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Conclusive Evaluation of Studies Assessing the Environmental Impact of the Use of Palm Oil as a Bioenergy Carrier

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Background and goal & scope

In the past months, the use of palm oil for both a stationary as well as a transport fuel has increasingly shifted into the focus of public interest; this is due to the increased use of palm oil in exactly these fields and is consequently seen in connection to the deforestation of tropical natural forests. Furthermore, numerous publications report different energy and greenhouse gas balances which – seemingly – contradict each other: in some cases, palm oil-based transport biofuels help save greenhouse gases when replacing conventional fuel, in other cases they lead to greater emissions.

In order to help clarify the results of these publications, the IFEU Institute Heidelberg (Germany) was commissioned by Greenpeace Nordic, Stockholm (Sweden), on 30 August 2007 to produce a conclusive evaluation regarding these studies on the field of palm oil as a source of bioenergy.

The aim of this statement is to (1) compare the outcomes of different studies, (2) analyse the relevance of the findings, (3) where necessary, clarify and evaluate the reasons for any differences and finally (4) deduct conclusions and recommendations. The focus is to lie especially on the greenhouse gas balance of palm oil-based transport biofuels. This places two publications at the centre of attention: one evaluates NExBTL (/IFEU 2006/), resulting from an innovative process for biofuel production from plant oil, while the other regards conventional biodiesel from transesterified plant oil (/IFEU 2007a/).

In the following, these two studies are described and ranked individually. Subsequently, further results regarding the topic are presented and conclusions are drawn.

NExBTL study

In early 2006, the IFEU Institute Heidelberg (Germany) was commissioned by the Neste Oil Corporation, Porvoo (Finland) to calculate energy and greenhouse gas balances (along the lines of the Life Cycle Assessment Standards ISO 14040-14043) for the NExBTL process they had developed. Further environmental impacts such as acidification, eutrophication and ozone depletion, categories for which according to experience biofuels generally deliver less favourable results than their fossil equivalents, were explicitly excluded from the examination. The study focussed mainly on the comparison of different process options which differ in their energy inputs, their degree of efficiency and the utilisation of the by-products. In addition, only rapeseed and palm oil were analysed from among the variety of triglyceride raw materials which can be undertaken the hydrotreating step. For each of these two plant oils, two scenarios were regarded: rapeseed from Europe and from overseas (Canada) and palm oil from Malaysia and from the world market.

NExBTL from rapeseed oil: For the raw material rapeseed oil, the exclusively positive outcomes for the NExBTL energy and greenhouse gas balances lie within a very narrow range when regarded for all process options. Merely in the case of European rapeseed oil, the specific greenhouse gas balances show more variation; this is due to the decisive influence of the regarded agricultural reference system (permanent fallow or set-aside land)[1]. Nevertheless, the results can be rated as most reliable both in qualitative (direction) and quantitative (numerical value) terms.

NExBTL from palm oil: By contrast, the results of the energy and greenhouse gas balances for NExBTL produced from palm oil cover an exceedingly great range which depends primarily on two parameters that do not play a role in this form in the case of rapeseed oil: (1) the plantation management practice and (2) the change in land use which the cultivation sites undergo. Regarding the plantation management two scenarios were developed which differ in terms of the yield of fresh fruit bunches and the by-product uses; they lead to very unequal quantitative results, i.e. that are difficult to narrow down to a concise range.

Furthermore, three land use changes which affect the greenhouse gas balances to different extents were regarded: (1) the clearing or deforestation of tropical natural forest, (2) the production switch in an existing oil palm plantation from cooking oil to biofuel and (3) the conversion of a coconut plantation. Other possibilities such as the conversion of an existing rubber plantation, which leads to disadvantageous results, were excluded from the examination. Neste declared not to buy palm oil from the world market but instead directly from established Malaysian plantations through direct supply contracts. Because the aim of the NExBTL was to thoroughly evaluate the NExBTL technology and not the utilisation of palm oil, the same system boundaries were set for the other scenarios such as „palm oil from the world market“ in order to aide comparability, i.e. here, too, the conversion of rubber plantations was not regarded.

The carbon stock change and the depreciation period proved to be further important parameters: when natural forest is cleared, the carbon stock of the area in question decreases. This singular carbon stock change then must be equally divided over a certain period of time, the so-called depreciation period. For natural forest on mineral soils, IFEU set a carbon loss of 100 t per hectare based on /IPCC 1996/. Regarding the depreciation period, it is – under the above-mentioned Neste-specific conditions, i.e. a continuous plantation use over several decades – quite adequate to depreciate the greenhouse gas emissions which result from a land use change over a longer period of time. By choosing to apply 100 years in their calculations, IFEU has opted for a time period within which a sustainable oil palm plantation management should – at least in Malaysia – be possible.

