Commissie
Duurzaamheidsvraagstukken
Biomassa

Maak landbouw deel van de oplossing!

Advies over Indirect Land Use Change (ILUC)

Make agriculture part of the solution!

Recommendation on Indirect Land Use Change (ILUC)

The members of Commissie Duurzaamheidsvraagstukken Biomassa (CDB) are Dorette Corbey (Chair), Prem Bindraban, Dominic Boot, Ewald Breunesse, Bart-Willem ten Cate, Daan Dijk, André Faaij, Wilfred Hadders, Helma Kip, Willem-Jan Laan, Karen Lagendijk, Karlijn van Lierop, Madelon Meijer, Daniëlle de Nie, Sven Sielhorst, Pier Vellinga, Ron Wit.
Ella Lammers and Judith van der Stel (secretariat).

In the preparation of this recommendation, CDB was assisted by Sjaak Conijn, Koen Overmars, Jan Ros, Pita Verweij, Willem Wiskerke. Jack van den Hoek attended the preparatory meetings.

Recommendation

Even following the adoption of two EU Directives, biofuels are still high on the political agenda. The EU directives encourage the use of biofuels in the transport sector, but leave an important question unanswered: What are the indirect effects of using biofuels? In the view of Commissie Duurzaamheidsvraagstukken Biomassa (CDB), the committee for biomass sustainability matters, the indirect effects can be substantial. This makes it necessary to pursue a policy that prevents adverse effects, yet one that also includes incentives to make agriculture sustainable throughout the world and improve its efficiency. Such a policy has to be implemented EU-wide.

Indirect effects: farmer A and farmer B

Mixing biofuels with transport fuels can help reduce CO_2 emissions, because the plants from which biofuel is made ingest CO_2 to grow. However, the cultivation of biofuel plants causes changes in land use, which can result in the large emission of CO_2 and other greenhouse gases. This is certainly true in the case of deforestation or the use of grasslands for cultivation. For this reason, the EU directives rightly set criteria for the use of land: the growing of biofuel plants in nature reserves, grasslands and woodland areas is not to be encouraged. This is not adequate in all situations, though, and an example can help make this clear. Suppose a farmer grows a food crop in section A of his farm. He decides that next year he will grow an energy crop there instead of a food crop, or sell the food crop on the energy market. If we assume that the demand for food remains constant (or even increases), then a food crop has to be grown elsewhere in section B. If section B was formerly grassland or a woodland area for example, the new use will result in more emission of greenhouse gases, and possibly a loss of biodiversity or valuable nature reserves. To obtain a realistic idea of the greenhouse gas emissions, the emission from section B has to be added to the emission from the production of the energy crop in section A. The emission from section B is an indirect effect, referred to as Indirect Land Use Change (ILUC). ILUC is a global phenomenon, because the agricultural market is international and the greenhouse gas impact worldwide. Various studies show that the indirect effects can be substantial, in terms of greenhouse gas emissions as well as for biodiversity. Other studies show that the use of land for energy crops can be offset by greater efficiency in arable and cattle farming. In any event, the processes underlying indirect changes in land use are complex.

The challenge

In the view of CDB, the indirect effects must also figure when assessing the sustainability of biofuels. If that is not done, the use of biofuels for transport might seem more beneficial than it actually is. There are situations, however, where the effects of ILUC do not occur or occur to a reduced extent. This is the case if specific residual flows are utilised or energy crops are grown on degraded or marginal land. Little or no ILUC also occurs if the productivity of agriculture increases to such an extent that farmland is left unused, making it unnecessary to use new acreage for food crops.

The policy concerned should concentrate on preventing indirect changes of land use. This is not easy, however, as residual flows and marginal lands are not always profitable, and a steep rise in productivity is already necessary on its own to feed the growing world population. The United Nations' Food and Agriculture Organisation (FAO) recently calculated that food production would have to climb by 70% to feed the larger and richer global population in 2050 (FAO, 2009). Agriculture and land use are already major factors in the loss of biodiversity and greenhouse gas emissions. A rising demand for food, energy crops and other products increases the pressure even further. Minister Cramer recently argued for international agreements to mandate that not another acre of agricultural land should be created anywhere in the world (Volkskrant, 26 October 2009). That would be an enormous challenge. It would mean agricultural productivity continuing to increase faster to match the growing demand for food and simultaneously making land available for biomass without ILUC. Investment in agriculture is vital, so that synergy can arise from the production of food alongside that of bioenergy.

Three measures

The question of how to factor in ILUC effects has to be answered based on scientific understanding. But the trick is to adopt the right measures that will prevent ILUC and/or encourage innovation in the agricultural sector. Accordingly, CDB recommends a set of three related European measures:

1. Calculate an ILUC value for greenhouse gas emissions on the assumption that the use of 1 hectare of agricultural land for biofuel production entails the use of roughly an additional area of 1 hectare as agricultural land. This ILUC value should be the average of the greenhouse gas emissions of newly used land for each group of crops that is interchangeable in practice (see Appendix 3 for an explanation of the formula). This ILUC value should already be added to the set of standard values for crops as stipulated by the EU Directives, Renewable Energy Directive (RED) and Fuel Quality Directive (FQD). This method is transparent and justifiable. However, once a mathematical model enjoying scientific consensus has been developed for each type of fuel – by the Joint Research Centre (JRC) for example – it can replace the above crude method. As the ILUC value takes no account of local conditions that can reduce the ILUC in practice, it is necessary to have a supplementary policy that recognises local conditions. Accordingly:

2. Vary the application of the ILUC value proportionally in accordance with the following conditions:
   a. If regions or countries demonstrably invest in improving the efficiency of agricultural production and the resulting increase exceeds that of both business as usual and the rise in demand for food, the ILUC value can be reduced in proportion. The justification is that indirect effects only occur if the production of energy crops leads to increased land usage. As part of joint development alliances with developing countries, investments should be made in programmes that help exporting countries make their agriculture more efficient. When determining the reduction in the ILUC value, the potential for raising productivity in each country must also be taken into account.
   b. In case degraded or marginal land is put to use. Any bonus granted under EU directives must be taken into account. Criteria should be developed for this based on Appendix 1.
   c. Set off for coproducts. If part of the crop enters the food supply chain, rather than going to the electricity or fuel sector, the ILUC value can be reduced in proportion.

   The measures under a, b and c are political levers for improving agricultural efficiency. They can be applied through contracts with exporting countries, as well as through private certification systems. CDB wishes to point out that this naturally demands credible control and would be pleased to deal with the subject in a future recommendation.

3. Protect biodiversity. Measures described under 1 and 2 concern the calculation of greenhouse gas emissions and, to a lesser extent, the indirect impact on biodiversity. In the context of ILUC, biodiversity is still difficult to express as a formula or factor. Accordingly, the approach to the erosion of biodiversity demands a tight focus, as forests, nature reserves, and valuable grasslands have to be protected. But without a stable and adequate source of funding, this is a pointless recommendation. CDB wishes to ask the Minister to actively seek a source of funding and to advocate this at the European level. In this connection, CDB suggests considering implementation of a small levy on fuels.[1] Moreover, a stable and adequate source of funding for biodiversity and forestry programmes is a prerequisite for a global climate agreement.

