

To whom it may concern

TCB S(46) 2007

The Hague, 2 July 2007

Re: TCB advisory report on biomass production

Dear Sir, Madam,

Almost completely renewable, biomass is hailed as a promising sustainable energy source. Soil, as both crop site and substrate, is an important factor in biomass production. The Soil Protection Technical Committee (TCB) therefore feels that soil and land-use issues are important topics in the debate on sustainability.

The TCB gives advice on technical and scientific aspects of soil protection to Dutch ministries involved with soil policy.

In 2006, wishing to contribute to the debate on the sustainability of biomass energy, the TCB commissioned research¹ into the effects of growing biomass production for energy on land use and soil quality in the Netherlands. The research report² describes the development and application of a framework to assess the impact of bio-energy on the soil.

The assessment framework comprises a theoretical model as well as practical soil quality indicators such as land use, biodiversity, organic matter, nutrients supply and mineral surpluses. A closed carbon cycle is a key factor in the assessment framework. The report describes how the framework was used to assess the green electricity and transport biofuel chains. It may also be useful in establishing criteria for sustainable biomass production, an intention announced in the report³ by the sustainable biomass project group chaired until February 2007 by the current Minister of the Environment and Spatial Planning.

The results of the research conducted are incorporated in the TCB's advisory report to the Minister of the Environment and Spatial Planning, the Minister of Agriculture, Nature and Food Quality,

1 The research was carried out by the Nutrient Management Institute and Wageningen University and Research Centre, Business Unit Biobased Products.

2 Hanegraaf, M.C., S.W. Moolenaar, H.W. Elbersen and E. Annevelink, Effecten van biomassaketens op landgebruik en bodemkwaliteit in Nederland. Ontwikkeling en toepassing van een toetsingskader, report no. 1183, NMI, Oosterbeek, 2007.

3 Toetsingskader voor duurzame biomassa. Final report of the sustainable biomass project group, March 2007.

and the Minister of Economic Affairs. This advisory report emphasises organic matter as an indicator of soil fertility and soil structure, among other things, and thus of soil quality. Moreover, as organic matter is the main carbon carrier in the soil, it is also relevant in the debate on the global carbon cycle.

The main recommendations are:

Decentralised land-based production of energy from biomass by means of anaerobic digestion, with the digestate being put back into the soil, offers the best chance of a closed carbon cycle. In the interests of more sustainable energy production, the TCB therefore advises the Dutch government to promote small-scale energy generation by on-farm anaerobic digestion plants.

First-generation biomass for transport biofuels (including cereals and oilseed rape) have a negative impact on soil quality. As these crops have a relatively low energy yield, they must be cultivated intensively and on a large scale in order to be worthwhile, but this results in soil impoverishment. The alternative, importing biomass for biofuel production into the Netherlands, would produce new mineral surpluses. The TCB therefore advises the Dutch government to discontinue efforts focused on the further development of first-generation biomass.

The picture may be more positive for second-generation biomass for biofuels (woody crops and perennial grasses). These crops can have a positive effect on soil quality in terms of the soil's structure and nutrient requirements. The TCB advises selecting crops that have a high energy yield and strong root development. If the roots remain in the soil after harvesting, this will help ensure good organic matter management.

More generally, the TCB advises carrying out additional research into the effects of biomass production on soil quality, to steer biomass production in the direction of optimum sustainable use of the soil, in the Netherlands and elsewhere.

Please find attached a copy of the TCB's advisory report and the research report on which it is based. The TCB hopes it will contribute to the debate on the sustainability of using biomass for energy, specifically from the perspective of soil quality.

We would welcome any remarks that you might have regarding the advisory report. Please email them to info@tcbodem.nl. The advisory report and the research report (in Dutch) can be downloaded from www.tcbodem.nl. If you would like us to keep you informed of related developments, please send us an e-mail containing your address, with the subject line 'Progress on biomass energy advisory report'.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'J. van Wensem', written in a cursive style.

Dr. J. van Wensem
General Secretary, Soil Protection Technical Committee

To
the Minister of Environment and Spatial Planning,
Postbus 30945
2500 GX Den Haag

TCB S07(2007)

The Hague, 19 March 2007

Re: Advisory report Effects of biomass production for energy on soil quality in the Netherlands

Dear Minister,

A significant upturn in the production of energy from biomass is regarded as one way of reducing the use of fossil fuels. A substantial increase in the cultivation of biomass for energy production (cultivation of energy crops) will lead to changes in land use and possibly to changes in soil quality.

