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The Impact of Transport Biofuels on Developing Countries: Ensuring Policy Coherence

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Subject: The Impact of Transport Biofuels on Developing Countries: Ensuring Policy Coherence

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Glossary and acronyms

DSU	Dutch Sustainability Unit
EU	European Union
FQD	Fuel Quality Directive
GHG	Greenhouse gas emissions
IGG	Inclusive Green Growth Department
ILUC	Indirect Land Use Change
MFA	Netherlands Ministry of Foreign Affairs
NCEA	Netherlands Commission for Environmental Assessment
NGO	non-governmental organization
RED	Renewable Energy Directive
RVO	Netherlands Enterprise Agency
SDG	Sustainable Development Goals
UN	United Nations

Abstract

The Dutch Sustainability Unit (DSU), part of the Netherlands Commission for Environmental Assessment (NCEA), has been requested by the Inclusive Green Growth Department (IGG) of the Netherlands Ministry of Foreign Affairs (MFA), to address a number of questions relevant for the debate how to integrate impacts in developing countries in decisions on the use of biofuels in transport in The Netherlands. Before end of 2017 the Netherlands will have to implement the European Union Indirect Land Use Change Directive (EU ILUC) and, hence, this year decide on for example the maximum level of conventional biofuels in transport.

Prior to answering these questions we present a preamble of thoughts. Based on the assumption that biofuels contribute to sustainable development, governments, including the EU, impose blending targets (RED) and quality standards (FQD) for transport fuel. Yet, a strong body of scientific evidence questions the effectiveness of these measures and argues that these might even be counterproductive because of negative direct and indirect ecological and socio-economic effects of biofuels production and use. This has raised societal debates and led the EU to down-regulate its policies with reducing targets. Also, biofuels producers and member states now have to report about a large number of sustainable development criteria, in order to balance public and private interests. From this, in our opinion, it can be concluded that it is of the highest importance to judiciously monitor and evaluate biofuels to safeguard sustainable development and policy coherence, while preventing reputational damage for the Netherlands.

Integral part of this monitoring and evaluation should be the consequences of biofuels decisions and measures for developing countries, on which DGIS has asked the DSU the following three questions:

1. What criteria should be considered in determining the best policy options to achieve policy coherence, i.e. to achieve the objectives of both the Renewable Energy Directive[1], the Fuel Quality Directive[2] and the Dutch government's objectives[3] for development cooperation and trade?

   This report (see chapter 2) argues that criteria should be based on a) fundamental physical-chemical, biological and ecological processes related to the production of biomass for biofuels[4] and b) goals set at national (the coherence goals) and international level (e.g. the SDGs)[5]. On this basis, this review proposes criteria from the following categories to be assessed to enable for conclusions on policy coherence:
   - ecological aspects, at least food security, greenhouse gas emissions, land use, water use, fertilizer use, biodiversity
   - socio-economic implications, at least food price, land grabbing, labour requirement, inclusiveness, women participation

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[1] Richtlijn 2009/28/EG ter bevordering van het gebruik van energie uit hernieuwbare bronnen.

[2] Richtlijn 98/70/EC betreffende de kwaliteit van benzine en dieselbrandstof.

[3] The coherence paragraph from DGIS 2015 – "*Wat de wereld verdient: een nieuwe agenda voor hulp, handel en investeringen'.*

[4] Also see annex 1.

[5] Also see annex 2.

- transparency and stakeholder involvement, also in monitoring and certification

2. To which extent have these criteria been sufficiently assessed in a study conducted by the Netherlands Enterprise Agency (RVO)[6] ? If not, what information is lacking?

   The aim of the RVO study was to assess the influence of Dutch policy choices for biofuels in transport on achieving the targets of the RED and FQD Directives. For this reason the criteria relevant to assess sustainability of biofuels and policy coherence are not addressed (see chapter 3 of this review).

3. Based on expert judgement, how will developing countries be affected by a choice:
   a) between maximum blending scenarios of 2%, 5% or 7% for conventional biofuels in transport and/or b) to eliminate 'double counting' of advanced biofuels.

   Biofuel measures in the Netherlands have global implications because of indirect land use change and GHG emissions, but also on global price implications of food and fuel, and substitution practices. Implementation practices under real-life conditions directly affect people's livelihoods. Hence, higher blending targets can be reasoned to have stronger impacts on these global and local developments, irrespective of whether the target is the 2%, 5% or 7% scenario (see chapter 4 of this review).

   No double counting means the necessity of either more advanced biofuels or more conventional biofuels to achieve targets. Due to technical challenges and high investment costs it is unlikely that advanced biofuels by 2020 will be produced at a large scale. Therefore, given the 10% RED objectives, abolishing double counting implies significant more use of conventional biofuels, with associated consequences.

Intervention tools; a call for a more inclusive and transparent process
Current certification systems for biofuels reveal great differences in transparency, inclusiveness and stakeholder participation. This may lead to overlooking unintended consequences of realizing RED and FQD targets. This, in turn, may cause societal upheaval and environmental degradation. We suggest therefore to stimulate transparent and inclusive monitoring and evaluation processes related to biofuel production and use. In this regard, the Dutch diamond approach - involving government, private sector, CSOs and knowledge institutes - can be an important democratic and transparent vehicle to provide well-balanced information for Dutch policy measures.

Based on a transparent evaluation of the contribution to sustainable development of the production and use of biofuels in terms of GHG reduction, natural resources use and socio-economic impact, continued adjustment of the RED and FQD may be negotiated by the Netherlands government. Literature reviews, complemented with background field studies and biofuels project results, will allow an informed society wide dialogue to design a more comprehensive package of energy-related intervention measures to meet RED, FQD and other objectives, for example with evaluations every two years.

[6] Rijksdienst voor Ondernemend Nederland - '*Impact assessment naar de hoogte van de in te voeren limiet voor conventionele biobrandstoffen in vervoer*', oktober 2015.

1. Introduction

1.1 Objectives of this review

Before end of 2017 the Netherlands will have to implement the European Union Indirect Land Use Change Directive (EU ILUC) and, hence, this year decide on for example the maximum level of conventional biofuels in transport.