---

[1] CDB wishes to draw attention to the fact that the use of biofuels is certainly not the only cause of biodiversity erosion, and stresses that the cultivation of energy crops can even result in improved biodiversity in some cases. It remains true that the impact on biodiversity is difficult to quantify, so that funding for the protection of biodiversity should be according to the polluter pays principle. The idea of introducing a levy on the use of fuels does not rule out that such a measure should also apply to other perpetrators of biodiversity reduction. Accordingly, some members of CDB consider it premature to talk about such a levy on fuels already.

CDB is convinced that this set of measures recognises the significance of indirect changes in land use, placing emphasis on greenhouse gas emissions and biodiversity. It is not impossible that indirect effects also impact the supply of food, favourably or unfavourably. In a future recommendation, CDB will discuss the relationship between biofuels and food supply in greater depth. The intention is also for that document to deal with the processes and criteria for revising the objectives for bioenergy and biotransport fuels in the event of increasing food shortages. CDB wishes to stress that the approach recommended here includes political levers and incentives for improving agricultural efficiency worldwide and for safeguarding biodiversity. By including the ILUC value in the greenhouse gas balance sheet, inefficient energy crops are ruled out and the maximum utilisation of residual flows and by-products is encouraged. This will cause productivity to rise and investments in efficiency to increase. Of vital importance is the synergy between the production of biomass, raising of incomes, rural development and investments in a more efficient agriculture. This way, agriculture can contribute to solving the climate change problem.

Background information

The EU's RED and FQD both set out sustainability criteria for the production of biofuels. They deal with the direct effects of the cultivation of energy crops. To be considered sustainable, energy crops must satisfy the criteria for direct reduction in greenhouse gases as well as biodiversity on the cultivation surface area, among other things. But there are indirect effects as well. The cultivation of energy crops commandeers existing agricultural land, which is needed to satisfy the rising demand for food. Hence, the additional demand for energy crops leads to an expansion of the global stock of agricultural acreage at the expense of virgin land, unless degraded or marginal areas not competing with current agriculture are used. The expansion concerned can be anywhere in the world, as the agricultural market is global and many crops are interchangeable. The soil and vegetation of many ecosystems store large amounts of carbon, which is released as CO_2 or methane if such ecosystems are used for cultivation. Approximately 20% to 25% of the current increase in greenhouse gases in the atmosphere is not the result of burning fossil fuels, but is attributable to the aforementioned changes in land use, as well as to agriculture and cattle farming (IPCC, 2007). The cause is not simply deforestation and the draining of peatlands, as grasslands and fallow land can also contain relatively large amounts of carbon (Fargione et al., 2008). The expansion of agricultural acreage therefore occurs beyond the control of growers of energy crops. In other words, the expansion effect is *indirect* and, hence, cannot always be removed by regulating energy crop cultivation at the micro level. Such an effect is referred to as ILUC. And given the large amount of carbon stored in many ecosystems, it can be substantial. One calculation shows that, if 22 hectare of palm oil cultivation require 1 hectare of forest to be cleared, there is no benefit to the climate (Fargione et al., 2008; Reijnders, 2008; Van der Voort et al., 2008).

Recent studies

ILUC appeared on the political agenda following the publication of a large number of scientific studies showing that ILUC is a fundamental problem arising from incentive policies for biofuels (Searchinger et al., 2008; Fargione et al., 2008; JRC, 2008; PBL, 2008; FAO, 2008; OECD, 2008; IIED, 2008; RFA, 2008; Tilman et al., 2009; SCOPE, 2009; WAB, 2009). For the record, these studies focus mainly on the first generation of biofuels and the range of results reported is extensive. Other studies, however, reveal that the processes underlying the changes are complex and that land use for additional biomass production can be offset by greater efficiency in agriculture and cattle farming (Smeets et al., 2008 and Hoogwijk et al., 2005/2009). Land use for the leading agricultural crops has been increasing very slowly for decades (according to figures from FAO, 5.5% in more than 20 years), whereas output has been rising steeply. For the future, FAO forecasts an expansion of 120 million hectare in developing countries (as against a reduction of 50 million hectare in developed countries). However, this does not fully take the effect of biofuels into account.

ILUC does not refer to greenhouse gases alone; it also concerns biodiversity. Throughout the world, deforestation is increasing and biodiversity decreasing. Biofuels represent just one of the many factors. Approximately two-thirds of changes in land use, expressed as loss of forestation, nature reserves and natural grassland, is related to subsistence farming and firewood gathering (FAO, 2005). Poverty and the need for food are both major drivers of deforestation. Strategies that address poverty and (rural) development are fundamental to preventing large-scale land conversion. On this point, the cultivation of perennial crops (grasses and trees) can be beneficial, as they store more carbon in the soil than annual agricultural crops do. Moreover, environmental performance improves and thanks to mixed types and planting (agroforestry systems), biodiversity benefits. This way, bioenergy crops can help to enhance biodiversity and reduce poverty.

In brief, the range of studies provides a broad picture of the issues. The question of whether biofuels will cause land use to grow or reduce over the next few decades is currently at the heart of the debate, as is the degree to which land not required for food production and of little value in terms of biodiversity will start to be used for energy crops. As such, the implications of ILUC are not limited to greenhouse gas emissions alone. They also extend to biodiversity, human rights and, for example, the availability of fresh water. Accordingly, the impact of ILUC on the sustainability of current biofuel policy depends largely on the use of agricultural land. By way of example, if the productivity of agricultural land increases faster than the demand for food crops, more space will become available for energy crops.

The European context

The EU's RED (2009/28/EC) and FQD promote the use of biofuels. The RED mandates that at least 10% of energy used for transport has to be renewable, with part of this target to be achieved through the addition of biofuels to the traditional fuel mix. The FQD obliges fuel suppliers to measure greenhouse gas emissions from well-to-wheel and then to reduce the amount by at least 6%. The ways to realise this include improvements at refineries and switching to electric cars as well as the use of biofuels. The RED and the FQD both specify that the European Commission is to issue a report by 31 December 2010 on indirect land use change due to the production of biomass for biofuels, "reviewing the impact of indirect land use change on greenhouse gas emissions and addressing ways to minimise that impact"[2]. When the Commission submits the report to the Council and the European Parliament, it can be accompanied by a legislative proposal for including the above-mentioned emissions. The Commission informally announced earlier its wish to bring the date of the report (and hence any legislative proposal as well) forward to March 2010. This allows the Member States to anticipate the results of the legislative process when drawing up their national action plans for energy from renewable sources. They have to submit these plans to the Commission by 30 June 2010. By way of preparation, a consultative round of talks is taking place in autumn 2009. At the preconsultative meeting, the Commission asked the Member States what they considered would be suitable policy options for tackling the problem of the indirect effects of land use change as effectively as possible. In its request, the Commission briefly mentioned eight such options (A to H). CDB was asked by the Minister to give its recommendation for the final position on ILUC.