The Soil Protection Technical Committee (TCB) commissioned NMI¹ and WUR-BBP² to study the development of biomass energy in the Netherlands, and the consequences for soil quality and land use. I am pleased to present you with a copy of the research report, *Effecten van biomassaketens op landgebruik en bodemkwaliteit in Nederland* ("Effects of biomass chains on land use and soil quality in the Netherlands").

The main findings are set out below, followed by the social context and the viewpoint of the TCB, and the link between energy from biomass and soil quality. Several scenarios have been developed (see appendix), on the basis of two production chains for biomass energy. Based on an analysis of these scenarios, the TCB has formulated recommendations regarding welcome and less welcome developments, primarily from the perspective of soil quality, but also taking into account broader environmental and social interests.

I have also sent this advisory report to the Minister of Agriculture, Nature and Food Quality and the Minister of Economic Affairs.

MAIN FINDINGS

¹ Nutrient Management Institute (NMI).

² Wageningen University and Research Centre, Business Unit Biobased Products.

Although this advisory report focuses primarily on soil quality in the Netherlands, international production of and trade in biofuels will, especially, have major consequences for soil quality in other parts of the world. The large-scale import of biomass to generate energy in the Netherlands may lead to overexploitation and hence soil depletion elsewhere, with adverse consequences for natural biodiversity and local food supply. A thorough analysis of these issues would require more time and resources than the TCB has at its disposal.

The research report identifies the parameters for assessing the sustainability of biomass energy production, from the point of view of soil quality in the Netherlands. A closed carbon cycle would seem to be a key factor here. Electricity production is one of the biomass chains studied. The generation of electricity through anaerobic digestion of biomass can be effectively organised in a decentralised, small-scale production system on an agricultural holding. The residual product of anaerobic digestion (the digestate) can be put back into the soil as a source of minerals and slowly decomposing organic matter (humus). The other chain studied concerns the production of biofuels for transport, which involves processing biomass into a concentrated liquid that can then be used as motor fuel (ethanol, biodiesel). This is usually carried out in large production units.

Decentralised production of electricity, largely from regionally produced biomass, by means of anaerobic digestion on farms, with the digestate being put back into the soil, offers the best prospects for maintaining and perhaps even improving soil quality. On the other hand, first-generation biomass for transport fuels can have a negative impact on soil quality. This is because there is a good chance that this kind of centralised energy production will not have a closed carbon cycle, which means that there is a risk of soil depletion and rising mineral surpluses in the Netherlands. The TCB therefore recommends not pursuing the option of developing first-generation biomass for transport fuels.

The picture may be more positive for second-generation biomass for fuels, but efficient production methods are not expected to be developed until after 2010. In this case, the TCB advises selecting crops that also have good root development, which will help ensure good management of the soil in terms of organic matter content.

The TCB also recommends further research into the impact of biomass energy production on soil quality. It is essential to clearly identify which scenarios have a positive effect on soil quality, and which should preferably be avoided. Using this information, it will be possible to manage the present development of biomass energy production in such a way as to ensure that land, whether in the Netherlands or elsewhere in the world, is used in the most sustainable way possible.

SOCIAL TRENDS

The Intergovernmental Panel on Climate Change (IPPC)³ thinks it is very likely that the observed increase in average global temperature is due to the observed increase in greenhouse gas concentrations in the atmosphere. The global increases in carbon dioxide concentration are due primarily to fossil fuel use and – to a slightly lesser extent – to land-use change, while those of other greenhouse gases (methane and nitrous oxide) are primarily due to agriculture. One way to

³ Climate Change 2007: The Physical Science Basis. Summary for Policymakers. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 5 February 2007.

reduce fossil fuel use is to use biomass as an energy source. The expected benefits of biomass are a net neutral carbon balance and an effective and relatively clean way of using solar energy (by photosynthesis) to supply energy.

There is currently a great deal of debate about the net contribution of energy crops to greenhouse gas emissions, as changing land use can also cause new emissions of greenhouse gases. The conversion of peatland forest in Indonesia into palm oil plantations has led to high carbon dioxide emissions as a result of oxidation of the drained peat. Palm oil is traded as a “climate-neutral” fuel, but taking into account carbon dioxide emissions from the soil, the net greenhouse gas reduction is actually negative⁴. There are also conflicting expectations about the contribution that bio-energy can make to meeting total energy requirements. This is related to doubts or optimism about the possibility of achieving further technological innovations.