In light of this implementation, the Dutch Sustainability Unit (DSU), part of the Netherlands Commission for Environmental Assessment (NCEA), has been requested by the Inclusive Green Growth Department (IGG) of the Ministry of Foreign Affairs, to answer the following questions :

1. What criteria should be considered in determining the best policy options to achieve policy coherence, i.e. to achieve the objectives of both the Renewable Energy Directive[7], the Fuel Quality Directive[8] and the Dutch government's objectives[9] for development cooperation and trade?
2. To which extent have these criteria been sufficiently assessed in a study conducted by the Netherlands Enterprise Agency (RVO)[10] ? If not, what information is lacking?
3. Based on expert judgement, how will developing countries be affected by a choice: a) between maximum blending scenarios of 2%, 5% or 7% for conventional biofuels in transport and/or b) to eliminate 'double counting' of advanced biofuels.

1.2 Methodology and scope of this review

Methodology

This report is based on expert judgement. The strict deadline for this review, and the subsequent short time available, only allowed a scant literature review of relevant sources. This implies a degree of uncertainty and generality in the answers given.

Scope

This review takes place within the debate if, and if yes, to what extent biofuels are contributing to sustainability as a renewable energy source and a means to mitigate climate change. In this debate on biofuels or bioenergy two perceptions prevail in the Netherlands scientific community (see further Annex 3):

- One of these approaches, based on basic physical, biological and ecological principles calculates and argues that productive land is already in use for food, fuel and energy production (growing population, changing diets) and for the sustainment of biodiversity and ecosystem functioning. Hardly any land, including currently considered marginal lands, is unused and therefore any expansion of land for biomass production will have indirect food and land use change effects, including a decreasing food availability and/or loss of biodiversity or ecosystem degradation.

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[7] Richtlijn 2009/28/EG ter bevordering van het gebruik van energie uit hernieuwbare bronnen.

[8] Richtlijn 98/70/EC betreffende de kwaliteit van benzine en dieselbrandstof.

[9] The coherence paragraph from DGIS 2015 – "*Wat de wereld verdient: een nieuwe agenda voor hulp, handel en investeringen'.*

[10] Rijksdienst voor Ondernemend Nederland – '*Impact assessment naar de hoogte van de in te voeren limiet voor conventionele biobrandstoffen in vervoer'*, oktober 2015.

- The other approach calculates or assumes that there is unused or extensively used land available, basically of marginal quality, that could be used for bioenergy production without jeopardizing (or even simultaneously strengthening) other goals, particularly food and biodiversity goals.

It is beyond the scope of this review to assess the merits of each of these approaches. Rather the scope of this review is to provide a factual representation of current insights relevant for answering the stated questions.

Furthermore, this assessment does not provide:

- a second opinion on the RVO impact assessment;
- an evaluation of policies or directives such as RED, FQD or ILUC;
- a policy advice, as this would require normative weighting of relevant aspects, which ultimately is a political decision;
- alternative options to meet RED and FQD targets.

2. Criteria relevant for policy coherence

Criteria relevant for achieving policy coherence can be derived from a) basic principles underlying the intended use of biofuels to achieve sustainable development and b) goals set at national (the coherence goals) and international level (e.g. the SDGs).

Basic principles

For its biofuels the Netherland is highly dependent on import of biomass. While about half of the current biomass is obtained from European countries, the proportion from developing nations is growing rapidly. Annex 1 'Basic principles' describes the basic ecological concepts related to the production of biomass for biofuels. It reveals why biomass production and use as fuels cannot exceed energy efficiencies of about 1% per area unit and requires massive land areas and water, hence resulting in extremely low resource use efficiencies.

Biofuels have been introduced with the aim to 1) replace fossil fuels with renewable fuels produced from plant biomass (reducing dependency from oil producing and exporting countries), and simultaneously 2) reduce the emission of Greenhouse Gases to curtail climate change (as fossil fuels are a major contributor to climate change). The basic logic applied in this reasoning is that plants capture CO_2 for their growth, and when burned as fuels, the CO_2 will be released again, making it a net CO_2 neutral energy source. Annex 1 provides an overview of the ecological and socio-economic aspects of biofuels in order to identify relevant criteria for assessing sustainability le development and policy coherence.

Coherency goals and SDG's

The Netherlands Ministry of Foreign Affairs' Department for Foreign Trade and Development Cooperation aims to combine aid and trade, thereby emphasizing 1) women's right and sexual and reproducible health, 2) food security, 3) water and 4) safety and justice.

Also, coherence goals have been set[11], meaning that the consequences of our policy for low- and middle-income countries will be taken into account in decision-making. Relevant for setting criteria for policy coherence are some of the Sustainable Development Goals as recently adopted by the UN countries[12] and a number of international conventions and agreements that the Netherlands agreed on.
Annex 2 'Global issues and international goals' provides an overview of relevant global issues and goals.

Criteria

Based on both basic principles, coherency goals, SDGs and conventions there are three clusters of criteria to distinguish. First of all, there is the direct ecological impact of the production of biomass for the use of biofuel: impacts on food security, land-, water- and fertilizer use, the biodiversity and the emission of greenhouse gas emissions. Secondly, there are direct effects on the communities where the production takes place such as labour requirements and inclusiveness, particularly of the participation of women, and indirect effects on food prices and land claims/grabbing. Thirdly, there is a need for transparency and stakeholder involvement in decisions on biofuels, which is discussed in the next paragraph.

The above description of the various dimensions linked to the production and use of biofuels suggests that targets, policies, and intervention measures should be evaluated at both macro and micro scale levels:

- Macro: Indirect land use change and GHG emissions, but also substitution practices and (global) price implications of food and fuel, necessitate continued monitoring and assessments at global and national scale levels.
- Micro: Implementation practices under real-life conditions that directly affect peoples' livelihoods should be closely monitored and evaluated at the local level.

The effects on livelihoods lead to the third cluster of criteria for policy coherence: transparency and stakeholder involvement. Transparency is important not only in policymaking but also in monitoring and certification. A misbalance in the involvement of stakeholders may lead to a less equitable distribution of benefits.

The criteria in short:

- ecological aspects, at least food security, greenhouse gas emissions, land use, water use, fertilizer use, biodiversity
- socio-economic implications, at least food price, land grabbing, labour requirement, inclusiveness, women participation
- transparency and stakeholder involvement, also in monitoring and certification

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[11] Coherence paragraph from; DGIS 2015 - '*Wat de wereld verdient: een nieuwe agenda voor hulp, handel en investeringen'*.

[12] www.sustainabledevelopment.un.org

3. RVO impact assessment

The research question in RVO's impact assessment study (RVO, 2015) was to assess to what extent the Netherlands can realize its RED and FQD targets. For this reason the RVO study does not consider the criteria relevant for policy coherence. In other words, information on effects of biofuels on coherence goals, as measured by a broader set of criteria (chapter 2), is not available in the RVO impact assessment. This creates a risk since biofuels development promoted strictly from a renewable energy and fuel quality perspective may be detrimental for achieving the coherence goals. It is therefore suggested that a more exhaustive and systematic literature review should be conducted, complemented with a survey among stakeholders of the Dutch diamond approach, as a basis for coherent policy measures.