Assessment criteria

In the opinion of CDB, the scientific studies show that ILUC has to be taken seriously. In principle, greenhouse gas emission from land use is a general effect attributable to every agricultural crop. However, the effects of ILUC must be specifically mentioned in the case of biofuels, as their production is an activity initiated, subsidised or otherwise encouraged by governments. The issue here is one of policy intent: the use of biofuels receives government encouragement in order to reduce the emission of greenhouse gases. If ILUC negates the benefit to the climate, the government policy in question is counterproductive.
CDB assesses the policy options stated by the European Commission against the following criteria:

1. Effectiveness: The effectiveness of a policy option in terms of the ultimate prevention of additional greenhouse gas emissions and other adverse effects, such as the loss of biodiversity through ILUC.
2. Feasibility: Is the option feasible, realistic and legally enforceable? Is the option also transparent?
3. Fast implementation: It is important that the option bears fruit in the short-term.
4. Science-based: Does the policy option have a (sufficient) scientific basis or is it a random choice?
5. Priority for food. To what extent does the policy option affect food supply?

---

[2] See Article 19, section 6, of the Directive.

The options from the European Commission

A. Extend to other commodities/countries (food for example) the restrictions on land use change that will be imposed on biofuels consumed in the European Union

Using land for biofuel purposes can lead to land use changes in respect of other crops. This option is based on the insight that as soon as the sustainability criteria for biofuels apply to all crops, the effect of ILUC is mitigated. Furthermore, even if no biomass for energy were produced, harmful changes in land use are already occurring. Although this problem should be tackled most certainly, it clearly offers no solution in the short term. It is unrealistic to propose that within about five years, a situation can be created in which almost all the world's agriculture satisfies sustainability criteria and is certified as such. It is of course extremely important to strive to this through global collaboration in the certification of major agricultural crops. So far, most of the loss of forestlands, nature and natural grassland has been attributable to current food production. As poverty is a leading catalyst for land conversion, rural development and fighting poverty must form the core of the strategy. The question is whether sustainable biomass production can play a positive role. CDB will address this in a future recommendation.

B. International agreements on protecting carbon-rich habitats

As stated above, a substantial part of the increase in greenhouse gases in the atmosphere is related to land use change. Accordingly, it is relevant to devote attention to this in the light of climate policy. International agreements on preventing deforestation and protecting valuable areas are enormously important. The question is how to fund the protection of forests, valuable grasslands and peatlands. In the framework of international negotiations on climate and biodiversity treaties, policy is being created with a focus on the protection of biodiversity (such as forests, wetlands, etc.). While this is laudable, as long as there is no stable and adequate source of funding, option B is not an effective solution. All the more so since ILUC effects can also arise outside the carbon-rich areas. Anyone advocating this option must first think about securing a stable source of funding.

C. Do nothing, on the assumption that the current wording of the Directive provides sufficient protection

The aim of the RED and the FQD is to reduce greenhouse gas emissions. If the ILUC emissions are not taken into account, it means the EU is deliberately ignoring the consequences of its own policy. This is indefensible, even more so because ILUC due to biofuel production has been proved to occur. The actual issue is to include ILUC as accurately as possible in the greenhouse gas balance sheet.

D. Increase the minimum required level of greenhouse gas savings

The Directive currently stipulates that the reduction in greenhouse gases must be at least 35%. The idea behind option D is that indirect greenhouse emissions can be prevented by raising this minimum. This is however illogical. One effect of this option is certainly that the most inefficient biofuels that just about satisfy the lower limit of 35% will most probably drop out of the picture. However, the actual reduction is overestimated, as the option does not consider ILUC, making the mandated well-to-wheel reduction reported under the FQD implausible.

E. Extending the use of bonuses in the calculation of greenhouse gas emissions

The present Directive specifies a bonus (29 gram CO_{2eq}/GJ) in the greenhouse gas balance sheet for biofuels produced using severely degraded and polluted land. The reasoning is that biofuel production in this case competes less or not at all with existing agriculture and therefore causes no

ILUC. The purpose of the bonus is to encourage the utilisation of such land. Ecofys, as well as UNEP and IIASA, are currently looking for a way to define these types of land.

In the opinion of CDB, the extension of such bonuses obscures the true level of greenhouse gas emissions. Instead of a bonus for utilising marginal land, there ought to be a penalty for utilising other types of land. The bonus itself is discretionary, unrelated to the actual benefit for the climate and only intended as an incentive. Furthermore, CDB wishes to point out that, to make marginal or degraded land more productive, the input of water and nutrients is necessary, as well as many other agrotechnical resources, which results in extra greenhouse gas emissions. Moreover, such land is often lacking other essential nutrients such as phosphate. (An example is the *cerrado* in Brazil, where considerable phosphate – that will eventually be exhausted – is applied.) In addition, there is still little understanding of the need for micronutrients. It is becoming increasingly clearer that a micronutrient deficiency is one reason why crop yields from old, weather-beaten land in Africa is low. At the same time, it is also clear that, given the right conditions, the added planting of perennial crops can over time result in soil recovery (for example, where the soil is salinated or has developed a seriously low organic carbon content), improve water retention, and restore the soil structure. Furthermore, the production and use of woody (lignocellulose) biomass can eventually be carried out with a virtual closed cycle of nutrients. An example is the recycling of ashes from conversion with phosphate and micronutrients, already adopted for forest management in Scandinavia and Austria. Of course, the experience in these countries provides no guarantee of success in other climate zones. For an extensive discussion of marginal land, see Appendix 2.

F. Additional sustainability requirements for biofuels from crops/areas whose production is liable to lead to a high level of damaging land use change

Just like option D, this option fails to appreciate the real nature of ILUC. ILUC is an effect occurring on the global market for agricultural crops, attributable to an increasing demand for crops for the production of biofuels. In general, it cannot be prevented locally or regionally by imposing supplementary sustainability requirements for biofuel production in specific areas. However, there are two conceivable variants:

1. Sustainability requirements that guarantee without exception that ILUC is not occurring and will not occur in the future. They could be supplementary criteria intended to prevent competition with existing agricultural land. Restricting use solely to marginal and degraded land, or to land that has lain fallow for a specified number of years could be possible criteria.
2. Option F is also acceptable if the additional requirements in question relate to the productivity and efficiency of agricultural activities. The use of additional acreage for food, animal feed or energy can be prevented by increasing the productivity of agricultural land. Guarantees will have to be in place that the rise in productivity of the land has sufficient momentum (more than business as usual and more than enough to keep pace with the growth in demand for food and feed) so that space becomes available allowing the use of biomass for other purposes than just producing food, while grasslands, natural areas and forests remain intact. After all, it is feared that the increase in productivity will lag behind the demand for biomass, resulting in grassland and forested areas being appropriated for cultivation. Accordingly, the criterion for option F to work is that enough progress is made nationally or regionally for existing agricultural land to be released and used for a purpose unrelated to food. The sustainability and efficiency of agriculture in the areas concerned should be guaranteed by bilateral agreements with producer countries or arrangements with certifying bodies.