Biomass energy is not necessarily sustainable. The Dutch government commissioned the sustainable biomass project group, which you headed, to draw up a framework for assessing sustainably produced biomass.⁵ One of the guiding principles of the project group’s report was maintaining or improving soil quality. Three assessment criteria were also established. Compliance with relevant national and local rules and legislation⁶ is a minimum requirement. Furthermore, production and processing of biomass must be in line with best practices. Thirdly, the use of crop residues may not impoverish the soil to such an extent that it is no longer able to produce essential commodities for the local population, such as straw for housing. Since best-practice production methods depend on the crop grown and the location of biomass production, it is not possible to formulate verifiable indicators. It is therefore proposed that compulsory reporting might provide insight into the strategy for sustainable soil management and for maintaining the ecological carbon and nutrient cycles. The TCB notes that it is a relatively new development in the Netherlands for soil quality to be explicitly addressed in the sustainability debate. Soil is an important production factor for biomass, as both crop site and substrate. Land use and land-use change are key factors in efforts to reduce greenhouse gas emissions. The NMI/WUR-BBP report provides a few specific pointers for translating the proposed idea of compulsory reporting into a practicable plan.

Most of the Earth’s biomass exists in the form of living plants in natural ecosystems. Agricultural production systems are the second most significant source. This kind of biomass is mainly intended for food, but also, for example, for energy production (wood) and raw materials (wood for paper, cotton for clothing). The quantity and quality of all available biomass is limited by the availability of land, water and nutrients, especially nitrogen. Recent forecasts regarding the size of the world population indicate an upward trend to approximately 9 billion, which in combination with increasing prosperity levels means growing demand for biomass for food supplies. Its increasing use for energy supply will boost demand further. This level of demand can only be met by increasing the agricultural production area, which would negatively impact on natural ecosystems, or by intensifying agricultural production. The Netherlands Environmental

⁴ Hooijer *et al.*, 2006. PEAT-CO₂: Assessment of CO₂ emissions from drained peatlands in SE Asia. Delft Hydraulics report Q3943(2006).

⁵ *Toetsingskader voor duurzaam geproduceerde biomassa*. Final report of the sustainable biomass project group, draft of 23 February 2007.

⁶ Regarding waste management, use of agrochemicals, minerals management, prevention of soil erosion, environmental impact assessment and company audits.

Assessment Agency (MNP)⁷ has worked out that, generally speaking, the cultivation of energy crops for biofuels is not an attractive option from an ecological perspective; any scenario involving a lot of bio-energy would result in a loss of ecological value worldwide by 2050. This applies to crops currently grown as well as to those under development. Substantially higher productivity in cultivation is needed to turn this situation around.

As long as demand for biomass outstrips supply, biomass for energy will continue to compete with biomass for food. This element of competition is already evident in North and Central America, where the price of tortillas in Mexico has risen sharply, partly due to increasing demand for maize for biofuels (ethanol production) in the US.⁸ This is good news for farmers, as it leads to higher prices for their products, thereby boosting their income. It is bad news for people with limited purchasing power, as food becomes less affordable for them. This competition mechanism gives rise to an ethical dilemma that can be summed up as “fuel for the rich and food for the poor”.⁹

Even as the public debate about the benefits and necessity of energy from biomass continues, the reality is that more and more agricultural products and by-products are being used as a source of energy. Until 2005 the Netherlands gave much less support to initiatives to market biofuels than other EU countries.¹⁰ It is now trying to narrow the gap, notably by focusing on the requirement to blend biofuel with mineral fuels at a rate of 2% in 2007, and increasing to 5.75% in 2010. This offers fresh opportunities for the agricultural industry.

THE ASSESSMENT FRAMEWORK USED BY THE TCB

The TCB assesses social trends and policy proposals primarily for their effects on soil quality. In its report on more sustainable land use in agriculture,¹¹ it urges that attention should be focused on maintaining and, if possible, improving soil quality, both in the Netherlands and further afield. Soil is the ideal medium for agricultural production such as biomass production for energy, provided this does not lead to diversion of pollutants elsewhere or at a later date, or to irreversible disruption of the soil ecosystem. The challenge is to use soil economically and in an ecologically sustainable way. The TCB defines sustainable soil management as “preventing adverse consequences of land use elsewhere and at a later date, preserving land use in the long term, taking into account the possibility of switching between different types of land use and maintaining ecological services that are of general interest”. The ecological perspective forms the basis on which a policy-related evaluation must be made, also taking into account economic and socio-cultural values.

