European Commission Indirect Land Use Change (ILUC) public consultation

BP Submission

BP welcomes the opportunity to comment on the questions presented to stakeholders on the results of the recent Indirect Land Use Change (ILUC) modelling analysis. We recognise the complexity of the issue and commend the European Commission fo r their efforts in undertaking analysis to understand the subject matter better. Our responses to the questions are included in the following pages but we would like to support this input with some overarching observations:

- BP recognizes the need to improve our understanding of the potential role biofuels can play in decarbonising transport fuels and specifically the land use change impacts of increased biofuel production. We have undertaken extensive analysis to identify the most effective routes to decarbonise transport fuels and believe that biofuels used in more efficient vehicles will be one of the key approach in the coming decades (1).

- It is paramount that some degree of closu re can be agreed on the ILUC issue to provide assurances for investment to flow to sustainable biofuel projects. Fuel providers in Europe also require a clear signal on how ILUC will be addressed to allow them to plan for compliance for both the Renewable Energy Directive (RED) and Fuels Quality Directive (FQD).

- It should also be recognised that an ILUC factor would increase the need for more biofuel to meet the carbon target in the FQD. Fuel suppliers need clarity on their biofuel blending requirements so they can invest in the necessary infrastructure. Some member states are faced with substantial fines for lack of compliance and need clarity now to avoid non -compliance.

- The modelling work carried out does not yet provide a consistent or robust set of r esults in terms of quantifying the impacts of biofuels on land use, as evidenced by the wide ranges of results emerging from the different mode ls. Several factors are contributing to this lack of consistency, including: the inability of the models to incl ude many factors which are impacting land use and land use change, combined with inconsistencies in underlying assumptions and uncertainty of input data (2). This uncertainty needs to be recognized when deciding the appropriate policy response.

- <u>Energy policy is not the appropriate tool to address primarily an agricultural/land use management issue</u>. Any policy approach should be <u>effective</u> at addressing emissions from land use change and encourage action both inside and outside of the biofuel sector. We be lieve the most effective measures for the biofuel sector would be to focus on yield improvement and more effective land optimization to grow biofuel feedstocks (4). Outside the biofuel sector efforts should encourage better land use management/planning and strengthen protection of forests and other sensitive ecosystems. It is important to recognize that since biofuels currently use less than 2 – 3% of global cropland, we must be careful not to allow the current debate about biofuels and its potential ILUC impacts to distract us from broader land use change concerns. The impacts of timber harvesting on forests; the growing beef industry as a result of changing dietary patterns, poor subsistence farming practices in the developing wor ld all need to be addressed if land use change emissions are to be effectively tackled (5).

- To a large extent, indirect emission impacts are already accounted for due to the conservative approach taken on direct emissions. The Renewable Energy Directive (RED) biofuel feedstock emission defaults are set at conservative rather than typical levels. Additionally, GHG hurdles are set to provide assurance that most biofuels provide real emissions savings versus fossil fuels.
- There appears to be no historical/empirical evidence that illustrates a direct link between expansion of biofuels and deforestation – one of the principle drivers of land use emissions . For example research from Brazil illustrates that biofuels production in Brazil and the US expanded rapidly at a time where rat es of deforestation decreased – See Figure 1:

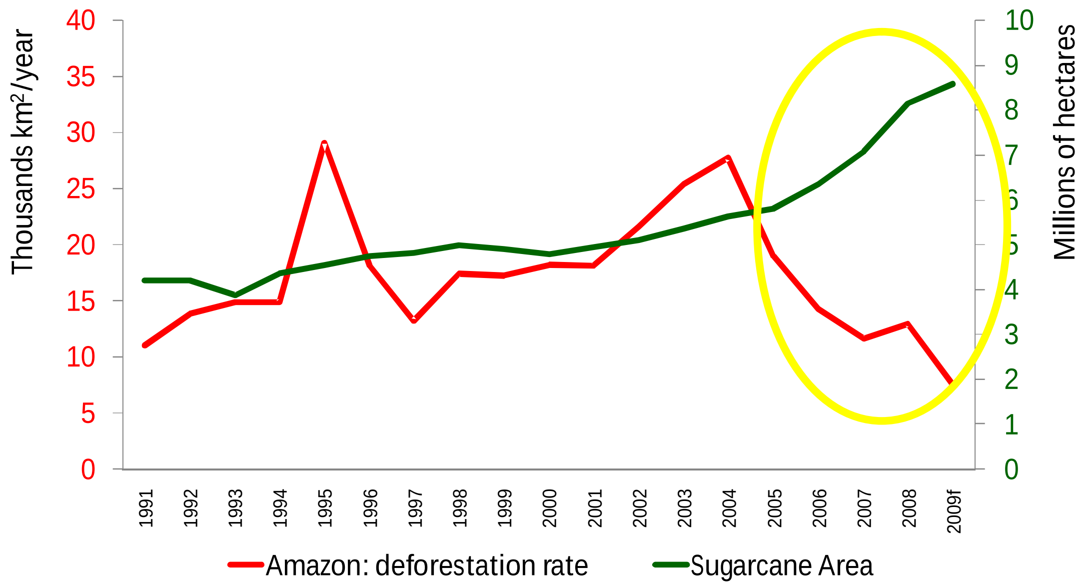


Figure 1: **Sugarcane area and annual deforestation rate in the legal Amazon [Sources - INPE (deforestation rates) and IBGE (sugarcane area)]**

- Finally, the most effective first st ep to minimize land use change emissions from biofuel production is to ensure that the sustainability criteria laid out in the Renewable Energy Directive are a success and embraced by producers both inside and outside of the EU. The sustainability criteria contain important elements that protect high carbon stock areas and encourage the production of better greenhouse gas (GHG) performing biofuels. BP is committed to work closely with other stakeholders to ensure the success of the sustainability criteria.

BP's response to the questions posed in the ILUC consultation

Question 1 - Do you consider that the analytical work referred to above, and/or other analytical work in this field, provides a good basis for determining how significant indirect land use ch ange resulting from the production of biofuels is?

