The effect of bumblebees: Pollination costs for tomato growers in 2010 were EUR 3.9 million. The effect of other pollinating insects is very small.	With hand pollination (shaking), the costs would be EUR 16.8 million a year and with mechanical vibration, EUR 42 million.

Source: LEI (2011)

Greenhouse horticulture

To compare: with hand pollination the costs are EUR 1.00 per m2 and with mechanical vibration EUR 2.5 per m^2 (Source: personal statement by Mr H. Silvis, LEI, based on an unpublished study). This means that tomato growers would save EUR 12.9 million to EUR 38.1 million annually by using bumblebees, compared with manual shaking or mechanical vibration.

Effect on income

The consequences for the income statement of an individual greenhouse horticulture business are substantial, based on the change in income from normal business operations. The transition from pollination by bumblebees to hand pollination would increase the costs of paid labour and cause income to fall by 30% (see figure 39). This example demonstrates the horticulturalist's dependence on ecosystem services.

Effect on ecosystem balance sheet and on other parties and society

The transition to hand pollination does not in itself have an impact on the ecosystem balance sheet. The disappearance of honey bees and bumblebees, by contrast, does have substantial negative effects, because other flowers and plants also depend on them. Without bumblebees, it would probably no longer be possible to grow tomatoes in the Netherlands.

Figure 39: Impact of hand pollination on income of greenhouse horticulture business (in EUR)

	EUR total	EUR Δ	% Δ
Total income	858,100	0	0%
Paid labour	157,802	+ 4,380	+ 3%
Other costs and depreciation	681,480	0	0%
Income from normal business	**18,818**	**- 4,380**	**30%**

Explanatory note: The calculations are based on an average business of 3.5 ha, of which 0.6 ha is devoted to growing tomatoes.

Greenhouse horticulture

Case study 4B: Biological pest control

This case study concerns biological pest control – an alternative to the use of chemical pesticides – in closed systems

Substantial quantities of pesticides are used in food production and, in addition to their intended effects, can have serious harmful effects, particularly from residues of pesticides left on vegetables.

The environmental burden and the public health risks of residues on vegetables present a major challenge to the ornamental plant, fruit and vegetable sectors, in particular, but there are promising developments in the use of biological pest control (Melman & Van der Heide, 2011).

The use of chemical agents varies greatly from one crop to another, and the challenge to growers is to curtail their use as far as possible. An obvious option is to link efforts to improve pollination to measures for biological pest control (Melman & Van der Heide, 2011). The progress made in that regard varies from one sector to another:

- Biological pest control is now the norm for the cultivation of vegetables under glass.
- The greenhouse flower sector is either in transition or pest control is already largely biological.
- Flower bulb growers still use chemical pest control.

In this case study, we therefore briefly discuss biological pest control in the greenhouse vegetable sector, as a sector which demonstrates promising prospects for the other sectors.

More stringent EU rules on the use of harmful chemical agents could promote the use of biological pest control, which already has an extremely positive public image (Melman & Van der Heide, 2011). Wider use of the method will improve the quality of products (consumers are willing to pay more for organic produce) and help to improve the sector's image in the Netherlands.

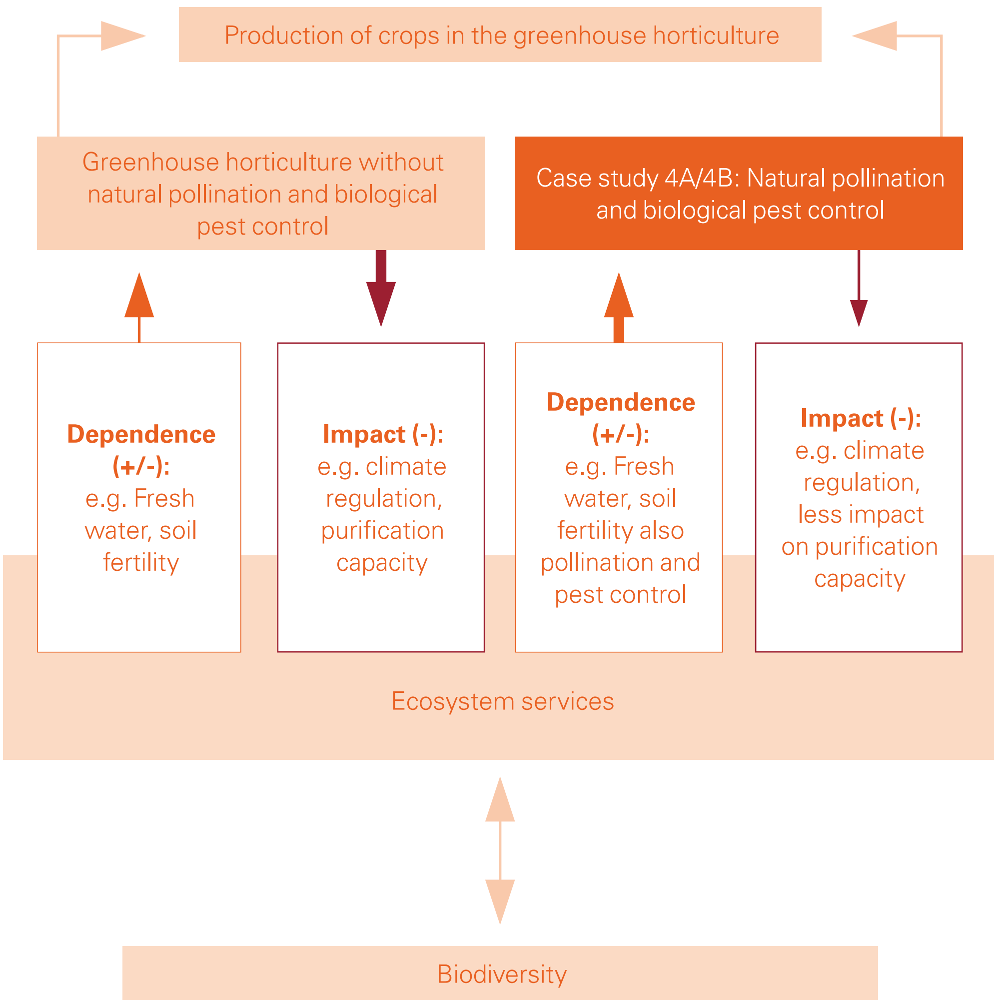
The use of biological pest control is now taken for granted in the greenhouse horticulture sector. The method involves using parasites (such as the ichneumon wasp) for biological control of insects. Where necessary, they can be supplemented by pesticides (if the biological pest control proves ineffective during a sudden outbreak). A study by the LEI (in preparation) shows that wider use of biological parasites does not lead to lower costs for the purchase of chemical agents for tomato, pepper and cucumber growers. In fact, the total cost of crop protection increases with the wider use of biological parasites. The reason for this is that the chemical agents that are used if the plague is too great must not harm the biological agents, and those chemicals are generally more expensive than regular chemical agents.

Greenhouse horticulture

Issues and implications for business and policymakers

A diagrammatic overview of the importance of ecosystem services
Hand pollination is a substitute for pollination by honey bees and bumblebees. Alternative methods of pollination remove the dependence on ecosystem services, which means the dependence is greater with natural pollination. Dependence on this ecosystem service also increases with a shift from chemical to biological pest control. At the same time, the impact is reduced because there is less runoff of chemicals.

Issues and strategic implications for business
In the short term, the greenhouse horticulture sector will very likely be confronted with growing pressure from supermarkets and the food industry to make the entire chain sustainable. Among other things, this will increase the demand for certified sustainable products and responsible business operations. It will therefore be important for companies and their trade associations to anticipate these developments in good time.



Greenhouse horticulture

In the worst-case scenario, companies will be confronted with a sudden loss of demand to competitors that can adequately guarantee that they operate sustainably. The principle of closed systems will play an important role in that respect. Using ecosystem services (e.g., natural pollination) effectively and eliminating the impact on those services (e.g., biological pest control) is one way of meeting the demands of consumers. Mitigating risks such as water and soil pollution will also enhance a company's reputation.

Some other trends that the greenhouse horticulture sector could face sooner or later are:

- Higher energy costs. The greenhouse horticulture sector is a large consumer of energy (mainly natural gas) and is therefore very vulnerable to increases in the price of energy. On the other hand, the sector is a pioneer in energy saving, energy production and CO_2 reduction. With CHP, the sector now supplies around 15% of the electricity needs of Dutch households.
- Because of sustained year-round consumer demand for vegetables, there is growing competition from sunnier countries.

Open-field horticulture

The practices and know-how in the greenhouse horticulture sector could also serve as inspiration for the businesses engaged in open-field horticulture. Although the methods cannot simply be replicated, the principle of a closed system (where ecosystem services provide pollination and biological pest control and the negative impact is reduced) is extremely interesting for the open-field horticulture.

- Fruit growers: In the fruit sector, natural pollination is at risk from the disappearance of bees and the use of chemical pest control. Further research is needed to preserve honey bee and bumblebee populations or to find smarter ways of using them to pollinate the fruit crop. Sharing knowledge with the greenhouse horticulture sector could be helpful in that.
- Open-field horticulture: Businesses have only recently started using biological pest control in open-field horticulture (Melman & Van der Heide, 2011). Chemical pest control is still often used for cabbage and sprouts, for example. Research into the possibilities of biological pest control in open-field horticulture is necessary to ascertain its true potential. There are not enough data available at the moment.

Issues and policy implications for policymakers

The greenhouse horticulture sector is heavily dependent on beekeepers. The question for policymakers is to what extent they can leave it up to the sector itself to reverse the decline in the number of beekeepers. The need to make the entire chain sustainable demands constant attention. Finally, the government will have to play a conscious role in translating the lessons from the greenhouse horticulture sector to open-field horticulture.

Creative Industry

Creative Industry

Description of the sector

The sector in the Netherlands

The Dutch creative industry is an important top sector that has scarcely any direct dependence or impact on biodiversity and ecosystems, but could have a major impact via other sectors.

Statistics Netherlands (CBS) breaks the creative sector down into three clusters:

- creative commercial services, which include architecture, landscape gardening, design, graphic design, fashion and industrial design;
- media and entertainment, a category that includes the radio and television industry, press agencies and publishers;
- arts and cultural heritage, which covers the performing arts, museums and cultural heritage.

The creative industry encompassed more than 43,000 companies in 2009, 28,000 of them in the commercial services segment (Urlings and Braams, 2010). The sector represented 5% of the Dutch business sector and 3% of total employment in 2008.

An average of 180,000 people are employed in a creative profession in the Netherlands (CBS, 2011), with 42% working in creative commercial services, 25% in the media and entertainment industry and 33% in the arts and cultural heritage segment. A remarkably large percentage (50%) of the people working in the sector are self-employed, and only 1% of the companies in the sector have more than 50 employees (TNO, 2011). Between 2006 and 2009, the sector's output expanded by 19% and employment by 6% (TNO, 2011; CBS, 2010).

The major actors in the creative industry are the knowledge institutions (such as universities), large media companies (such as Endemol) and design firms (such as Van Berlo) (Kaashoek et al., 2010).

The creative industry is concentrated mainly in the large citites, with clusters in places like the north of Amsterdam. The industry has a good international reputation: Amsterdam is one of the top five creative centres in the world, and the Netherlands is ranked among the top ten countries in the world in practically every segment. The main strength of the creative sector lies in creating added value for other sectors.

Figure 40: Key figures for the creative sector

	Number
Total added value of creative industry (in EUR million) (2010) [25]	16,900
Annual exports (in EUR million)[25]	7,000
Production value of architects and engineering firms (in EUR million) (2009) [26]	13,559
Total number of companies – creative industry (2009) [25]	43,000
Number of companies – architects and engineering firms (2008) [27, 28]	20,055

[25] Urlings and Braams (2010)[26] CBS (2011)27 CBS (2008)[28]
Note: Not all engineering firms are classified as part of the creative industry.

Fashion industry

A sub-sector with a relevant ecological footprint – and that is dependent to a certain extent on ecosystem services – is fashion. The clothing industry uses a lot of natural raw materials. Although production has contracted, cotton is still the most commonly used material and its production is harmful to the environment in several ways. A quarter of all pesticides and insecticides are used in the world-wide production of cotton, and 10,000 litres of water are needed to produce every kilo. There are alternatives that could reduce this impact, such as biocotton and recycled polyester, which have already been embraced by various leading fashion chains, in the Better Cotton Initiative, for example (IDH, 2012).

Architecture

In this chapter, we focus mainly on architects, who have an indirect impact on ecosystems through the materials and locations they choose and the environmental burden caused by the buildings they design. The building sector is devoting more attention to sustainability in the area of energy efficiency and the use of materials. Examples of measures taken to add value to ecosystem services include:

- green roofs, covered with vegetation that filters water, improves the air quality, provides cooling and can serve as a buffer in the event of heavy showers;
- heat storage and heat generation through groundwater storage and heat collectors;
- cradle-to-cradle design, where the waste produced is used as a raw material (the use of waste water for the toilet, is one example of this).

Creative Industry

Dependencies, impacts, risks and opportunities

Input: Dependence on ecosystem services

- **Raw materials:** Architects themselves are minimally dependent on ecosystem services, although paper is used during the design process, for example.

Output: Impact on ecosystem services

- **Raw materials:** Architects have an impact on ecosystem services through the choices they make in the use of raw materials:

  - use of cement;
  - use of wood from illegally harvested trees;
  - use of metals (e.g., mining for ores can have a major impact on ecosystems).

Risks in relation to ecosystem services

- **Reputational risks:** Designing buildings that seriously damage an ecosystem can harm the architect's reputation.
- **Operational risks:** architects who fail to keep up with the trends in sustainability in general, and the protection of ecosystem services in particular, could in time secure fewer commissions as the scarcity of raw materials increases.

Opportunities in the area of ecosystem services

- **Markets for ecosystem services:** Architects can create a niche market by concentrating on ecodesign, biomimicry and innovations that promote the sustainable use of ecosystems.
- **Cost savings:** A smart design can lead to annual savings in energy costs, additional savings on building costs and lower CO_2 emissions.

Creative Industry

Case study 5: Strijp (ecosystem imitation in Eindhoven) and NIOO

The impact of architects on ecosystem services and biodiversity extends to a number of areas. With smart designs, the environment can be spared and costs can be reduced. In this case study, we consider a number of designs that take ecosystem services into account.

Strijp is a new-build project that is currently (2012-2015) being built in Eindhoven. With the use of techniques such as biomimicry, the houses and residents will have less impact on the ecosystem. Biomimicry is based on the idea of creating a built-up environment that functions as an ecosystem, so that the buildings and their occupants have little or no impact on the environment.

In Strijp, the residents use thermal energy, which leads to lower consumption of conventional energy and thus reduces the burden on the environment, yielding total savings of more than 50% in CO_2 emissions (Sanergy, 2012). Other projects in the Netherlands also use thermal energy, usually in the form of heat and cold storage. For the new offices of the Netherlands Institute of Ecology (NIOO), architects have opted for a system that combines heat and cold storage with the use of residual heat from industry, producing energy savings of 70%-80% (Nieuwendijk, 2011).