Without a future integral assessment there is the risk of under- or overestimating the effects of an increase in the use of biomass as biofuels. Some research shows that the use of land for bioenergy inherently comes at the cost of not using that land for food, feed, or sustained carbon storage and will undercut efforts to combat climate change and to achieve a sustainable food future. The use of water, pesticides and fertilizers have increased over the past decades imposing environmental hazards as well as greenhouse gas (GHG) emissions (including fertilizers N_2O emissions). The net balance of GHG is further dependent on the type of crop, the impact of indirect land use change (clearing new lands etc.). The required increase in land use to meet food production for the growing population implies that each and every hectare of additional land needed for the cultivation of biofuels, by definition, will add up to the expansion of land and to the loss of biodiversity.

Biofuels are typically regarded as high-volume low-value commodity due to the low energy density and the large amounts of biomass that have to be collected from extensive land areas. This is certainly true when "waste" has to be collected. Heavy equipment, optimal logistics, dense road network, efficient collection systems and economies of scale are key in collecting and transporting biomass to biofuels production plants. These conditions determine the type of farming systems that may physically and economically contribute to biofuels feedstock supply.

On the other hand, there is ongoing debate whether the potential of biomass as an energy source can serve as a way to mitigate greenhouse gas emissions. A quick literature review reveals that proponents in favour of exploiting this potential also identify the need for proper enabling institutional conditions to minimize adverse side effects or for minimum price levels or stable yields for the endeavour to be profitable (see further annex 3).

In line with the requirement of these enabling conditions to reap potential benefits, the observations about the socio-economic implication in annex 1 suggest the need to more comprehensively monitor and evaluate livelihood implications on the local community, because the EU RED so far did not include social issues and indirect land use change considerations. In the recent ILUC guidelines a more comprehensive set of criteria including indirect effects have been proposed, but to be reported about only. It is worthwhile noting that the livelihoods of local people may be affected through direct local activities related to biomass production, but also by indirect effects such as land claims from external parties and price effects.

Where certification systems are supposed to warrant compliance with sustainability criteria, literature suggests to ensure transparency of such systems and to secure stakeholder involvement. While commercially-oriented initiatives are generally leaner and quicker than multi-stakeholder processes, they are also generally less democratic, more attuned to industry interests, more easily discriminatory against small players and actors in the global South, hence featuring industry-dominated and top-down governance structures.

4. Fuel mix scenarios and double counting

The EU agreed on a cap of 7% for conventional bio based fuels in energy used in transportation. Member states are given the option to set lower limits. The Dutch parliament requested the Dutch government to impose a limit of 5%. Given the discussion above, similar effects can be expected at either percentage but different in magnitude. In other words, higher blending targets can be reasoned to have stronger impacts on global and local developments, irrespective of whether the target is the 2%, 5% or 7% scenario.

Current biofuel is primarily produced from food crops (conventional feedstock). The use of waste, residues, non-food cellulosic material and lignocellulosic material for the production of biofuels (so called advanced biofuels) is supported as a favourable alternative for conventional biofuels. In order to stimulate the use of such feedstock's, the RED foresees that biofuels from these feedstock types can be counted twice (double counting) in the monitoring of the renewable energy in transport target. This measure, that has been adopted in the Netherlands, does stimulate the production of advanced biofuels. However, the measure also results in lower greenhouse gas emission reductions because double counted biofuels do not have a double impact on CO_2 emissions. Development of advanced biofuels is likely to take about a decade, if not longer, as a result of high R&D investments, high costs of production, and high initial investment costs in the production capacity. This is particularly true for biodiesel that also requires the gathering of massive amounts of biomass feedstock to supply the production plants.

Removal of double counting would imply that higher amounts of advanced biofuels would have to be brought to the market to meet the RED objective of 10%. Due to the unlikely nature of large scale production of advanced biofuels by 2020 (because of e.g. technical difficulties and high investment costs) conventional biofuels are likely to remain important. In other words: removal of double counting implies the necessity of more conventional biofuels to achieve the RED targets, leading to an increased impact on the global and local impacts mentioned.

5. Final remarks

5.1 Interconnected global and local assessments

The description of the various dimensions of biofuels production and use suggests that targets, policies, and intervention measures should be evaluated at both macro and micro scale levels. Indirect land use change and GHG emissions, but also substitution practices and global price implications of food and fuel, require continued monitoring and assessments at global and national scale levels. Implementation practices under real-life conditions that directly affect peoples' livelihoods should be closely monitored and evaluated at the local level. While much of the feedstock for biofuels is currently obtained from within the EU, the principles of indirect effects remain valid. In the end, any allocation of land for biofuels feedstock ultimately displace biodiverse-rich lands.

5.2 Aid and Trade objectives and the Dutch diamond approach

The negative impacts that biofuel policies may pose, can cause significant risks to realization of the 'Aid and Trade' objectives. The huge amount of available information on the impacts of biofuels will have to be systematically and critically reviewed to prevent misinterpretation as that may lead to both risks and opportunities being overlooked. For a coherent policy of the Netherlands Government, it is essential to include assessments of the impact on indirect effects and consequences related to production of biofuels globally and in developing countries, in addition to the compliance with the RED and the FQD. Lack of inclusion of these components in the assessment of the production and use of biofuels may pose political and reputational risks to the Netherlands as unintended consequences of realizing RED and FQD targets may cause societal upheaval and environmental degradation.

In terms of volume, claims relating to land, water and other resources for realization of Dutch goals are not insignificant. A 10% blending target, for instance, would coincide with the cultivation of crops under optimal growth conditions equivalent to almost the entire arable area of the Netherlands. While the Netherlands' decision about the maximum allowable blending may be relatively small as compared to the rest of Europe or the international fuel consumption, its exemplary role may be essential. The Netherlands are, traditionally, considered one of the more enlightened countries in terms of international cooperation and development and sustainable development.

The Netherlands has always been in the lead to strive for an integral and inclusive sustainable development agenda, certainly so in the food - fuel - nature, water and climate change debates. Indeed has the Netherlands initiated or catalysed global change processes such as on sustainable development certification of food crops. For example, on crops like soy bean and palm oil through round tables, on the concept of climate smart agriculture, and on water use and sanitation. Therefore, decisions taken by the Netherlands are usually placed under a magnifying glass, thus having wider ramifications and a higher impact than can be deduced from a volume base only.