- **<u>NO</u>** - The range of outputs from the modelling work provide little clarity or consistency regarding the indirect effects from the production of biofuels. BP has carried out its own evaluation of econometric modelling as a means for evaluating indirect impacts of biofuels and concludes that there are a number of factors which are preventing the models from delivering consistent or robust results:

  - The models in their current state of development are unable to model the dynamic global environment in which biofuel policy takes place and in particular the impact on that environment of rapidly changing regulation (2). In particular, econometric models are based on historic datasets to derive elasticity functions – elasticity functions are vulnerable to regulatory / societal and technological change.
  - The models suffer from several important limitations (6):
    - Advanced biofuels are often not included or inadequately modelled
    - Direct impacts for example as caused by lo cal factors cannot be modelled
    - The impacts of increasing sustainability standards within and outside the biofuel sector are not included
    - Agricultural management (by targeted policies, land -use planning, incentives, etc.) are not included.
    - The potential of exploiting synergies (e.g. between biofuel production and rural development) are not modelled
  - The models use different starting assumptions and input data sets, whilst some of the input data itself is subject to significant uncertainty (7).

- Despite the differences between the method categories, specific methodologies, and remaining uncertainty surrounding estimates, there is a general convergence and trend towards lower estimates of ILUC GHG effects in more recent data, and an understanding of ILUC estimates from different models, although the extent of causal relationship between biofuels and ILUC is still uncertain (8).

- In addition, state-of-the-art biomass resource potential analyses (9, 10, and 11) show that there is substantial potential for develop ing biomass resources as well as meeting growing food demand whilst meeting key sustainability criteria. For example, the study by Dornburg et al (9) shows that taking into account known water limitations, biodiversity protection and food demand, between 200 – 500 exajoules (2 – 5 $x10^{18}$joules) of biomass energy could be available by 2050, equivalent to around one third of the world's projected fuel demand. Key factors for delivering this potential are agricultural efficiency and crop choice. The modelled (IFPRI study) EU increase in biofuel demand by 2020 is 7.3 million tonnes oil equivalent, equivalent to around 0.3 exajoules, or just 0.06 – 0.15% of the 2050 bioenergy potential according to the Dornburg et al study (not allowing for conversion losses) .

- Advanced biofuels are often omitted or under estimated in the ILUC modelling work. The production of biofuels from residues & wastes, biomass produced on marginal and degraded lands and (high yielding) perennial crops from arable and pasture lands have a low risk of causing indirect impact on land use, may reverse carbon impacts on soils and can produce on average three times better energy yield per hectare used compared to 1st generation biofuels on the same land type (12).

- The Global Trade and Environmental Impact Study of the EU Biofuels Mandate Study prepared by IFPRI acknowledges that:
  1. Yield responses and land elasticities play a critical role in the assessment and are explicitly modelled.
  2. The quality of various databases (including Social Accounting Matrices) is often poor.

  Therefore it is a significant concern to see results presented with precision without recognizing the uncertainties in the key inputs. For example:
    - The projected biofuels share of 5.6% in the EU in 2020 translates to increased cropland use with 0.07%.
    - Direct emission savings by biofuel use are 18 Mton CO2eq and additional emissions from ILUC amount 5.3. Mton, resulting in net GHG emission savings of 13 Mton in 2020.
    - Effects on food prices of realizing this production are very limited: 0.5% price change of the food bundle in Brazil, 0.14% in Europe.

- The JRC-IPTS comparison of 6 models for two EU27 scenarios (marginal ethanol and marginal biodiesel) breaks out the variances in the key factors which impact the overall results and shows that some of the key values calculated within the models varied by one or two orders of magnitude between models/scenarios:
    - The fraction of savings in ILUC as a result of induced lower food consumption varied from 0.5% to 59% for the different models
    - The savings in ILUC as a result of by-products varied from small savings for the LEITAP model to savings around 50% of the potential ILUC for the GTAP model
    - the CARD-FAPRI model reported a 22% contribution of yield change to EU wheat feedstock production, whilst the AGLINK-COSIMO model reported a 41% change

  With this degree of variation between equivalent modelled factors within the models, it is not surprising that the eventual outputs from the models is inconsistent

- Sensitivity analyses in the JRC-IPTS study are very limited; however the results show that the final outcomes are very sensitive to minor changes in underlying assumptions, in particular with respect to yield responses when demand increases. A study by Apola et al., PNAS (with focus on Brazil) acknowledges that the results of modelling ILUC are almost fully determined by actions taken (and data assumed) on improvement rates of livestock and agricultural management.

Question 2 - On the basis of the available evidence, do you think that EU action is needed to address indirect land use change?

- **<u>NO</u>** - Based on the evidence produced in the modelling work, BP believes that action to address <u>indirect</u> land use change would not be possible through regulation /policy focusing on the biofuels sector. Limiting attention to only the biofuels sector will do little in addressing the broader drivers of land use change (13).

- The first and most important priority is to ensure a workable and pragmatic set of sustainability criteria are implemented across Europe and adopted by countries wishing to supply biofuels to European markets. BP fully supports the Sustainability Criteria laid out in the Renewable Energy Directive and has been working hard to ensure the system is a success. The sustainability criteria protect environmentally sensitive and high carbon stock areas – this will be an important first step in mitigating land use effects from biofuel expansion. They also establish challenging GHG hurdles that ensure that only good GHG performing biofuels qualify.

- In the spirit of the European Commission's endeavour for better regulation BP believes that any measure to address ILUC should be effective and tackle the principle drivers of Land Use Change. <u>BP believes that ILUC GHG penalties will have little effect on changing behaviours in the biofuels sector and more importantly will not tackle the principle causes of LUC.</u> A recent paper by Ecometrica (14) develops some alternative policy approaches. Other studies show that rural development and improving land use practices are essential in slowing down the expansion of agricultural land use. The increase in investment and technology transfer which will result from the expansion of the biofuel industry will play a strong part in facilitating such acceleration in rural development and land use practice improvements.