In addition to storing heat in the groundwater, Strijp also uses Sanergy, a system that combines energy storage and soil remediation in a single process, which cleans up the soil more quickly than natural processes. The soil around Strijp is contaminated with various substances that contain chlorine (Sanergy, 2012). Natural microorganisms break down these contaminants, and Sanergy accelerates the degradation process by causing the groundwater to circulate more quickly. The closed system ensures that the contamination remains where it is, but degrades more quickly. As a result, the soil in Strijp will be cleaner and can also be used to store energy.

Strijp's designers have restricted the use of non-renewable raw materials to spare the environment (Sanergy, 2012). There are also fewer, if any, non-renewable raw materials, such as PVC, cement and polyurethane foam, being used in the NIOO building. For example, 80% less cement than usual has been used (Nieuwendijk, 2011).

For some buildings in Strijp, green roofs, covered with grass or other vegetation, have been used as an alternative to conventional roofing. The concept of green roofs is also being used elsewhere, for example in a roof park in the Delfshaven district of Rotterdam. Examples of ways in which green roofs can increase sustainability and enhance ecosystems include (Fraanje, 2011):

- purifying the air;
- providing cooling, thus saving on the energy used for air conditioning;
- providing insulation and saving energy;
- serving as a mechanism for treating water;
- increasing biodiversity;
- storing water during heavy showers, thus preventing sewers from overflowing.

The City of the Sun: Heerhugowaard

Heerhugowaard offers another example of a new housing estate where the burden on ecosystems has been reduced. The following text is taken verbatim from a report by the International Union for Conservation of Nature (IUCN) (2011):

"The municipality of Heerhugowaard has built an exceptional housing estate: the City of the Sun. Solar panels adorn the roofs of all the 1500-plus houses. Eight detached homes and the supermarket in the district use not only solar energy but also literally draw heat from the earth at depths of approximately 80 to 130 metres. There are three wind turbines on the edge of the estate and 100 hectares of recreational woodland have been planted to capture CO_2. The energy management of the City of the Sun is CO_2-neutral. The City of the Sun uses a closed water system. The plants grown in the surrounding recreational area filter the water without artificial chemicals."

In this example, the burden on ecosystems is minimal. There is climate regulation through CO_2 sequestration, natural filtration of the water without contamination of the soil and water consumption is regulated through a closed system.

Creative Industry

Issues and implications for business and policymakers

Issues

There are many ways in which architects can integrate ecosystems and the services they provide in the design of new building projects. Many of the techniques aimed at saving energy and generating sustainable energy have enormous potential. In the Netherlands, there are obviously opportunities to replace bitumen roofs with green roofs (Arcadis, 2012), and there are hundreds of areas where the conditions are the same as in Strijp and soil remediation can be combined with heat and cold storage. That technique, for example, not only benefits the environment but also saves on the costs of soil remediation.

More generally, there are a number of trends evident in the urban environment:

- A major challenge facing the Netherlands in the medium term is 'retrofitting': the renovation of existing, often ageing buildings. The average age of a Dutch house is 39 years. At the same time, although the vacancy rate has fallen by 14% in a year, 15% of the existing office space is standing empty. In general, older buildings have a greater impact on the environment. It is therefore important to rejuvenate the housing stock, using the technological measures described in this case study to reduce the dependence on energy and the impact in terms of air and soil pollution, for example. It is also important to adopt a holistic approach to retrofitting. In that context, close collaboration between planners, property developers, architects, builders, etc., will produce the best results for ecosystems and the services they provide.

- In other parts of the world, particularly in developing countries and the BRIC countries, the challenge is to ensure that the planning and construction of new buildings occurs in a controlled manner. To illustrate, every year a city the size of Rome is being built in China, and this is having a material impact on the environment. In India, the usable area will grow to 41 billion m^2 in 2030, an increase of more than 40% over the 8 billion m^2 in 2005. Progressive urbanisation will increase the pressure on virgin land and lead to conversion of land that provides ecosystem services. Environmentally conscious building design – in architectural terms, but also in terms of urban planning – is crucial for the conservation of ecosystem services in these regions of the world.

- Many prominent architects in the Netherlands carry out major commissions in China, India and other growth markets. They could further improve their competitive position by sharing their knowledge and experience in incorporating ecosystem services and biodiversity into their designs. They could also use the experience they have gained in other countries to promote innovation in this area in the Netherlands.

Life sciences

Life sciences

Description of the sector

The life sciences & health sector in the Netherlands

Life sciences & health is a rapidly growing sector, which generates a turnover of EUR 18 billion, or 2.5% of the Dutch GDP, with solutions for a worldwide healthcare sector that is growing at an annual rate of over 6%. In 2009, there were 314 companies with 24,000 employees operating in the sector. The Dutch life sciences & health sector provides solutions and technologies for a sector that is expected to be worth EUR 63 billion in the Netherlands alone in 2011 (Top Team Life Sciences & Health, 2010).

Life sciences & health is one of the designated top sectors in the Netherlands. It delivers products and technologies designed to prevent illness, diagnose diseases at an early stage, treat them effectively (with tailored therapies) and allow care to be relocated to the home (self-management).

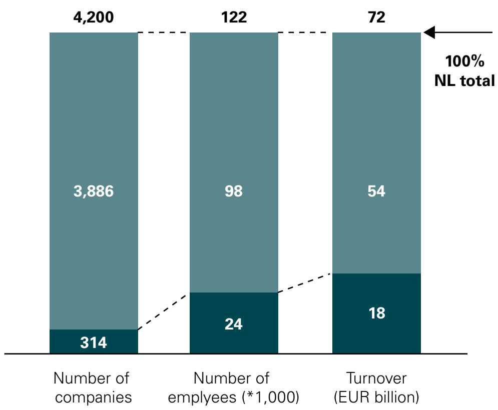
The sector improves the quality of people's lives, increases their productivity and increases the sustainability of care. The sector encompasses the treatment of common chronic diseases such as cancer, cardiovascular diseases and Alzheimer's, as well as infectious diseases, such as flu, and diseases that can be transmitted from animal to humans ('zoonoses'); pharmaceuticals; biotech; materials for diagnostics; medical technologies and 'telemedicine'.

The life sciences & health sector consists of innovative and technology-intensive companies and knowledge institutes in areas such as medical technology, (bio) pharmaceuticals and regenerative medicine for both human and veterinary applications. Companies such as Philips, DSM, MSD/Intervet and Crucell are global market leaders in these fields, and others such as medical imaging and patient monitoring, biomaterials, veterinary medicine and vaccine technology.

Figure 41: Size of the Life Sciences & Health sector in the Netherlands

Broad classification of companies:
- Production companies
- Wholesale and retail
- Hospitals, laboratories

Key innovative companies:
- R&D-intensive companies
- R&D specialists



Source: Top Team Life Sciences & Health (2010)

There are also a great many other companies operating in the Dutch and international markets, including AKZO Pharma, Altana Pharma, Cordis, Genzyme, Medtronic, Organon and Solvay. The sector is also intensively engaged in research and development (R&D), spending EUR 2.1 billion, or more than 10% of their turnover, on R&D. With 5,000 patents a year, the Netherlands ranks ninth in the world, and rates even more highly in terms of scientific publications, occupying seventh place in the global rankings (Top Team Life Sciences & Health, 2010).

In the remainder of this chapter, we will focus on the pharmaceutical sector in the Netherlands.

The pharmaceutical industry in the Netherlands

With most of the pharmaceutical manufacturers operating on a global scale, the Dutch pharmaceutical industry represents a large part of the life sciences & health sector, with an annual turnover of EUR 6.4 billion in 2008, R&D expenditure of EUR 550 million and 16,900 employees. Major players in the Netherlands include DSM, Abbott, Bristol-Myers Squibb, GlaxoSmith Kline, Novartis and Pfizer. The costs of medicines account for just under 10% of the total healthcare costs in the Netherlands.

Life sciences

Dependencies, impacts, risks and opportunities

Input: Dependence on ecosystem services

- **Genetic diversity:** Loss of biodiversity reduces the supply of raw materials for medicines and biotechnology as well as the possibility of discovering potential medicines (bioprospecting).
- **Water:** For the growth and conservation of medicinal plants.
- **Crops:** Filler materials (e.g., talc, soy and sugar).
- **Pollination:** Crops with medicinal properties depend heavily on natural pollination.

Output: Impact on ecosystem services

- **Medicinal plants (+):** The cultivation of medicinal plants for biopharmaceuticals.
- **Genetic diversity (-):** Over-exploitation of natural products could lead to loss of genetic diversity.
- **Purifying/treatment capacity (-):**
  - Sometimes up to 80% of a medication is excreted in urine and faeces before it can be fully metabolised by the consumer and ends up in the water supply. The increased use of oestrogen (in the contraceptive pill and hormone-replacement therapy) could have an impact on the sustainability of wild fish populations through feminisation of fish and reduced fertility.
  - Mining for minerals used in pharmaceuticals, such as titanium dioxide and calcium, can cause water pollution.

Risks arising from impacts and dependencies on ecosystem services

- **Operational risks:** It is thought that cheap artificial herbicides are contributing to the decline of bee populations worldwide. If these herbicides are used in the horticulture sector – and ecological plant and herb gardens – bees in the vicinity cannot be protected.
- **Reputational risk:** Companies that fail to behave responsibly with respect to the rights of local populations or which fail to take adequate precautions to protect the environment in the search for new, valuable plants (for example, deforestation by others in the supply chain) face the risk of serious damage to their reputation.
- **Regulatory risk:** There are limits to the patentability of new medicines based on natural raw materials.

Opportunities arising from impacts and dependencies on ecosystem services

- **Preservation of genetic diversity:** Ecological plant and herb gardens provide ingredients for natural medicines and cosmetics.
- **Markets for ecosystem services:**
  - Market opportunities arising from having a reputation for using biological components in medicines.
  - Biology as a source of inspiration for developing new technologies by imitating natural phenomena (biomimicry).

Source: KPMG & Natural Value Initative (2011)

Life sciences

Case study 6: Biopharmacy and biodiversity

In this case study, we consider the use of medicinal plants in the pharmaceutical industry. This sector's dependence on ecosystem services for production is evident.

Biopharmacy is one of the fastest-growing markets at the moment, with annual growth of about 15%. In 2002, 42% of the 25 most frequently sold medicines were natural remedies or were produced from natural products.

Since ancient times, plants and herbs have been used as a raw material for pharmaceuticals, and they still play an essential role in healthcare today.

The World Health Organization (WHO) has estimated that roughly 75%-80% of the world's population use natural products for all or part of their medication requirements, often out of necessity because they cannot afford the expense of commercially produced drugs.

The value of biodiversity for human health lies in the large number of medical applications that are based on natural raw materials.

Examples include the following:

- Aspirin is a pain killer produced from the bark of the willow tree.
- Quinidine regulates the rhythm of the heart; the substance comes from the bark of the cinchona tree.
- Vinblastine is used to treat Hodgkin's disease; it is obtained from the alkaloid of the Madagascar periwinkle (Catharanthus roseus).
- Galantamine, which can alleviate the symptoms of Alzheimer's disease, is obtained from daffodil bulbs.

Major changes in forests, savannahs and other ecsoystems are having an impact on the availability and cost of natural medicines. Over the last four decades, deforestation in the Amazon region of Brazil has led to a decline in the availability of various commonly used species of medicinal plant.

Because the world is constantly changing, species of medicinal plant have to grow under changing conditions. The cultivation of threatened wild species and the sustainable collection of wild plants are important factors in the preservation of natural medicinal plants. It is estimated that only a fraction of the 53,000 species with medicinal properties are used in the pharmaceutical industry, and there is speculation that the earth loses one essential medicinal plant species every two years.

The life cycle of a biopharmaceutical product can be broken down into four steps.

In each of these steps, there are close links between biopharma and ecosystem services, in terms of the availability and quality of natural raw materials and the biopharmaceutical industry's dependence and impact on ecosystem services. These connections create either an opportunity or a threat for both the industry and biodiversity at every step. The study 'Biodiversity and ecosystem services: Risk and Opportunity Analysis within the Pharmaceutical Sector' (KPMG & Natural Value Initiative, 2011) explains these links step by step.

Water

Water

Description of the sector

Figure 42: Key figures for the water sector

	Number
Estimated turnover of water sector (in EUR million)[29]	43,500
Estimated turnover – maritime cluster (in EUR million)[30]	26,300
Estimated turnover – water technology cluster (in EUR million)[29]	9,700
Estimated turnover – delta technology cluster (in EUR million) [29]	7,500

[29] TNO (2010), [30] The Dutch Maritime Network (2010)

The sector in the Netherlands

Water has numerous functions. People drink it and use it for sanitary facilities, it is used to grow food in the agricultural sector, and it is used by industry.
The water industry is a very important sector in its own right and is vital for the productivity of other sectors, including agro & food, chemicals and energy.

Besides supplying water, the sector is also responsible for water management and delta management. It comprises the maritime affairs cluster, the water technology cluster and the delta technology cluster:

- With EUR 26.3 billion, the maritime cluster accounts for the largest share of the estimated turnover of the water sector. The cluster also has the highest proportion of private companies in the sector, including companies in shipping, shipbuilding, offshore, inland shipping, dredging, ports, the navy, fisheries, maritime services, water sports and marine equipment suppliers (The Dutch Maritime Network, 2010). The maritime cluster is a global market leader in some segments and accounts for 4.6% of Dutch exports.

- The water technology cluster focuses on ensuring the availability of water and developing water-related technologies.It comprises a mix of public and private companies engaged in the preparation of drinking water, water purification and treatment, the supply of process water for industry, the management and maintenance of waterways, and the allocation of water for different uses. In 2009, more than EUR 6 billion in public money from taxes and levies was spent on the performance of public tasks relating to water (National Administrative Consultation Committee on Water [Landelijk Bestuurlijk Overleg Water], 2009).

- The delta technology cluster embraces public activities relating to water safety (including the relevant infrastructure), preventing disruptions to supply, responding to disasters and using delta technology to provide a good quality of life for people living and working in a low-lying delta region like the Netherlands.
  The Netherlands enjoys a worldwide reputation for its expertise in creating a safe environment, particularly in relation to security of supply, the allocation of water and spatial planning.

The delta areas of the world have great economic importance, but there is enormous pressure from the populations in these areas, often associated with issues of food supply, problems with sanitation and the need to anticipate the effects of climate change (TNO, 2010).

Drinking-water production

One of the activities of the water cluster is the production of drinking water. In 2009, drinking-water companies employed approximately 5,000 people and generated a turnover of EUR 1.45 billion. Although that is a modest sum in relation to the turnover of the sector as a whole, the water companies have considerable economic and social importance, producinge approximately 1.1 billion m3 of drinking water (Vewin, 2012), for which the average houshold spends roughly 0.6% of its budget (Accenture, 2009).

The companies manage approximately 21,000 ha of nature (which are home to 80% of all Dutch wild species), making them the third-largest manager of land in the country (Vewin, 2011).

The sub-sector depends heavily on fresh water, relying on surface water (40%) and water extracted from groundwater (60%). A number of companies have been recovering water from the dunes since the 19th century. In this chapter, we show how the water companies depend on the ecosystem services provided by the dunes.

Water

Dependencies, impacts, risks and opportunities

Input: Dependence on ecosystem services

- **Fresh water:** Drinking-water companies.
- **Climate regulation:** For the water supply.
- **Purifying /treatment capacity:** Drinking-water companies are heavily dependent on the purification capacity of the areas where they recover water.