Assessment of the compliance with the RED and FQD directives of the Netherlands policies on foreign trade and development requires a comprehensive approach. The most important debates about the impact of biofuels on ensuring sufficient food is often limited to the availability of land and indirect land use change. Yet, food security may hinge more on the maintenance of essential ecosystem services than the mere availability of cultivable land. In assessing the impact of biofuels on development it is therefore essential for sustainable development to consider multiple variables that maintain ecosystem services, including terrestrial and marine biodiversity, soil fertility and health, water quantity and quality, in spatial-temporal context.

In addition to these ecological aspects, the production and use of biofuels also have far reaching socio-economic implications. There is growing scientific evidence of socio-economic problems arising from feedstock production of biofuels in developing countries, including food security, land displacement, water shortage, and skewed economic and social development not addressing poverty nor inclusiveness. These effects may be caused by direct claims but also by indirect claims on natural resources, including indirect land use change (ILUC). Other more remote or disguised indirect effects may result from the substitution of products, such as changes in feed composition by the meat and dairy industry due to the re-allocation of feedstock to biofuels, or the relocation of "waste" for biofuels production with a previous destination.

There is some scant evidence that governance drivers more readily influence socio-economic and biophysical drivers than the other way around, which illustrates an important role for policy as a driver towards sustainable development. The 'Dutch diamond' approach may well be suited to safeguard a democratic and transparent evaluation methodology that balances the needs and interests of private and public sectors, and warrant a comprehensive assessment of all sustainable development dimensions.

Annex 1: Principles underlying criteria

Basic principles in plant biology and ecosystem functioning

Debates about ensuring sufficient food and biofuels, while protecting biodiversity and ecosystem services, are often limited to the availability of land. Yet, food security may hinge more on the maintenance of essential ecosystem services simultaneously with an increase in food production than the mere availability of arable land (Lambin, 2012). It is therefore essential for the achievement of sustainable development to consider multiple variables that maintain ecosystem services in assessing the impact of biofuels on development, including terrestrial and marine biodiversity, soil fertility and health, and water quantity and quality in spatial-temporal context.

Biomass production

Plants absorb solar energy to convert CO_2 taken up from the air, together with H_2O (water) into carbohydrates. This is the primary process that converts lifeless material into living organic components: carbohydrates. Carbohydrates are converted with nutrients (nitrogen, phosphorus, potassium, magnesium, calcium, zinc, iron etc.) supplied to plants in the form of organic or mineral (artificial) fertilizers, into proteins, lignins, fats and the like, to form plant biomass. Moreover, plants need massive amounts of water for transpiration. Finally, they may need to be protected against weeds, pests and diseases.

Resource use

Only about 2.3% of the solar radiation reaching the plant is converted through growth process into plant biomass (Spedding, 1988). Assuming that about half of the energy is needed for cultivation practices, i.e. plowing the soils, production and application of fertilizers, transport, and conversion into fuels, a maximum of about 1% energy efficiency can be obtained around the equator with year-round cultivation. Cultivation in temperate regions with a growth period of 4-6 months further reduce the conversion efficiency to about 0.5% on an annual basis. These amounts are only realized when plants are grown under optimal conditions, i.e. when supplied with all the water and nutrients they need and protected against weeds, pests and diseases. In reality, these potential production conditions are hardly ever realized and efficiencies may drop to close to zero and even turn negative under cultivated conditions, certainly so under “marginal conditions” with low rainfall and low inherent soil fertility.

As 97.5% of the energy is not used, it has to be dissipated by the plant through transpiration. Theoretical minima range from 250-300 litres of water per kilogram of biomass. This amount doubles for the production of 1 kg of grain because only half of the crop weight (Harvest Index = 0.5) is grain. In practice it takes about a 1000 litres of water to produce 1 kg of grains which is achieved under well-managed conditions only (Rockström, 2003). These amounts can increase to 2000 litres or more under low yielding (marginal) conditions.

Plants need nutrients. Natural systems can provide sufficient nutrients to feed about 2.5-3 billion people. Artificial fertilizers have to be added to the system to enhance plant growth to reach food production for 7, and projected 9-10 billion people. Fertilizer use also comes with GHG emissions, specifically from nitrogen fertilizer as nitrous-oxides (N2O) (Crutzen, 2007 and following discussions).

Additionally, the loss of nutrients to surface and ground water causes eutrophication and contributes to coastal dead zones. Cultivating crops without the addition of fertilizers, on the other hand, leads to soil nutrient depletion and degradation, deteriorating the production base, with declining yields over time.

And finally, the production and application of herbicides and pesticides require large amounts of energy, while the products may have negative environmental side-effects. These negative side-effects call for their judicious use.

Agricultural - Ecological principles

Land Use and Change

Food production will have to increase to feed the projected 9-10 billion people in 2050, in addition to complementary measures taken to reduce food waste and changed diets. The increase in rate of crop yields has decreased over the past decades. In other words, it becomes harder and harder to push up yields quickly. We have reaped the low hanging fruits during the 1960's-1980's with high rates of yield increase and encounter challenges, among others due to deteriorating soil productivity, limited water supply, changing climate, and increasing weather variability. It is therefore projected that meeting food supply in the next decades will come with the expansion of the total area of agricultural land (e.g. Bruinsma, 2003 and following reports). Ultimately, any extra expansion of land use will use savannahs and forest areas (Gibbs, 2010).

The use of "waste land" is presented as a sustainable option for the production of feedstock for biofuels, as these would represent "empty" or "unproductive" land available for development. Baka (2014) however argues for Tamil Nadu, India that the introduction of Jatropha for production of biofuels would crowd out current systems on these lands, that supply more energy, jobs and economic development opportunities. Similar non-existence of "political constructs of wasteland" has been reported for the "vast" and presumably "empty" African continent.

Land investment and land grabbing have been coined to reflect the expansion of land demands in developing countries. Boaham (2014) synthesizes that this concept can be strategically applied. Biofuel investors whose projects have been labeled ''land grabbing'' switched to food production to downplay public scepticism. Others portray investments on biofuels as ''pro-poor'' projects and use the ''land transaction'' concept to pre-empt possible public criticisms. Boaham, however, found that some projects with potentially promising outcomes have thus been terminated, while others with problematic outcomes have continued to be promoted, underlining the need for strong regulations.