- Indirect emission impacts can be linked to almost anything including other alternative energy sources. e.g. the demand for renewable energy for electric vehicles could cause electricity prices to rise and an increase in coal electricity generation in developing countries. Is it the intention of European policy makers to analyze indirect impacts of all European climate policies?

- Any action to address ILUC should also be WTO compatible

Question 3 - If action is to be taken, and if it is to have the effect of encouraging greater use of some categories of biofuel and/or less use of other categories of biofuel than would otherwise be the case, it would be necessary to identify these categ ories of biofuel on the basis of the analytical work. As such, do you think it is possible to draw sufficiently reliable conclusions on whether ILUC impacts of biofuels vary according to :

As stated in previous sections BP believes that it is **difficult to draw sufficiently reliable conclusions** on the indirect impacts of biofuels based on the evidence presented in the modelling work due the level of uncertainty in key modelling inputs and the deficiencies of the models in capturing the dynamic nature of global systems.

However we would like to make a number of comments on these categories:

1. feedstock type?

- In terms of making a material impact on reducing CO2 emissions in the transport sector , good performing biofuels will have to be produced at scale. B P, after considerable analysis and guidance from independent third parties (1) agreed on a strategy that would focus principally on 3 principal feedstock routes
  1. Brazilian Sugarcane
  2. Lignocellulosic crops such as energy cane and switch grass
  3. Some grain crops that show good GHG performance and provide additional benefits from co-products.

  Additionally BP is working with other parties to maximise the potential of improved vegetable oils and biofuels produced from waste and residues

- We believe all these fee dstocks can be produced at scale, be sustainable and deliver greenhouse gas reductions above the 50% threshold in RED .
- The priority for feedstock is **yield**. Feedstocks that produce high biomass yields per hectare will therefore be optimizing land more effic iently and minimizing any potential ILUC impacts (15). In addition it is important to understand that increasing yield can, in some circumstances lead to higher emissions and environmental impacts elsewhere in the value chain (e.g., from additional fertilizer manufacture). Therefore, wherever possible, higher yields should be driven by improved technology and farming practices, and/or by a progr ession to advanced biofuels (e.g., LC ethanol) which are known to produce higher biofuel yields per hectare with substantially lower inputs (e.g., fertilizer, irrigation).
- Technology can also play an important role in optimizing land and delivering high biomass yields per hectare – for example advanced biofuel technologies that utilize l ignocellulosic feedstocks, intercropping options (e.g. agroforestry), and advanced land-use strategies. (15).
- Europe is more dependent on diesel than other developed world regions, primarily because it has a higher portion of diesel passenger vehicles than other regions. As a result, currently, the vast majority of biofuel blended in Europe is biodiesel, in sharp contrast to the other two main biofuel demand regions, the US and Brazil, where biofuel blending is dominated by ethanol . Bioethanol is also more likely to be compatible with future vehicle efficiency measures and hybrid electric vehicles. (16)
- BioButanol's superior compatibility with the vehicle fleet and fuel distribution infrastructure makes it possible for a greater penetration of renewable energy in transport taking some

pressure off bioethanol compatibility issues with the current car fleet as well as off biodiesel. For these reasons Biobutanol should be recognised and facilitated in policy (17).

2. geographical location?

- The EU should consider that there is less ri sk of direct and indirect land use change effects in geographic areas where there are good land use change laws and where there is confidence that these laws are being properly enforced. The Brazilian agro-zoning laws are a model for other bio-fuel producing countries to follow (18) . The EU has significant potential to deploy the various instruments under the Common Agricultural Policy (CAP) to stimulate efficient land-use and agriculture and to achieve good governance of land-use that avoids ILUC. (19)

- The EU should consider that there is less risk of indirect effects in geographic areas where agricultural land is coming out of agricultural production such as in the EU and in Brazil due to improved farming techniques and intensification. In some cases, biofuel production is merely slowing down the rate of land coming out of agricultural use rather than indirectly causing new land to be cultivated (20).

3. land management?

- Large direct impacts are a direct result of agricultural crops being grown in h igh carbon land areas, or displacing crops which would then be grown in those areas . Mitigating the magnitude of indirect effects can be achieved by setting policy which rewards those biofuels which make better use of existing biofuel planted arable land (thereby freeing up land for other arable crops), can be grown on abandoned/unused/degraded land, or can be grown using intercropping, or agro-forestry (21).

- The projected increase in lignocellulosic (LC) ethanol driven by US biofuel policy will tend to increase the biofuel yield per hectare, resulting in a lower demand for land per unit of biofuel demand in future. In side by side trials, <u>unfertilized</u> perennial lignocellulosic crops such as Miscanthus x giganteus or energy canes can produce around 60% more biomass than a well fertilized highly productive maize crop (22). There are many opportunities for this type of crop in Europe – with Poland, Romania, Belarus, and the Ukraine especially suited. If this transition can be effectively managed, then land c ould be freed-up for use for growing other arable commodities, thus reducing pressure on land generally. Studies have shown that cultivation of lignocellulosic crops in North America can sequester carbon into the soil, increasing soil carbon levels. Also, according to US Environmental Protection Agency (USEPA) studies, the carbon balance of LC ethanol can be extreme ly good, resulting in up to a 130% greenhouse gas (GHG) saving compared with a fossil fuel baseline (23).
- ILUC is minimized where biofuel crop s have been grown in areas that do not displace food crops e.g. on abandoned agricultural or degraded land, the displacement of non food crops, yield improvements, the use of co-products for animal feed or cattle intensification (24).

- ILUC studies in Europe demonstrate that modern farming reduces land use to such an extent that land is coming out of agricultural production – even with biofuel blend mandates. Indirect effects can be minimised by investing in new farming technology in developing countries (24).

Biofuel investment is in these countries is helping to improve yields in general agriculture and is having a positive impact on land use change and indirect emissions.

- As previously mentioned in section 2 above the Brazilian Agro-zoning policy is an effective measure in establishing land zoning for bio-energy production and strengthening protection of areas of high biodiversity.