Output: Influence on ecosystem services

- **Fresh water (-):** Excessive use of groundwater in dune reserves.
- **Genetic diversity (-):** Due to the growth of the population, there is less water available for nature, which increases the pressure on biodiversity.
- **Habitat:** The delta sector damages the seabed with its dredging activities, while other changes in the use of land (deforestation) can lead to flooding and other natural disasters.

Risks in relation to ecosystem services

- **Operationeel:** Availability of fresh water
  - Netherlands: Higher costs for fresh water because of increased use of water for different functions (consumption, agriculture and business).
  - Netherlands: Effect of climate change on the fresh/salt water balance in coastal areas.
  - International: Conflicts over water rights due to worldwide population growth, growing economies and climate change.
- **Operational risks:** Water quality
  - Netherlands and EU: New technologies are needed to remove chemicals that contaminate water systems (e.g., hormones and hormone by-products, phosphates and nitrate) (TNO, 2010).
  - Contamination from accidents and natural disasters, which cause serious water pollution and thus higher costs for water treatment.
  - Upstream contamination of the rivers used as a source of water.
- **Operational risks:** Extreme weather conditions
  - International: Periods of drought caused by climate change will put pressure on the supply of water for consumption (TNO, 2010).
- **Legislative and regulatory risks:** Fines for the pollution of water.

Kansen op het gebied van ecosysteemdiensten

- **Operationeel:**
  - Verlagen van watervervuiling en meer gebruikmaken van reinigend vermogen (zoals duininfiltratie).
  - Verhoogde efficiëntie in waterverbruik.
- **Markten voor ecosysteemdiensten:**
  - Accommoderen van water in stedelijke gebieden (bijvoorbeeld door gebiedsontwikkeling).
  - De sector kan andere landen adviseren over de Kaderrichtlijn Water (KRW). De KRW beoogt een veilige delta waarbij het menselijke en het ecologische systeem in evenwicht zijn (TNO, 2010). Op een dergelijke wijze kan Nederland zich ook elders profileren als waterland.

Water

Case study 7: Artifical infiltration in the dunes

In this case study, we consider dune infiltration, a process by which nature is used to purify the water for drinking water. Dune infiltration is interesting not only for its capacity to purify water, but also because the water reservoirs in the dunes constitute strategic reserves.

Water production areas in the dunes
The first pipeline to carry drinking water from the dunes was built in 1853 near Vogelzang to carry water to Amsterdam. A century later, when the volume of water being extracted was twice as great as the level of precipitation, the salt water boundary in the groundwater was found to have risen by 60 metres along the length of the dunes, which meant that the balance with fresh water has to be restored. This was accomplished with the unique process of artifical infiltration of river water into the dunes.

River water was guided to specially constructed infiltration channels, where, using surface infiltration, the water passed through the sand and was filtered. It was then extracted for further treatment. Large areas of the dunes were excavated to lay the pipelines, wells and infiltration channels, which damaged the soil structure and affected rare plant species. Another problem with this technique was that the river water was contaminated and contained concentrations of nutrients that did not naturally occur in the dunes, resulting in the growth of undesirable plants such as nettles, while rare species such as orchids were suppressed. Partly in response to a protest movement in the 1970s, water companies now use the deep-well infiltration method with water that is pre-treated. Unlike surface infiltration, this method has practically no effect on the environment, but it does lead to higher energy costs.

Today, for water production from dune areas, the water is taken from rivers or the IJsselmeer and is pre-treated according to the degree of contamination. When there is rain, the pre-treated water sinks into the infiltration channels in the dune soil, where a natural anaerobic process in the soil breaks down bacteria and viruses. After approximately two to three months, the water is pumped back up and treated again for use as drinking water.

There are four water companies that use water infiltration in the Netherlands. PWN Waterleidingenmaatschappij Noord-Holland (PWN) produces drinking water both directly from the IJsselmeer and after infiltration in the dune reserve in the province of Noord-Holland. The drinking water company for the Amsterdam region uses an area of dunes called the Amsterdamse Waterleidingduinen to purify surface water. The Leidse Duinwatermaatschappij infiltrates pre-treated river water for Dunea, the supplier for The Hague and Leiden region, and Evides recovers water from the dunes of Goeree. In all, these four companies use an area of approximately 11,000 ha of dunes (about one-fourth of the total dune area of 40,000 ha – 1% of the total land area – in the country) (Geocaching, 2010) for water infiltration, an area larger than the combined area used for water production by the six other water companies (Wageningen University and Research Centre, 2005).

Figure 43: Geographic coverage of water companies

Source: Vewin (2011)

Figure 44: Dune area per water company (in ha x 1,000)

	Catchment area for dune infiltration	Area of dunes
PWN	Between Bergen and Zandvoort	5.2 [31]
Waternet	Between Zandvoort and Noordwijk	3.4 [32]
Dunea	Between Katwijk and Monster	2.2 [33]
Evides	Central and eastern dunes near Goeree	0.2 [34]

[31] PWN (2010), [32] Waternet (2010), [33] Dunea (2010), [34] Evides (n.d.)

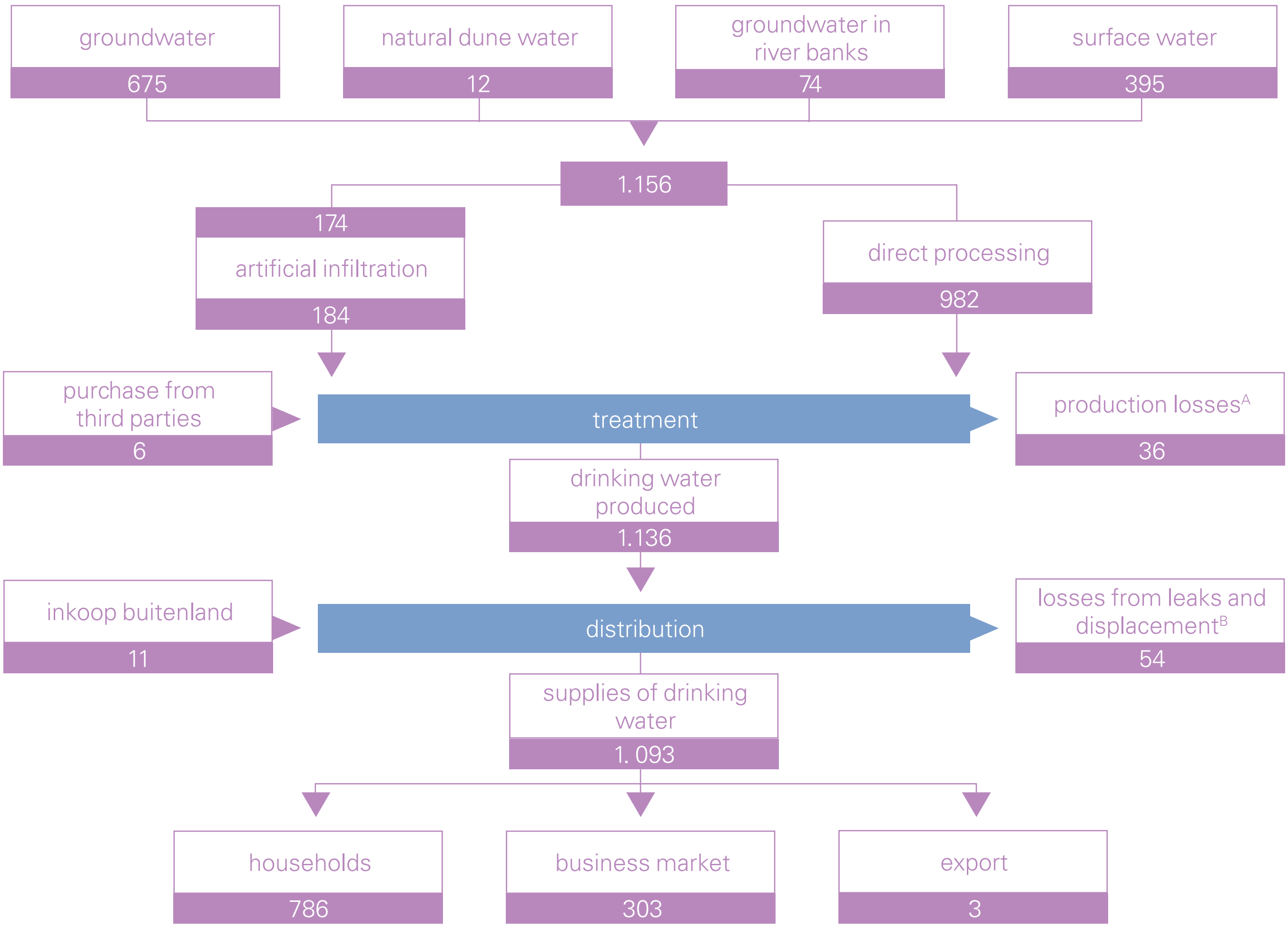
Water

Contribution of artificial infiltration to the production of Dutch drinking water
To prevent fresh water mixing with salt water, only a very small portion of the groundwater in the dunes is used (12 million m³).

The purification capacity of the dunes is used to produce approximately 15% of the drinking water in the Netherlands (184 million m³), as figure 45 shows. If the dunes are not properly managed, the four major water companies face the risk of having to adapt all of their existing infrastructure and production processes to direct processing.

The importance of good dune management
Although Evides only uses the dunes for 4% of the total volume of drinking

Figure 45: Drinking-water balance 2010 (in millions of cubic metres)



[A] Includes measurement discrepancies between gross semi-manufactures and gross purchased semi-manufactures.
[B] Includes non-charged sales (e.g. water for fire extinguishing) and measurement discrepancies.

Sourcen: Vewin (2011)

Water

water it produces, all four water companies that use water infiltration in the dunes depend heavily on the ecosystem service of fresh water purification. The table in Figure 46 shows the number of residents supplied with drinking water, the volume of artificial infiltration, the total production of drinking water and the turnover from drinking water for each company.

As mentioned above, the water companies had a major impact on the soil structure when dunes were excavated to lay infiltration channels and pipelines. The dunes were also damaged when untreated river water was infiltrated into the dunes. Damage to the soil structure can undermine the purification capacity of the dunes and there are high costs attached to re-moving polluted water. In addition, if too much fresh water is extracted, desertification can occur and brackish water can mix with fresh water. As a rule, the water companies have their own ecologists, whose task is to ensure that the production of water does not impair the natural system in the dunes.

The importance of artificial infiltration and natural dune water

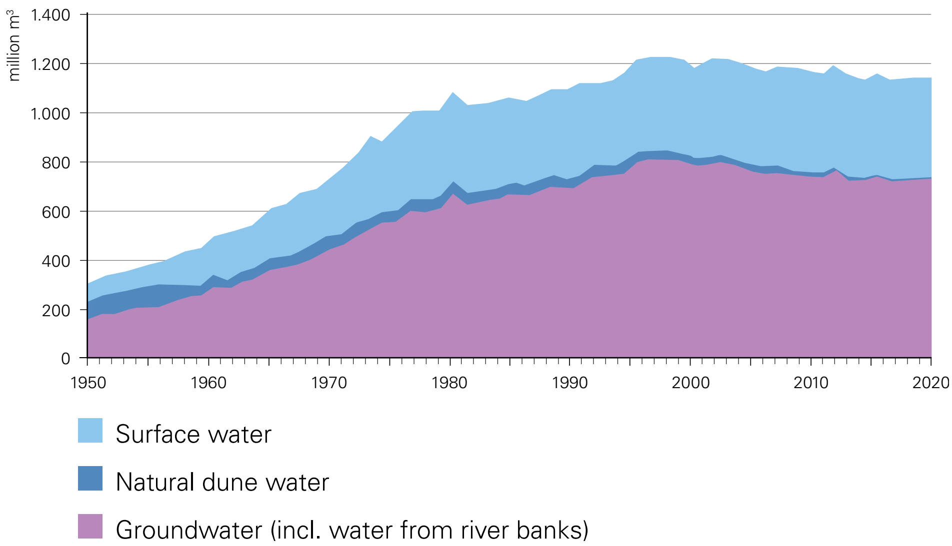
Groundwater does not have to be treated as intensively as surface water, which means fewer chemical agents and less energy have to be used, so it is less expensive to treat. However, the use of groundwater and natural dune water has declined in the last twenty years, which has driven up costs (Accenture, 2009).

Figure 46: Key figures for drinking water companies

	Residents in catchment area (in EUR (x 1,000) [35]	**Artificial infiltration** (millions of m^3 / year, rounded off) [36]	**Total drinking-water production** (millions of m^3) [35]	**Turnover** (in EUR million) [35]
PWN	1,666	46	88	157
Waternet	922	50.4	86	95
Dunea	1,227	78.8	76	121
Evides	2,040	6.6	176	201
Total (Netherlands)	**16,735**	**181.8**	**1,136**	**1,442**

[35] Vewin (2011), [36] Vewin (2012)

Figure 47: Production of drinking water by source, 1950-2010
(in millions of cubic metres)



Source: Vewin (2011)

Water

The principal objective of Dutch water companies is to ensure a reliable supply of drinking water. By law, water companies must have sufficient reserves to supply drinking water for at least 100 days, even if the sources are polluted. Water companies that use groundwater have a large reserve, but companies that depend on surface water have to maintain a reserve of fresh water. The water produced in the dunes is of strategic importance for this fresh water reserve and can provide fresh water for a period ranging from several weeks to several months. If water can no longer be recovered from the dunes, companies will have to invest in reservoirs for water storage – at a high cost.

It is impossible to make a general calculation of the difference between artificial infiltration and direct processing in terms of operating costs because it differs from one situation to another.

With artificial infiltration, the surface water sinks into the dunes and mixes with the fresh water in the groundwater, and fluctuations in the temperature of the surface water are levelled out when it mixes with the groundwater. With direct processing, the surface water may contain high concentrations of contaminants, but with artificial infiltration, peak concentrations are diluted in the large volume of fresh water.

Dune management for recreation and preservation of genetic diversity

Water companies also benefit from the aesthetic value of the dune landscape through recreation. For example, every year more than a million people visit Dunea's land in the dunes between Katwijk and Monster (Dunea, 2010) and the land owned by Amsterdamse Waterleidingduinen attracts more than 800,000 visitors (Waternet, 2010). The dune reserve in the province of Noord-Holland has attracted a record number of seven million visitors.

The Dutch water companies own 36 nature reserves, including areas of dunes, all of which are protected under the EU's Natura 2000 programme. The dunes provide habitats for rare species such as orchids, grass of Parnassus and centaury. A variety of birds could be attracted by constructing infiltration channels with bird sanctuaries, wide banks and marshlands. More than 80% of the Natura 2000 areas that are owned by water companies are also part of the National Ecological Network (Vewin, 2011).

Careful management and responsible treatment of the dunes by the water companies will benefit a number of ecosystem services: aesthetic value, preservation of genetic diversity and recreation (by opening up these areas to the public). In its annual report for 2010, PWN quantified the value of these services: the income from recreation came to EUR 7,362,000 and from nature management to EUR 3,324,000. The income from recreation was generated by the facilities provided in the nature reserves owned by PWN and included entrance fees and the sale of maps of walking and cycling paths. The income from management (in terms of participating interests) includes fees for managing dunes and other natural and recreational areas in the province on behalf of the province of Noord-Holland. Allowing the public access to the dunes is also good for the image of the water companies.

