Bioenergy: Land-use and mitigating iLUC

Summary and Conclusions from the IEA Bioenergy ExCo74 Workshop


Extensive land use in Mozambique

This publication provides the summary and conclusions from the workshop 'Bioenergy: Land-use and mitigating iLUC' held in conjunction with the meeting of the Executive Committee of IEA Bioenergy in Brussels, Belgium on 23 October 2014.

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Bioenergy: Land-use and mitigating iLUC[1]

Summary and Conclusions from the IEA Bioenergy ExCo74 Workshop

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[1] Indirect land use change.

EXECUTIVE SUMMARY

Arthur Wellinger, Technical Coordinator, IEA Bioenergy

IEA Bioenergy held its biannual workshop in Brussels on the 23rd October 2014 in conjunction with the Executive Committee meeting (ExCo74). The workshop on '*Bioenergy: land use and mitigating iLUC*' was prepared in close collaboration with DG ENER of the European Commission. More than 100 participants, which included representatives from various European government ministries and NGO's, attended presentations by leading experts on this important topic. Eleven speakers and a discussion panel from nine different countries, including Europe, North America and South America, made high quality contributions which fully engaged the audience.

The workshop was opened by Marie Donnelly, Director of New and Renewable Sources of Energy, Energy Efficiency and Innovation at the European Commission. She set a high target for the workshop to deliver as an outcome: Provide a clear and scientifically robust message on iLUC mitigation in an easily accessible format that can be used to inform politicians. All of the scientific speakers accepted Marie's challenge and formulated the most important messages of their work in a few bullet points. It was interesting to note that most of the findings were consistent even though speakers came from different parts of the world where they were applying different approaches and models. The following is a compilation of the major conclusions drawn from the presentations:

- Food-versus-fuel reports that initiated the work on sustainability and iLUC in particular, which were not scientifically robust, should no longer be part of the general discourse.
- Even though research has come a long way, the current iLUC models still cover only part of the full picture: they do not include uncertainty (where weak assumptions are treated as though they are facts in a model) nor do they take into account improvement through evolving agricultural practice.
- Agricultural land for food and crop production has also to be taken into account. Creation of iLUC is independent of the use of the product of the land. If iLUC is to be mitigated, all agricultural production has to be included and it is important to remember that biofuel production accounts for only a small percentage of this.
- A holistic approach, which covers the whole biomass chain, including food wastage (according to FAO still one third of all food is wasted) and the ongoing global change in diet (less meat consumption means less iLUC), is mandatory.
- If the current trend of growth intensification in the industrialized world through improved crop yield and double cropping can be extended to developing countries, there is considerable scope for iLUC free bioenergy or other biomass production.
- The most important factors in mitigating iLUC are

  – Increasing value chain efficiency

  – Bringing under-utilized land into production

The central conclusion of the workshop was that iLUC could be prevented when food, feed and fibre production were married to good agricultural practice, in parallel with the deployment of bioenergy.

The PowerPoint presentations can be downloaded from IEA Bioenergy's website.[2]

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2 http://www.ieabioenergy.com/publications/ws19-bioenergy-land-use-mitigating-iluc/

WELCOME SPEECHES

Kees Kwant

NL Enterprise Agency, Ministry of Economic Affairs, the Netherlands

Chair, IEA Bioenergy

Kees Kwant, the newly elected chair, welcomed all participants and expressed IEA Bioenergy's gratitude to the European Commission for its help in organising the workshop. It was a special honour, he said, to welcome Marie Donnelly, Director of New and Renewable Sources of Energy, Energy Efficiency and Innovation at the European Commission. He highlighted the role of IEA Bioenergy, with its 23 contracting parties, including the Commission. He presented IEA Bioenergy's vision of achieving a substantial bioenergy contribution to future global energy demands through accelerating the production and use of environmentally sound, socially accepted and cost-competitive bioenergy on a sustainable basis.

Mr Kwant said that IEA Bioenergy provided an international forum for sharing information and developing best practice on technology development, non-technical barriers, and regulatory and legislative issues, and produced authoritative information on key strategic issues affecting deployment. It dealt with the whole chain of sustainable bioenergy in the Tasks' work and especially in dedicated workshops like the one on iLUC mitigation.

Marie Donnelly

Director of New and Renewable Sources of Energy, Energy Efficiency and Innovation at the European Commission

Marie Donnelly first pointed out that all European government heads would be meeting only 200m away from the workshop location to decide on Europe's energy and climate package beyond 2020. The discussion on land use change (LUC) and iLUC was a highly debated part of this, she said.

The challenge of land use change was to convince people that there was actually a problem, even though it was invisible. There would always be reasons for not seeing it. The Commission acknowledged the problem but struggled to find a solution because every study came to a different conclusion. There were, in particular, confusions within political minds: Is food for fuel and iLUC the same or are these two different things? Do we solve the iLUC problem when prohibiting or limiting the use of food for fuel?

The workshop, however, could be a 'mindsetter', and thus clear the way for better understanding.

The sub-target of 10% for transport in the Renewable Energy Directive (RED), with its 2020 target, had not really been carefully thought through, in terms of what that target would really mean at the end of the day. The 10% would have to come mostly from biofuel, but most politicians thought it would come from electricity. The truth was that, even after 2020, electricity would not fulfil the needs of aviation fuel nor heavy-duty vehicles. The Commission's real problem was that it couldn't make this understandable to the politicians.

The problem of the scientists, on the other hand, was their divergence in views, and in the long and complicated explanations they provided to politicians. The possible solutions needed to be described 'in a nutshell'. Her wish for the workshop was: Draft a simple message that can be used by the Commission for formulating policies.

Session 1: Policy background

ILUC: STATUS OF EU LEGISLATION

Paula Marques

DG ENERGY, Head of Unit C1, Renewables & CCS Policy

The Renewable Energy Directive (RED) (2009/28/EC)[3] has set 20% targets (20% renewable energies, 20% CO_2 reduction, 20% reduction in energy consumption) by 2020, amended by the 10% target of renewable energy in transport. The RED is accompanied by the Fuel Quality Directive (FQD 2009/30/EC)[4], seeking a 6% greenhouse-gas (GHG) reduction target in carbon intensity of road transport fuels by 2020.

The large part of the 10% RE in transport is to be covered by biofuels. However, they have to be sustainable. Biofuels need to save at least 35% GHG emission compared to fossil fuels, increasing to 50% in 2017. The RED defines what sustainability means. The iLUC discussion gave room for a four-year-long discussion between Commission, Parliament, Council and Presidency.