Question 4 - If so, please say which, and indicate the evidence used to reach your conclusion. Based on your responses to the above questions, what course of action do you think appropriate ?

1. ***Take no action for the time being, while monitoring impacts including trends in certain key parameters and, if appropriate, proposing corrective action at a later date. Please say how the monitoring should be done and what these parameters should be.***
2. ***Take action by encouraging greater use of some categories of biofuel***
3. ***Take action by discouraging the use of some categories of biofuel***

As stressed throughout our response, BP believes the most effective measure should be taken outside of biofuel space through a more focused global effort to tackle emissions from all land use activities. Focusing on the biofuels sector only would be a dangerous distraction that avoids addressing the key drivers of land use change emissions. That said BP will continue to play an active role to ensure biofuels play their role in encouraging better practices across the sector to mitigate potential perverse effects of biofuel expansion.

The actions that BP recommends in order to help mitigate potential perverse impacts of biofuels expansion are:

- Ensure successful implementation and adoption of the Sustainability Criteria of the Renewable Energy Directive for producers both inside and outside Europe. BP is fully committed in supporting this action as the most important prerequisite.
- Support agro-zoning initiatives in key biofuel producing countries .
- Support farming technology development to improve land production capacity in key biofuel producing countries.
- Develop better incentives to encourage the early use of advanced biofuel technology .
- Provide additional incentives for biofuels grown on degraded and under utilized land.
- Look at approaches that optimise the use of land through intensification and integration with other farming practices i.e. more intensive cattle grazing that could free up land for biofuel production

15 September 2010

This is a draft document yet to be submitted to the European Commission – if you would like to comment on any of the points raised in the paper please contact:

Simon Worthington – simon.worthington@bp.com

To find out more on the work BP are doing in biofuels please visit www.bp.com/biofuels

Footnotes:

(1). BP has carried out extensive research into the potential of bioenergy and specifically biofuels. Whilst much of the material is not published owing to the commercially sensitive nature of its content, BP has published several speeches and papers describing our findings and the basis for those findings, for example:

- "Low Carbon Energy: A Pragmatic Vision", **Iain Conn,** Chief Executive, BP Refining & Marketing at the **World Forum on Enterprise and the Environment, 29thJune, 2010**
- "Advanced Biofuels – Why We Need to Get There Sooner!" Phillip New, President, BP Biofuels at the Advanced Biofuels Leadership Conference, Washington DC, 27 – 29th April, 2010
- BP Biofuels a growing alternative Ian Dobson London, 7 September 2007, www.docstoc.com/docs/22621119/BP-Biofuel-Strategy

(2). "Are Models Suitable for Determining ILUC Factors", Anne Gerdien, Elke Stehfest, Koen Overmars and Jan Ros, Netherlands Environmental Assessment Agency, May 2010. www.pbl.nl This report compares a number of partial and global equilibrium models in terms of their suitability for determining ILUC factors for biofuels. One major conclusion is that the models cannot currently deal with the dynamism on the global economy, particularly with the changes which will be brought about by changes in policy in the future. In other words, the models assume that the world is run by a perfect global economy which behaves in a predictable way and discontinuities or other influences which are not driven by markets or economics cannot be modelled.

(3). Partial and Global Equilibrium Models, which have been used to carry out the modelling work under review, rely on modelling the impacts of changes in demand for commodities upon their market prices and then modelling the impact of those market prices on future demand for the commodities. The impacts on land use change are then inferred from the increased demand. The models have no capacity to model the impacts on land use change of local factors, such as changes in the levels of subsistence farming, the implementation and enforcement of new land/habitat/forest protection programmes and regulation, or the increasing focus upon land use management.

(4). Several recent studies have explored the potential for increasing yields of conventional crops (i.e., those crops which provide feedstocks for conventional biofuels). For example, the study by ADAS for the 2008 Gallagher review "Anticipated and potential improvements in land productivity and increased agricultural inputs with intensification" concludes that "it seems that there are no serious technical constraints to increasing yields of most crops across most regions" and that for most crops there is potential to increase yields at rates at least 1% faster than historic trends on average. The report identified that opportunities for increasing yields and land productivity include intensification of previously extensive systems, investment in crop breeding, nutrition and protection; and enhanced availability of water supply/irrigation. By 2020, such a 1% increase in yield per annum over and above historic trends/business as usual would give up to a 12% increase in production above "business as usual". Given that it is forecast that biofuels demand will take up around 2.3% of global arable land by 2030 (FAO forecasts, see note 5), then a 12% increase in productivity of most arable crops would provide up to five times the amount of feedstock required for biofuel needs by 2020.
Several recent studies also explore the potential for using land more optimally, for example, doubling the intensity of Brazil's cattle ranching from 1 to 2 head per hectare would free up enough land to replace 15% of global gasoline demand (2004/5) with biofuels. Brazil uses 160 Mha of land for

ranching (source FAOstat), much of which is carried out at low farming intensities (e.g., around 1 head of cattle per ha of land). If Brazilian ranching could become more land efficient, increasing to around 2 head/ha, then 80 Mha of land could be freed up, which could produce around 300 bn litres of ethanol, equivalent to 15% of current global gasoline demand, (sources: USDA International Agricultural Baseline Projections to 2007/AER -767; USAD Major Uses of Land in the United States, 2002/EIB -14). Brazil also has between 25 – 40 Mha of degraded, abandoned pasture land with low soil carbon stocks (source: Bled Strategic Forum, Panel A: "From Bali to Copenhagen – Tackling climate with renewable solutions" Géraldine Kutas, International Advisor to the President, Brazilian Sugarcane Industry Association, Bled, 1 September 2008, (www.unica.com). This land could produce enough ethanol from sugar cane to replace between 5 – 7.5% of global gasoline demand.