G. Include an indirect land use change factor (ILUC factor) in the greenhouse gas balance sheet calculations

The purpose of introducing an ILUC factor is to include the actual greenhouse gas emissions attributable to indirect changes in land use in the calculations of the greenhouse gas balance sheet. Inclusion of this factor is currently the option most discussed, especially outside the EU. In the

United States, 2007 saw the enactment (but not the implementation) of legislation mandating ILUC as a component of the greenhouse gas balance sheet for biofuels. The Environmental Protection Agency (EPA) is currently determining the ILUC values for various commodities in the Renewable Fuel Standard (RFS) (EPA, 2009). In the spring of 2009, California adopted the Low Carbon Fuel Standard (LCFS), which includes an ILUC factor. Calculations show that the ILUC factor for bioethanol made from maize and sugarcane, two leading commodities, is substantial, with the result that this biofuel no longer satisfies the US standard of a 20% reduction or more in greenhouse gas emissions. Analyses made by Brazil, however, show that, thanks to the many investments and stable demand, the productivity of sugarcane has risen much faster in that country than in the rest of the world. In other words, it is too early to draw a conclusion on this point. Owing to the major interests at stake here, a dispute is now underway between the political supporters and opponents of an ILUC factor. The opponents claim that the scientific knowledge is insufficient to introduce an ILUC factor, and allege that too little is known about this phenomenon to incorporate it in legislation. CDB wishes to point out that this argument implies that the current biofuel incentive policy can (or does) have a negative effect on balance, but that the knowledge is lacking to quantify it. If the knowledge is indeed lacking, it is better to postpone incentives to use first generation biofuels until more is understood about ILUC – in accordance with the precautionary principle. However, this would also mean missing opportunities. CDB returns to this point in the next section. However, one thing is certain: the debate on whether there is sufficient scientific knowledge available can only be meaningfully conducted if the methodology for calculating the ILUC factor is made explicit and transparent. Only once a method has been devised, can it be determined whether suitable data exist.

There are various methods for calculating the ILUC factor, from the relatively crude to the relatively detailed (for an extensive discussion, see Appendix 2). CDB acknowledges that no single method can precisely calculate the ILUC factor for any crop. Currently, work is underway in trying to link complex economic models that include the drivers and forces behind actual changes (elasticity, food prices, trade flows, consumption patterns, etc.) to agro-economic and agro-ecologic models and datasets for land use and carbon stocks. This will enable modelling of the effect of a demand for biofuels on changes in land use and related greenhouse gas emissions, in an effort to study and understand the processes and relationships. The aspects requiring inclusion in an improved methodology are described in the WAB Biomass Assessment (Dornburg, 2008) for instance. Using these models makes it possible to assign an indirect greenhouse gas factor to each type of biofuel. The factors can then be applied to the aggregate greenhouse gas balance sheet for biofuels. This approach is being used in the USA and is currently under further development in the rest of the world, including by the JRC of the European Commission.

CDB is arguing for a methodology that is as transparent as possible and based on assumptions that fairly reflect reality. As long as no consensus exists on the ILUC methodology, CDB opts for assuming that, in principle, ILUC occurs for 100%, i.e. 1 hectare of agricultural land used for a bioenergy purpose results in the cultivation of 1 additional hectare somewhere else to produce food. This means that for each crop, a carbon stock equal to the average emission for the newly appropriated land (rainforest, grassland, savannah, etc.) has to be added to the total of emissions. It must be stressed that the 1-to-1 ratio is only a rough approximation to reality. The ratio for the indirect effect can be larger or smaller depending on the type of land. Appendix 3 presents this methodology in more detail.

In the opinion of CDB, a two-stage approach is possible. During the initial stage, the ILUC value from a crude formula is included in the greenhouse gas balance sheet for biofuels. The ILUC value can be adjusted every three years in the light of greater scientific understanding and/or changes in the actual emission of greenhouse gases. During a later stage – when the (JRC) models have gained enough scientific consensus – specific ILUC values can be included.

H. Other policy elements: only residual flows and degraded land

Under "Other policy elements", CDB wishes to draw attention to an option not mentioned by the European Commission: the exclusion of crops that, based on current understanding and calculations, entail a substantial ILUC effect. It should be possible to exclude today's biofuels produced from vegetable oils and sugars from the RED and the FQD. By removing the incentives for these biofuels, the focus will be entirely on the development of (advanced) biofuels produced from (lignocellulose) residual flows, allowing a more rapid introduction and upscaling of these fuels. Moreover, it is conceivable that this approach is more or less equivalent to the inclusion of the ILUC factor, as described under option G, something indicated by the initial US calculations. The US state of Massachusetts recently decided to promote only biofuels made from residual flows. CDB wishes to state that selecting this option will not be easy within the EU. There are some possible variants of this option:

1. Permit only biofuels produced from residual flows from sustainable forest and landscape management, agriculture and industry that are of no further practical use. Possibly also allow the cultivation of perennial crops as part of sustainable landscape management. This will prevent residual flows that are currently of practical value, such as cattle feed or manure, from being used to produce biofuels, thus placing the energy-related uses for biomass at the end of the application cascade. Excluding other flows prevents the use of land for biofuel purposes.
2. Permit only biofuels produced from residual flows (that are of no other practical use) as well as energy crops grown on degraded or marginal land.

In the opinion of CDB, the second variant could be a radical way to tackle the ILUC issue. It should allow governments to create policies or programmes that help developing countries make degraded and marginal land productive or restore such land to a productive state. CDB is convinced that this approach would be a powerful motivation for the development of second-generation biofuels. At the same time, CDB is aware that this option is not easy to implement politically, because it by far excludes most existing biofuels. That is undesirable, as opportunities would also be lost.

Considerations

At the preconsultative meeting in July 2009, the Minister of Housing, Spatial Planning and the Environment presented a provisional Dutch position, expressing a preference for the combination of options G, E, A and B, in order of urgency. CDB agrees with the Minister's preference for the introduction of an ILUC factor. This option satisfies all the criteria that CDB proposes. Deviating from the provisional Dutch position, CDB sees no value in granting additional bonuses (option E). On the contrary, to deal effectively with actual greenhouse gas emissions from indirect land use change, penalties should be imposed. In CDB's view, option A is highly desirable, but cannot be implemented in the short-term. That is possible for option B, provided there is funding. This will not prevent ILUC in all situations, however. Subject to certain conditions and combined with the introduction of an ILUC factor, option F is acceptable in CDB's view. CDB wishes to add a type H option that basically recognises the significance of ILUC, but that would be problematic in a real political setting. In the opinion of CDB, though, it is a good fallback option if the introduction of an ILUC factor proves impossible. The table below summarises the findings of CDB.

Option	Effective ness	Feasibility	Science -based	Fast implementation	Priority for food
A. Certification of all agricultural crops	++	--	+	--	- ?
B. Use of a levy to safeguard carbon stocks	+	+	+	+	-
C. Do nothing	--	++	--	++	

D. Increase the minimum required greenhouse gas reduction	+/-	++	--	++	+
E. Extend the use of bonuses	--	-	--	-	--
F. Additional criteria for certain product/region combinations	-/+	+	+ Provided the criteria apply to productivity	-/+	++
G. ILUC factor	++	+	+	+	+
H. Exclusion of certain energy crops	++	+	+	-	+

Conclusion: make agriculture part of the solution!