For this setting of values, i.e. a carbon loss of 100 t and a depreciation period of 100 years, the greenhouse gas balance for NExBTL delivers advantageous results even when natural forest on mineral soils is cleared for the cultivation of oil palms.

Topics such as the clearing of natural forests on peat soils and displacement or leakage effects – which have just recently been brought into the discussion (see /Hooijer et al. 2006/, /Fritsche 2007/) – were not addressed in this study.

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[1] Considering different boundary conditions, studies such as /CONCAWE et al. 2007/, /IFEU 2004/ and /VIEWLS 2005/ all display their results in certain ranges

WWF study

Around the middle of 2006, IFEU expanded the range of analysed biofuels by calculating energy and greenhouse gas balances for palm oil biodiesel as well as for stationary uses of palm oil in a study for WWF Germany in cooperation with WWF Switzerland and WWF Netherlands /IFEU 2007a/. Simultaneously, questions of biodiversity loss and sustainability were moved into the focus of the discussion. The focus thereby lay on an elaborate description of the environmental impacts of palm oil and not as much on a technology comparison. A number of parameters were varied and their influence on the overall outcome was evaluated, for example different pre- and post-plantation land uses as well as the impact of the depreciation period on the greenhouse gas balances.

The findings clearly reveal that the greenhouse gas balances can be either positive or negative, depending on the framework conditions (see Fig 1). If, for example, the depreciation period is decreased from 100 to 25 years (a time span which is equivalent to the average life cycle duration of an oil palm plantation), then the greenhouse gas balance is clearly disadvantageous for palm oil biodiesel originating from sites where natural forest was cleared for the plantation. In this case, an additional climate-gas burden of 3-12 tonnes of CO_2 equivalents per hectare and year would arise.

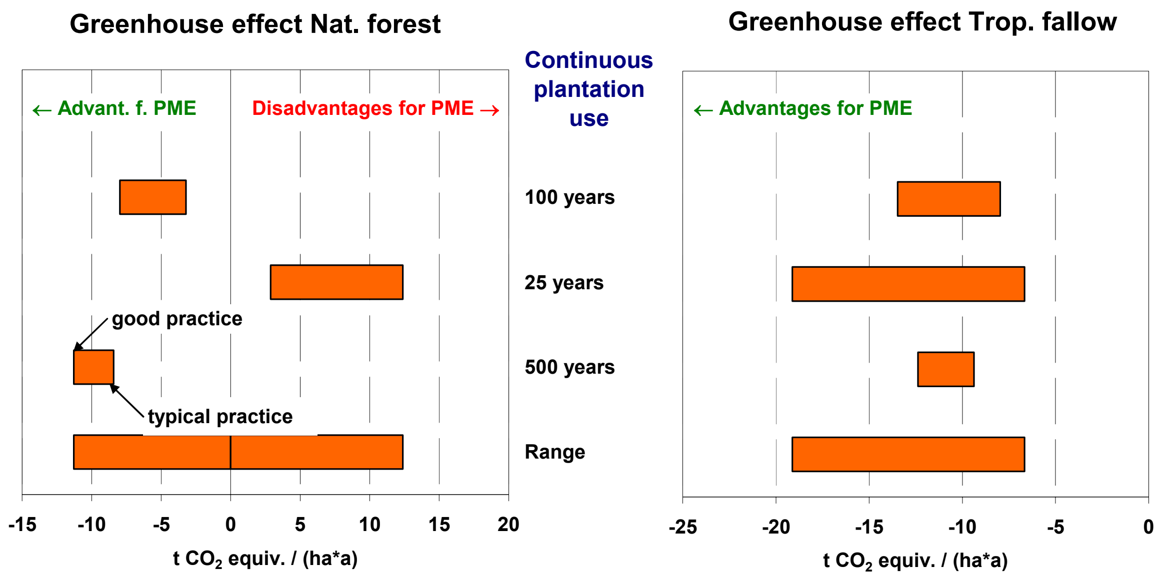

Fig. 1: Effect of different depreciation periods on greenhouse gas saving for the natural forest and fallow options assuming continuous plantation use

Besides the different depreciation periods, previous land uses also proved to have a great influence on the results. The conversion of rubber plantations to oil palm plantations, for example, a development which took place to a great extent in Malaysia during the 1990's, leads to clearly disadvantageous results for the greenhouse gas balances. If, however, degraded land such as *Imperata* grassland is developed into an oil palm plantation, the greenhouse gas balance of the thus produced palm oil delivers great advantages. In addition, such a land development in most cases does not have a negative impact on the biological diversity of the respective area – much in contrast to when natural forests are cleared.