The Commission carried out two public consultation exercises dealing with iLUC in 2009 and 2010. It commissioned an International Food Policy Research Institute (IFPRI) study. In 2010, the Joint Research Centre (JRC) organised a workshop on 'The effects of increased demand for biofuel feedstock on world agricultural markets and areas', and initiated an expert consultation on behalf of the Commission.

The IFPRI report was considered as the key study. Since iLUC can neither be observed nor measured, it is necessary to use modelling that has inherent uncertainties. IFPRI, JRC IPTS (Institute for Prospective Technological Studies) and JRC IE (Institute for Energy and Transport) published results based on models for the GHG emissions of biofuels.

The IFPRI study[5] came up with the following technical findings:

- The total land converted globally for the increased EU biofuels consumption in 2020 is estimated at 1.7MHa, leading to the release of 500Mt CO_2.
- On average, these emissions would negate around 70% of the direct savings offered by biofuels, leaving the average biofuel mix at 22% savings (biofuels on average still save emissions compared to fossil fuels).
- There are large differences in estimated iLUC impacts between crop groups, these being lower for sugars and cereals than for vegetable oils.
- iLUC is a serious concern, but significant uncertainties remain (Fig.1).

The report concluded that the minimum GHG savings from biofuels should be increased.

[3] RED (2009/28/EC) http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

[4] FQD (2009/30/EC) http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0030&from=EN

[5] http://www.ifpri.org/publication/assessing-land-use-change-consequences-european-biofuel-policies

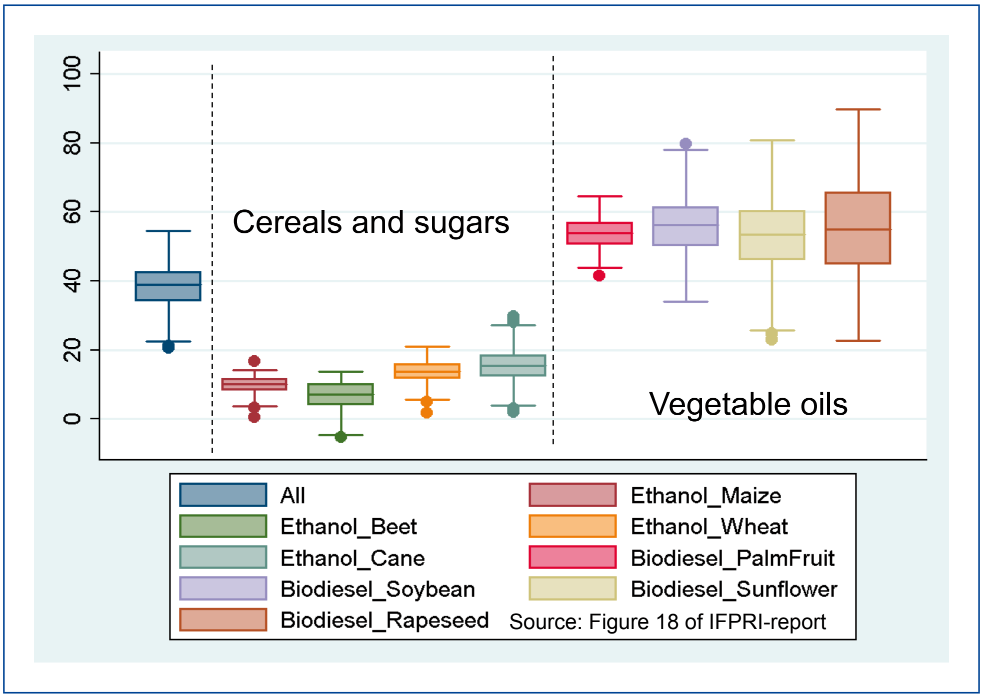

Figure 1: Feedstock-specific results of GHG emissions in gCO_2eq/MJ (Source IFPRI)

In 2012 the Commission came out with a proposal asking for:

- Reporting of iLUC by member states and by the Commission
- Reduction of GHG emission to min. 60% in new installations and 50% in existing plants, starting June 2014
- Cap on first-generation biofuels at 5% by 2020
- Double or quadruple counting of non-food or feed crop
- No more subsidies for food and feed based first-generation biofuels after 2020

However, no agreement was achieved between Parliament, Council and Presidency by the date of this workshop.[6]

PRODUCTION AND PROTECTION: BEYOND DEFORESTATION POLICY IN BRAZIL

Carlos A. Klink, Ministry of the Environment, Brazil

In 2009 the Brazilian Parliament approved a national policy on climate change. The programme fighting deforestation has made substantial progress. Since 2004 deforestation has been cut back by around 80% (Fig. 2), even as GDP increased by more than 40%. This success shows the effectiveness of the Brazilian system in monitoring and controlling deforestation. A programme against deforestation was also approved by the Brazilian Amazon Fund, to support all neighbouring countries in the Amazon in the area of forest monitoring, which is already having considerable success in coordinating regional policy.

6 In April 2015, the European Parliament and the Council reached a political agreement. The 'iLUC Directive' is expected to be adopted in September 2015.

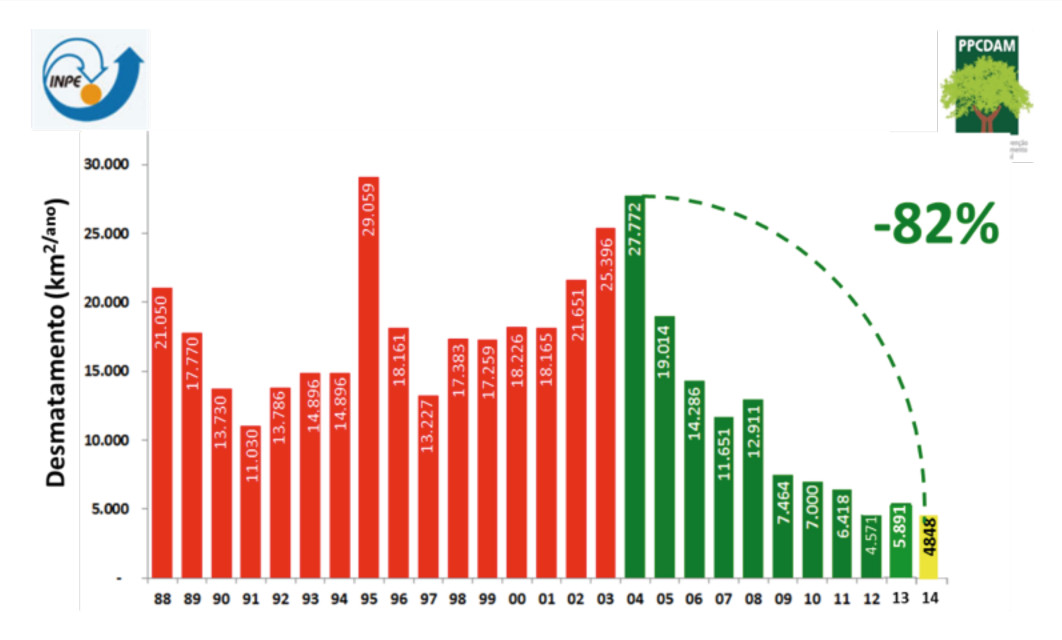

Figure 2: Reduction of deforestation in Brazil since 2004[7]

The avoided emissions increased to 650Mtonnes CO_2 eq. per year on average between 2010 and 2012, a reduction equivalent to the yearly emission of the UK. Despite the success, the cutting of trees is still too high; it is extremely difficult to further reduce deforestation, at around 30,000 km²/year in the past to the current 5,000 km²/year.