CDB is convinced that indirect land use change effects are real and must therefore figure in biofuel and bioenergy policy. Doing nothing is clearly not an option, as the unintended indirect consequences (threats) of incentives for energy crops are too serious. Doing nothing turns agriculture into a constantly increasing global problem. On the other side, the opposite approach, which excludes the use of biofuels, would deprive many countries and many producers of the opportunity to escape poverty and increase agricultural efficiency. Accordingly, CDB recommends a set of three related measures that recognise the significance of ILUC and, at the same time, offer incentives to make agriculture sustainable and more efficient:

1. Calculate an ILUC value for each group of crops on the assumption that the use of 1 hectare of agricultural land for biofuel production entails the use of 1 additional hectare of agricultural land. The ILUC value is the average emission due to the new appropriation of land (see Appendix 3 for an explanation of the calculation method). When the RED and the FQD come into force, add the ILUC value to the standard values for each crop as stipulated by the Directives. This method is transparent and justifiable, but not particularly refined. Once a formula and model are known that enjoy scientific consensus (the JRC model for example), they can replace this crude method of calculation. An ILUC value derived by the above crude method takes no account of local conditions that can reduce the ILUC in practice. Therefore it is necessary to have supplementary policy that recognises local conditions. Hence:

2. Vary the application of the ILUC value proportionally in accordance with the following conditions:
   a. If regions or countries demonstrably invest in improving the efficiency of agricultural production and the resulting increase exceeds both that of business as usual and the rise in demand for food, the constant can be reduced in proportion. The justification is that indirect effects only occur if the production of energy crops leads to increased land usage. The improvements in efficiency have to be in addition to autonomous development and be measurable. As part of joint development alliances with developing countries, invest in programmes that help exporting countries make their agriculture more efficient. When determining the reduction, each country's potential for raising productivity must also be taken into account.

b. If degraded or marginal land is put to use, the ILUC value can be adjusted proportionally. Criteria should be developed for this based on Appendix 1. When adjusting the ILUC value, any bonuses granted under the RED have to be taken into account.
c. Set off for coproducts. If part of the crop does not go to the electricity or fuel sector, but enters the food or animal feed supply chain, the ILUC constant can be reduced in proportion.

3. The measures described under 1 and 2 concern greenhouse gas emissions, not the indirect effects on biodiversity. These are difficult to express as a formula or factor, even though it can generally be said that they are related: the greater the loss of biodiversity, the greater the emission of greenhouse gases. The impact on biodiversity can be adverse, but it can also be beneficial. The cultivation of perennial crops (grasses and trees) is extremely important, as they can store more carbon in the soil than annual agricultural crops can. Moreover, environmental performance improves and thanks to mixed types and planting (agroforestry systems), biodiversity benefits. Strategies that address poverty and (rural) development are fundamental to preventing large-scale land conversion. In the context of ILUC, biodiversity is still difficult to express as a formula or factor. Accordingly, CDB is asking for a tightly focused approach to safeguard biodiversity, which will require a stable and adequate source of funding. CDB wishes to ask the Minister to actively seek a source of funding and to advocate this at the European level. In this connection, CDB suggests considering implementation of a small levy on fuels. Calculation of the levy could then be based on the (European) consumption of fuel and a proportion of the costs for preserving biodiversity. It could then be expressed as a number of cents per litre of fuel. Allocation of the revenue from the levy could be arranged via international organisations and, if possible, incorporated in the funding arrangements being developed in the framework of the global climate negotiations. Moreover, clarity regarding an adequate source of funding would be beneficial to the negotiations in Copenhagen. Proper communications to consumers and transparency about the allocation are essential, though. These communications would have to stress that the levy is an expression of the polluter pays principle and a matter of common global responsibility: If we want protection for the environment, then we have to pay for it. CDB wishes to state that, apart from a levy, other sources of funding are conceivable.

CDB is convinced that this set of measures recognises the significance of indirect changes in land use, placing emphasis on greenhouse gas emissions and biodiversity. It is not impossible that indirect effects also impact the supply of food, favourably or unfavourably. In a future recommendation, CDB will discuss the relationship between biofuels and food supply in greater depth. The intention is also for that document to deal with the processes and criteria for revising the objectives for bioenergy and biotransport fuels in the event of increasing food shortages. CDB wishes to stress that the approach recommended here includes political levers and incentives for improving agricultural efficiency worldwide and for safeguarding biodiversity. In passing, CDB wishes to state that a proposal for a stable and adequate source of funding to safeguard biodiversity can be an important political signal en route to a global agreement in Copenhagen.

By including the ILUC value in the greenhouse gas balance sheet, inefficient energy crops are ruled out and the maximum utilisation of residual flows in agriculture is encouraged. This will cause productivity to rise and investments in efficiency to increase. Of vital importance is the synergy between the production of biomass, raising of incomes, rural development, and investments in a more efficient agriculture. This way, agriculture can contribute to solving the climate change problem.

Final remarks

CDB realises that more knowledge needs to be generated. In this context, it sees two activities:

1. Defining the extent of the indirect effects is complex. However, with existing and newly generated methods, these effects can be determined with ever-greater precision and

distinguished by crop where necessary. Various groups are currently developing such a methodology. It is vitally important, however, that they take basic ecological principles applying to crops and soil into account, principles that are not included enough in large, complex analyses. Accordingly, it is necessary to allow for the storage and loss of carbon by soil, because soil holds over one third of the carbon stock in the geosphere and the atmosphere. As part of this, the influence of other factors such as water and nutrients in relation to biomass production will also have to be analysed. Considerable hope is invested, for example, in the utilisation of marginal and degraded land. To obtain a reliable estimate of the potential for utilising such land, or even improving its quality, a sound approach based on both production and ecology is necessary. The ratio of acreage for crops (factor A in the formula for indirect effects) can consequently be determined likewise. CDB therefore suggest that these specific aspects of ILUC be further developed in collaboration with internationally recognised institutes for the purpose of arriving at broadly supported proposals.

2. Knowledge about energy crops ought to be better assembled globally. For each crop, knowledge of land use change (direct as well as indirect), efficiency, socio-economic aspects, and local and regional details should be combined. Such peer-reviewed knowledge can help policy makers and politicians adopt policies that recognise the implications of encouraging the cultivation of energy crops. CDB recommends prioritising the support to be given to these and other projects.