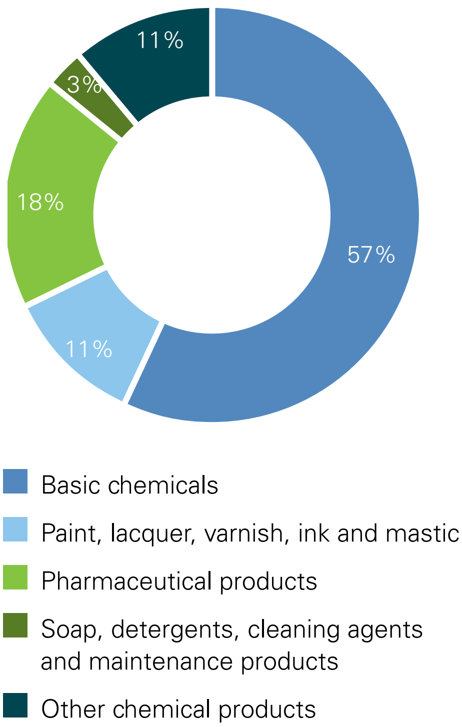
Conclusion

Good dune management can protect the supply of fresh water and keep the production costs of drinking water relatively stable. If the reserves of fresh water are depleted, the companies will have to invest large sums in building storage reservoirs, as mentioned above.

Chemicals

Chemicals
Description of the sector

Figure 48: Shares in sales of chemical products



Source: CBS 2009

The chemical sector in the Netherlands

The chemical industry is the second-largest industrial sector in the Netherlands after the food industry, with a turnover of EUR 47 billion in 2010. There are more than 400 companies in the sector, employing around 64,000 people and accounting for 19% of the country's exports. In 2010, it contributed more than EUR 19 billion to the trade balance (VNCI, 2010).

The chemical sector produces an infinite range of raw materials and products for food, plastic fibres, cosmetics, advanced metals, pigments, medicines, energy-efficient engines, shampoo and many other goods. Figure 48 shows the relative shares of sales of chemical products: basic chemicals account for more than half of the sector's sales (VNCI, 2010).

The Netherlands has a mature chemical sector with a number of multinationals, innovative SMEs and many spin-offs from universities. International peers regard the chemical research by Dutch knowledge institutes as 'outstanding' (Working Group on Business Plan for Biobased Economy, 2011). The annual investment in R&D by the private sector is EUR 1.4 billion (more than 2.5% of the turnover) (VNCI, 2010).

The chemical sector and a policy for use of renewable raw materials

In 2001, the EU countries agreed to curb the emissions of substances that cause acidification and air pollution by establishing national emission ceilings (NECs). Figure 49 shows that the sector's total emissions of substances covered by the NECs have declined substantially in the last 10 years.

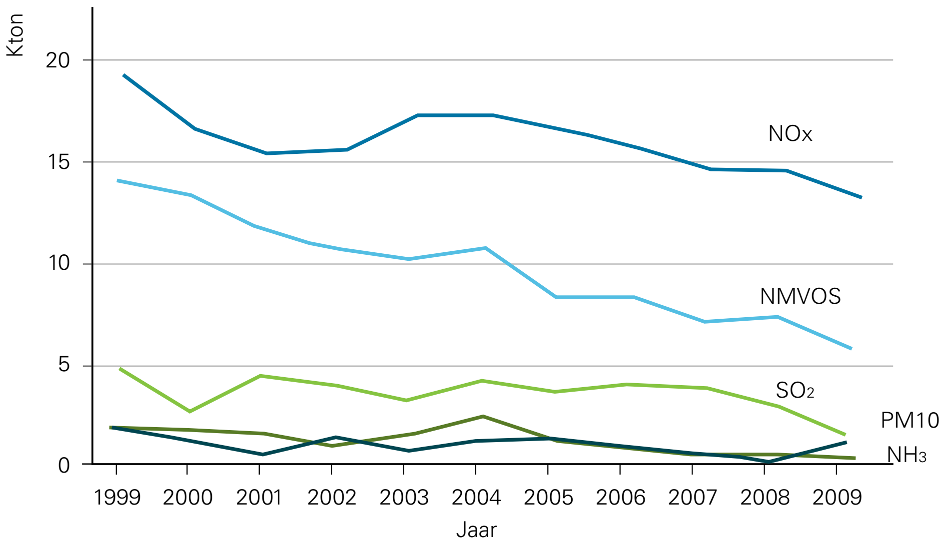
In its action agenda, the Top Sector Chemicals formulated two new main objectives for the longer term, with a focus on the biobased economy (Action Agenda Top Sector Chemicals, 2011):

- By 2050, the Netherlands will be known worldwide as the country of green chemicals. Food, energy and plastics will be produced mainly from biomass-based raw materials. The chemical industry will have developed clean and sustainable production processes to convert biomass into a wide range of new and existing products in a sustainable manner.

- By 2050, the Netherlands will be among the three leading producers of smart materials in the world. Companies established in the Netherlands will produce creative and innovative products with high added value: materials for energy storage and catalysts that are manufactured from abundant and easily accessible raw materials rather than scarce metals, for example. Plastics will be light-weight, self-repairing, self-cleaning and fully recyclable.

Chemicals

Figure 49: Emissions by the chemical sector of substances that cause acidification and air pollution, 1999-2009



- Total NO_x = Nitrogen oxide
- Total SO_2 = Sulphur dioxide
- Total NH_3 - Ammonia
- Total PM10 = particulate matter (<10 micrometer)
- Totaal NMVOC = Non-methane volatile organic compounds

Source: VNCI 2010

Chemicals

Dependencies, impacts, risks and opportunities

Input: Dependence on ecosystem services

- **Food:** Use of sugar- and starch-based crops for biochemical production.
- **Fresh water:** Large amounts of water used in some processes.
- **Raw materials:** Oil - organic compounds - and salt are not ecosystem services but can impair ecosystem services.

Output: Impact on ecosystem services

- **Climate and air-quality regulation (-):** Fossil fuels are often used as a raw material and for energy in the production process.
- **Fresh water (-):** Large amounts of water are consumed in some regions of the world, particularly outside the Netherlands.
- **Purifying/treatment capacity (-):** Because of emissions of volatile organic compounds (VOC) and waste water with high concentrations of organic compounds and solvents.
- **Soil fertility:** Pollution of soil, air and water by chemical waste (both from production of intermediate products and end products for other sectors).
- **Preservation of genetic diversity (-):**
  - In addition to the effects of CO_2 emissions, intensive economic activity affects the stability of ecosystems and reduces biodiversity.
  - Consequences for the health of species that are exposed to particular types of chemical agents (e.g. endocrine-disrupting substances).

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Risks in relation to ecosystem services

- **Legislative and regulatory risks**
  - In the EU, compliance with REACH requires measures to be taken with regard to the traceability of the impact on biodiversity, for example. Larger companies could move their activities to countries with weaker regulation of hazardous chemicals.
  - Climate change could lead to more stringent laws and regulations for emissions of greenhouse gases.
  - SMEs could find the costs of compliance with rules for soil or water pollution, for example, too high.

Output: Impact on ecosystem services

- **Climate and air-quality regulation (-):** Fossil fuels are often used as a raw material and for energy in the production process.
- **Freshwater (-):** Large amounts of water are consumed in some regions of the world, particularly outside the Netherlands.
- **Purifying/treatment capacity (-):** Because of emissions of volatile organic compounds (VOC) and waste water with high concentrations of organic compounds and solvents.
- **Soil fertility:** Pollution of soil, air and water by chemical waste (both from production of intermediate products and end products for other sectors).
- **Preservation of genetic diversity (-):**
  - In addition to the effects of CO_2 emissions, intensive economic activity affects the stability of ecosystems and reduces biodiversity.
  - Consequences for the health of species that are exposed to particular types of chemical agents (e.g. endocrine-disrupting substances).

Chemicals

Case study: Synthetic plastics versus bioplastics

A transition to bioplastics would have various advantages. For example, it would anticipate the likely scarcity of oil, reduce our dependence on oil imports, mitigate concerns about climate change and stimulate the agricultural economy.

Plastics are used in products such as packaging, fibres and bottles. Synthetic plastics are produced from polymers derived from fossil fuels, such as crude oil. The production of polymers accounts for 10% of the global consumption of fossil fuels. Half of that total is used for the materials themselves and the other 5% is used to generate the energy needed to produce the polymer (Bolck et al., 2012). Synthetic plastics depend on fossil fuels, but reserves of these fuels are not infinite and the price of oil has risen substantially in recent years.

There has been growing attention to bio-based plastics recently because they are produced from renewable sources (crops or crop residues), they are biodegradable and they have less impact in causing climate change. There are various types of bioplastics, including polylactic acid ((PLA), bioPE and bioPET. Companies like Unilever and Coca-Cola have been developing and using bioplastic packaging materials for years because they are partially renewable and to reduce CO_2 emissions. Coca-Cola is developing a commercial application for the next-generation PlantBottle packaging produced entirely from plant-based materials. The Dutch company Avantium has developed a technology to produce bottles entirely from bio-based PEF (Poly(ethylene 2.5-furandicarboxylate)), as an alternative for polyethylene terephthelate (PET). In December 2001, Avantium signed an agreement with Coca-Cola, which plans to sell its soft drinks in these bottles.

Bioplastics can be produced on the basis of starch, glucose and sugar, among other things. Because of the high sugar price in Europe in the past and lower labour costs in other countries, many chemical companies have located their production plants for bioplastics outside the EU. The price of sugar in Europe is now lower than the price in the global market; accordingly, it might be attractive for companies to establish their production sites closer to the European market. Furthermore, increased production of bioplastics could lead to expansion of the cultivation of sugar beets and potatoes in the Netherlands.

These trends illustrate the economic and social importance of a transition to bioplastics.

Purac

In this case study, we have explored the market potential of polylactic acid (PLA) and the effects on ecosystem services in association with Purac, a subsidiary of CSM. Purac produces lactic acid and lactide monomers for the production of PLA, which is used in packaging materials, among other products, and which could partially replace PET. Purac also produces both lactic acid and polylactic acid for medical applications.

The lactic acid is manufactured mainly from cane sugar and tapioca from Brazil and Thailand. In addition to the production of lactic acid on the basis of cane sugar, the case study considers the potential for producing PLA from alternative raw materials from Europe, such as beet sugar, agricultural residues, paper and roadside waste.

Polylactic acid (PLA)

PLA is a biodegradable plastic that is used in the production of packaging materials, bottles, carpets and other consumer products. In theory, PLA can be produced from any raw material that contains starch (such as potatoes and tapioca) or sugar (from sugar beet or sugar cane).

In the case of sugar beet and sugar cane, the saccharose is extracted directly from the crop. With wheat and maize, the starch is extracted from the grains and then converted into fermentable sugars by hydrolysis. These fermentable sugars are an important raw material in the bio-based industry because, through a process of fermentation (the proess whereby microorganisms convert fermentable sugars into other substances), they produce ethanol, acetic acid and lactic acid (Bos et al., 2010).

Various life-cycle analyses (LCA) have been performed to evaluate the environmental effects of the life cycles of regular plastics and bioplastics. But since an LCA can produce different results depending on the methods and parameters used, it cannot be stated with certainty that PLA is a better alternative than PET.

A study by Wageningen University investigated the energy use and greenhouse emissions of bio-based products that use sugars as a raw material (Bos et al., 2011), assuming that the agricultural residues are used as energy in the production process. The results of the study showed that approximately 70GJ in fossil energy could be saved in the production of one ton of PLA on the basis of cane sugar, compared with a similar volume of PET under current farming practices (Bos et al., 2011).

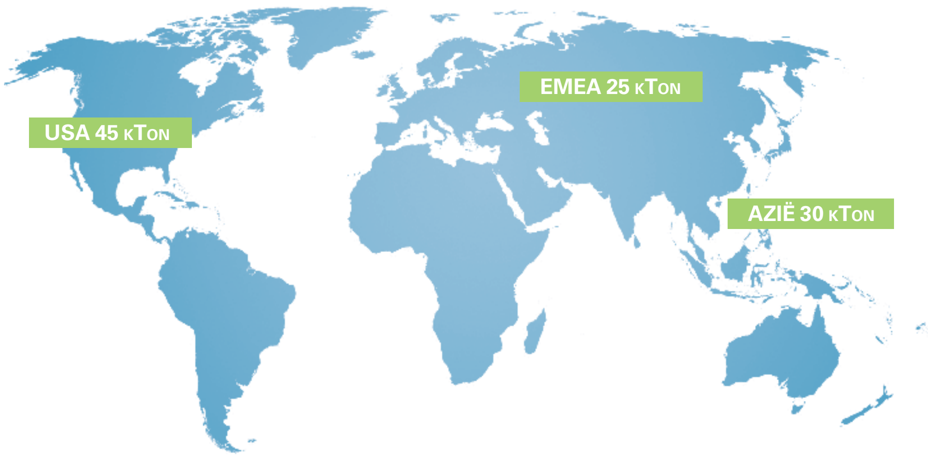
Chemicals

The value chain of PLA

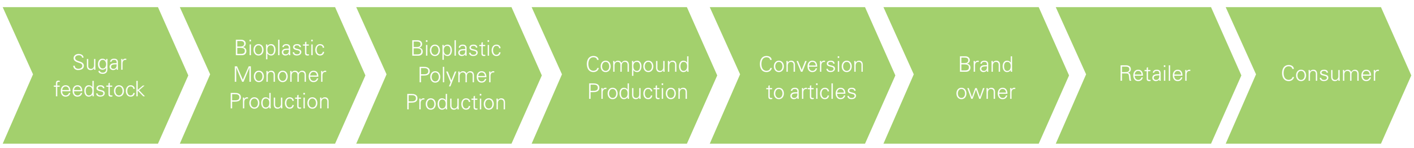
Various parties create value in the PLA chain. Farmers grow sugar-based crops, which are converted into bioplastic monomers (lactide) by biochemical companies.

Lactide is then used to produce polymers, from which PLA is produced. PLA is processed (often in collaboration with the previous party in the chain) into the final article, such as packaging. The brand owner uses this packaging for its product (e.g., shampoo), which is then sold to the retailer and finally to the consumer. Within this chain, Purac produces lactic acid and lactide and collaborates with customers in the production of polymers (polylactic acid) that are ultimately converted into products.

Figure 50: Worldwide PLA sales, 2011



Source: US export statistics (2011)



Worldwide PLA production

PLA is manufactured at a number of small production locations in Europe and Asia, and one major site in the United States (NatureWorks, which, in 2002, opened a plant with an annual production capacity of 140,000 tons of PLA) (Bos et al., 2011). There are a number of companies in the Netherlands that produce bio-based plastics. These innovative pioneers include Croda, Purac, DSM, Rodenburg and Synbra. The international market leaders are companies like Innovia, NatureWorks, Novamont and Telles (Bolck et al., 2012). Chemical companies that do not produce oil themselves develop polymers mainly to reduce their dependence on oil. They include Arkema, DuPont, Solvay and Dow, and there are other chemical companies with easy access to renewable raw materials, such as the Brazilian company Braskem (Bolck et al., 2012).