Soil health

Soil is a complex medium to store and release water and nutrients to plants. Maintaining proper soil conditions is essential for plant production, to retain water and nutrients and with that to sustain the plant production base and to prevent soil degradation. Organic matter content is essential to this aim, certainly so on poor (and sandy) soils with limited capacity to adsorb nutrients. Fallen leaves and stems are the primary sources that serve as food for fungi, bacteria and worm to convert these compounds into soil organic matter and therefore maintain soil biodiversity (flora and fauna). Hence, there is no such thing as waste in ecology.

Water and fertilizer use

Plants have to transpire to dissipate the huge amounts of solar energy they are exposed to. Hence, claims that plants can grow under marginal conditions, i.e. with low water supply, are physically and biologically not possible. Water for irrigation will be needed, either to supplement rainwater or to mitigate periods of drought, even for crops like Jatropha, to realize reasonable yields, else growth levels will be marginal if not nil. Water is the most limiting factor in agricultural production already, with large global production areas experiencing falling ground water levels because of excessive depletion for food production only. Cultivation of biomass will add to this extraction.

Jatropha has been portrayed as a crop that can be grown under marginal conditions and will not interfere with the food chain. It produces biodiesel of better environmental quality than mineral oils. Yet, the cultivation of Jatropha puts claims on limited resources, mainly water and soil, for its growth. Palacios-Diaz (2015), for instance, calculated water consumption of 5.6 - 15.5 thousand litre of water per litre of oil. This example is illustrative for “illusions” that have emerged in the world of biofuels, where private enterprises had engaged themselves in large scale investments in marginal regions but had to withdraw because of low production. Negussie et al. (2015) shows that organic or mineral fertilizer application remains crucial to satisfy the nutrient requirements of Jatropha, considering that the nutrient input through litterfall is limited.

Food security

The World Resources Institute (Searchinger and Heimlich, 2015) states that the use of land for bioenergy inherently comes at the cost of not using that land for food, feed, or sustained carbon storage and will undercut efforts to combat climate change and to achieve a sustainable food future.

The challenge to sustainably produce sufficient food is recognized to be significant, but Liu and colleagues (2015) add to this by revealing that resource use including water, pesticides and fertilizers have increased over the past decades while their use efficiency has decreased, imposing environmental hazards. They argue that expansion of biofuels may intensify the risks of a global food crisis in the coming decades.

At the local level, Hoffman et al (2015) found that the use of sunflower and groundnut oils for the production of biofuels for rural electrification promotes development, but threatens food security in Western Tanzania due to replacement. Likewise, more reports and science-based analyses confirm comparable findings.

Greenhouse gas emissions reduction

Basic principles reveal that the net balance of GHG emissions, i.e. the amounts captured by the crop and the amounts needed to produce the crops, are crop dependent and reveal a wide range with only a few crops with a clear positive balance. These are primarily crops with a long growth cycle such as perennial crops (e.g. sugarcane) and permanent crops (e.g. oil palm). Adding the impact of indirect land use change to these losses, i.e. the emissions from clearing new lands, pushes many crops into a negative balance, leading to an increase in GHG emissions worldwide rather than a reduction. Mitigation of GHG emissions have to be evaluated in a global perspective because GHG’s have no political or geographic borders.

Reducing N_2O emissions from fertilizer use is essential to improve the GHG balance for biofuels feedstock. Soares et al (2015) for instance suggests to use inhibitors that reduce N_2O losses in sugarcane as an effective measure. Yet, inhibitors pose their particular environmental challenges.

Biodiversity

Increase in land use to meet food production implies that each and every hectare of additional land needed for the cultivation of biofuels, by definition, will add to the expansion of land and to the loss of biodiversity, ultimately of high value biodiversity. Moreover, the cultivation of agricultural crops for food or fuel alike, lead to the reduction of the biodiversity index in a cultivation region itself.

Human development increases demand for food, timber and other goods and services with direct consequences for the extent of natural areas with the loss of biodiversity. PBL (2007) expects the loss of biodiversity to continue over the coming decades, while measures for limiting climate change by, amongst others, large-scale production of bioenergy seem to inevitably lead to additional loss of biodiversity in the medium term (2010-2050). Most pressures on biodiversity are stated (PBL, 2010) not to be directly relieved by conservation and protection, but by structural changes in production and consumption. Indeed, more traditional biodiversity policies focus on conservation and protection measures, but have limited effect on ongoing pressures. This implies that structural measures, such as the structural addition of biofuel production, will add to the overall pressure and enhance loss of biodiversity.

Socio-economic implications

Biofuels can typically be regarded as high-volume low-value commodity due to the low energy density and the large amounts of biomass that have to be collected from extensive land areas. This is certainly true when "waste" has to be collected. Heavy equipment, optimal logistics, dense road network, efficient collection systems and economies of scale are key in collecting and transporting biomass to biofuels production plants. These conditions determine the type of farming systems that may physically and economically contribute to biofuels feedstock supply.

The volume of biofuels is sufficiently large to impact agricultural prices and to create a strong link between food and fuel prices (Ciaian and Kancs, 2011; Smeets et al., 2013; Zhang et al., 2010). An extensive review of literature on biofuels-related price transmission on food prices (Serra and Zilberma, 2013) suggests that instability in energy markets is transferred to food markets, and that spill overs are especially intensive since the second-half of the 2000s decade, due to the emergence of the global biofuels industry. Policies promoting biofuel production and use may drive agricultural commodity prices up. This may stimulate rural economic growth, but can be especially harmful for consumers that spend a high percentage of income on food.

It is commonly stated that biofuels have the potential to contribute to improve livelihood in developing countries, provided a number of enabling conditions have been met, such as appropriate pricing, recycling of nutrients, pollution reduction, proper institutional conditions and the like (e.g. Zvinavashe et al., 2011).

An increasing body of literature however indicate significant negative effects on livelihood. Van Eijck and colleagues (2014) compare two real-life jatropha farming systems in Tanzania. The smallholder approach scored better on land rights, GHG balance and biodiversity and reached more people, whereas the plantation created more employment and higher (local prosperity) benefits for smaller numbers of people, and could lead to higher yields. Minimal negative impacts were reported for smallholders, whereas the plantation approach could lead to decreased food security, loss of land rights and biodiversity. They argue that negative effect can be mitigated by appropriate policies. The biggest hurdle towards achieving sustained positive societal impacts was, however, noted to be the marginal profitability at current yields, costs and prices, which were highly sensitive to uncertain yields and oil prices. They plea for more reliable sustainable development assessments that require much location-specific and operational company data.