The new Forest Code is a new opportunity to reconcile the need for increased food, timber and bioenergy production with the protection of Brazil's unique environmental assets. It represents the commitment of Brazilian society to protect and restore a substantial portion of all Brazilian biomes, combined with the expansion of production to feed millions in Brazil and new consumers around the globe. The Brazilian agriculture, forestry and bioenergy sectors have been undergoing major structural changes over the last 15 years. The centuries-old pattern of agricultural exploitation based on the abundance of cheap land is rapidly being replaced by a technology-based system that saves on non-renewable factors and improves yields. Thanks to more information and physical and human capital, agricultural production in Brazil rose by 64% between 2005 and 2013, while the area used for agriculture increased by just 9%.

The climate actions are financed by funds, the national treasury and international donations. The climate-change fund, which receives a small contribution from oil exploration in Brazil, provides grants to civil society and investments to the private sector in the area of climate innovation. The Amazon fund combined with governmental investments support actions to curb deforestation. The low-carbon agriculture programme provides concessional investments to farmers who use carbon-saving technologies. The success of an action depends on a number of factors, as well as innovative business plans in the field of climate improvement.

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[7] INPE Brazilian Space Agency & Brazilian Ministry of the Environment.

The Brazilian success has come from the better use of land and assigning protected areas. Brazil has made significant commitments to preservation in the past four decades, setting aside 152 million hectares of public land as protected areas and 111 million hectares as indigenous territories. Already one million hectares are protected land. The Legal Amazon Region alone corresponds to a protected area of 400 million hectares. It could contain the whole of Europe (Fig. 3).

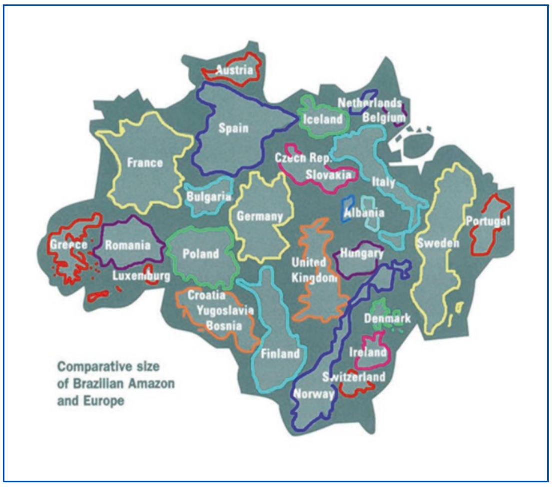

Figure 3: The whole of Europe could fit into the Legal Amazon Region of Brazil

Two important questions are: what happens to the deforested land, and how can we restore and reforest degraded lands in Brazil?

Out of the 750,000 km^2 of deforested land in the Amazon, 66% is used as planted pastureland, 5% is under the plough, and 21% is given to forest regrowth. Progress is monitored every second year.

This monitoring is now being combined with forest restoration and reforestation strategies, since they are the most cost-effective way to scale up carbon uptake from the atmosphere. They also bring important benefits such as biodiversity conservation and improved water quality and availability. They can thus be yet another unique contribution of Brazil to reducing overall global carbon emissions:

- Brazil is an ideal place for large-scale forest restoration due to its large tracts of degraded pastureland, a highly competitive agribusiness, a vigorous commercial timber industry, an innovative nascent economic restoration business, and an extraordinary policy window afforded by the new Forest Code, approved in 2012.
- The code will help increase land productivity by speeding up technology adoption, promoting higher investment in equipment and techniques, and promoting improved coordination of public policies. Complying with environmental rules and providing pertinent information are already required for any farmer to receive credit from Brazilian banks, and will help to ensure that improved policies are implemented. Information technology is also key. A cornerstone of the Forest Code is the inventory of all the land available to agriculture, collected in the centralised Rural Environmental Registry (CAR), already under implementation with the support of the private sector. The CAR will provide information on all existing forests and natural reserves, and areas in need of restoration within private lands

Progress should be based on the production-protection strategy, with the goal of developing the rural economy while protecting vital natural resources. Pasture makes up most of private land use, but since 1970 both cropland and private forest have increased as an integrated part of rural land use. Landowners are encouraged to use land with the highest efficiency, meaning increased productivity. Intensification can significantly increase GDP, as is shown by the example of Mato Grosso do Sul where sugarcane plantations were intensified, and the number of mills increased from eight in 2005 to 22 in 2012, which created jobs and wealth. GDP doubled in the same period as a result of population growth and income increase (Fig. 4).

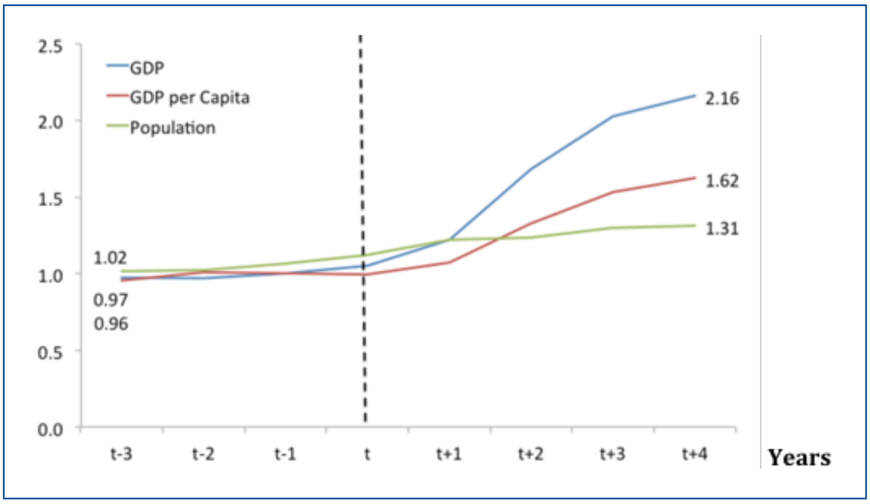

Figure 4: Effect of mill establishments on GDP[8]

Private industry is willing to contribute to climate-change abatement. As a consequence, the saying 'small is beautiful' is no longer valid for Brazil. Industry has to engage on a large scale to significantly reduce GHG emission and at the same time increase agricultural income. Already today, 78 municipalities have enjoyed a doubling of GDP due to improved productivity.