Markets for PLA

The growing demand for bioplastics, including PLA, is clearly evident from the rise in consumption and sales. Figure 50 shows the worldwide sales of PLA, which came to approximately 100,000 tons in 2011, with the US and EMEA (Europe, Middle East and Africa) being the largest markets. In the period 2000-2008, global sales of bioplastics increased by 600% (Product Board for Margarine, Fats and Oils, 2012), and various sources estimate that worldwide sales of PLA will reach between 1.6 and 3 million tons by 2020 (McKinsey, 2010).

PLA is derived from an expensive polymer (costing more than EUR 50/kg), which was originally used mainly in the biomedical industry, but with the development of efficient bulk polymerisation processes, the price has fallen sharply (Bolck et al, 2012). The price of PLA now ranges from USD 1.90/kg to USD 2.30/kg, depending on the region.

With the greater supply and lower price, PLA is better able to compete with regular plastics such as PET.

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Scaling up and increasing efficiency in the PLA industry

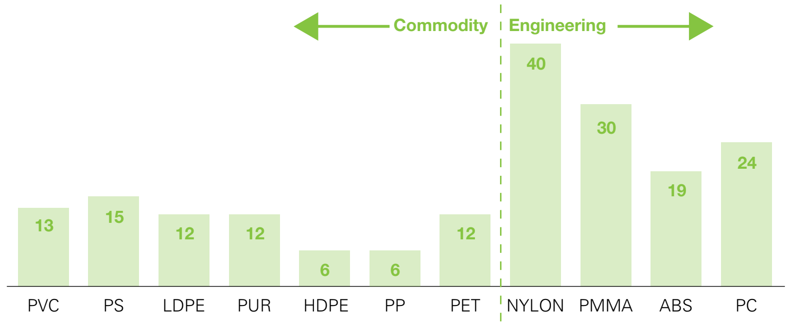
Around 250 million tons of polymers are produced globally every year. Most of the production is still based on petrochemicals, but that could change. The results of various studies suggest that the worldwide market for PLA will grow strongly, which is also expected to lead to consolidation and, hence, to economies of scale and increased efficiency.

Figure 51 shows how many years it has taken a number of years for new synthetic plastics to reach substantial production volumes and annual sales of around 136,000 tons (GBP 300 million): roughly 10 years for commodity plastics and 25 years for engineering plastics (McKinsey, 2010).

In 2002, NatureWorks opened a plant with an annual production capacity of 140,000 tons of PLA (Bos et al., 2011). In 2011, the plant produced around 100,000 tons, which represents roughly 71% of its capacity. When it has been producing PLA for ten years, in all likelihood the sales will be in line with those of traditional plastics.

The current worldwide production capacity of PET is 22.54 million tons a year (ICIS), but the production processes have improved steadily over time. The industry has scaled up, with some plants producing around 700,000 tons a year. A PET production facility with a capacity of 1 million tons a year is expected to be built in 2013. Consequently, the unit production costs of PET are relatively low and the product can be sold at an attractive price.

Figure 51: Average time taken to reach annual sales of 136,000 tons of a polymer per production facility



	PVC	PS	LDPE	PUR	HDPE	PP	PET	NYLON	PMMA	ABS	PC
Introduction year (US)	1938	1938	1943	1953	1956	1959	1963	1938	1938	1948	1961
Turnover dune 2004 (billion lb)	15,8	6,0	7,8	4,4	17,7	17,8	7,6	1,3	1,8	1,4	1,4

Source: McKinsey (2010)

Even the largest PLA plants do not come close to the size of the largest PET plants, with the annual production of PLA plants averaging about 100,000 tons. The discrepancy between PLA and PET is no surprise, since the PET industry has 35 years of development and innovation behind it and, accordingly, its production costs have fallen significantly. The PLA industry is 'only' ten years old and therefore has significant potential to optimise production. Further expansion of PLA's share in the polymer market will call for technological development and the scaling up of production.

Continuous improvement of processes, the application of new technologies and economies of scale could increase the efficiency of production, for example through more effective use of raw materials. To illustrate, since 1990 the yield from polycarbonates has risen from around 96% to close to 99.5% (Purac, 2012).

Production efficiency also has an impact on the variable cost price of the product, meaning that the product can be sold for a lower price or sold at the same price with a wider margin. The sector expects a similar improvement in the efficiency of production of PLA to that achieved with polycarbonates.

Economic analysis of PLA: investment costs and scaling up

Figure 52 shows how the investment costs for the construction of a new chemical plant decline per unit of product as the scale increases. This is mainly related to the fixed cost of the product.

When the volume of production is scaled up, investment costs per unit of product decline. With a doubling of the produc-

Chemicals

tion capacity, the investment costs increase by roughly 50%.

As supply and demand reach a balance over time, further increases in the supply will generally lead to a decline in the average price of the product.

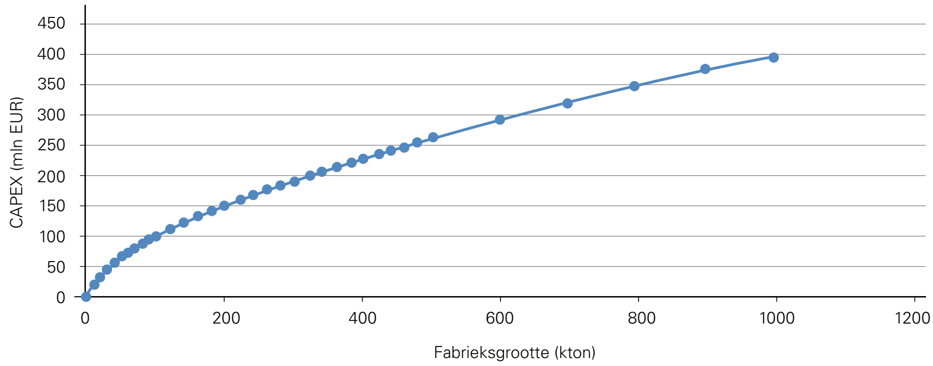
Evaluation of the prices of crude oil, PET, sugar and PLA

The indexed price in figure 53 shows a correlation between PET and crude oil. Raw materials often account for 50%-70% of the production costs of chemical companies (Top Sector Chemicals, 2011), and the PET price depends heavily on the price of crude oil. The indexed price of PLA comes from North America, where most PLA is produced from maize. The price of PLA has been more stable than that of PET in recent years.

Changes in the price of raw materials and the demand for sustainable chemicals are major reasons for a chemical company to switch to production based on renewable raw materials.

It is essential for the survival of a company to monitor price developments and market trends and, if necessary, to diversify its portfolio of raw materials.

Figure 52: Relationship between CAPEX and plant size

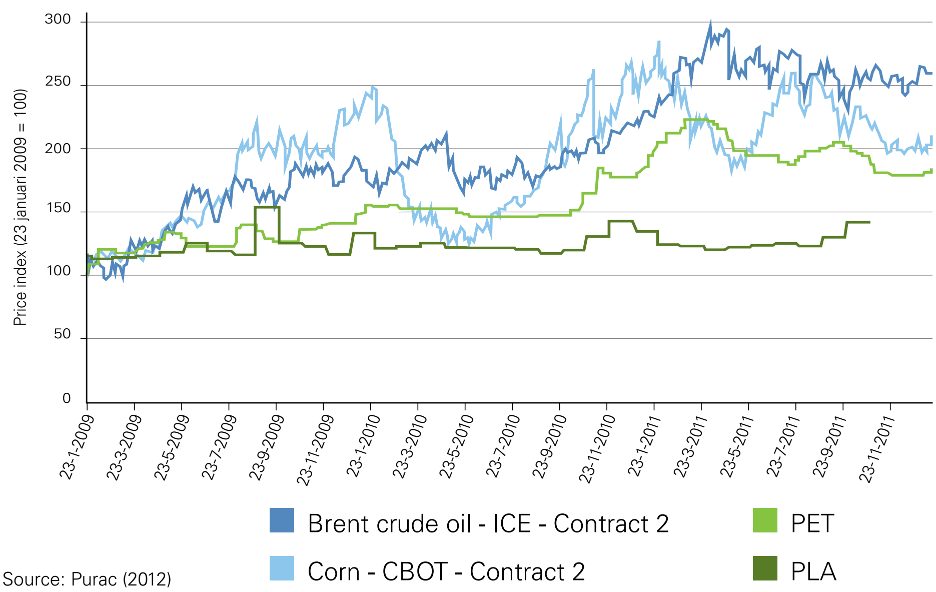


General rule of thumb for investments in production facilities on a commercial scale,where the reference capacity, 'c0', is 100 kiloton here and 'cx' is the variable capacity.

$$\text{CAPEX} = \text{CAPEX (c0)} * \left(\frac{\text{Volume (cx)}}{\text{Volume (c0)}}\right)^{0,6}$$

Source: Purac (2012)

Figure 53: Price indices for crude oil, PET, maize and PLA, 2009-2011



Source: Purac (2012)

Chemicals

Case study 8a: Transition from PET to PLA on the basis of alternative raw materials (sugar cane and sugar beet)

In this case study, we explore the possibilities and consequences of a transition from the production of PET to PLA on the basis of alternative raw materials. We look in particular at the use of sugar cane and the current EU policy towards sugar.

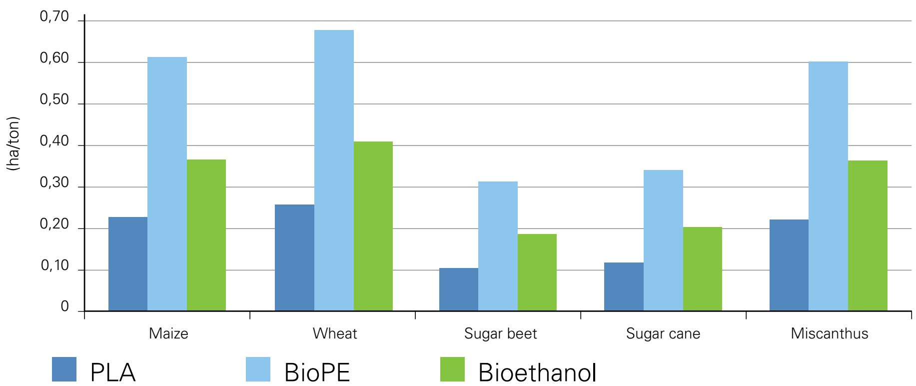
From raw material to bioplastic

Because the conversion efficiency differs depending on the bio-based product, fewer fermentable sugars may be needed as raw material. In figure 54, the theoretical conversion and conversion efficiency are shown for PLA and BioPET, two products that could be used as partial alternatives to PET. PLA needs less sugar than BioPET to produce 1 kg of polymer.

Figure 54: Conversion efficiency of bio-based products

	Conversion	Conversion efficiency	Number of kg sugar for 1 kg polymer
PLA	Sugar to lactic acid and lactides	80 %	1.25
BioPET	Sugar to monomers to BioPET	36 %	2.77

Figure 55: Land use per ton of product



Source: Bos et al. (2011)

In theory, in the conversion of lactic acid, a maximum of 80% of the original weight of the sugar is converted to PLA (Bos et al., 2011). The current conversion efficiency could be improved further. With a higher conversion efficiency, the raw material costs per ton of product would be lower, and less agricultural land would be needed.

Cane sugar as a raw material for PLA

Fermentable sugars can be obtained from various crops. In North America, PLA is produced mainly from maize starch. In the rest of the world, a great deal of the base material is also extracted from sugar cane and sugar beet. There are a number of economic and social considerations — both advantages and disadvantages — to using sugar cane for the production of PLA.

Figure 55 shows that in relative terms, sugar beet and sugar cane yield the greatest volume of crops per hectare of agricultural land (Bos et al., 2011). However, unlike sugar beet, maize and wheat, sugar cane cannot be grown in the European climate and therefore has to be imported (Bos et al., 2011). The largest producers of cane sugar are Brazil, India and China, where the high yields per hectare and low labour costs make the crop economically attractive for PLA. On the other hand, the product does have to be exported to the market (e.g., Europe).

Chemicals

The cultivation of sugar cane has various environmental effects. First, the yield is increased by irrigation, so it is extremely water-intensive. A study into the water footprint of sugar-cane production showed that 1,400 litres of water are needed to produce one litre of bioethanol from sugar beet, while 2,500 litres of water are required for the same amount of bioethanol from sugar cane in Brazil (Gerbens-Leenes et al., 2009). Second, sugar cane is frequently a monoculture crop, which can harm the fertility of the soil because the same types of nutrients are constantly being withdrawn by the crop. In some regions, the sugar cane is burned before being cut to remove the leaves and leave the stem for harvesting, but this can cause damage to soil organisms and create smoke pollution. Finally, sugar cane can lead indirectly to illegal deforestation. In addition, local production of sugar cane can deprive many people of their ability to make a living if land-tenure rights are not respected (Bolck et al., 2012).

The effects of sugar cane production on the ecosystem balance sheet are described below.

Alternative raw materials for PLA

The economic importance of PLA is expected to grow, and sugar cane has economic advantages, but as explained above, sugar cane also clearly has negative effects on the quality and availability of a number of ecosystem services. One way to counter this would be to buy only sustainably-produced cane sugar. Certification (such as the Bonsucro Certification system for sugar cane) can guarantee that the sugar cane has been produced in a sustainable manner. The Bonsucro Standard measures the impact of the production of sugar cane to ensure it is sustainable and is targeted mainly at the factory that buys the crop. To qualify for certification, a plant must ensure that farmers grow the sugar cane in a responsible manner (without using child labour or pesticides, for example). The factories must also observe rules relating to safety, health and the right to form trade unions.

Bonsucro was launched in 2008 by a number of actors in the sugar cane chain to make the sector more sustainable. In 2011, Coca-Cola bought the first certified cane sugar, which was manufactured in São Paulo, Brazil. Purac/CSM has also joined the Bonsucro organisation in order to buy Bonsucro-certified raw materials.

Sugar beets as a raw material for PLA

The high sugar content and the high yield per hectare of sugar beets (Bos et al., 2011) make it interesting for PLA production; however, there are obstacles to the production of PLA using sugar beet in Europe:

- **Security of supply:**
  The European production of sugar is constrained by a quota system, which was established at a time when there were production surpluses in Europe and an enormous gap between the high sugar prices in Europe and the prices on the world market. Nowadays, however, demand is growing faster than the quotas, and the chemical industry in Europe is consequently forced to import sugar (imports that are subject to duties, which undermine the companies' competitive position). Because of the shortages the European Commission is regularly compelled to take emergency measures, such as opening import quotas or allowing sugar produced outside the quotas onto the market, but that has not provided a permanent solution for the shortages. In the proposals for the CAP over the period 2014-2020, one measure being considered is the abolition of the existing quota system for sugar in 2015. However, this proposal is facing a lot of opposition from the agriculture lobby.

- **Price**
  A number of lactic acid plants in Europe have closed in the last six years. Purac, for example, has moved lactic acid production from Spain and the Netherlands to Brazil and Thailand, mainly because of lower raw material costs.

At around EUR 350 per ton, the estimated production costs of sugar beets in Europe are persistently higher than prices on the world market, and because of import duties, the CAP creates an obstacle for companies wishing to acquire renewable raw materials at world market prices. (Figure 56 shows the European import duties on various crops.) By contrast, fossil fuels, such as oil, can enter Europe without any import tariff (Top Sector Chemicals, 2011).