On the other hand one could also state that a higher level of efficiency can be reached on larger plants and that these larger plants are less sensitive to uncertain yields and oil prices.

In a review about livelihood impacts of biofuel crop production, Hunsberger and colleagues (2014) conclude that governance instruments remain weak on livelihood and equity, and suggest explicit inclusion of income, food, land access and their equity dimensions. Interestingly, they suggest parallels between current expansion of biofuel crops and trends in the production of other cash crops, such as rubber, cocoa, oil palm, coffee and commercial tree plantations, as well as shrimp aquaculture. In these crops a lack of formal property rights has often facilitated encroachment into customary tenure areas and the subsequent consolidation of formal property rights. Industrial round wood and rubber plantations have facilitated local processes of land ownership concentration, loss of customary rights of resource access, rural displacement, and socioeconomic decline in neighbouring communities, with uneven benefits in the form of wage labour.

Hunsberger et al. (2014) describe similar effect of biofuel crop expansion in the global South. Expansion of biofuel crops generates unskilled jobs and increases local farm and/or wage income. Small-scale, state-assisted oil palm plantations in Malaysia and Indonesia have reportedly increased farm income substantially. In contrast, large-scale sugarcane and soy production in Brazil on mechanized plantations have benefited better-off farmers while providing fewer opportunities to poorer farmers. Oil palm plantations in Guatemala only employ labourers between 14 and 30 years old and not older household heads, leading to income inequality and social conflicts. Slow-growing crops (e.g. jatropha, oil palm) require alternative income streams until the plants mature and favour well-off farmers. Large-scale biofuel expansions have been found to displace ‘landless’, informal or poor tenure holders through aggressive investments, land concentration, or land grabs, for example in India and Brazil. In a government-led, smallholder-focused jatropha cultivation program in Mexico, households without formal land titles were reportedly excluded from the program and its associated subsidies. A case study of jatropha production in Ghana found that women lost informal access to land and resources more easily than men.

Dauvergne and Neville (2010) report that already vulnerable people and communities will bear a disproportionate share of the costs of biofuel development, particularly for biofuels from crops already embedded in industrial production systems. A core reason, they argue, is that biofuel alliances are reinforcing processes and structures that increase pressures on the ecological integrity and further wrest control of resources from subsistence farmers, indigenous peoples, and people with insecure land rights. Even the development of so-called ‘sustainable’ biofuels set to displace livelihoods and reinforce and extend previous waves of hardship for such marginalised peoples. Acosta and colleagues (2013) indeed reveal the need for sustainable development determinants for biofuel production and use to be directly associated to daily living due to the complex socio-cultural aspects. Mintz-Habib (2013) finds that farmers’ decisions to participate in the biofuels global value chain may result in negative income effects, household food security reduction, and biodiversity loss from peat land destruction.

Transparency, stakeholder involvement and certification

Ponte (2014) synthesizes lessons from “round tabling” sustainable development in the biofuels industry. He reports that “sustainability roundtables in general have adopted complex webs of institutional and governance features with managerial systems that are time- and resource-consuming and procedures to meet codes of good practice in standard setting and management. These slow down processes, add costs, and in the long run may create stakeholder fatigue, but open up space for mainstream competitors to establish substantial presence in the market for sustainability certifications. Commercially-oriented initiatives are generally less democratic, leaner, quicker, and more attuned to industry interests. They also tend to more easily discriminate against small players and actors in the global South, feature industry-dominated and top-down governance structures and do not attempt to give equal voice to stakeholders.”

Ponte further notes specifically for biofuels that “the EU RED failed to properly include social issues and indirect land use change considerations. It also failed to require a minimum set of standards on the quality of procedures, participation, transparency and accountability of EU-recognized certification initiatives. Including these features would have led to more democratic certification systems, more meaningful participation from feedstock producers in the South (especially smallholders) and a more geographically equitable distribution of benefits. EU regulation, however, limited itself to indicate what parameters of sustainability should be included in certification systems (and especially GHG emission reduction) and provided little or no guidance on governance best practices. As a result, the most commercially-oriented, top-down and global North-focused biofuel certification scheme has monopolized the sustainability market thus far.”

Florin and colleagues (2014), demonstrate that to influence sustainability of biofuel production, interactions between biophysical, socio- economic and governance drivers must be considered. Most studies only address a small subset of drivers and indicators, while a comprehensive assessment of sustainability of biofuels can be addressed through a systems thinking framework. They suggest that there appears to be a loose hierarchy of drivers where governance drivers more readily influence socio-economic and biophysical drivers than the other way around. This illustrates an important role for policy as an important and influential driver towards sustainability.
These observations suggest that current certification systems that comply with EU RED, may not warrant sustainability criteria.

Annex 2: Global issues and international goals

The UN countries recently adopted a new set of sustainable development targets as a follow-up to the Millennium Goals. They agree on seventeen Sustainable Development Goals[13] divided over the four Sustainability Compass categories as follows:

- Wellbeing (SDGs (1 t/m 4 and 6)
- Society (SDGs (5, 10, 11, 16 and 17)
- Economy SDGs (7 t/m 9 and 12)
- Nature: SDGs (13 t/m 15)

The leading principle for the Netherlands in international relations is 'aid and trade' and the stimulation of sustainable and inclusive growth. This principle is translated in several priority issues:

- Women's rights
- Water
- Food security
- Safety and rule of law
- Sustainable development
- Social rights

These priority issues play a central role both in programmes aimed at poverty reduction as in economic relationships. In all international relationships the international commons (trade, safety, food security, water, climate and migration) play a central role. The Netherlands wants to make a difference on the issues.

Point of attention is that many of the coherence goals (and SDGs and other commitments for that matter) are in absolute terms, such as sustainable water use, conservation of marine and terrestrial ecosystems and biodiversity, whereas the policy measures are in relative terms: % share of biofuels, % share of conventional biofuels. A % means that any increase in fuel consumption leads to an increasing absolute volume of biofuels and the way they affect the coherence goals. In other words: a relative measure cannot guarantee that absolute targets will be met.

The Netherlands have ratified a number of international conventions and agreements that are relevant for the evaluation of the policies relating to biofuels. A specific relevant one here is the *Convention on Biological Diversity.* Conferences of Parties to the Convention have repeatedly called for halting the loss of biodiversity[14]. Key message out of numerous publications is that biodiversity conservation is not to be limited to just protected areas. It is fundamental to maintain the ecological quality of all landscapes and fundamental to achieve sustainable land use. Especially outside protected area the loss of biodiversity is alarming (Nature, December 2014)[15].
Any policy on biofuels should be analysed with respect to its impact against the following targets:

[13] https://sustainabledevelopment.un.org/?menu=1300)
[14] www.cbd.int
[15] http://www.nature.com/news/biodiversity-life-a-status-report-1.16523

- 17% of land and fresh water surface set aside for biodiversity and natural ecosystems conservation;
- 10% of marine area set aside for similar purposes;
- 15% of degraded ecosystems restored.