POSSIBLE SOLUTIONS FOR WORLDWIDE LAND-USE CHANGE

Jan Mizgajski, Technical University Darmstadt

From an economic point of view, land is one of the basic factors of production. Land use and land-use change provide substantial economic and social benefits, which enable societies to build their welfare. On the other hand, land-use change entails substantial cost to the environment, which can reduce welfare. This cost is not taken into account during most land-allocation decisions, and may lead to environmental damage. The most cited case is global deforestation.

In the system of public and private landownership, the market is key to optimal allocation of land use. However, markets will allocate land effectively between alternative uses, and between public and private uses only when each transaction and each land-use change reflects opportunity costs. In reality, investors take into account only a small part of the opportunity costs, ignoring the value of many of the ecosystem services provided by different land-use types.

Land-use change is not a new issue and cannot be directly linked to the development of biofuels.

Massive deforestation, for example, has been occurring since the 1950s. Indeed, long-term deforestation processes are often explained by global population change (Fig. 5).

[8] Juliano Assunção et al, Dept. of Economics, Catholic University of Rio de Janeiro and Climate Policy Initiative; available at: http://climatepolicyinitiative.org/wp-content/uploads/2013/12/Production-and-Protection-A-First-Look-at-Key-Challenges-in-Brazil-executive-summary.pdf

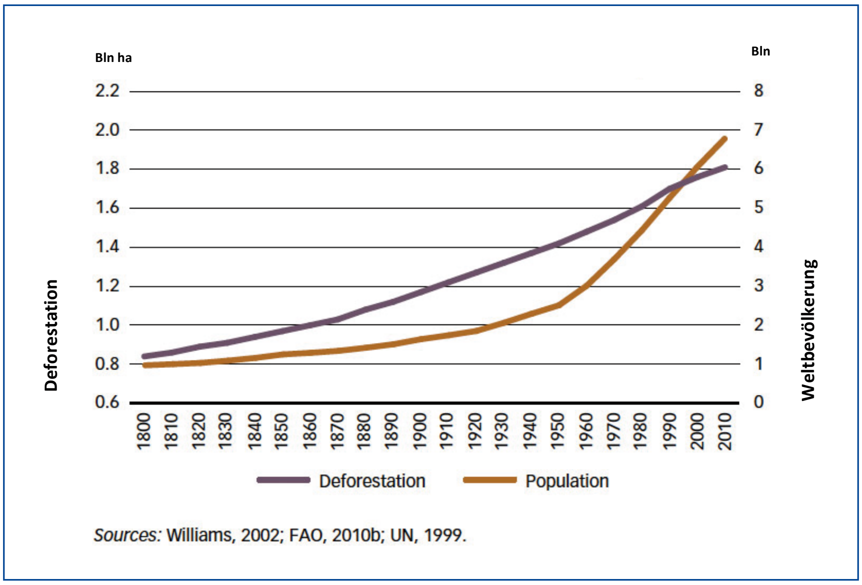

Figure 5: The relationship between cumulative deforestation and world population

However, when considering the causes of deforestation from a local perspective in shorter periods of time, there is evidence that deforestation is a result of different combinations of various proximate causes and underlying driving forces.[9] The extension of overland transport infrastructure, followed by commercial wood extraction, permanent cultivation and cattle ranching, are the leading proximate causes of deforestation. The analysis of underlying levels shows that multiple factors are acting synergistically, but economic factors are prominent forces of tropical deforestation.

The unsustainable trend of deforestation is not the only example of intemperance in today's world. The rate of deforestation just reflects the general incapability of global society to control its consumption. There is no doubt that increasing the growth of energy crops carries some environmental risks. But biofuels cannot be identified as the most important or single global cause of land-use change (LUC). Projected changes in land use caused by biofuel policies are very small in comparison to other changes. This is why the effective solution to LUC should go far beyond biofuels.

The most evident solutions for mitigating LUC worldwide can be summarised in two actions: Land-use conservation measures and decrease of pressure on land by increasing resource efficiency on both sides of the market, in production and consumption.

The basic and most important type of action to reduce LUC is conservation of land. On the global scale, conservation measures are often attenuated by weak governance in land management. Land protection should be improved by continuous enhancement of governance and expansion of land protection policies to new areas.

Direct land conservation measures must be accompanied by a change in production and consumption patterns: intensification of crop yield by optimal cropland management (plant management, double cropping), grazing land management (plant, animal and fodder management) and using integrated agriculture

[9] Geist, H.J. and E.F. Lambin, *Proximate Causes and Underlying Driving Forces of Tropical Deforestation: Tropical forests are disappearing as the result of many pressures, both local and regional, acting in various combinations in different geographical locations, BioScience*, 2002. 52(2): p. 143-150.

production systems. There is also growing interest in using abandoned or degraded land, which can be suitable for agriculture development, including bioenergy purposes. Sustainable intensification of agriculture (*sustainsification*) resulting in higher yields is the key to iLUC mitigation.

Another opportunity is the use of abandoned or set-aside land; 8% of current primary energy demand, based on historical land-use data, satellite-derived land cover data, and global ecosystem modelling, could be covered by crops grown on abandoned land[10] of an estimated global area of 385-472 million hectares (Fig. 6), corresponding to 66-110% of the areas reported in previous assessments. The area-weighted mean production of above-ground biomass is 4.3 tons of wet biomass per hectare and year, a factor of two lower than previous assessments assumed. The potential energy content is still significant, at 10% of primary energy consumption in industrialised countries, but it may cover more than the actual energy demand in some African nations.

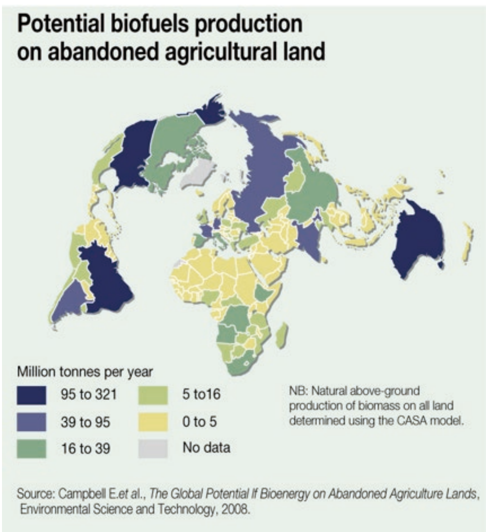

Figure 6: Potential biofuel production on abandoned land

When it comes to the demand-side solutions, the focus should be primarily on the change of food consumption patterns, including change of diets to less meat, followed by more careful storage and use of nutrition. According to FAO, globally one-third of the edible parts of food produced for human consumption are lost or wasted.[11]

Session 2: iLUC mitigation models and application

PRECONDITIONS FOR SUSTAINABLE BIOMASS SOURCING, IMPROVED MODELS, MONITORING AND GOVERNANCE

André Faaij, University of Groningen, Energy Academy Europe

When looking at bioenergy, the first questions are always 'What is the potential?' and 'Can it be sustainably produced?'. Hence the trigger point is what we can do to mobilise biomass in a sustainable way.