⁷ Brink, ten B. *et al.*, 2006. Cross-roads of Planet Earth's Life, Exploring means to meet the 2010 biodiversity target. MNP report 555050001/2006.

⁸ Various Dutch newspaper articles, e.g. *Schaalvergroting maakt heilige tortilla duur* (“Upscaling pushes up price of tortillas”), NRC Handelsblad, 20 January 2007, and *Mexico kan zichzelf niet meer te eten geven* (“Mexico can no longer feed itself”), de Volkskrant, 1 February 2007.

⁹ Katan, M., R. Rabbinge and W. van Swaaij, *Toekomst voor biodiesel is illusie* (“The future of biodiesel is a pipe-dream”), Het Financieele Dagblad, 7 July 2006.

¹⁰ Ros, J.P.M. and J.A. Montfoort, 2006. *Evaluatie van transitie: systeemoptie vloeibare biobrandstoffen*, MNP report 500083002/2006.

¹¹ Advisory report on the more sustainable use of agricultural land, A36e, TCB, 2005.

THE SIGNIFICANCE OF THE SOIL IN THE PRODUCTION OF BIO-ENERGY

The soil is involved at various stages in the biomass-for-energy chain. It serves as a crop site and a substrate, and it also regulates water and nutrient flows while plants are growing. The soil also receives crop residues and fertilisers. The NMI/WUR-BBP report makes a distinction between terms such as “cultivation”, “harvest”, “divert” and “use”. These offer practical suggestions for more sustainable soil management.

The indicator of soil quality emphasised in this report is organic matter. As organic matter is the main source of carbon in soil, it is relevant in the debate about the global carbon cycle. Moreover, the subject of nutrient balances has largely been covered in legislation on manure and fertilisers, while the Soil Protection Act¹² deals with pollutants. Organic matter is an indicator of soil fertility and soil structure, amongst other things.

Cultivating biomass requires the application of fertilisers to the soil, which are taken up by the growing plants. The soil may be fertilised using animal manure, compost or chemical fertiliser, or by growing a green manure crop. The by-products of bio-energy production – digestate obtained from anaerobic digestion and ash from thermal systems – can also be used as fertilisers, but their agricultural quality is the decisive factor. Current manure and fertiliser legislation limits the marketing of digestate as fertiliser. Digestate must also satisfy environmental quality standards before it can be used for this purpose.

One aspect that has a positive impact on the soil is that energy crops require less nitrogen than many food crops, as the emphasis is on obtaining a high carbohydrate content (starch, cellulose) rather than a high protein content. Careful management of agricultural production prevents depletion of soil fertility and leaching of excess nutrients into groundwater and surface water. This applies to all crops, and energy crops are no exception. Good soil management means that crop protection measures do not necessarily affect soil and groundwater quality. Growing crops naturally requires water, and the use of farm machinery can result in soil compaction during harvesting. This may have an impact on water management in the surrounding area. Changes in land use may also lead to the release of greenhouse gases from the soil, which may be substantial in the case of peat soils. The cultivation of energy crops (perennial or otherwise) may also impose limitations on crop rotation.

Residues of traditional arable crops are usually left on the land after harvesting and are ploughed under to enhance soil organic matter content. When these crop residues are diverted for use as primary by-products for energy production, this brings about changes in the carbon and nutrient cycle that can be either negative (reduced soil fertility, soil depletion) or positive (phosphate removal from overfertilised land). The question of whether there will be a net positive or a net negative impact on soil quality largely depends on the balance struck between the input and output of nutrients and carbon to and from the soil.

¹² This report does not discuss the possibility of combining the cultivation of biomass for energy production with *in situ* soil remediation.

SCENARIOS FOR BIOMASS CHAINS

In their report, NMI and WUR-BBP assume there is a growing demand for biomass for energy production. In the initial phase, volumes are low and the cheapest raw material available is used. This often yields an immediate sustainability advantage if waste can be recovered. In the next phase, demand increases and there is competition for available by-products. More land is used to grow biomass for energy production and other types of cultivars are developed; the result is more intensive farming practices and changes in land use. Depending on how things develop, this leads – broadly speaking – to a net decline in the sustainability of biomass production. In the third phase, demand is high, resulting in large volumes of biomass, increased competition, intensive farming methods and the cultivation of natural soils, with a net negative effect on soil quality due to disruption of the nutrient cycles. In the fourth phase, this negative effect levels off, as the deterioration in soil quality leads to falling production of biomass for energy. This leads to measures to improve soil quality.