Peat soils and displacement issues

Towards the end of the year 2006, the issue of peat soils increasingly moved into the focus of the debate, e.g. through the publication of /Hooijer et al. 2006/. Elaborate analyses concerning this topic show that greenhouse gas balances are indeed unfavourable to palm oil when oil palm plantations are established on peat sites by means of clearance of natural forests. This even applies to extremely long depreciation periods: the break-even point lies beyond 1000 years /IFEU 2007b/. Other parameters that considerably affect the results are changes in the carbon inventory of the above- and below-ground biomass and N_2O emissions from peat soils. Generally, it can be stated that the clearing of natural forests on peat soils leads to a considerable increase of greenhouse gas emissions which can not even be compensated for within a period of 1000 years. In contrast, establishing new oil palm plantations on degraded land leads to exclusively advantageous balances.

Another important issue are displacement or leakage effects: they occur if the use of palm oil from an established plantation for bioenergy purposes leads to an establishment of new plantations on agricultural land. The crops cultivated on that area of land are ‘outcompeted’ and subsequently displaced to other areas, i.e. ‘leaking’ from agricultural land into natural forests, for example. For practical reasons, so-called default values are currently being discussed with respect to the problem of how to consider the leakage effect. From a strictly LCA-related perspective, however, the consideration of the leakage effect would lead to the necessity of offsetting the balance results of the already presented cases where natural forest (both on mineral and peat soils) is cleared against those of palm oil originating from already existing plantations; this would lead to results similar to those described above. This is not the case, however, if the additionally produced amount of palm oil is gained through optimisation measures in existing plantations. In other cases, these leakage effects can lead to clearly less favourable – or even straight disadvantageous greenhouse gas balances.

This topic, however, has not been evaluated sufficiently and is currently being discussed intensively in connection with planned certification systems for sustainable palm oil, e.g. by the RSPO or the EU Commission. Against this background, it is justified to question if – while no reliable certification system exists which excludes such leakage effects – palm oil can be called a sustainable bioenergy carrier.

Conclusions and recommendations

While the energy and greenhouse gas balances for biofuels from rapeseed or sunflower oil in comparison to fossil fuels are advantageous under most boundary conditions, this is not always true for palm oil-based biofuels: here, the outcomes may be either positive or negative.

Under a number of boundary conditions, the energy and greenhouse gas balances for palm oil-based biofuels are advantageous compared to fossil fuels, in other words: fossil energy is saved and less greenhouse gases are emitted. This is the case, for example, when existing oil palm plantations are optimised or new plantations are established on degraded or fallow land such as so-called *Imperata* grasslands – as far as this is possible.

In some cases, the balances might even be advantageous in spite of the fact that natural forests are cleared for the establishment of palm oil plantations. Two prerequisites must be fulfilled in this case, however: (1) the logged natural forests did not have very high biomass or soil carbon inventories (e.g. as peat forests do) and (2) a long-term sustainable use of the area which lasts over several plantation cycles follows the clearing. Nevertheless, even in this case, the biodiversity of the destroyed natural forest will be permanently lost. Therefore, it must be carefully decided if saving fossil energy and greenhouse gases is to be given the priority in spite of the loss of biodiversity and above that other environmental disadvantages such as acidification and eutrophication.

The energy and greenhouse gas balances for palm oil-based biofuels are disadvantageous

- if specific already existing rubber plantations are converted to oil palm plantations.
- if tropical natural forests are cleared and the following oil palm plantation is only used for a short time (e.g. for only one or two plantation cycles, 25 or 50 years, respectively).
- if tropical natural forests on peat soils are cleared for the establishment of oil palm plantations.
- if the utilisation of palm oil originating from already existing, established plantations leads to the establishment of oil palm plantations under the conditions described in the first three scenarios above through so-called displacement or leakage effects (indirect land use changes). In these cases, an increased demand for palm oil by a stronger utilisation for bioenergy may lead to the establishment of new plantations on natural forest sites.

From our perspective, such utilisation paths for palm oil-based transport biofuels must be regarded as unsustainable if they lead to disadvantageous greenhouse gas balances or biodiversity is irrecoverably diminished through the clearing of natural forests for the establishment of new oil palm plantations. Because the currently available instruments, for example from the RSPO, cannot exclude such detrimental practices, such utilisation paths for palm oil-based biofuels must be regarded as unsustainable. This applies as long as no certification system is available which can guarantee that the certified palm oil was produced in a sustainable way.

On the way towards a sustainable production and utilisation of palm oil, however, numerous improvements are possible and necessary already today. For this purpose, it is predominantly essential to tap the full potential of the existing optimisation potential regarding yield increase and by-product uses as well as to find ways of stimulating the establishment of oil palm plantations on degraded (fallow) lands. How this can be woven into future certification systems remains to be seen; these would have to ensure that such palm oil can be certified as sustainable.

The statements made here apply generally, i.e. they are valid for all palm oil-based transport biofuels independently from the question if the palm oil is fed into NExBTL facilities or processed in conventional transesterification plants – or used directly as neat oil. By and large, they also apply for many utilisation scenarios involving stationary facilities.

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