As a first step, we need to specify whether the potential is a technical, economic, implemented or sustainable potential. Potentials are not carved in stone; they develop over time and are always linked to biomass categories and production systems. They are overlain by the supply and demand potential of biomass. There are some decisive parameters on the supply side such as improvement of agricultural management, choice of crops, food demand and human diet, use of degraded land and, last but not least, competition for water.

[10] www.grida.no/graphicslib/detail/indirect-land-use-change-induced-by-increased-biofuels-production_e9af

[11] FAO, *Global food losses and food waste – Extent, causes and prevention*. 2011, Rome.

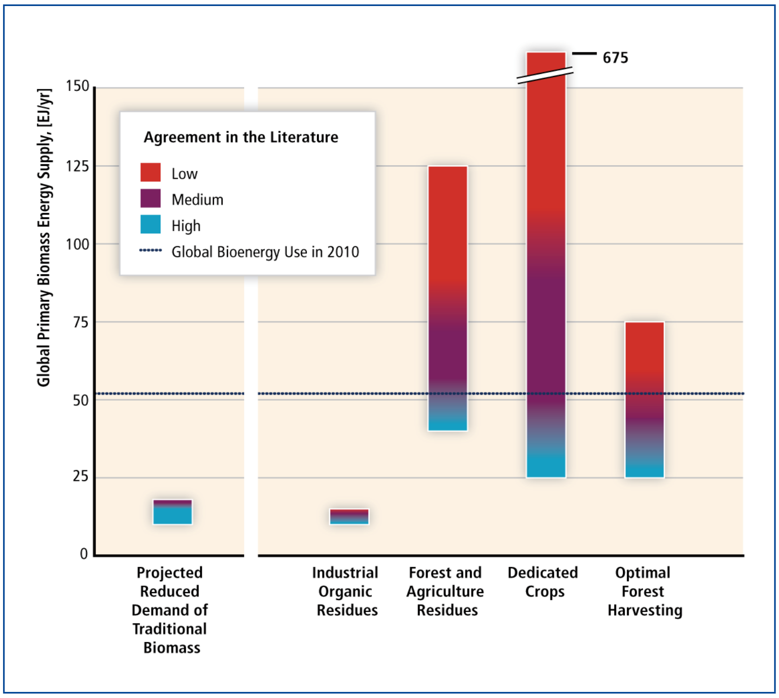

Figure 7: Bioenergy potentials for 2050 based on expert opinion

In the framework of the Intergovernmental Panel on Climate Change (IPCC),[12] expert opinions on potential energy supply from biomass were collated (Fig 7). The relatively high agreement is rather encouraging. There is high probability that the sustainable potential for 2050 is a minimum of 25 EJ per year, with a good chance of covering at least the actual bioenergy use of 50 EJ/y.

Yield factors are extremely important for reaching the potential. From 1960 to 2010 the average yields increased by a factor of about 2.5, even though fertiliser application has been substantially reduced since the mid-1980s, to reach levels comparable to those in 1960. However, as regards the example of wheat in Western Europe, the values reached are far higher than in Eastern Europe[13] (Fig 8). If Eastern yields were raised to Western values, the higher production would be impressive.

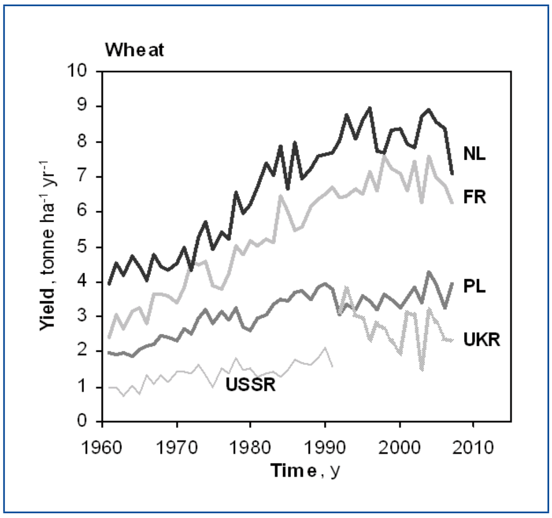

Figure 8: Yield development of wheat in different European states

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12 IPCC – AR5 WGIII, 2014.

13 De Wit et al, *Renew Sustain Energy Rev (RSER)*, 2011. [Not an adequate reference]

Overall, there is considerable feedstock potential that could be produced on 65 Mha of arable lands and on 24 Mha of pastures (grass and wood). The cost of biomass, of course, plays a substantial role[14] (Fig. 9).

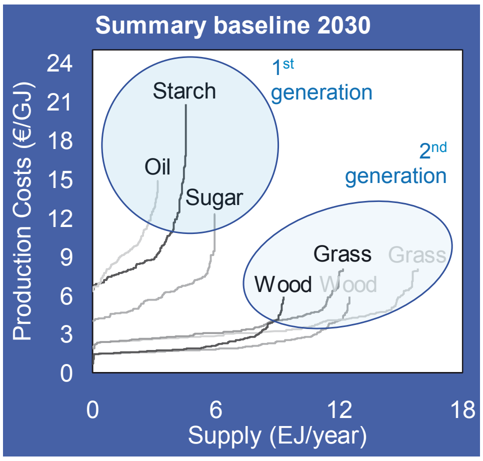

Figure 9: Crop-specific supply curves

There is a significant difference in supply and production cost between first- and second-generation crops. The supply potential is high when compared to the demand in 2010 (0.78 EJ/yr) and the projected demand in 2020 (1.48 EJ/yr).

Today there are good tools for modelling yields and corresponding sustainability for regional or global assessments. They take all kinds of factors into consideration, such as current land use, soil suitability, population density, distance to roads and cities, and distance to water, and they show us that yields can be increased so as to offer enough room for biofuel production. The question is more about whether we really understand the results.