Appendices

Appendix 1: Marginal and degraded land

The use of marginal land for producing biofuels is currently a hot topic. It seems a highly promising approach as this land is assumed not to be in competition with existing agricultural land. There are many aspects to this picture, however:

- Marginal land, as well as degraded land, that is suitable for growing energy crops is hard to define, and thus hard to conceptualise for a policy. For example, a tropical peat forest that is partially dehydrated could be classified as degraded, whereas it still has a large carbon stock. Other degraded areas would be ideal for storing additional carbon if the land were resown, as demonstrated for marginal grassland in Indonesia (Wicke et al., 2009).
- Marginal land produces a marginal yield (Bindraban et al., 2009). So a farmer who wishes to make a profit will not grow a crop on marginal land of his own accord. Naturally, this partly depends on the crop concerned. "Marginal" for food crops does not also by definition mean "marginal" for trees or grass. Jatropha could be an example, albeit that the benefits as well as the prerequisites for its growth are still unproven for the long term.
- Water shortage is usually a major problem in marginal land areas. The use of scarce fresh water to irrigate energy crops for export should be avoided (SCOPE, 2008). This aside, the revegetation of marginal and degraded land can also benefit water management, such as in the form of improved water retention, reduced soil dehydration, and lower salt content of the topsoil.
- Marginal land certainly fulfils an economic function for the local population, often as grazing land for cattle. In this situation, displacement occurs because the herdsmen will have to find other grazing areas (IIED, 2008).
- The socio-economic position of the inhabitants of these areas is often weak. They are poorer on average, are exposed to major risks, and live in an economy that is often more informal than in areas that are more productive. Ownership of land is usually not formally regulated, but based on tradition instead. One benefit of energy crops is boosting the prosperity of these areas. What has to be prevented is large plantations displacing people from land they completely depend on for their existence. The RED currently includes no hard criteria for socio-economic aspects (IIED, 2008). Such criteria will have to be developed. Strategies based on smallholder models should be successful in this respect.
- Marginal land is not by definition marginal in relation to biodiversity. The quality of available data has been a problem so far: some situations involve fragile ecosystems with a large variety of species, where a monoculture would mean genuine losses; in others, revegetation could be beneficial in terms of biodiversity.
- The question is whether the large-scale import of biofuels whose production involves the use of marginal land is realistic, considering the higher costs.
- Agriculture on marginal land contradicts every form of economic logic. Yet, and precisely because of this, it offers opportunities. Specifically, indirect effects can also turn out to be beneficial. As an example, growing the right energy crops at the right location can help increase local soil fertility. In the long-term, this can also benefit local food production. Small-scale cultivation of bioenergy crops can thus play a role in the improvement of biodiversity and the reduction of poverty.

Appendix 2: List of models for ILUC

1. Öko-Institut's Risk Adder method[3]

Principle: There is no difference between direct land use change (LUC) and ILUC. The issue is to determine **where** ILUC occurs.
Assumption: Net ILUC only occurs in countries that export biofuels. For these countries, the representative direct LUC is determined:

Commodities	Ecosystem	Region	LUC (ton. CO_2/ha.)
Rapeseed/grain	Grassland	EU	254
Maize	Grassland	US	254
Sugar cane	Savannah	Brazil	491
Palm oil	Tropical rainforest	Indonesia	972

A risk factor is then designated for the ratio of ILUC to LUC: For example, setting the risk factor at 100% assumes that 1 hectare of land for producing palm oil entails the deforestation of 1 hectare of land elsewhere. The Risk Adder uses three values: Minimum (25%), Average (50%) and Maximum (75%).

Conclusion: The approach is very crude mathematically. Allocation of the risk is arbitrary. In fact, this is not a model, but a form of risk estimation.

2. Joint Research Centre (JRC)

JRC is developing an ILUC factor entailing the following steps:

1. JRC is evaluating various models and datasets under development and in use throughout the world. By comparing the results, it obtains an understanding of the associated uncertainties. The evaluation applies to the following elements:

- **Agro-economic models** that provide information on *how much* production-expansion occurs due to the increasing demand for biofuels, allowing for coproducts. These static models take into account the current competition for agricultural land, but not the future increase in demand for food. Although they are not time-based models, some can indicate in which countries the expansion will probably occur. These models make calculations for a large number of different regions.
- The calculations are fed into **agro-ecological models** that can determine at grid level *the reason* the expansion is occurring and *how much greenhouse gas is emitted* as a result.
- As each of these models is only as accurate as its underlying **dataset**, several datasets are compared with each other: satellite data (GIS), soil organic carbon data, global land cover data, protected areas data, agro-ecological zoning data, etc. The datasets in question are superimposed to identify likely areas of agricultural land expansion.

JRC acknowledges that this methodology is broadly the same as the one used by the EPA in the United States (see below). Models used in the United States are included in JRC's evaluation. Generally speaking, the above modelling work is said to be the way forward globally, at least in broad scientific terms: Scientists in this field agree that this is the best way to approach the problem. Now it is important to put effort into improving the data, as well as into further refinement and better integration of the models.

[3] Öko-Institut, *Greenhouse Gas Balances for Biomass: Issues for further discussion*, 2008, http://www.oeko.de/service/bio/dateien/en/ghg_balance_bioenergy.pdf

2. JRC is also conducting a survey among the leading research groups engaged in ILUC modelling, with the aim of gaining a better feel for the remaining uncertainties. The results of this survey will be sent to CDB before October 2009.

3. Finally, JRC is itself developing ILUC factors based on existing models and data. These results will be presented at the end of 2009.

JRC's response to the question of when the modelling will be good enough for legislation, is that models will always be an approximation to reality, but that using an approximation is always better than ignoring ILUC. In other words, it is never possible to specify a time when the ILUC factors will be good enough. That choice is up to politicians.

Conclusion: As the project is only just underway, few details can be given at this point. The approach certainly appears thorough. By comparing various models, more understanding can be gained of the associated uncertainties. The use of the above models and methods is the way forward in scientific terms. Internationally, considerable effort is going into improving the models and the data. At the end of 2009, JRC will present its initial ILUC factors. These will be subject to a continuous process of improvement. Hence, it is not possible to specify any one time when the ILUC factors will be good enough.

3. Renewable Fuel Standard

The United States is the leader in this area and is using a two-stage assault[4]:

1. ILUC is incorporated in US legislation via the Energy Independency and Security Act (EISA), passed in 2007. It stipulates that the life-cycle greenhouse gas emissions of all fuels must be included when assessing the reduction in these gases. These life-cycle greenhouse gas emissions expressly include indirect emissions due to land use change.
2. Only now that the principle of ILUC is embedded in legislation as an element for the assessment of greenhouse gas reduction are values being calculated for ILUC. These will subsequently be included in the revised Renewable Fuel Standard (RFS), the programme aimed at reducing the greenhouse gases from transport fuels.

The advantage of this strategy is that EISA serves as a goad to ensure the ILUC factors will definitely be in place, independently of the actual values determined by scientists. This is in line with JRC's conclusion that the incorporation of an ILUC factor for calculating greenhouse gas emissions is mainly a political decision independent of scientific efforts.

The spring of 2009 saw the publication of the initial ILUC factors to be used in the US for feedstocks. From 2010 onwards, these factors will be the responsibility of a new body, the Renewable Fuels Agency (RFA). The modelling was carried out by the EPA, and the ILUC factors it calculated are substantial.

A striking aspect of the process is the importance of transparency for the institutionalising of ILUC factors. All information on the methodology used, assumptions made and peer reviews are available on the Internet in detail. There are also public meetings where stakeholders can voice their comments. One striking conclusion is that criticism of the ILUC factors never concerns the underlying principle, but rather the lack of detail: the data and models are regarded as too crude, resulting in ILUC factors that are considered to be too approximate.