(5). Food and Agricultural Organization of the United Nations, "Climate Change, biofuels and land" ftp://ftp.fao.org/nr/HCLinfo/Land-Infosheet-En-pdf. This paper shows that based on FAO modelling work, by 2030, projected growth in biofuel demand will require 35 million hectares of land. Based on the current global arable land area of ~1.5 billion hectares, this projection equates to around 2.3% of the current global arable land area. In this context, direct measures on other sectors and on land protection outside the biofuels space are very important since it will be impossible to control or even materially slow down global land use change by focusing mainly on biofuels which only uses 2.3% of that (arable) land.

The latest study from the World Bank found that the impact of biofuels production and use on commodity prices wasn't as prominent as initially believed. The study is in direct opposition to an internal World Bank Policy Research Working Paper, released in 2008, that found that 70 -75% of the increase in food prices that year was due to biofuels. "Worldwide, biofuels account for only about 1.5% of the area under grains/oilseeds. This raises serious doubts about claims that biofuels account for a big shift in global demand. Even though wide spread perceptions about such a shift played a big role during the recent commodity price boom, it is striking that maize prices hardly moved during the first period of increase in U.S. ethanol production, and oilseed prices dropped when the EU increased impressively its use of biodiesel. On the other hand, prices spiked while ethanol use was slowing down in the U.S., and biodiesel use was stabilizing in the EU "http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2010/07/21/000158349_20100721110120/Rendered/PDF/WPS5371.pdf

A report by the UK Government on 'The 2007/08 Agricultural Price Spikes: Causes and Policy Implications' was published December 2009. In this study the UK claim that "the available evidence, and analysis in annex 5 suggest that biofuels had a small contribution to the 2007/08 spike in agricultural commodity prices" http://www.defra.gov.uk/foodfarm/food/security/price.htm

(6). "Global Trade and Environmental Impact Study of the EU Biofuels Mandate Final Report March 2010", prepared by: Perrihan Al-Riffai (IFPRI); Betina Dimaranan (IFPRI); David Laborde (IFPRI) Annex I (demonstrates that the modelling is based on conventional biofuels and that advanced/2G biofuels are not modelled), Annex VI demonstrates that the modelling is focused on the economic impacts on land use change and does not fully consider causes of land use from local, direct factors (such as extensification of subsistence farming) for example by stating: "The first important idea is that this representation of land use is based on the principle that an increase in the price of land used for economic activity leads to conversion of new land." It is also important to consider that, from the econometric point of view, the relationship between deforestation and cropland expansion is not yet fully understood. These phenomena are quite complex, and most of them depend on the combination of various factors which includes prices and others. Furthermore, due to the lack of robust estimates, field specialists and geographic economists are very reluctan t to propose aggregated elasticities of prices variations with respect to land expansion variation. Some scientists also stress that deforestation is impossible to model. Geist and Lambin (2001) provide a very goo d insight on this complex issue strongly supporting the view that the modelling carried out does not fully or realistically represent many (non economic) factors which are driving land use patterns.

"Impacts of the EU biofuel target on agricultural markets and land use: a comparative modeling assessment". María Blanco Fonseca, Alison Burrell, Hubertus Gay, Martin Henseler, Aikaterini Kavallari, Robert M'Barek, Ignácio Pérez Domínguez, Axel Tonini. Edited by Alison Burrell, EUR 24449 EN – 2010. Section 6.1.2 states "The ease with which biofuel tar gets can be met and the cost of meeting them in the coming years depends on technological developments and productivity trends. The most important of these concern the development of second -generation biofuels, and productivity trends both in crop production and in the conversion of feedstocks to biofuel. **Supply and demand for second-generation biofuels are not included in most available models. …** The cost conditions for commercialized versions of these products are not known, nor the timing of their introduction. Nonetheless, it is possible that second -generation biofuels will be on the market within the next 10 years. Their price and the timing of their market entry will depend partly on the prices of first - generation feedstocks and energy prices. Msangi et al. (2007) performed simulations, using the IMPACT model, which show that if second-generation biofuels become available in 2015 and displace some consumption of first generation fuel, the price increases for the major crops worldwide due to biofuels policy would be 35-45% lower."

Section 6.1.3 demonstrates that in the partial equilibrium models used in the study, indirect land use changes "are the combined effect of changed relative prices (in favour of energy crops) and an overall increase in the pri ces of agricultural (land -using) outputs generally stimulated by higher aggregate demand.

(7). The different modelling studies carried out for the EU Commission have used different key input data and assumptions. The different modeling studies/assessment s:

- IFPRI modeling using a modified MIRAGE model, with 2 alternative policy scenarios and 5 biofuel incorporation scenarios
- JRC-IPTS modeling using the OECD AGLINK -COSIMO model
- JRC-IPTS modeling using the European Simulation Model (ESIM)
- JRC-IPTS modeling using the CAPRI model
- JRC-Ispra comparison of 6 models (AGLINK -COSIMO, CARD, IMPACT, G -TAP, LEI-TAP and CAPRI) to model 2 different EU biofuel scenarios (marginal extra ethanol demand and marginal extra biodiesel demand

For example, the IFPRI study models a basecase biofuels increase of 2.3% by 2020, whereas the JRC - IPTS models a range of increases from 3.7 – 5.2% as different base cases in the different studies. The different studies also use different starting assumptions for total transport fu el demand by 2020: IFPRI assumes 316 million tonnes oil equivalent (Mtoe), JRC -IPTS AGLINK COSIMO assumes 300 Mtoe, JRC-IPTS ESIM assumes 389.4 Mtoe, whilst JRC -IPTS CAPRI assumes 351.5 Mtoe. The JRC Ispra studies all assume 300 Mtoe. The studies also ma ke different assumptions for the contribution of advanced (2G) biofuels by 2020. IFPRI assumes 2G will contribute 2.2% of fuels, whilst JRC -IPTS

ESIM and CAPRI assume 1.4 and 3.0% respectively. 2G biofuels are not modelled in the JRC-Ispra work.