The modelling of iLUC mitigation bears considerable incertitude. This is acceptable as long as it is shown and explained; e.g. the comparator (g CO_2/MJ) or type of fossil energy source (tar sands, shale gas, etc). The improvement of iLUC modelling shows that we do not know the full reality. A number of key efforts have still to be made, such as description of the historic data basis, model shock, short-term considerations, business as usual (BAU), current technology. The LUC and GHG implications (carbon stock) have to be quantified. We also need bottom-up insights.

Agricultural technology advancements by biological and bioengineering methods have to be covered, and changes in land and production have to be verified. LUC depends also on zoning, productivity, socio-economic drivers, the governing of forest and agriculture, and identification of the 'best' lands.

Searchinger et al's 2008 paper has led to a large number of partially incomprehensible political decisions and has, as a result, done a lot of damage to the development of biofuels. On a positive note, however, good scientific work has been initiated, making us confident that future biomass resources will not be in conflict with food and feed production if we consider a number of parameters.

The main improvements in the modelling (Fig. 10) relate to updates in the global economic database used in the Global Trade Analysis Project (GTAP) (from 2001 to 2006): inclusion of pastureland as an option for bioenergy production, inclusion of animal feed co-products, crop yields (both for agricultural crops and bioenergy crops) on existing agricultural land and newly converted land, and the fraction of carbon that is stored for a longer period in wood products.

[14] Wit & Faaij, *Biomass & Bioenergy*, 2010.
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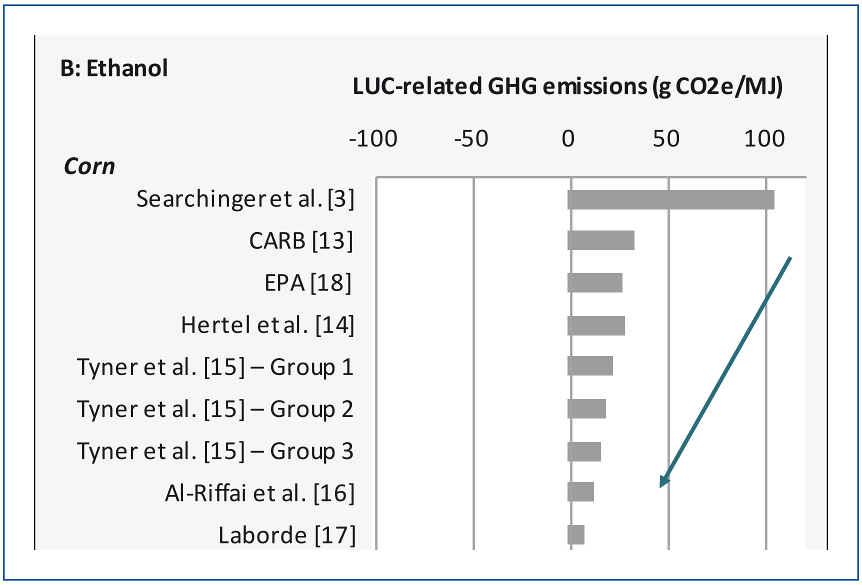

Figure 10: Development of GHG emissions as a function of model improvement[15]

In real life there are still a number of opportunities to mitigate iLUC:

- Increasing efficiency in agriculture, livestock and bioenergy production
- Integrating food, feed and fuel production
- Increasing chain efficiencies
- Minimising degradation and abandonment of agricultural land

Integrated food, feed and fuel production is important for increasing overall biomass production and, at the other end of the chain, for increasing the efficiency of biomass use.

The modelling of iLUC factors is only half of the scientific work needed. It is reactive and retro-oriented work. What is required is the development of proactive concepts.

The actual biofuel policy is even less than half of what we need. Interlinked agricultural and bio-based economy policies (agri, clima, energy, etc) are required. Integral land-use strategies have to be investigated and implemented to achieve synergies.

A final thought: If we accept that there are developments in food and feed production, we will have very low net iLUC emissions at the end of the day. When mitigation is properly applied, results can even be positive.

LANDMARK TEST OF ILUC BIOFUELS THEORY

Tristan Brown, SUNY College of Environmental Science & Forestry

While iLUC has been discussed since the 1990s, the concept achieved widespread recognition following the publication in *Science*[16] by Timothy Searchinger and colleagues in 2008 (see also André Faaij) that calculated the lifecycle greenhouse-gas (GHG) emissions of US biofuels when accounting for emissions from iLUC.

[15] Wicke et al, *Biofuels*, 2012.

[16] T. Searchinger et al, (2008), Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change, *Science* 29: Vol. 319 no. 5867, pp. 1238-1240.

The paper received immense attention from the US government, academia and the media, and influenced the political decision in the USA that led to tight GHG emission thresholds (Table 1), even though subsequent analyses found its results to be very sensitive to the assumptions it made.

Table 1: The Renewable Fuel Standard 2 (RFS2) GHG emission reduction thresholds

RFS2 Biofuel category	GHG emission reduction threshold
Renewable fuel (corn ethanol)	20%
Advanced biofuel	50%
Biomass-based diesel	50%
Cellulosic biofuel	60%

In particular, Searchinger et al attributed iLUC, in the form of the deforestation of primeval forests in Brazil, to the commercial-scale production of US maize ethanol. However, they failed to quantify the lumbering during the years when US production of ethanol from maize greatly increased. Annual deforestation in the Amazon peaked in 2004 at 2.7 million hectares before falling to 0.5 million hectares in 2012 (Fig. 11). During the same period, US ethanol production (virtually all of it from maize feedstock) increased from 12,869 million litres to 50,341 million litres. In other words, while the Searchinger analysis predicted that an increase in annual US ethanol production by 56,000 million litres would result in two million hectares of tropical deforestation in Brazil alone, the annual rate actually fell by the same number between 2004 and 2012.

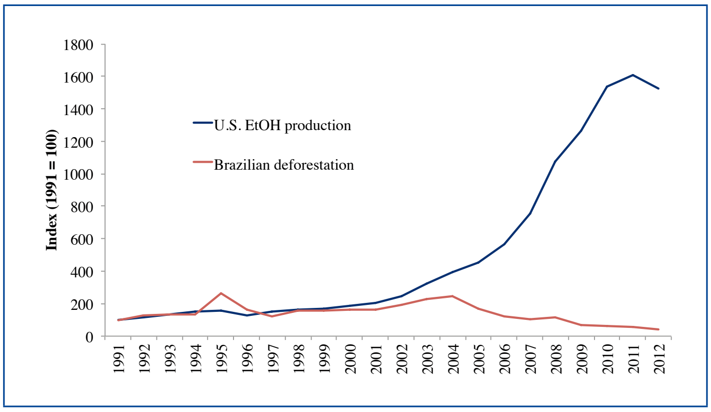

Figure 11: Brazilian deforestation compared to US EtOH production

Much of the decrease in Brazil's deforestation rate has been attributed to the country's enforcement of anti-deforestation laws, including an expansion of its space program to include the monitoring of Amazonian rainforests via satellite. While the basic mechanism behind the theory of iLUC remains plausible, Brazil's experience with deforestation in the 21st century suggests that other factors (such as law enforcement) can override the influence of first-generation biofuel production in the developed world on deforestation in developing countries. Brazil's experience also demonstrates why accurate quantification of a particular biofuel's lifecycle GHG emissions under iLUC should take into account actual deforestation in the affected country.