Working on the basis of these four phases, NMI and WUR-BBP analysed two biomass chains: converting biomass into green electricity by means of anaerobic digestion and processing biomass into transport fuels.

Green electricity

Green electricity can be generated decentrally or centrally. In the decentralised option, biomass is converted into electricity in anaerobic digestion plants on arable farms¹³ and the electricity is supplied to the national grid. The digestion residues (digestate) consist mainly of persistent organic matter and minerals. In the decentralised option, the digestate is returned to the same soil in which the biomass was grown, to be used as fertiliser. This has a positive impact on soil quality provided the nutrient uptake by the previous biomass crop is balanced by the amount that is returned to the soil. If energy demand increases, so too will demand for biomass. If energy demand then continues to rise gradually, it will not be possible to produce sufficient energy maize in the Netherlands without loss of soil quality. The biomass required to generate green electricity will then have to be supplemented with imported biomass. This raises the spectre of a recurrence of the current problems with the manure surplus, which is the result of substantial imports of biomass as cattle feed for meat production.

In the centrally organised option, anaerobic digestion takes place in off-farm, in large-scale central production units. In this case, the effect on soil quality in the Netherlands will initially be positive, because the present nutrient surplus is taken out of the soil. Should there be an increase in energy demand, this may change to a negative effect if soil depletion occurs.

Transport biofuels

As yet, the biomass-based production of biofuels for vehicles is less efficient in energy terms than the production of green electricity by means of anaerobic digestion, for example. There is huge demand for substitutes for petrol and diesel, however. Bio-ethanol and biodiesel will mainly be

¹³ As part of efforts to find solutions to the manure surplus, co-digestion is currently being promoted; this involves mixing slurry with other carbon sources (agricultural waste streams, food industry by-products) and converting it into electricity in on-farm anaerobic digestion plants, with digestate as a by-product.

produced centrally in large production units. Little organic matter or nutrients will be put back into the soil in the Netherlands. First-generation transport biofuels are produced from crops with a high sugar, starch or oil content, e.g. sugar beet, potatoes, sunflowers and oilseed rape, as well as cereals such as wheat. The residues of these common agricultural crops are usually left on the land, which enhances the organic matter content. However, biofuels from these crops only reduce carbon dioxide emissions by a maximum of 50%. Second-generation biomass for transport biofuels comprises lignocellulose crops (e.g. perennial energy grasses such as miscanthus and fescue, and fast-growing woody crops such as willow) and organic waste (straw, trimmings, sawdust, waste wood). The technology associated with both biomass cultivation and bio-energy production is still being developed. Second-generation transport biofuels are expected to cut carbon dioxide emissions by 90%. Moreover, a much higher crop yield per hectare is expected. It remains to be seen what impact this will have on soil quality. In the case of second-generation biomass for transport fuels, as much cellulose as possible will be used for energy production, leaving less organic matter on the land. It is possible to compensate for this if the crop grows both above and below ground, as root formation helps ensure good management of the soil in terms of organic matter content. Second-generation biofuels are not expected to come onto the market before 2010.

Detailed quantitative analysis

Due to the myriad factors at work, it is difficult to generalise and quantify the different scenarios. The research report rightly points out that biomass chains involve a complex range of factors that influence each other and change depending on the spatial scale and technological phase applicable to such chains. Interactions and diversions as a result of changes in imports, land use in the Netherlands and elsewhere, crop plans, and the quantity and composition of waste streams generated and used are important characteristics that help determine the net effects on soil quality. All things considered, this calls for a specific, detailed quantitative analysis of the chain to enable its sustainability to be assessed more effectively.

CONCLUSIONS AND RECOMMENDATIONS

In the current intense debate about the benefits and necessity of using biomass for energy, the TCB has observed a growing interest in the sustainability of this option. Whereas sustainability was initially judged solely against the background of climate problems, increasingly the focus is now on all aspects of sustainability, including the world food issue and soil quality. The TCB is keen to make a contribution here, because the possibilities for change are legion. It does not expect all of the development scenarios to lead to sustainably produced biomass, or the most favourable scenarios to develop by themselves. The TCB has therefore formulated a number of policy recommendations.

The study has shown that, based on currently available information about the effects on soil quality, there is no clear preferential scenario for the sustainable development of biomass for energy supply purposes. Both green electricity and transport biofuels can be developed according to positive or negative scenarios. The study clearly names the parameters and soil quality aspects that must be taken into consideration when assessing the sustainability of the different soil quality scenarios. A locally or regionally closed carbon cycle would seem to be a key factor here. This is easier to organise for the production of green electricity than for transport biofuels.