(8). Data from earlier ILUC impact modeling studies shows that the tren d is towards lower estimates of impact:

Taken from: DR-TREN: ASSESSMENT OF THE IMPACT OF LAND USE CHANGE ON GREENHOUSE GAS EMISSIONS FROM BIOFUELS AND BIOLIQUIDS. Incomplete draft; version 4 1 10

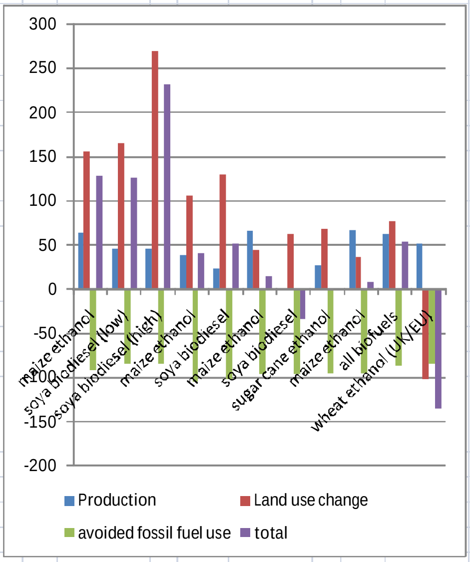
http://ec.europa.eu/energy/renewables/studies/land_use_change_en.htm

Source		Production	Land use change	avoided fossil fuel use	total	total
Searchinger et al. (2008)	maize ethanol	64	156	-91	129	129
	soya biodiesel (low)	46	165	-84	127	127-232
	soya biodiesel (high)	46	270	-84	232	127-232
EPA (data for use in US Renewable Fuel Standard)	maize ethanol	39	106	-104	41	41
	soya biodiesel	24	130	-102	52	52
CARB (data for use in California's Low Carbon Fuel Standard)	maize ethanol	66	45	-96	15	15
	soya biodiesel		63	-96	-33	??
	sugar cane ethanol	27	69	-95	1	-13
Tyner et al. (2009)	maize ethanol	67	36	-95	8	8
CEPII/IFPRI (study for European Commission 2010)	all biofuels	63	77	-86	54	54
ENSUS	wheat ethanol (UK/EU)	52	-102	-84.4	-134.4	

Sources: Searchinger et al. (2008), Searchinger (2009), EPA (2009), CARB (2009), Tyner et al. (2009a), Al-Riffai et al. (2009)

a: Emissions from land use change have been divided over 20 years. See section [ ].

b: Wheat to ethanol from ENSUS, 2008. Submission to the UK Gallagher Review



GTAP modelling updates are resulting in marked differences from previous studies. Land Use Changes and Consequent CO2 Emissions due to US Corn Etha nol Production: A Comprehensive Analysis by Tyner, Wally, Farzad Taheripour, Qianlai Zhuan g, Dileep Birur and Uris Baldos. These Purdue University researchers found that the California Air Resources Board (CARB) overestimated the impact that indirect land use change (ILUC) had on grain -based ethanol by a factor of two in developing the state's low carbon fuel standard (LCFS) in 2009. "We have better data on land productivity and on cropland pasture and CRP lands, and these data and associated parameters ar e now in the model. We have improved the treatment of the livestock and livestock feed sectors. Similarly, these changes are reflected in the current version of the model," the study said. "We have amassed data on crop yields and many other variables for e very region of the world and used much of that data in our analysis and model calibration. These data and model improvements have significantly improved the analysis and model results." July 2010 updated study is here: https://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=3288

(9). Veronika Dornburg, Detlef van Vuuren, Gerrie van de Ven, Hans Langeveld, Marieke Meeusen, Martin Banse, Mark van Oorsc hot, Jan Ros, Gert Jan van den Born, Harry Aiking, Marc Londo, Hamid Mozaffarian, Pita Verweij, Erik Lysen, André Faaij, Bioenergy Revisited: Key Factors in Global Potentials of Bioenergy, Energy & Environmental Science, February 2010, 3, Pages 258 –267

(10). Günther Fischer, Sylvia Prieler, Harrij van Velthuizen, Göran Berndes, André Faaij, Marc Londo, Marc de Wit, Biofuel production potentials in Europe: Sustainable use of cultivated land and pastures,

Part II: Land use scenarios, Biomass and Bioenergy, Volume 34, Issue 2, February 2010, Pages 173 - 187.

(11). Marc de Wit, André Faaij, European biomass resource potential and costs, Biomass and Bioenergy, Volume 34, Issue 2, February 2010, Pages 188 -202

(12). Wastes and residues: the UK Renewable fuels Agency carried out a study in 2009 to explore the indirect impacts of using wastes and residues as feedstock for biofuel production. The study found that some wastes do indeed have indirect impacts (tallow, molasses) but that municipal solid waste (MSW) has no indirect impacts and that there are indirect benefits. The conclusion was that biofuel from MSW, creates an average greenhouse gas (GHG) saving of 193% relative to fossil diesel. "Methodology and Evidence Base on the Indirect Greenhouse Gas Effects of Using Wastes, Residues, and By-products for Biofuels and Bioenergy" Report to the Renewable Fuels Agency and the Department for Energy and Climate Change, Report reference: PR -091007-A, Date: 30 November 2009. http://www.renewablefuelsagency.gov.uk/reportsandpublications/indirecteffectsofwastes

Lignocellulosic ethanol yield and productivity: Many papers have been published exploring the potential yield and productivity of ethanol from farmed lignocellulosic feedstocks such as energy grasses. A recent example is the white paper by Winrock (" The Impact of Expanding Biofuel Production on GHG emissions White paper #1: Accessing and interpreting existing data" available for download from: http://www.globalbioenergy.org/uploads/media/0904_Winrock_International_-_White_paper_1_GHG_implications_biofuel.pdf), which shows that ethanol from switch grass would be expected to produce 6.5 tonnes of ethanol per hectare compared with 4.6 tonnes/ha for corn ethanol (Table 1). Furthermore, the production of biofuels from lignocellulosic feedstocks is shown to have a better lifecycle GHG balance over a range of methodological approaches and assumptions than most conventional (1st generation) biofuels).