It is interesting to note that Brazilian sugarcane ethanol was not of concern. In fact, both growth areas are regulated and are some 2,000 km away from the Amazon. The real culprit for deforestation in the early years of the third millennium was soya production.

After US policy introduced iLUC into GHG emission calculations, other studies with more thorough data bases appeared, showing that the iLUC effect was far lower, falling from more than 100g CO_2/MJ to values as low as 5g/MJ (Fig.12).

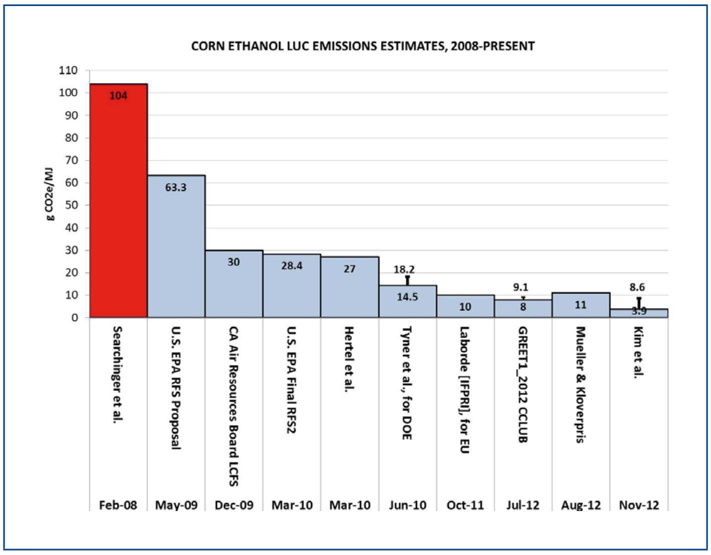

Figure 12: iLUC estimates for corn ethanol since 2008 (source Cooper, 2013)

The EPA's early calculations attributing large iLUC impacts to US maize ethanol production have remained unchanged, however. Soon after the Brazilian case, deforestation in Indonesia due to palm-oil production for biofuel became the evil. Again, the same question has to be raised: is there really such a simple correlation? Learning from Brazil tells us to be more careful with snap judgments. The fact that Searchinger et al's LUC emission calculation is lowered by 80% when a one-time increase to yield is assumed tells us that the data base is still not robust enough.

We may conclude that the alleged Amazonian deforestation created by US maize EtOH production was based on weak data and snap conclusions. Deforestation has fallen by 83% since 2004 even as EtOH production from corn has tripled in volume. Modelled projections have steadily fallen as flawed assumptions have been reviewed.

Care should be taken that the Indonesian deforestation models undergo similar scrutiny before results are used to develop biofuel regulations. In addition, this is of high importance considering multiple deforestation preventative measures.

PRACTICAL WAYS TO ACHIEVE ILUC-FREE BIOFUELS

Daan Peters, Ecofys

Biofuels and other forms of bioenergy are expected to play an important role in meeting future energy demands, especially in sectors without major alternatives such as aviation, shipping, long-distance heavy-duty transport, or industries requiring high-temperature heating. During a transition period to alternatives, bioenergy can also play a role in decreasing GHG emissions from passenger vehicles and heat and power generation.

Bioenergy feedstock demand and associated land demand might have direct and indirect impacts like LUC or iLUC. LUC and other direct impacts can generally be determined and attributed to the party that caused them. However, indirect effects like iLUC and food/feed commodity price increases are more difficult to attribute to a given biofuel and generally cannot be measured. Increased commodity prices in turn can cause market reactions, some of which have impacts on LUC: conversion of additional land eventually including land with high carbon stocks, additional production through intensification, or price-induced reduction in consumption.

Both effects – iLUC and impacts on food security – are so-called indirect impacts, caused by increased biofuel production. Other indirect impacts could include additional fertiliser and water consumption.

The strategy to solve iLUC in the long term is the prevention of direct LUC. Actually, mainly short-term solutions are applied, such as expansion of the use of iLUC-free biofuels, a cap on or reduction in the use of high iLUC-risk biofuels, and acceptance of iLUC risks but compensation of the effect through offsetting.

There are numerous options to prevent iLUC:

1. Using non land-using (residue) materials as biofuel feedstocks available in surplus quantities
2. Using unused land
3. Increasing crop yields
4. Sugarcane-cattle integration
5. Using fallow land as part of crop rotation
6. Introducing multi-cropping
7. Reducing post-harvest losses
8. Improving the conversion efficiency of biofuel installations
9. Using land historically used for biofuels
10. Substituting animal feed-co-product (*partly an offsetting option*)

To facilitate the options, Ecofys in collaboration with the World Wide Fund for Nature (WWF) and the Roundtable on Sustainable Biomaterials (RSB) have developed the Low Indirect Impact Biofuels (LIIB) methodology to describe concepts for mitigation of iLUC and other indirect impacts of biofuels. It includes four different approaches: Using non land-requiring materials (residue and wastes) as biofuel feedstock available in surplus quantities, unused land, increase of crop yield and ethanol sugarcane-cattle integration – i.e. items 1-4 listed above.

All four options have been pilot-tested with partners and auditors in Brazil for ethanol sugarcane, oil-palm yield increase in Indonesia, unused land in Mozambique and biodiesel from residues in South Africa. In addition, the LIIB method has been applied in desk studies on bioenergy projects in Tanzania and Ukraine.

It should be underlined that LIIB is not a model but a practical implementation method. Nor is it another voluntary certification scheme, but it can be used as an add-on to existing schemes; Ecofys currently develops LIIB compliance indicators for the RSB certification scheme.

As one of the first options, the option of waste and residues as raw material for bioenergy has been examined. Residues only have an iLUC risk in cases where materials are already used by other sectors. Other than that, surplus quantities of residues are iLUC-free. The current system at the European Commission is a 'go or no go' method based on positive lists. In the LIIB method, we propose to identify the available surplus per residue material and set caps on biofuel consumptions per residue feedstock. Essentially, however, caps should be set at the EU level to avoid differences among the different voluntary schemes. In addition, central lists can be regularly updated.