[4] http://www.epa.gov/otaq/renewablefuels/420f09023.htm

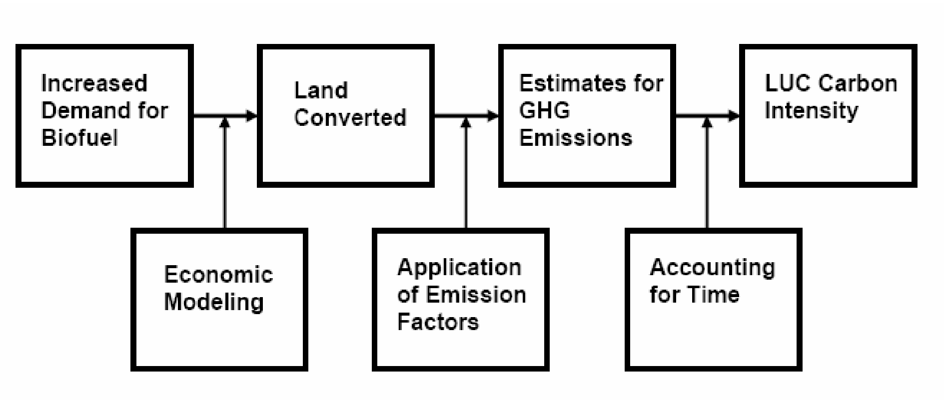

Figure 1: Block diagram of the model that the California Air Resources Board (CARB) employs for calculating the indirect greenhouse gas emissions of biofuels (CEPA, 2009). A specific demand for biofuels is used as input for an agro-economic model. The model incorporates a reference scenario for the autonomous growth of the agricultural sector assuming zero demand for biofuels. It then calculates the effect that increasing demand for commodities used in the production of biofuels has on the global agro-economy, and determines the location of the corresponding acreage expansion. Locations of expansion have greenhouse gas factors assigned to them, the size of the factor depending on the location's region. The greenhouse gas emissions are then spread over a payback period specified for the energy crop concerned. In the RED, this period is set at 20 years (in Annex V of the Directive).

Conclusion

By definition, an ILUC factor approximates reality. It is impossible to determine the indirect greenhouse gas emission for each litre of biofuel. Generalisation of the problem is unavoidable, and is the approach for determining the direct greenhouse gas reduction for biofuels (the default values in the RED). As such, provided the right methodology is employed, it is more valid scientifically to use an ILUC factor than not to include one in the greenhouse gas balance sheet (i.e. an ILUC factor of zero).

Appendix 3: CDB's proposed methodology for determining ILUC values

CDB recommends that indirect changes in land use due to the demand for biofuels should also be included when determining the greenhouse gas emissions from the use of biofuels. This will enable the application of a consistent, transparent methodology that matches the European Commission's current approach for calculating greenhouse gas emissions resulting from *direct* changes in land use relating to the cultivation of biofuel crops. This methodology is set out in section C of Annex V of the RED[5]. CDB proposes this methodology be adjusted as set out below:

1. An ILUC emission is inserted in formula 1 of Annex V, section C.

$$E = e_{ec} + e_l + \mathbf{e_{ILUC}} + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$$

Where:

E = Total emissions attributable to the use of the biofuel (CO_2-equivalent/MJ energy content of the biofuel, in grams)

e_{ec} = Emissions attributable to cultivation

e_l = Annualised emissions attributable to carbon stock changes caused by *direct* land use change

e_{ILUC} = Annualised emissions attributable to carbon stock changes caused by *indirect* land use change

e_p = Emissions attributable to processing

e_{td} = Emissions attributable to transport and distribution

e_u = Emissions attributable to the fuel used

e_{sca} = Emission saving attributable to soil carbon accumulation via improved agricultural management

e_{ccs} = Emission saving attributable to carbon capture and geological storage

e_{ccr} = Emission saving attributable to carbon capture and replacement

e_{ee} = Emission saving attributable to excess electricity from cogeneration

2. The calculation of the ILUC emission, e_{ILUC}, is similar to the calculation of the direct emission due to change in land use, e_l, detailed in Annex V, section C, subsection 7:

$$e_{ILUC} = (CS_{ILUC} - CS_A) * 3.664 * 1/20 * (1/P_B) * (1- P_{CO}/P_T) * A$$

Where:

CS_{ILUC} = The average carbon stock of additional land that is globally appropriated for use as agricultural land (in kilograms of carbon per hectare, including soil as well as vegetation)

CS_A = The carbon stock corresponding to the actual use of land where the energy crop is cultivated (in kilograms of carbon per hectare, including soil as well as vegetation)

3.664 = Factor for converting carbon (C) into carbon dioxide (CO_2) units

1/20 = In the Directive, the emissions are discounted over a period of 20 years[1]

P_B = The biofuel productivity of the energy crop (in MJ per hectare per annum)

P_{CO} = The coproductivity of the energy crop (in MJ per hectare per annum)[6]

P_T = $P_B + P_{CO}$

A = Degree of indirect expansion of agricultural acreage attributable to the production of biofuel (ha./ha.)

[5] Renewable Energy Directive:
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:NL:PDF

[6] This only concerns coproducts that can replace other products for which land is needed to produce them (e.g. protein-rich scrap etc., but not straw or glycerine).

3. The degree of indirect change in land use (A) is initially set at 100%, on the assumption that each hectare used for energy crop cultivation eventually results in the creation of one additional hectare of agricultural acreage somewhere else, at the cost of forestland and/or natural grassland. This is based on the projection that, in the next few decades, more agricultural land will be needed to satisfy the increasing demand for food. The *additional* demand on a global market for agricultural crops used in the production of biofuels, the crops being interchangeable on this market, will lead to a directly proportional increase in the agricultural acreage required.

   An average value is taken, by assuming that the degree of the indirect effect is 100%. The indirect expansion of agricultural acreage can be over 100% if the biofuel crops on the market are replaced by crops of lower productivity, and vice versa. Accordingly, factor A is initially set at 1 in formula 2.

   To obtain more insight into the operation of factor A, more research is necessary. By analysing land use data relating to food production and biofuels, as well as the loss of woodlands and other ecosystems, it is possible to determine, at the global level, the extent to which the production of biofuels results in the additional expansion of agricultural acreage at the expense of forestland and/or grassland in a ratio of 1 to 1. When the above-mentioned data become available, they can be used to adjust factor A sometime later.

Carbon stock of land indirectly appropriated (CSILUC)

Eventually, the demand in Europe for biofuels because of the RED will lead to the global agro-economy demanding more agricultural land. The resulting indirect expansion of agricultural acreage can occur anywhere and is not always directly related to specific biofuel-region combinations. Ultimately, this concerns a global market for agricultural crops on which different crops are interchangeable. Farmers can switch to growing energy crops, for example, if these are more profitable than the crops they currently grow. Accordingly, the production of the crops grown currently declines, resulting in them becoming scarcer and commanding a higher price. The response to this is an increase in production somewhere else, which can actually be anywhere. In this situation, therefore, the ILUC cannot be allocated to a particular region.

For the above reason, it is imperative to use a globally weighted average of the carbon released due to the expansion of agricultural acreage. In economic terms, this is the marginal volume of carbon released as a result of the current global expansion of agricultural acreage.

The table below provides a list of the carbon stocks in a number of ecosystems.

Table 1. Carbon stock in various ecosystems.