Another recent, authoritative study (The International Energy Agency, Energy Technology Perspectives 2008) suggests that yields from lignocellulosic ethanol production could reach 5360 litres gasoline equivalent per hectare by 2050, compared with 2260 lge/ha for EU wheat ethanol in 2050, thus giving more than double the biofuel yield per hectare.

(13). FAO modeling suggests that by 2030, biofuel demand will require land equivalent to around just 2.3% of current global cropland (see note 5).

(14). Tipper, R, Hutchinson, C and Brander, M (2009); "A Practical Approach for Policies to Address GHG Emissions from Indirect Land Use Change Associated with Biofuels", Technical Paper TP - 080212-A, Ecometrica Press.

(15). Biofuel yield per hectare of land could be improved in two ways:
- improve crop yields of existing, conventional biofuel feedstocks (e. g., corn, wheat, sugar cane)
- move to higher yielding "advanced/second generation) feedstocks such as energy grasses and farmed wood

Note 4 presents several items of evidence to support the view that increasing yields of conventional biofuel feedstocks has significant potential. Increasing yields of conventional crops would have a greater impact than just increasing the yields of the biofuel feedstocks – it would impact most/all arable crops, thus "freeing up" land. The impact of the biofuels industry, by bringing a new focus on

increasing land productivity, new investment and technology could play a major role in realizing this potential.
Note 12 presents several items of evidence to support the view that lignocellulosic crops (e.g., energy grasses, woody crops) could offer higher biofuel yields per hectare than conventional biofuel feedstocks. By replacing existing biofuel crops with LC crops would increase the biofuel output from the land already used for biofuels thus reducing the pressure on land u se.

(16). "Energy analysis of electric vehicles using batteries or fuel cells through well-to-wheel driving cycle simulations" Stefano Campanari, Giampaolo Manzolini, Fernando Garcia de la Iglesia, Journal of Power Sources 186 (2009) 464–477

And "Techno-economic comparison of series hybrid, plug -in hybrid, fuel cell and regular cars Oscar P.R. van Vliet, Thomas Kruithof, Wim C. Turkenburg, André P.C. Faaij, Journal of Power Sources 195 (2010) 6570–6585.

(17). The US department of Energy claims recognise s the benefits of Biobutanol:

- Its energy density is only 10 to 20% lower than gasoline's.
- It is compatible with the current gasoline distribution infrastructure and would not require new or modified pipelines, blending facilities, storage tanks, or retail station pumps.
- It is compatible with ethanol blending and can improve the blending of ethanol with gasoline.
- It can be produced using existing ethanol production facilities with relatively minor modifications.

http://www.afdc.energy.gov/afdc/fuels/emerging_biobutanol_benefits.html

Biobutanol can achieve further emission reductions compared to ethanol. "Currently, European regulations allow biobutanol to be blended at up to 15% by volume. The higher concentration biobutanol blend means that more renewable components make up the end fuel, which reduces greenhouse gas emissions further than is possible with a 10% by volume ethanol blend. Biobutanol can be produced from the same agricultural feedstocks as ethanol (e.g. sugar cane, corn, wheat, sorghum and, in future, dedicated energy grasses).The production process is similar to ethanol offering the possibility to retrofit existing ethanol capacity to biobutanol production."
http://www.butamax.com/_assets/pdf/biobutanol_a_more_advanced_biofuel.pdf

(18). The European Commission has recognized the importance of ecological zoning in the sustainable production of biofuels: "Joint Statement by the European Union and Brazil, Stockholm, 6 October 2009": http://www.consilium.europa.eu/ueDocs/cms_Data /docs/pressData/en/er/110440.pdf

The Brazilian ecological zoning laws are a set of strict environmental, economic, social, climate and soil restrictions that serve as mandatory guidelines, limiting future expansion of sugarcane to 7.5% of the Brazilian territory (or 64.7 million hectares). Under the criteria, 92.5% of the country is not suitable for planting sugarcane. Today, using less than 1% of Brazil's landmass (equivalent to 7.8 million hectares), the country is the largest producer and exporter of s ugar in the world, second largest producer and largest exporter of ethanol. Projections from the Ministry of Agriculture indicate that if Brazilian production doubled by 2017, only 1.7% of the land would be used.
http://english.unica.com.br/download.asp?mmdCode=2BCDEE84 -EC80-4647-BC11-7D4C2B89A61E.

(19). Two papers written as part of the REFUEL project explore the potential of improved land use efficiency in a mode which would minimize or avoid indirect land use impacts.

The first paper "Biofuel production potentials in Europe: Sustainable use of cultivated land and pastures, Part II: Land use scenarios" Gunt her Fischera, Sylvia Prielera, Harrij van Velthuizena, Go¨ran Berndesb, Andre´ Faaijc, Marc Londod, Marc de Witc, biomass and bioenergy 34(2010) 173 – 187. This paper explores several options and makes key recommendations, for example: "conversion of annual crop land into perennial lignocellulosic en ergy feedstock plantations wou ld need careful considerations beyond agronomic and economic factors and will involve modifying current regulations and spatial policies both at the national level and in the Common Agricultural Policy (CAP). A large - scale establishment of especially the longer -rotation options would also lead to far reaching changes in the traditional agricultural/cultural landscape "

A second paper in the REFUEL series explores other aspects, including the potential for improved land use efficiency across the EU27 as a whole: "European biomass resource potential and costs" Marc de Wit, Andre´ Faaij, biomass and bioenergy 34(2010)188 –202. This paper identifies significant potential for agricultural efficiency improvements in Central and Easter n European Countries (CEEC's). The accession of the 12 CEEC to the EU will likely affect the development of the agricultural sector. By extension of the EU's Common Agricultural Policy (CAP) and other policy support measures to the CEEC, it is expected tha t the CEEC and the WEC yields will converge by 2050. Developments that can contribute to this convergence are: access to capital for modernization and up-scaling and support for strengthening the social-economic rural situation.