Decentralised anaerobic digestion for the purpose of generating green electricity

The scenario of decentralised land-based production of energy from biomass by means of anaerobic digestion, with the digestate being put back into the soil, offers the best chance of a closed carbon cycle. This scenario is possible with small-scale electricity production on farms with anaerobic digestion plants, where the electricity generated is supplied directly to the national grid. Market forces will tend towards amalgamating operations in order to increase income, which might once again cancel out the positive effect on soil quality. In Germany, prompted partly by the higher electricity prices paid by buyers, farmers have built thousands of anaerobic digestion plants in the past few years. Together, these are equivalent to several large-scale conventional power stations. This initiative provides farms with a reliable source of income, thereby improving their chances of survival and contributing to the quality of life and social structure of the countryside. The TCB regards farmers as the key soil managers in rural areas. By ensuring continuation of agricultural operations, decentrally organised production of energy from biomass by means of on-farm anaerobic digestion plants therefore indirectly has a positive impact on soil quality, and hence soil management in the private domain. The TCB therefore advises that the Dutch government, in line with its neighbours, should promote decentralised anaerobic digestion of biomass.

The scenario of using decentralised anaerobic digestion of domestically-produced biomass to produce green electricity, with organic matter and minerals being put back into the soil, will reach a turning point as volumes rise to a certain level. The positive effect of maintaining or even increasing the organic matter content of the Dutch soil will then change into a minerals surplus. The current fertilisation rules restrict nitrogen and phosphate inputs into the soil. If biomass intended for the production of green electricity is imported on a large scale, a scenario involving a huge minerals surplus, similar to that produced in present-day intensive livestock farming, is inevitable.

Central anaerobic digestion and/or incineration of biomass from the Netherlands, where the crop residues are not put back into the soil, can lead to phosphate removal from soils with a history of overfertilisation. In this case, excess nutrients are taken out of the soil, which has a positive effect on soil quality.

First-generation biomass for transport biofuels

As yet, the production of transport biofuels from biomass is much less efficient in energy terms than the production of electricity by means of anaerobic digestion. It is expected that production will be largely centralised, in large production units. Very little organic matter or nutrients will be put back into the soil. It is uncertain whether sufficient crop residues will remain on the land. This may give rise to a carbon cycle involving heavy losses for the soil, leading to impoverishment. Moreover, the area devoted to energy crops in the Netherlands is much too small to yield any meaningful quantity of transport biofuels. Large-scale imports would therefore be required. Since the import of carbonaceous biomass automatically leads to the import of nitrogen and other minerals, this option also gives rise to a new manure surplus.

Second-generation biomass for transport fuels

The picture may be more positive for second-generation biomass. Growing perennial woody crops and grasses such as miscanthus (also known as elephant grass) can have a positive effect on soil

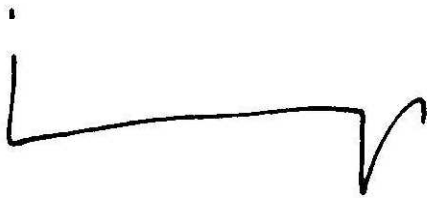
quality in terms of the soil's structure and nutrient requirements. For the purpose of developing second-generation biomass for fuels, the TCB advises selecting crops that have a high energy yield and strong root development. If the roots remain in the soil after harvesting, this will help ensure good organic matter management.

Development scenarios

There are still many gaps in our knowledge about the development scenarios for biomass as a source of energy and the consequences for soil quality. The various nutrient and organic matter streams must be quantified for each of the scenarios and the effects on soil quality must be specified more fully. This additional information will facilitate the selection of crops with the highest return in terms of sustainability. The effects on soil quality elsewhere must also be included in the analysis. Armed with this knowledge, it will be possible to identify the scenarios that must be encouraged from a sustainability point of view, and those that should preferably be discouraged.

The TCB hopes that this advisory report will contribute to the debate about the sustainability of using biomass for energy, specifically from the perspective of soil quality. The Committee would like to be kept informed of developments with regard to the establishment of sustainability criteria for the cultivation of biomass for energy supply purposes.

Yours sincerely,

A handwritten signature in black ink, consisting of a vertical line on the left, a horizontal line extending to the right, and a small loop at the end.

Ir. L.E. Stolker-Nanninga
Chair of the Soil Protection Technical Committee