Chemicals

In 2010, because the high world market price for sugar threatened to disrupt imports of raw sugar, and consequently its processing in Europe, the EU temporarily scrapped some of the tariffs for imports of raw cane sugar for processing. And the import tariff of EUR 98/ton for cane sugar from the 'Most Favoured Nations' was suspended from 1 December 2010 until 31 August 2011. This exemption from duties applied for total of 666,000 tons of sugar.

While exemptions from the import duty can be requested every year, many European chemical companies do not feel that this (together with the limited security of supply) provides sufficient basis for investing in a lactic acid or PLA plant in Europe. There are insufficient guarantees that the bio-based raw materials will be available at a competitive price.

Figure 56: EU import duties on crops

	(EUR/100 kg)
Sugar beets	43.04
Sugar cane	43.04
Tapioca starch	(6.4% +) 15.1
Maize starch	166

Source: EU (2012)

Chemicals

Figure 57: Effect on the ecosystem balance sheet: transition from PET to PLA on the basis of alternative raw materials
(sugar cane and sugar beet)

Ecosystem services	Location	Status	Comments
Provisioning services			
Food	International (e.g. Brazilië)	▲ ▼	Growing demand for sugar cane for the production of bioplastics has the advantage of a high crop yield per hectare (+) but can lead to depletion of agricultural crops (-).
Fresh water	International (e.g. Brazilië)	▼	Growing demand for renewable raw materials will lead to increased water consumption. If the sugar cane crop is irrigated it can lead to higher crop yields. In some regions of the world, sugar cultivation is affecting the water supply.
Regulating services			
Climate and air-quality regulation	Worldwide	▲	10% of the worldwide consumption of fossil fuels is used in the production of polymers. Half of this total is used for the materials themselves and the other half to generate the necessary energy to produce the polymers (Bolck et al., 2012). The use of fossil fuels will decline with a transition to bioplastics because fossil fuels are not used as the raw material for the products.
	Local	▼	In some regions the sugar cane is burned before being cut, which leads to local air pollution.
Purifying/treatment capacity	International (e.g. Brazilië)	▲ ▼	Some bioplastics are biodegradable, unlike oil-based plastics. The use of artificial fertiliser in sugar cane cultivation could cause acidification of the soil.
Preservation of soil fertility	International (e.g. Brazilië)	▼	Sugar cane cultivation is often a monoculture, which can impair the fertility of the soil. In some regions, the burning of sugar cane before it is cut can also damage soil life.
Supporting services			
Habitat for flora and fauna	International (e.g. Brazilië)	▲ ▼	Synthetic plastics are a serious waste problem in marine ecosystems. This would be greatly reduced with the use of bioplastics. The production of green raw materials could be a driving force for deforestation.
Preservation of genetic diversity	International (e.g. Brazilië)	▼	Growing demand for sugar cane could lead to more widespread monoculture and an increase in the scale of production of genetically modified crops worldwide. Critics point out that these trends could impair the preservation of genetic diversity because they constitute a threat to the natural improvement of crops.

▲ Positive effect on the ecosystem service ▼ Negative effect on the ecosystem service

Chemicals

Figure 58: Effect on other parties and society: transition from PET to PLA on the basis of alternative raw materials (sugar cane and sugar beet)

Other parties in the physical environment and the chain	**Physical environment** • The production of PLA from sugar cane will not have fundamentally different environmental effects in the vicinity of the production location. • The transition from PET to PLA could, however, lead to the relocation of factories where the plastic is produced. • The effects on the environment therefore depend on whether production is relocated. • Naturally, there are various effects connected with the production of the raw materials (from oil to sugar cane), which are summed up in the ecosystem balance sheet.	**Chain** • The waste processing and recycling industry is searching for new ways to process bioplastics. • Farming worldwide is meeting a growing demand for the cultivation of crops as raw materials for bioplastics. • The world market economy expects a more direct link between food, energy and fuel prices. If fuel prices rise, the long-term trend of declining real food prices could weaken and even be reversed (Bolck et al., 2012). • The economics of the substitution of oil with sugar cane is a complex issue and cannot be discussed in detail in this study.
Social gains and losses and general social effect	**Netherlands** • With its strong chemical sector, the Netherlands is extremely well positioned to play a leading role in the transition to a New Earth (Top Sector Chemicals' action plan for a transition to sustainable materials and chemicals). At the same time, the sector can make a major contribution to competitiveness, economic activity and prosperity in the Netherlands (Willems et al., 2011). • If bioplastics reduce/eliminate soil pollution, there could be positive health effects. • The trend towards bioplastics will make the Dutch economy less dependent on oil.	**International** • Competition with the food supply could lead to food scarcity if there is a shift towards the use of food crops for industrial applications (European Bioplastics, 2011). • Biodegradable plastic could ease concerns about waste in marine ecosystems. • With an extensive transition to a bio-based economy, the balance of power could shift from oil-rich countries to countries with extensive arable land (Rathenau Institute, 2011).

Chemicals

Case study 8b: Transition from PET to PLA on the basis of alternative raw materials (agricultural residues and paper waste)

In this case study, we investigate the possibilities and consequences of a transition from the production of PET to PLA on the basis of alternative raw materials, with special attention for the second generation of bioplastics: plastics produced from agricultural residues and paper waste.

The use of agricultural and woody residual materials (e.g., roadside and paper waste) for PLA is an interesting alternative. A lot of research is currently being conducted into ways of using residual materials, particularly the possibility of using smart technology for the enzymatic hydrolysis of the lignocellulose in the waste and then fermenting the sugars that are released.

Companies are investing in this. In the United States, for example, DSM is building its first factory for the large-scale production of bioethanol from maize residues. The result of these initiatives could be that applications are found for some residual materials sooner than others.

It remains primarily a technological issue, so there are major opportunities for the Netherlands because of its leadership position in agricultural know-how, the availability of suitable residual materials and the presence and expertise of the chemical sector.

There are sufficient residue streams and woody residual materials available in the Netherlands to produce several megatons of green products and raw materials over the long term (Croezen et al., 2006). In Rotterdam port, for example, there are around 600,000 tons of plant-based residual materials (e.g. roadside waste) from the food and agricultural sectors (Deltalinqs, 2011).

Using local agricultural residues or woody residual materials could reduce the Dutch chemical sector's dependence on imported raw materials and facilitate better use of existing raw materials. In addition, this would not be in direct competition with crops for the food supply.

The impact on ecosystem services of using paper waste is explored below. The use of paper waste to produce PLA has fewer negative effects on eco-system services than the use of cane sugar,but more research is needed into the production possibilities and market potential of scaling up the use of paper waste (and perhaps agricultural residues) in the biopolymer industry.

Chemicals

Figure 59: Impact on ecosystem balance sheet: transition from PET to PLA on the basis of alternative raw materials (agricultural residues and paper waste)

Ecosystem service	Location	Status	Comments
Provisioning services			
Raw materials and food	Netherlands (and Europe)	▲	New technologies are being developed for the use of residues as raw material for producing bioethanol and lactic acid. Paper waste could be an alternative raw material for the production of PLA, which, as with PET, would mean that no raw materials would be extracted from nature and/or agricultural land. This is a benefit compared to producing PLA from sugar cane, for which additional raw materials that could have been used as food are extracted. Because it would be low-grade waste paper that can no longer be used for other purposes, better use is made of the ecosystem service commodity (wood). We therefore rate this as positive for the availability of the ecosystem services raw materials and food.
Regulating services			
Climate and air-quality regulation	Worldwide	▲	The production of polymers accounts for 10% of the worldwide consumption of fossil fuels. Half of this amount is used for the materials themselves and the other half to generate the energy required to produce the polymer (Bolck et al., 2012). The use of fossil fuels will decline with the transition to bioplastics, since fossil fuels are not used for the materials themselves. The impact on climate change is more positive than with the use of sugar cane, because CO_2 emissions are kept out of the atmosphere longer.
Supporting services			
Habitat for flora and fauna	International	▲	In marine ecosystems, synthetic plastic is a major waste problem, which could decline significantly with the use of bioplastics.

▲ Positive effect on the ecosystem service ▼ Negative effect on the ecosystem service

Chemicals

Figure 60: Effect on other parties and society: transition from PET to PLA on the basis of alternative raw materials (agricultural residues and paper waste)

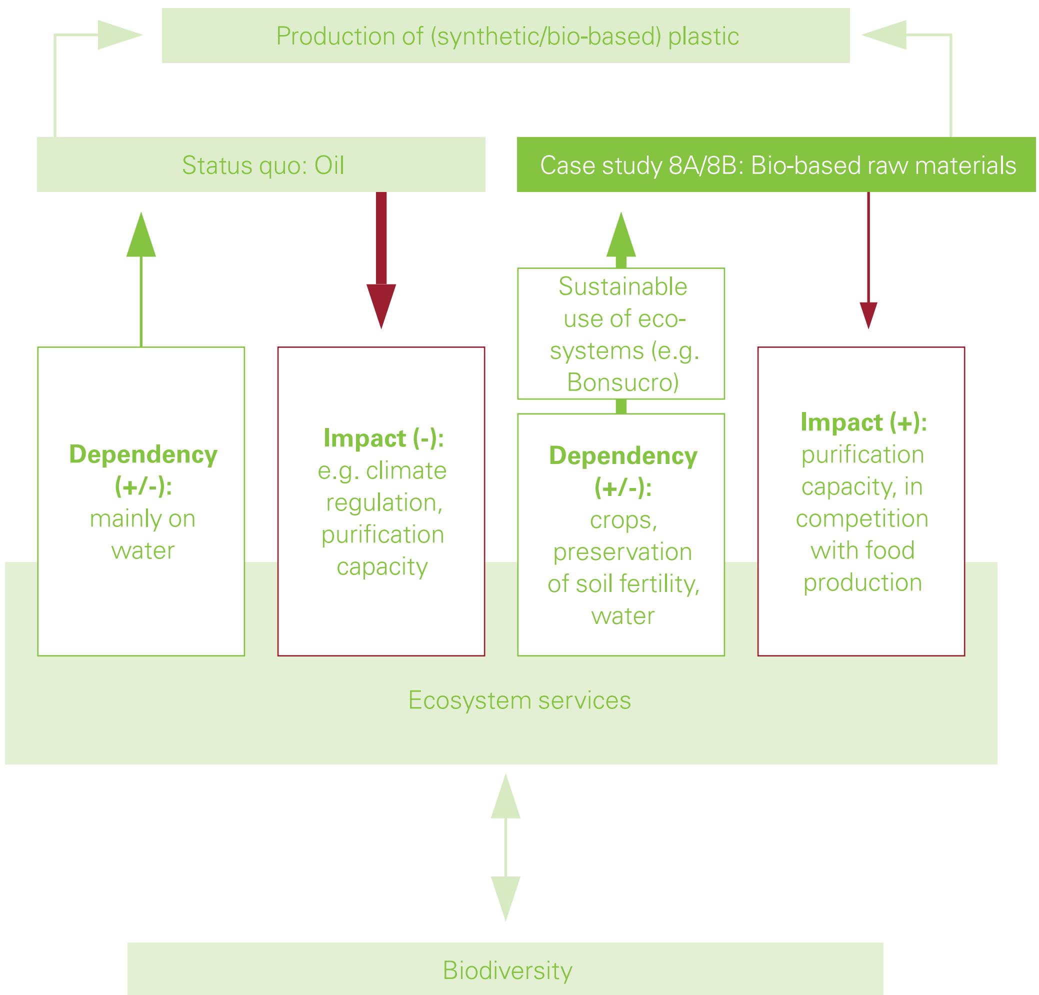
Other parties in the physical environment and the chain	**Physical environment** • The production of PLA using agricultural residues and paper waste does not lead to substantially different environmental effects in the vicinity of the production location. • However, the transition from PET to PLA could lead to the relocation of factories where the plastic is produced. • The effects on the environment therefore depend on whether production is relocated. • Naturally, there are various effects connected with the recovery of raw materials (from oil to agricultural residues and paper waste). These are summed up in the ecosystem balance sheet.	**Chain** • Processing and recycling systems might be optimised to capture paper waste and supply it to chemical companies. • Consumers and companies will become more aware of the need to separate paper waste in order help meet the growing demand for it. • Low-grade paper waste for PLA will be retrieved from existing waste streams. The total waste stream in the Netherlands will shrink.
Social gains and losses and general social affect	**The Netherlands** • Because of its strong chemical sector, the Netherlands is extremely well positioned to play a leading role in the transition to a New Earth (Action agenda of the Top Sector Chemicals for sustainable materials and chemicals). The sector can also make a major contribution to the Netherlands' competitiveness, economic activity and prosperity. • If bioplastics reduce/eliminate soil pollution, there could be positive health effects. • The trend towards bioplastics will make the Dutch economy less dependent on oil.	**International** • Since paper waste is not in competition with the food supply, this will not create issues of food scarcity. • Biodegradable plastic could ease concerns about waste in marine ecosystems.

Chemicals

Issues to address for business and policymakers

A diagrammatic overview of the importance of ecosystem services
The transition from synthetic plastics to bio-based plastics could significantly reduce the impact on ecosystem services. The demand for bio-based raw materials will increase the dependency on ecosystem services. Ecosystems will have to be used sustainably to safeguard the availability of raw materials.

Issues and strategic implications for business and the sector
In the long term, the chemical industry's dependency on oil for the production of plastics will be even greater than it is now. In order to reduce its dependency on a scare resource and to anticipate the (very likely) increase in market prices for oil, the chemical industry should explore the possibilities of bio-based raw materials in good time. There is also considerable potential for further growth of this relatively new market through innovation and up-scaling. Another trend is the growth in market demand for bio-based plastics. Large companies like Unilever and Coca-Cola have already been active in this market for some time and are willing to make major investments.



Chemicals

In the short term, companies in the chemical industry need to determine their position in the bio-based economy. With the rapid progress being made in the development of advanced plastics, timely market entry is important to preserve market share. This will require a willingness by companies to invest in R&D. It could also be worthwhile exploring alternative bio-based raw materials, such as roadside waste and paper waste. The greater demand for conventional bio-based raw materials, for energy and food as well, could have consequences for the supply and price of those commodities.

Issues and implications for policymakers

Regulation of the markets for starch and sugar products has an adverse effect on the competitive position of the European chemical sector. A free market for sugar and starch seems to be an important requirement for the future of the chemical sector in the Netherlands and Europe.

- Abolishing import duties on sugar-based raw materials for industrial use will promote the transition to a bio-based economy. It would also enhance the Dutch chemical sector's position as a market leader in terms of innovation and technological development of bio-based plastics.

- Abolition of the sugar quotas will increase the security of supply and encourage the chemical industry to commit itself to long-term investments in the bio-based economy in Europe.

- As long as import duties and quotas exist, the Netherlands must grasp every opportunity to secure exemptions from import duties on raw materials for the bulk chemical and fermentation industries.

If these conditions are met, the sector will probably be in a better position to play an important role in the development of the next generation of bio-plastics.

Tourism

Tourism

Description of the sector

The sector in the Netherlands

The Netherlands has a well-developed tourism (or 'leisure and culture') sector that is of vital economic importance to the country, accounting as it does for 3% of total GDP and 4% of total employment. To compare: more people work in tourism than in the agriculture and horticulture sector or the banking and insurance sector. At the end of 2011, there were 6,181 places offering accommodation in the Netherlands, including 3,194 hotels, 2,214 campsites, 856 holiday parks and 703 group accommodations.