Moreover, it should account for the impact it has on maintaining and restoring the biodiversity and ecological quality of land where resources for such fuels are being produced. For example, natural prairie ecosystems in the US have been or are being converted into crop lands for ethanol production, resulting in loss of typical biodiversity, ecosystem quality and resilience, and carbon loss. Another example is that conserving tropical rain forest in Brazil results in the conversion of the Cerrado (dry savannah) for soy and fuel resource production.

On this basis, a 'dashboard' that would be workable as a check to test biofuels policy options contains at least the following criteria:

- SDG 2, sustainable agriculture;
- SDG 6, sustainable management of water;
- SDG 13, urges to take action to combat climate change;
- SDG 15 calls for biodiversity and ecosystem conservation restoration and sustainable use.

Annex 3: Biomass debate

Annex 1 outlined the increasing amount of literature indicating that biofuels may cause a variety of sustainability and developmental issues that need to be addressed reasoning from basic physical, biological and ecological principles.

There is another strand of researchers that emphasizes the importance or even indispensability of biomass from a future energy system perspective. This research finds its basis primarily in the idea that in order to meet a growing energy demand a variety of renewable and also fossil (with CCS, carbon capture and sequestration) options will be needed, while at the same time mitigating climate change risks posed by increasing greenhouse gas concentrations in the atmosphere. Later this century, biomass is even projected to play an even more crucial role as one of the few possibilities to provide a net negative emission option. In most long-term scenarios or pathways that are able to keep global warming below +2 C with a fair chance, negative emission options are inevitable. This means removal of CO_2 of the atmosphere, lowering the concentration. Biomass systems (BECCS: Bio Energy with Carbon Capture and Storage) may be key technologies in providing this service. Other techniques may be mineralization (e.g. by olivine and other minerals) and soil carbon restoration (e.g. by biochar).

Taking this as a starting point, a variety of studies have estimated the potential of biomass as an energy source, and as a way to mitigate greenhouse gas emissions. In the course of time, a series of sustainable development criteria have been brought up in the debate, and these have been translated into constraints limiting bioenergy potentials.

The Global Energy Assessment[16] (the energy twin brother of the IPCC's climate assessments) estimates for 2009 a biomass use for energy of about 10% (51 EJ), mostly traditional biomass (wood). A recent potential assessment (Deng et al., 2014)[17] estimates a 2070 biofuel potential ranging between 40 and 190 EJ final energy (i.e. 130 – 400 EJ primary energy), depending on modelling assumptions. The authors note: "Sustainability constraints have been taken into account implicitly, by using small availability factors on land types which could host protected areas and accounting for competitive uses of residues."

The first strand starts bottom-up with plant biology and ecology, constrained by nutrients, water, and land availability. In this approach, available land is primarily attributed to food production and biodiversity production, while at the same time other sustainability challenges such as rights, equality, livelihoods and others should be met. In these analyses, only a limited potential for (sustainable) biomass for energy purposes can remain.

The second strand starts more top-down with the need to fuel the world while at the same time mitigating climate change. In this approach, macro-modelling exercises indicate the availability of arable land that could be used for bioenergy production. Additionally, organic waste flows can be found that could be converted into useable energy by means of fertilization, gasification and other technologies. More or less strict sustainability constraints lower

[16] http://www.globalenergyassessment.org
[17] http://www.ecofys.com/files/files/ecofys-2015-article-global-bioenergy-potential.pdf

the potentials. The perspectives of this strand of science are based on model analyses, the strength of which depend on the assumptions, such as the inclusion of indirect effects, the parameters uses, or lack thereof in the methodology, with highly differing quantitative estimates.

While these two strands of scientific literature seem to arrive to different conclusions, the proof of the pudding will be in the eating. As indicated, the EU has, based on science evidence and reports from real-life experiences, down-regulated the blending with food crops. Moreover, both strands notice that practical implementation comes with the need to enabling conditions to prevent negative sustainability and development impacts.

References

In this annex a selection of available literature on biofuels and the possible effects on e.g. biodiversity, women participation or land use is given.

- Acosta L.A., Enano Jr. N.H., Magcale-Macandog D.B., Engay D.G., Herrera M.N.Q., Nicopior O.B.S., Sumilang M.I.V., Eugenio J.M.A., Lucht W. (2013). How sustainable is bioenergy production in the Philippines? A conjoint analysis of knowledge and opinions of people with different typologies. J. Appl. Energ. 102:241-253.
- Anne-Gerdien Prins & Jan Ros (PBL, 2014). PBL - Bio-energieteelt: een onuitputtelijke bron? Het potentieel van bioenergieteelt nader bekeken; PBL Achtergrondstudie.
- Baka J. (2014). What wastelands? A critique of biofuel policy discourse in South India. Geoforum 54:315-323.
- Boamah F. (2014). Imageries of the contested concepts ''land grabbing'' and ''land transactions'': Implications for biofuels investments in Ghana. J. Geofor. 54:324-334.
- Bruinsma, J. E. (2003). World agriculture: Towards 2015/2030. An FAO perspective. Rome: Food and Agricultural Organization of the United Nations.
- Trudy Rood, Durk Nijdam en Jan Ros (PBL, 2014). Concurrerend gebruik van landbouwgrond: bio-energie versus dierlijke producten. Achtergrondstudie.
- COM(2015) 293 final Report from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the regions, Renewable energy progress report.
- Ciaian P., Kancs d'A. (2011). Interdependencies in the energy-bioenergy-food price systems: A cointegration analysis. J. Res. Energ. Econ. 33:326-348.
- Crutzen, P.J., A.R., Mosier, K.A. Smith & W. Winiwarter (2007). Atmos. Chem. Phys. Discuss, 7, 11191-11205.
- Dauvergne P., Neville K.J. (2010). Forests, food, and fuel in the tropics: the uneven social and ecological consequences of the emerging political economy of biofuels. J. Peas. Stud. 37:4, 631-660.
- DGIS (2015). Wat de wereld verdient: Een nieuwe agenda voor hulp, handel en investeringen. Policy document Ministry of Foreign Affairs. Government of the Netherlands, the Hague, the Netherlands.
- Dragojlovic N., Einsiedel E. (2015). What drives public acceptance of second generation biofuels? Evidence from Canada. Biomass Bioenergy. 75:201-212.
- European Commission (2013). Assessing the impact of biofuels production on developing countries from the point of view of Policy Coherence for Development. Eds. Diop, D., M. Blanco, A. Flammini, M. Schlaifer, M. A. Kropiwnicka, M. M. Markhof. The European Union's Framework Contract Commission 2011.
- EU (2015). Richtlijnen (EU) 2015/1513 van het Europees Parlement en de Raad tot wijziging van richtlijn 98/70/EG betreffende de kwaliteit van benzine en dieselbrandstof en tot wijziging van Richtlijnen 2009/28EG ter bevordering van het gebruik van energie uit hernieuwbare bronnen.
- Florin M.J, van de Ven G.W.J., van Ittersum M.K. (2014). What drives sustainable biofuels? A review of indicator assessments of biofuel production systems involving smallholder farmers. Sci. Direct. J. Env. Sci. Policy. 37:142-157.
- Gibbs, H. K., A. S. Ruesch, F. Achard, M. K. Clayton, P. Holmgren, N. Ramankutty, and J. A. Foley (2010). Tropical forests were the primary sources of new agricultural land in the 1980s, 1990s. PNAS 107(38): 16,732-16,737.