Original ecosystem	Region	Carbon stock (ton. C/ha.)	Reference
FOREST			
Lowland tropical rainforest SE Asia	SE Asia	204 – 312	Fargione et al., 2008
Peat land tropical rainforest SE Asia	SE Asia	942	Fargione et al., 2008
Tropical moist forest of SE Asia	SE Asia	313	Searchinger et al., 2008
Amazon rainforest	Brazil	205	Fargione et al., 2008
Brazilian Amazon deforestation	Brazil	150 – 350	Cunha da Costa R., 2004
Tropical forest	Worldwide	151 – 225	IPCC in Searchinger et al., 2008
Temperate forest	Worldwide	81 – 171	IPCC in Searchinger et al., 2008
Lightly forested area		181	European Commission, 2008
GRASSLANDS and WETLANDS			
Wetlands	Worldwide	204	IPCC in Searchinger et al., 2008
Permanent grassland		181	European Commission, 2008
Tropical grassland and savannah	Worldwide	52 – 58	IPCC in Searchinger et al., 2008
Temperate grassland	Worldwide	38 – 66	IPCC in Searchinger et al., 2008
Cerrado	Brazil	70	Cunha da Costa R., 2004
Woody *cerrado* and *cerradão*	Brazil	83	Fargione et al., 2008
Grassy *cerrado*	Brazil	48	Fargione et al., 2008
US central grasslands	USA	37	Fargione et al., 2008
US abandoned croplands	USA	19	Fargione et al., 2008

In determining a single weighted average for all crops, a problem arises concerning the production of palm oil in Southeast Asia. A tropical peat forest has an enormous carbon stock compared with other ecosystems. This type of peat forest is found mainly in Southeast Asia. Owing to large-scale deforestation in Indonesia, this country is the fourth largest emitter of greenhouse gases in the world. Approximately 85% of the world's palm oil originates from Southeast Asia. Moreover, deforestation and the production of palm oil are tightly interwoven. For this reason, it makes sense to use a separate CS_{ILUC} value for palm oil, such as the average of the values for tropical lowlands and tropical peat forests, which comes to 600 ton. C/ha.

For other crops, the initial value could be a weighted average for tropical/temperate grasslands and tropical/temperate forests ("Worldwide", see Table 1), excluding peat forests. Based on the above table, CDB recommends using 105 ton. C/ha. as the initial value of CS_{ILUC} for all crops other than palm oil.

References

FAO (Food and Agriculture Organisation of the United Nations), *How to feed the world in 2050?,* October 2009

IPCC (Intergovernmental Panel on Climate Change), *Fourth Assessment Report: Climate Change 2007*

IPCC (Intergovernmental Panel on Climate Change), *Good Practice Guidance for Land Use, Land Use Change and Forestry,* 2003

Reijnders L., "Transport biofuels – A lifecycle assessment approach"*, CAB Reviews: Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources*, 2008; Vol. 3, No. 071

Van der Voort M.P.J., R.D. Timmer, W. van Geel, W. Runia, W.J. Corré, *Economie van energiegewassen,* Praktijkonderzoek Plant & Omgeving B.V., 2008

Smeets E.M.W., A.P.C. Faaij, I.M. Lewandowski, W.C. Turkenburg, "A quickscan of global bio-energy potentials to 2050", *Progress in Energy and Combustion Science*, Vol. 33, Issue 1, February 2007, pp. 56-106

Hoogwijk M., A. Faaij, B. Eickhout, B. de Vries, W. Turkenburg, "Potential of biomass energy out to 2100, for four IPCC SRES land-use scenarios"*, Biomass & Bioenergy*, Vol. 29, Issue 4, October 2005, pp. 225-57

Hoogwijk M., A. Faaij, B. de Vries, W. Turkenburg, "Exploration of regional and global cost–supply curves of biomass energy from short-rotation crops at abandoned cropland and rest land under four IPCC SRES land-use scenarios", *Biomass & Bioenergy*, Vol. 33, Issue 1, January 2009, pp. 26-43

Fargione J., J. Hill, D. Tilman, S. Polasky, P. Hawthorne, "Land clearing and the biofuel carbon debt", *Science*, Vol. 319, 2008

Tilman D., R. Socolow, J.A. Foley, J. Hill, E. Larson, L. Lynd, S. Pacala, J. Reilly, T. Searchinger, C. Somerville , R. Williams, "Beneficial biofuels – The food, energy and environment trilemma", *Science*, Vol. 325, 2009

EPA (Environmental Protection Agency), *Emissions from land use change due to increased biofuel production; Satellite imagery and emissions factor analysis,* ICF International, 200

Wicke B., V. Dornburg, A. Faaij, M. Junginger, "Different palm oil production systems for energy purposes and their greenhouse gas implications", *Biomass and Bioenergy*, Vol. 32, Issue 12, December 2008, pp. 1322-37

SCOPE, *Biofuels: Environmental consequences and interactions with changing land use, Proceedings of the Scientific Committee on Problems of the Environment (SCOPE) International Biofuels Project Rapid Assessment*, 22-25 September 2008, Gummersbach, Germany, editors: R.W. Howarth and S. Bringezu, 2009

IIED (International Institute for Environment and Development), FAO (Food and Agriculture Organisation of the United Nations), *Fuelling exclusion? The biofuels boom and poor people's access to land,* 2008

CEPA (Californian Environmental Protection Agency), Air Resources Board, *Proposed regulation to implement the Low Carbon Fuel Standard (LCFS)*, 2009

Bindraban P, E. Bulte, S. Conijn, B. Eickhout, M. Hoogwijk, M. Londo, *Scientific assessment and policy analysis: Can biofuels be sustainable by 2020? An assessment for an obligatory blending target of 10% in the Netherlands* (WAB 24), 2009

JRC (Joint Research Centre of the European Commission), *Biofuels in the European context: Facts and uncertainties,* 2008

Searchinger T., "Use of U.S. croplands for biofuels increases greenhouse gasses through emissions from land use change", *Science*, Vol. 319, 2008

FAO (Food and Agriculture Organisation of the United Nations), *The state of food and agriculture 2008; Biofuels; prospects, risks and opportunities*, 2008

FAO (Food and Agriculture Organisation of the United Nations), *Global Forest Resources Assessment*, 2005

MNP (Milieu- en Natuur Planbureau), *Local and global consequences of the EU renewable directive for biofuels*, 2008

OECD (Organisation for Economic Co-operation and Development), Directorate for Trade and Agriculture, *Economic Assessment of Biofuel Support Policies*, 2008

RFA (Renewable Fuels Agency), *The Gallagher Review of the indirect effects of biofuels production,* 2008

Dornburg V., A. Faaij, H. Langeveld, G. van de Ven, F. Wester, H. van Keulen, K. van Diepen, J. Ros, D. van Vuuren, G.J. van den Born, M. van Oorschot, F. Smout, H. Aiking, M. Londo, H. Mozaffarian, K. Smekens, M. Meeusen, M. Banse, E. Lysen, S. van Egmond, *Biomass Assessment: Assessment of global biomass potentials and their links to food, water, biodiversity, energy demand and economy – Main Report*, Study performed by Copernicus Institute – Utrecht University, MNP, LEI, WUR-PPS, ECN, IVM and the Utrecht Centre for Energy Research, within the framework of the Netherlands Research Programme on Scientific Assessment and Policy Analysis for Climate Change. Report no. WAB 500102012, January 2008, p. 85 and appendices.