Tourism is not only economically important, it also benefits society in other ways. For example, by maintaining facilities tourism enhances the quality of life in the countryside.

The tourism sector relies to a large extent on biodiversity and ecosystem services. Nature and open space are important drivers of turnover and profits for operators in beach resorts, ski resorts, national parks and ecotourism centres, for example, as well as providing aesthetic value and hosting a wide variety of flora and fauna.

Spending on domestic holidays was EUR 2.8 billion in 2010, the same figure as in 2009, although there was a decline in the number of holidays in bungalow parks (-5%) and camp sites (-3%). The main reasons for the drop in the number of domestic holidays are that the economy was still recovering, the May holiday was unusually long and the weather in the second half of the summer was relatively poor.

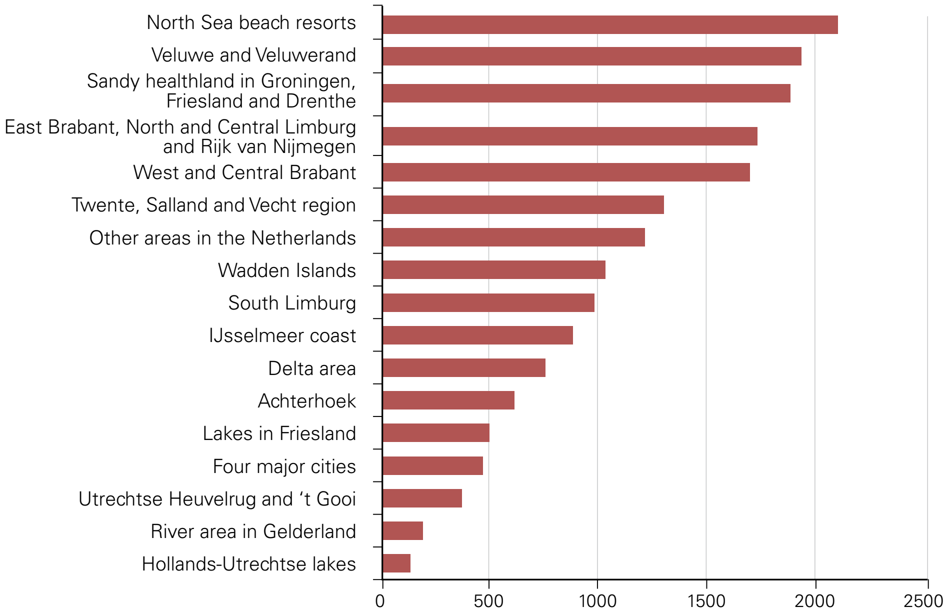
The North Sea beach resorts are the most important tourist destinations (13% of all holidays), followed (in order of popularity) by (1) the Veluwe and the Veluwerand, (2) the sandy heathland of Groningen, Friesland and Drenthe and (3) the tourist area 'East Brabant, North and Central Limburg and Rijk van Nijmegen'. The last three tourist destinations underscore the popularity of woodland and areas of natural beauty for domestic holidays.

Figure 61: Key figures for tourism

	Amount
Expenditure by Dutch people on domestic/international holidays (in EUR billion)	15
Expenditure on long domestic holidays (in EUR billion)	1.8
Expenditure on short domestic holidays (in EUR billion)	1.0
Average expenditure on long domestic holiday p.p. (in EUR)	211
Average expenditure on short domestic holiday p.p. (in EUR)	110

Source: CBS (2011)

Figure 62: Number of holidays by region (x1000)



Source: CBS (2011)

Tourism

Dependencies, impacts, risks and opportunities

Input: Dependence on ecosystem services

- **Natural beauty:** The Dutch countryside has many different types of landscape that attract tourists. Retaining and improving this natural beauty will safeguard that part of the tourism economy that depends on it.
- **Fresh water:** Hotels, campsites and holiday homes use water that often has to be available locally. Good quality swimming water enhances the appeal of an area.
- **Preservation of genetic diversity:** Apart from the natural beauty, it is important to protect the native flora and fauna. Many areas, such as the national parks, attract visitors mainly because they are home to particular species. Examples include the red deer in the Veluwe or the many different species of bird in the Oostvaardersplassen.

Output: Impact on ecosystem services

- **Fresh water (-):** Hotels, campsites and holiday homes cause water pollution.
- **Natural beauty (-):** The tourism sector can have a negative impact on the natural beauty of a region if facilities are not properly integrated in the landscape or if there are to many visitors.
- **Habitat (-):** Although nature reserves depend in part on tourists for their survival, the tourism sector also has an impact by virtue of the use of land for hotels and roads, which can cause fragmentation and disruption of nature reserves.

Tourism

Dependencies, impacts, risks and opportunities

Risks arising from impacts and dependencies on ecosystem services

- **Operational risks:** Business activities that depend heavily on the presence of a particular species of animal or plant face an operational risk if those species are less prevalent or disappear. The same applies for the natural beauty of an area as a whole.

- **Reputational risks:** The reputation of businesses in the hospitality sector could suffer if they fail to actively protect nature or the landscape.

Opportunities arising from impacts and dependencies on ecosystem services

- **Markets for ecosystem services:**
  - Market differentiation: A growing number of farmers have realised that they can supplement their income from farming by providing camping facilities for people who want to experience the landscape and the way of life.

  - Ecotourism: Although there is no uniform definition of ecotourism, it is generally regarded as a synonym for nature-related tourism, which has been growing faster than 'conventional' tourism in recent years. In 2004, for example, ecotourism grew by a factor of three (Young Bender, 2008).

Tourism

Case study 9: The economic value of a nature reserve

In this case study, we calculate the economic value of the Veluwe in terms of turnover per hectare from tourism in relation to the average turnover per hectare from tourism in the Netherlands. The case study shows that nature pays for itself.

Designated as a Natura 2000 area, the Veluwe is the largest lowland nature reserve in North-West Europe, with a surface area of 91,200 ha, or 2.2% of the total area of the Netherlands. The area has enormous ecological value, as shown by figure 63, which shows the number of ecosystem services per location (Melman et al., 2011).

Tourism is highly developed in the Veluwe. The best-known attraction is the Hoge Veluwe National Park, which, with a surface area of 5,400 ha of forest, heathland, grassland and sand drifts, is the largest actively managed conservation area in private hands in the country. The park attracted 505,667 visitors in 2010, generating a turnover of around EUR 5 million.

There are 470 accommodations in the region (6.7% of the total in the Netherlands), with relatively few hotels (151 = 4.7% of the country's total) but many campsites (180, or 8.1%) and bungalow parks (91, or 10.6%). Visitors and tourists rate the Veluwe very highly, as figure 64 shows. Every year around 28 million visitors make day trips to the Veluwe and there are 6.8 million overnight stays in the region, 2 million at campsites, 2.5 million in bungalows, 0.4 million in group accommodations and 1.8 million in hotels.

An estimate of the turnover from tourism in and around the Veluwe has been produced by adding the expenditure on hotels, campsites, bungalow parks and group accommodations plus the spending by visitors on day trips to cycle or walk in the area plus spending in restaurants. The calculation does not include additional income generated by visitors to the nature reserve for local businesses, recreation areas and nature reserves.

Figure 63: Number of accumulated ecosystem services

Source: Melman, et al (2011)

Figure 64: Predicted appeal of landscape on the basis of area features

Source: De Boer, et al (2010)

Tourism

Calculation of the economic value of the Veluwe for tourism

Figure 65 shows that the total turnover from tourism in the Veluwe region is EUR 484 million, compared with EUR 7,177 for the Netherlands as a whole (for the categories adopted in this report).

Expressed in terms of land use, this represents an annual turnover of EUR 5,304 per hectare of nature in the Veluwe. What stands out is the relatively large discrepancy with the national average (EUR 1,728); that national average refers to returns per hectare from tourism regardless of the use of the land (nature, building, agriculture, etc.). The difference in the returns underlines the economic value of nature.

The recreational facilities provided in the Veluwe, in combination with the nature, leads to more intensive tourism, which pushes up the returns per hectare. The calculations are based on average prices (for overnight stays and expenditures) for the Netherlands as a whole, because specific figures for the Veluwe are not available for every category. Naturally, the returns per hectare might be different if key figures specific to the Veluwe were used.

Figure 65: Turnover from tourism per hectare, Veluwe and the Netherlands

Overnight stays	**Number of overnight stays** (in millions)		**Price per overnight stay** (in EUR)	**Total income** (in EUR million)	
	Veluwe[37]	Netherlands[38]		Veluwe	Netherlands
Campsites	2.1	19.3	11.2 [39]	**24**	**216**
Bungalows	2.5	28.0	23.1 [40]	**58**	**647**
Group acco-mmodation	0.4	3.9	18.0 [41]	**7**	**70**
Hotels	1.8	33.7	108.0 [42]	**194**	**3,640**
Day trips	**Number of day trips** (in millions)		**Expen-ditures** (in EUR) [45]	**Total expenditures** (in EUR million)	
	Veluwe[43]	Netherlands[44]		Veluwe	Netherlands
Walking	14	48.1	2.48	**35**	**119**
Cycling	14	34.8	2.53	**35**	**88**
Hospitality sector	**Number of persons** (in millions)		**Expenditure** (in EUR) [45]	**Total expenditure** (in EUR million)	
	Veluwe[46]	Netherlands[44]		Veluwe	Netherlands
Eating out, re-freshments, etc.	8.7	159.6	15.02	**131**	**2,397**
Total overnight stays & day trips (in EUR)				**484**	**7,177**
Surface area (in hectares)				**91,200**	**4,154,300**
Turnover from tourism per ha (in EUR)				**5,304**	**1,728**

[37] CBS (2010), [38] CBS (2011), [39] ADAC (2012), [40] Province of Flevoland (2010), [41] Van der Meulen (2010), [42] The Hotel Price Index (2011), [43] Transport Knowledge Resource Centre (2008), [44] CBS (2010), [45] Netherlands Research Institute for Recreation and Tourism (2009), [46] Assumption: a quarter of day trippers and a quarter of people who stay overnight in the Veluwe visit a restaurant.

Conclusions

Conclusions

The Economics of Ecosystems and Biodiversity (TEEB) for Business – the Netherlands
The principal aim of this study, which follows up on the international study 'The Economics of Ecosystems and Biodiversity' (TEEB) is to highlight the economic value of biodiversity for society and business.

With thirteen analyses and specific case studies from nine economic sectors in the Netherlands, this study provides a clear impression of how companies and sectors depend on and have an impact on ecosystem services and biodiversity. The descriptions of the sectors identify a wide range of specific risks and opporunities. Companies that anticipate risks or correctly time their response to the opportunities that nature offers can gain an edge over their competitors.

Ecosystem services, as listed below, represent an economic value for companies:

- Provisioning services are the products obtained from ecoystems, such as fish, clean water and medicinal plants;

- Regulating services are the benefits obtained from the regulation of ecosystem processes, such as the treatment of contaminated water by 'wetlands' and climate regulation through the capture of CO_2;

- Cultural services are the non-material benefits obtained from ecosystems, for example in the form of recreation and tourism;

- Supporting services, such as habitats and the preservation of biodiversity, are the services necessary for the production of practically every other ecosystem service.

The provisioning services are the most illustrative for an analysis of the financial and economic value of ecosystem services for business, but the analysis also extends to other forms of ecosystem services that are directly relevant for companies.

Because of the country's great dependence on raw materials from abroad and the special position the Netherlands occupies in international supply chains, many of the issues surrounding biodiversity are global questions with a direct impact on the operating results of Dutch companies.

Naturally, there are also local issues that create their own specific dependencies and impacts and which have to be seen in the context of these global issues for a better understanding of the value of ecosystem services and biodiversity when it comes to setting priorities. The following findings constitute a common thread running through all of the sectors and case studies we have examined.

1. There is no standard method for determining the economic value of ecosystem services and biodiversity for companies.
The table in Figure 66 presents a summary of the sectors and case studies described in the report.

For each case study, the summary explains whether it was considered because of an impact or dependency on ecosystem services, or whether the primary concern was the risks or opportunities for companies, what the likely economic effects are, and where the effects might occur: locally, in the chain, in the Netherlands or elsewhere in the world. The diversity of the case studies in itself shows how complex the subject is.

This study only gives an initial impression of the economic value of ecosystem services and biodiversity for each sector or in each of the cases studied. The selected sectors and case studies give only a very limited impression of all the risks and opportunities for companies in relation to ecosystem services and biodiversity. Ultimately, it is companies themselves that are best placed to make their own specific analysis and assessmentof whether to make new investments. This study helps by providing a framework for analysis, sources of inspiration and examples, as well as issues that will need to be addressed by the far wider group of companies that are starting to think in terms of ecosystem services and biodiversity and are willing to conduct further research for the purposes of their own business operations.

2. Anticipating opportunities and risks in relation to the enormous dependence on ecosystem services in non-Western countries is essential for the survival of business.
Globalisation is increasing the dependence on biodiversity and ecosystem services in non-Western countries in practically every sector.

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Figure 66: Summary of TEEB for Business in the Netherlands

Sector	Case study	Primary concern		Significance of case study for business		Where effects occur	
		impact	dependence	risk	opportunity	Local party	Primarily in the chain
Dairy farming	Certified soy		●	●			●
	Rapeseed meal		●	●			●
Arable Farming	Field margin manage-ment	●			●	●	
	Non-inversion tillage	●			●	●	
Fisheries	Plant-based fish feed		●		●		●
Horticulture	Use of honey bees and bumblebees		●		●		●
	Biological pesticides	●			●	●	
Creative sector	Sustainable design of new housing estates	●			●	●	
Life sciences	Biopharmaceuticals		●		●		●
Water	Natural infiltration of dunes		●	●		●	
Chemicals	Plastics versus bio-plastics (sugar cane)		●	●			●
	Plastics versus bio-plastics (paper)		●	●		●	
Tourism	Veluwe		●		●	●	

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Effects on ecosystem services and well-being		Economic effects (income statement)		Explanation
NL	Global	NL	Global	
	●	🔴	🔴/🟢	The additional costs of certified soy have practically no effect on the income statement of the dairy farmer (costs of feed increase by 0.1%). A complex issue, however, is how to introduce RTRS throughout the chain.
	●	🔴	🔴	Permanently higher costs for dairy farmer (1.8% decline in income from operations) and complex 'trade-offs' in effects on biodiversity and ecosystem services requiring further research.
●		🔴	🔴	Minimum impact on ecosystem services. No viable business case even with current subsidies. Reform of CAP will bring little change.
●		🔴	🔴	Of limited ecological and economic value in the Netherlands. At best locally interesting.
	●	?	🟢	This innovation will create an excellent strategic position in a world with extreme scarcity of fish: 80% of fish species are over-exploited.
●		🟢	🟢	Honey bees and bumblebees are essential for growing tomatoes. Alternatives (manual or mechanical) are disastrous for the sector, with additional costs of around EUR 10-40 million annually.
●		🟢	🟢	Biological pest control is now the norm in greenhouse horticulture. Possible opportunity for field cultivation. Further research is needed.
●		?	🟢	Architects play an important role in spatial planning and building design. Their choice of location and materials can help to preserve ecosystems.
	●	🟢	🟢	Biodiversity is essential for the biopharmaceutical industry. The sector does not yet have a proper grip on the chain for non-medicinal raw materials. Margins may decline.
●		🟢	🟢	In the absence of dune management, there are major risks for the production costs of water. Water companies cannot afford the investment needed to maintain an emergency supply of water for 100 days.
	●	?	🟢	A multibillion business with robust growth projections: from 100,000 tons in 2011 to 1.6 to 3.0 million tons in 2020. The Netherlands starts from a good position because of its know-how and technology. Current import rules are an obstacle to investment in Europe and hamper a speedier transition to a bio-based economy. Complex trade-offs in terms of biodiversity and ecosystem services.
	●	?	🟢	Second-generation bioplastics eliminate the complex trade-offs with existing bioplastics. Experience with first-generation technology, although technologically very different, could be a driver of a second wave.
●		🟢	🟢	Turnover from tourism per year/ha is three times higher than the average in the Netherlands: approximately EUR 5,300 vs. EUR 1,700 (accommodation and passing trade, excluding spending with local businesses by people who stay overnight).