- Hunsberger C., Bolwig S., Corbera E., Creutzig F. (2014). Livelihood impacts of biofuel crop production: Implications for governance. Geoforum. 54:248-260.
- Liu Y., Pan X., Li J., (2015). Current Agricultural Practices Threaten Future Global. J. Agric. Environ. Ethics. 28:203-216.
- Mintz-Habib N., (2013). Malaysian biofuels industry experience: A socio-political analysis of the Commercial environment. J. Energ. Policy. 56:88-100.
- Negussie, A., Degerickx, J., Norgrove, L., et al., (2015). Effects of accession, spacing and pruning management on in-situ leaf litter decomposition of Jatropha curcas L. in Zambia. Biomass & bioenergy Vol. 81, Pages: 505-513.
- Netherlands Ministry of Foreign Affairs - A world to gain A World to Gain; A New Agenda for Aid, Trade and Investment (2013).
- NGO recommendations. Pitfalls and potentials - the role of bioenergy in the EU climate and energy policy post 2020.
- Palacios-Diaz, M., V. Mendoza-Grimon, I. Hernandez Brito, et al. (2015). WATER Vol 7, Issue 9, Pages 4848-4857.
- PBL (2007). Cross-roads of Life on Earth — Exploring means to meet the 2010 Biodiversity Target. Solution oriented scenarios for Global Biodiversity Outlook 2. Secretariat of the Convention on Biological Diversity and Netherlands Environmental Assessment Agency, Technical Series no. 31, 90 pages.
- PBL (2010). Voedsel, biodiversiteit en klimaatverandering Mondiale opgaven en nationaal beleid.
- PBL (2010). Rethinking Global Biodiversity Strategies: Exploring structural changes in production and consumption to reduce biodiversity loss. Netherlands Environmental Assessment Agency (PBL), The Hague/Bilthoven, 2010.
- PBL (2014). Struggling to deal with uncertainties What is known about indirect land-use change?
- PBL (2013). Comments on the EC proposal for amendment of the Renewable Energy and Fuel Quality Directives.
- Ponte S. (2014). ‘Roundtabling’ sustainability: Lessons from the biofuel industry. Geoforum 54:261-271.
- Ribeiro B.E., Quintanilla M.A. (2015). Transitions in biofuel technologies: An appraisal of the social impacts of cellulosic ethanol using the Delphi method. Tech. Forecast. Soc. Change. 92:53-68.
- Rockström, J. (2003). Water for food and nature in drought-prone tropics: Vapour shift in rain-fed agriculture. Philos. Trans. R. Soc. Lond. B 358:1997-2009.
- RVO (2015). Impact assessment naar de hoogte van de in te voeren limiet voor conventionele biobrandstoffen in vervoer. Rijksdienst voor Ondernemend Nederland. Utrecht, the Netherlands.
- Searchinger, T. and R. Heimlich (2015). Avoiding bioenergy competition for food crops and land. Working Paper, Installment 9 of Creating a sustainable food future. Washington DC; World Resources Institute.
- SER (2014). Een duurzame brandstofvisie met LEF. De belangrijkste uitkomsten ui het SER-visietraject nar een duurzame biobrandstoffenmix in Nederland. The Hague, Netherlands.
- Serra T., Zilberman D. (2013). Biofuel-related price transmission literature: A review. J. Energ. Econ. 37:141-151.
- Smeets, E., T. Achterbosch, S. van Berkum (2013). De invloed van biobrandstoffen op de volatiliteit van prijzen van agrarische grondstoffen. LEI, Wageningen UR, the Netherlands.

- Soares J.R., Cantarella H., Vargas V.P., Carmo J.B., Martins A.A., Sousa R.M., Andrade C.A. (2015). J. Environ. Qual. Special Ed. Pp. 423-430.
- Spedding, C.R.W. (1988). An Introduction to Agricultural Systems. Elsevier Applied Science, London, UK, p. 189.
- Transport & Environment (July 2015). Low Carbon Transport Fuel Policy for Europe Post 2020 How can a post 2020 low carbon transport fuel policy be designed that is effective and addresses the political pitfalls of the pre 2020 policies?
- Transport & Environment (2012). Biofuels and ILUC, Policy Brief.
- Transport & Environment (2015). Drivers & impact rivers & impacts of Europe's biofuel policy.
- Van Eijck, J., H. Romijn, E. Smeets, R. Bailis, M. Rooijakkers, N. Hooijkaas, P. Verweij, A. Faaij (2014). Comparative analysis of key socio-economic and environmental impacts of smallholder and plantation based jatropha biofuel production systems in Tanzania. Biomass and Bioenergy, 61: 25-45.
- Zhang Z., Lohr L., Escalante C., Wetzstein M. (2010). Food versus fuel: What do prices tell us? J. Energ. Policy. 38:445-451.
- Zvinavashe, E., H. Wolter Elbersen, M. Slingerland, S. Kolijn and J.P.M. Sanders (2011). Cassava for food and energy: exploring potential benefi ts of processing of cassava into cassava fl our and bioenergy at farmstead and community levels in rural Mozambique. Biofuels, Bioprod. Bioref. 5:151-164.