(20). FAOstat data for a ll crop production in Europe between 1999 and 2009 shows that the total harvested area has declined over that time from 247 million hectares (Mha) in 1999 to 235 Mha in 2009, a reduction of 12Mha, or almost 5%, over a time when biofuels production has ramp ed up in Europe very significantly.

Europe is currently (FAO, 2009) and is forecast to remain (FAPRI, 2009) a net exporter of wheat –with export growing slightly over the next 10 years in FAPRI's baseline sce nario –which includes biofuels. Even with extra land being brought into production in the low yield scenario, wheat cultivation area is still decreasing between 2008 and 2020.

Fischer et al. (2009b) suggest that by 2030 22 million ha of land in EU 27 countries would become idle in the absence of in creased demand for agricultural commodities above the baseline demand for food and feed (based on their "La nd use –Environment scenario").

OECD/FAO (2009) forecasts declining or static EU production in most other commodities –e.g. sugar, beef, veal, pig, poultry, sheep and some da iry products.

(21). Land use efficiency: based on the IEA ETP2008 data for biofuel yield potentials for the year 2050, (LC ethanol yield potential 5350 l itres gasoline equivalent /ha compared with corn ethanol 2260 – source given in note 12) and that, for example the US was using around 8.4 Mha of land for corn ethanol in 2004 (ie before the ILUC debate started – source FAO reference given in Note 5) then an additional 3,100 lge/ha of biofuel could be produced on 8.4 million ha of land giving a total additional production, with no additional land use compared with 2004, of 26 billion litres gasoline equivalent/year, which is equivalent to around 4% of the current gasoline demand of the USA.

Abandoned land:
UNICA estimates that there is between 25 and 35 million hectares of degraded pasture land in Brazil alone, with very low below-ground carbon stocks (15). Using this for well managed sugar cane cultivation could help to restore soil carbon and sequester carbon back into the soil (since sugar cane is a perennial root crop). At current rates of production (6000 litres/hectare/year, or 4000 litres gasoline equivalent/year), this degraded idle land could produce about 100 billion litres of gasoline -equivalent ethanol/year, theoretically displacing about 25 billion gallons/year of gasoline. This alone is almost 20% of current US gasoline demand and almost 8% of current global gasoline demand (source IEA). See reference: "Bled Strategic Forum, Panel A: "From Bali to Copenhagen – Tackling climate with re-NEW-able solutions" Géraldine Kutas, International Advisor to the President, Brazilian Sugarcane Industry Association, Bled, 1 September 2008
Agro-forestry:
See reference given in note 9.

(22). A recently published perspective 'Feedstocks for Lignocellulosic Biofuels' by the Energy Biosciences Institute, the University of California, Berkeley and the University of Illinois Chris Somerville, Heather Youngs, Caroline Taylor, Sarah C. Davis and Stephen P. Long. EBI report available at http://www.ncbi.nlm.nih.gov/pubmed/20705851

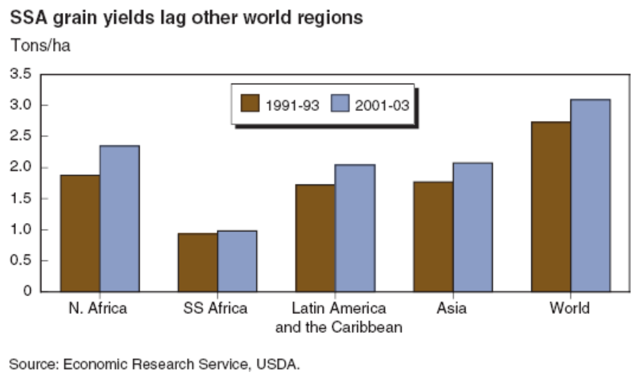
(23). EPA Lifecycle Analysis of Greenhouse Gas Emissions from Renewable Fuels, EPA report available at: http://www.epa.gov/oms/renewablefuels/420f09024.pdf

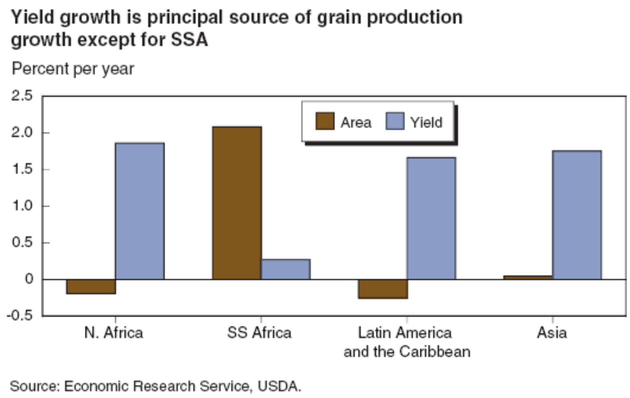
(24). A recent publication describes the role of technology in improving crop yields in the recent past, including the roles of plant breeding, crop nutrition and crop protection: "Possible changes to arable crop yields by 2050" Keith W. Jaggard, Aiming Qi and Eric S. Ober, Phil. Trans. R. Soc. B 2010 365, 2835-2851.

There is other strong evidence that investment and technology transfer are paramount to increasing crop outputs without extensification. For example, research by the US Department of Agriculture shows that where there is a lack of investment and access to technology is limited, yields have not improved as quickly as in other parts of the world: for example between 1991 and 2003, grain yields in Sub-Saharan Africa (SSA), which is dominated by subsistence farming, increased by less than 5%, equivalent to less than 0.5% per year, badly lagging other world regions.

There is strong evidence that greater yield improvement occurs where there is good access to investment and technology, for example:

- According to the USDA economic research unit, the lack of yield gains in SSA is due to a lack of access to technology and lack of investment. As a result, SSA has intensified its crop area by around 2% per year, whilst other world regions have increased grain production with reduced total land area used.





This example demonstrates how biofuels, by bringing investment and technology to areas of the world previously lacking these benefits, could help to reduce extensification of crop areas (source: USDA Food Security Assessment/GFA -16; Forces Shaping Food Security: Factors Affecting Production).