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The most important trend directly connected with ecosystem services is the rising price of food, especially in relation to the expected population growth, changing consumer patterns and the growing demand for biofuels. There will also be severe water shortages, and climate change could cause as yet unknown damage to ecosystems.

Smart companies will respond to these trends in time and invest in programmes that will give them an edge in the global competitive race. Skretting, a subsidiary of the Dutch company Nutreco, for example, has responded to the growing scarcity of wild fish and the anticipated future rise in the price of fishmeal and fish oil by developing an alternative plant-based fishmeal as a raw material for the rapidly growing aquaculture market.

3. Public opinion and consumer behaviour is promoting sustainable value chains and innovation, thus creating genuine opportunities for companies.
Companies are under increasing pressure from public opinion and consumer behaviour to reduce the impact on ecosystem services and biodiversity caused by their suppliers and to introduce systems for certifying the sustainability of all or part of the chain, irrespective of a company's geunine ability to influence the chain. Thanks to programmes by the UN Global Compact, the FAO and the World Business Council for Sustainble Development (WBCSD), and because of European and national legislation, companies are being encouraged to reduce their negative impact on ecosystems and biodiversity.

The multinationals are currently setting the pace in that regard and their suppliers and competitors will have to match their level of ambition.

This will create both risks and opportunities for a great many companies in a large of number of sectors.
For example, suppliers in the food and retail industries can gain a competitive edge by supplying more sustainable raw materials and products. There will be greater opportunities for suppliers of certified soy or soybean substitutes and products containing them because, from 2015, the Dutch dairy sector will only allow certified soy to be used in animal feed. Although the additional costs for sustainable soy at the end of the value chain are minimal, dealing with local producers, exporters and international trading companies that are not necessarily interested in collaboration and transparency is a complex process. Companies like Coca-Cola have provided an enormous boost for innovation in the chemical industry by opting for bottles produced from bioplastic. Companies like the Dutch firm Purac – which is one of the first companies to supply raw materials for a practical alternative to the classical petroleum-based PET bottles – show where the business opportunities are at the moment. The case studies illustrate how responding to this trend will mainly involve capitalising on our existing technological know-how.

4. The net effect of measures on companies, their environment, the relevant chains and ecosystem services is not always clear, so economic value must always be considered from different perspectives.

A number of the case studies clearly demonstrate that alternatives to the traditional products that are often associated with negative effects for ecosystem services and biodiversity, such as soy and petroleum-based plastics, create new dilemmas of their own. Thinking in terms of the economic value of ecosystem services and biodiversity is a relatively new phenomenon, and there are many dimensions to it. In addition to a company's direct dependence and impact and the effects on its operating results, it is also essential to consider the economic effects for neighbouring businesses and other parties in the chain, as well as a whole series of direct or indirect effects on the quality or availability of numerous ecosystem services. In this study we have chosen not to 'discount' all the ecosystem services used by a company, but to calculate, where possible, the effects of a single measure or change. Even that has identified a number of major dilemmas and issues which will have to be addressed for a true understanding of the value of ecosystem services and biodiversity for Dutch business.

For example, what effect does choosing alternatives to soy have for the local economies in Brazil, Argentina and Paraguay? And what if the net contribution of those alternatives for climate change or the use of agricultural land in Europe is negative? And to what extent do bioplastics actually compete with food crops and what impact should this have on the price of bioplastics? And how realistic is it for Dutch companies to actually play or continue to play a leading role in developing second-generation bioplastics (based on waste) if the current EU import policy does not

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promote the production of first-generation bioplastics in this country?

Even looking solely at the operating results of companies in the current economic climate – which seems a relatively straightforward task – a number of challenges emerge that require further research.

For example, the economic value of honey bees and bumblebees for tomato growers can be looked at it in a number of ways. One is to say that they do not constitute an ecosystem service at all since the honey bees and bumblebees used are domesticated and not wild.

Another way of looking at it is that the sector is paying millions of euro a year to breed and keep bees because we have destroyed the habitat of wild bees, and without the domesticated bees the sector would have to spend several tens of millions for manual or mechanical pollination. And that might mean the end of the sector. A final point is that if bees were to die out altogether, the world would have far greater problems and tomato cultivation in the Netherlands would probably be one of the least of our worries.

5. Without mechanisms to allocate costs, the possibilities for companies to take steps to foster local biodiversity are often very limited.
We should not expect companies to take all sorts of measures to protect ecosystem services or biodiversity without incentives. For companies, profits are and will remain the decisive factor. But it is clear that some specific ecosystem services can have a distinct economic value for a large number of sectors. Examples are the presence of forests and nature (recreation and tourism) or the purification of water by dunes to produce good, affordable drinking water (drinking water companies). The economic value described for each sector in this study – whether it is expressed in terms of the investments required to meet the statutory norm of guaranteeing a hundred-day supply of drinking water or in the sum of money spent on recreation per hectare of forest in the Veluwe – is not the amount that the sector can invest to conserve or enhance biodiversity, to manage the dunes or to buy, plant or maintain forests.

The same applies for measures in the arable farming sector. Although many positive points are made about the economic value of field-margin management or non-inversion tillage, as a rule there is no positive business case for the entrepreneur. Farmers make a profit now, and may do so in the future, thanks to subsidies (from the EU or otherwise). It will probably also be difficult to replace the system of subsidies with a more direct transfer of value between businesses. The benefits of field-margin management for the water manager are very modest in purely economic terms. It is simply not the case that water treatment plants will no longer be necessary if more farmers were to adopt field-margin management.

6. Agenda for action by business and public authorities needs to be fleshed out.
The findings in this study suggest a number of further steps that could be taken by the business sector and the government.

Business
To start with, the study shows that the step-by-step plan in the international TEEB for Business study is extremely relevant and entirely applicable for individual companies and sectors in the Netherlands. Every company should take the following steps in order to gain an understanding of the full economic value of ecosystem services and biodiversity for its business and to identify specific actions it can take to capitalise on ecosystem services:

- Vision/strategy: Carry out a baseline measurement to assess the risks, opportunities, dependencies and impacts in relation to the four types of ecosystem services. An important aspect of this assessment is to quantify the financial and economic value of these services for the business.

- Change and implementation: Develop new product-market combinations or revise existing business processes and develop an ecosystem performance-management system that incorporates performance indicators and a monitoring system.

- External reporting: Explicitly include qualitative and quantitative information about trends and results relating to the relevant ecosystem services in the annual report or annual social report, and explain their effect on the income statement.

During this study, it emerged that determining the effects on the income statement of individual companies helps to create an initial sense of urgency and awareness of the possibilities for actually implementing alternatives.

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It also showed that the accompanying changes in the ecosystem balance sheet are complex. No attempt has been made in this report to explore ways in which companies could incorporate the combined effects of multiple positive and negative external impacts (which are unrelated to the results of the company itself). A valuable next step would be to develop an instrument for doing this. Since the possible actions of small and medium-sized companies are constrained by the current economic ground rules and the number of dependencies and impacts on ecosystem services is very great, any such instrument should preferably be straightforward.

It could supplement the instruments already available to analyse dependencies and impacts on ecosystem services and biodiversity. This is a task that companies should address together and not leave to the government, since it is companies themselves that will have to use whatever instrument is developed.

Government
Understanding the economic value of ecosystem services and biodiversity and acting accordingly is part of the wider strategic agenda for a transition to a sustainable society. The government traditionally has four roles in driving this transition: developing policies, facilitation, regulation and setting the right example (KPMG, 2012a).

For the moment, the government's main role in relation to ecosystem services and biodiversity is that of facilitator. The most effective way in which the government can increase the prospect of action by companies is by supplying more knowledge and better assessment mechanisms. For example:

- Increasing knowledge about the costs and benefits for ecosystem services and biodiversity of major planning decisions and producing an accompanying assessment framework (see the TEEB study on physical planning).
- Increasing knowledge about the ecological and economic footprint of our international supply chains with an emphasis on soft commodities (see the TEEB study on supply chains).
- Regulating transfers of measureable, actual financial benefits from one party to another (forms of payment for ecosystem services, tax measures, etc.).
- Being more transparent about the principles of valuation and actual financial costs and benefits of subsidies per stakeholder in order to allow limited funds to be targeted more effectively at financially interesting measures relating to ecosystem services and biodiversity.

The case studies described in this report represent an initial attempt to calculate the consequences of reducing the negative impact and dependence on ecosystem services for the bottom line of an individual company. The central question was, how do the measures presented affect the balance sheet of the individual company? The subject can also be approached from a wider perspective. For example, what are the effects on ecosystem services of the economic activities of companies? This would provide a more strategic basis from which the government could formulate policies and, if necessary, legislation designed to preserve or promote ecosystem services and biodiversity. It would require a 'baseline measurement' showing the external costs of the actions of companies. In that context, there is little point in looking only at the external costs in relation to biodiversity. It is better to look at external environmental costs in the wider sense of all costs caused by economic activity that are not included in the cost price but are instead passed on to a third party, often the public in general, nature or a future generation. One example is the cost to society resulting from emissions of CO_2 during production processes. By showing how these environmental costs relate to the corporate results, or even reporting them in annual financial statements, their significance will become clearer to business. To illustrate, the worldwide external environmental costs of eleven large sectors worldwide amounted to EUR 641 billion in 2010. In 2002, those external costs were EUR 430 billion (KPMG, 2012b).

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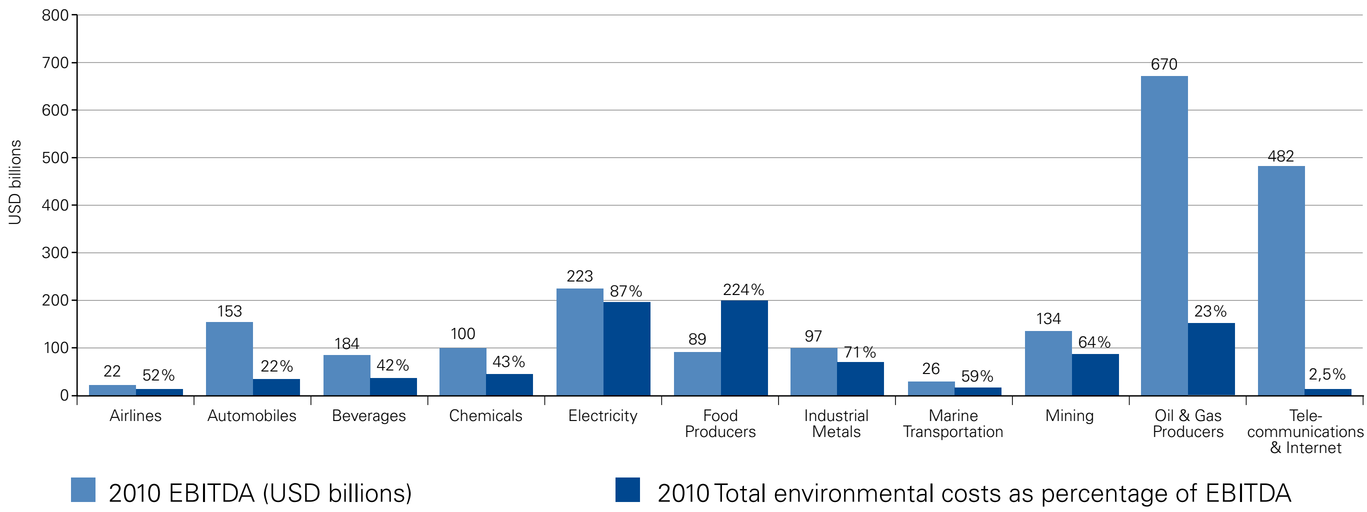
Figure 67: EBITDA[47] versus external environmental costs, per sector (2010)



[47] EBITDA: earnings before deduction of interest, taxes and depreciation on assets and depreciation on loans and goodwill.

Source: KPMG (2012)

Figure 67 shows the share of external environmental costs in relation to corporate earnings for various sectors worldwide. The message is clear: a substantial portion of the earnings would evaporate if companies had to pay all of the environmental costs.

A systematic method of calculating external environmental costs – developed by the business sector itself or otherwise – would give the government a sound basis for gaining a better understanding of the relationship between external environmental costs and corporate results and could be used to perform each of its four roles in sustainable transitions.

The knowledge acquired by Puma could help in this regard. In 2010, the German sporting goods manufacturer identified the damage it causes to the environment and expressed it in monetary terms: EUR 145 million, or 5.4% of its total consolidated turnover. The balance sheet reported, for example, the CO_2 emissions caused by cattle for the production of leather, the water consumed in the growing of cotton and the volume of waste produced during the production process. Puma's own business activities accounted for EUR 8 million; the remaining EUR 137 million was attributable to other parties in the chain (Puma, 2010).

For many companies, it is still too soon to follow Puma's example and fully integrate external effects in their balance sheet. However, it is essential to understand what is at stake and what the priorities should be. Where is the real impact caused by the different sectors? How can this impact be quantified? Should the positive contribution to ecosystem services also be reported? What standards should be adopted? How can we guarantee that the figures are reliable, and how will progress be measured?

This is a joint challenge for governments, the business sector and NGOs. With the current market mechanism, companies cannot be expected to perform miracles alone.

Annexes

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Annex 2

List of abbreviations

ARB:	Actief Randenbeheer Brabant
FAO:	Food and Agriculture Organization of the United Nations
CAP:	Common Agricultural Policy
GMO:	Genetically modified organism
IDS:	Initiative Sustainable Soy
IFFO:	International Fishmeal and Fish Oil Organisation
ILUC:	indirect land usage changes
LCA:	life-cycle analysis
MSC:	Marine Stewardship Council
NEC-plafond:	National Emissions Ceiling
NGO:	non-governmental organisation
NKG:	non-inversion tillage
PET:	polyethyleneterephthalate
PLA:	polylactic acid
REACH:	Registration, Evaluation, Authorisation and Restriction of Chemicals
RTRS:	Round Table on Responsible Soy
Sbeq:	soybean-equivalent.
TEEB:	The Economics of Ecosystems & Biodiversity
UNEP:	United Nations Environment Programme
WEF:	World Economic Forum
WHO:	World Health Organization
CHP:	Combined Heat and Power

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