As a second option, unused land can be abandoned farmland (e.g. in Eastern Europe) or low-carbon-stock, low-biodiversity land not used for agriculture before (e.g. alang grassland in Indonesia). Biofuel feedstock produced on unused land is iLUC-free because no existing agricultural production is displaced. Unused land can be certified per individual biomass producer, and is often used extensively (Fig. 13), or, for instance, a sheep herd may pass through occasionally.

The method has three steps:

1) A farmer or developer identifies land that has not been used for provisioning services during the previous three years.
2) An auditor checks *ex ante* if the land is currently unused and has been unused for the last three years, and checks *ex post* how much biofuel feedstock production took place on the land.
3) The sustainability requirements of the voluntary scheme chosen are applied.

Figure 13: Extensively used land can be LIIB-certified if there are viable local alternatives

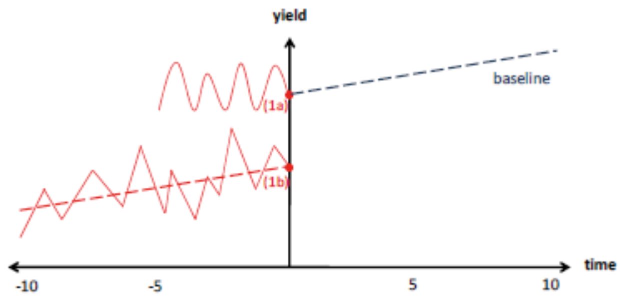

Figure 14: Individual farm-level baseline: historical yield data of farmers in the region compared to historical yield of farmer seeking certification

Future yield baseline created based on past trend.

1a *is the current year yield of the LIIB applicant farmer based on the average yield during the last 5 years.*

1b *is the expected current year yield of farmers of the same crop in the same region.*

Red dotted line *is yield trend line of the same crop in the same region over the previous 10 years.*

The third option is additional biofuel feedstock production on existing agricultural land. The resulting yield increase does not displace agricultural production to elsewhere. Yield increase should be certified per farm. Again, it's a three-step process:

1) The baseline yield is established based on historical yield increases at farm level combined with regional figures (Fig. 14).

2) Farmers develop measures to achieve above-baseline yield increases. The yield above the defined baseline is iLUC-free.

3) The auditor checks the baseline and measures *ex ante* and *ex post* whether the measures are being implemented, and the difference between baseline and actual yields.

Possible climatic impacts on current yields can be reduced by averaging actual yields over several years and/or by cross-checking with regional yield data. Again, the sustainability requirements of the voluntary scheme chosen will apply.

The last option is the integration of sugarcane production and cattle-grazing. The idea is to use the residues of sugar and EtOH production as cattle feed and thus to free part of the large surfaces for grazing for cane production. This allows increased density of cattle per hectare, creating more land for sugarcane without displacement effects. The iLUC-free certification should be done at the level of an individual sugarcane mill and the corresponding fields.

The method is slightly more complex than for the three options above:

1. Convert all sugarcane by-products to Total Digestible Nutrients (TDNs).
2. Convert TDN to a quantity of animal units (AUs).
3. Convert the AU into a surface required to produce enough grass to feed them – the resulting surface corresponds to the iLUC avoided area.
4. The amount of ethanol the mill produces on an equivalent area is iLUC-free.
5. Audit the quantity and quality of mill by-products and their uses, the cattle farmer purchasing and feeding the by-products, and ultimately the correct quantification of iLUC-free biofuel.

Sugarcane by-products include bagasse, molasses, yeast, cane straw, filter cake, vinasse and cane tops. Bagasse is hydrolysed to increase digestibility.

Only mills where more than 20% of by-products are fed to ruminants are eligible for certification. If 20% of by-products instead of 100% are fed to animals, the amount of iLUC-free biofuel is adjusted accordingly. This threshold avoids the inclusion of sugarcane by-product rations with a marginal contribution to cattle production.

In conclusion, we can say that the method looks pretty promising and easy to apply in the very near future. The methodology is a low-cost addition to existing sustainability models. The clear and simple message for policymakers is: there are methods coming to the market that allow production of iLUC-free first-generation biofuels.

Session 3 – Case studies of iLUC mitigation

INTEGRATING LINGO-CELLULOSIC CROPS INTO THE AGRICULTURAL LANDSCAPE

Göran Berndes, Chalmers University of Technology, Gothenburg

It is evident that society will continue to set a large 'footprint' on Earth, since our land use provides food and other products necessary for sustaining the increasing human population. It is also evident that the transition to a bio-based economy requires strategies for efficient use of biomass from sustainably managed landscapes. The management of natural resources to provide needs for human society whilst recognising environmental balance is the challenge facing society.

As mentioned by other speakers at the workshop, best agricultural practice adapted to local needs is a pre-condition for mitigation of direct and indirect LUC. However, the promotion of attractive options for bioenergy expansion does not require that displacement of food crop production should always be prevented. Displacement of food production is a common way of addressing negative impacts associated with prevailing agriculture practices. Results of poor practices include wind erosion, soil runoffs, salinisation and eutrophication of surface waters due to excess fertilisation. Biomass production systems can be integrated into agriculture landscapes so as to provide other ecosystem services than the provisioning service, i.e. the biomass supply.

There are many examples of how bioenergy systems – through well-chosen site location, design, management and system integration – can mitigate the negative impacts of current agriculture production and promote more sustainable uses of land and water. New biomass production systems can also help in improving habitat heterogeneity in agricultural landscapes and reverse the negative biodiversity effects of land abandonment in marginal regions. Maintenance of landscape components favouring biodiversity (e.g. wetlands and highly biodiverse grasslands) can be combined with biomass production.

Grassed waterways are often used in agricultural ecosystems as a best management practice to reduce erosion off fields and within ephemeral stream channels (Fig. 15). Terraces and other structures, such as buffer or filter strips with perennial vegetation, can slow surface runoff and trap sediments, nutrients and other contaminants. They can also reduce soil erosion. Shelterbelt plantations, or windbreaks, slow the wind to reduce wind erosion, provide shelter from the wind for livestock and homes, and can also trap snow (Fig. 16). Riparian buffer strips with trees, shrubs and grasses adjacent to streams, lakes and other water bodies provide habitat for wildlife, increase biodiversity and trap sediment and nutrients that would otherwise reach the water. The plant roots help to control bank erosion by holding the soil together.

Plantations can also be used as vegetation filter systems for the treatment (via irrigation) of nutrient-bearing water such as wastewater from households, collected runoff water from farmlands and leachate from landfills. Sewage sludge from treatment plants can be used as fertiliser in vegetation filters, supporting nutrient recirculation back to soils.

Figure 15: Grassed waterway in Marshall County, Iowa, USA

Photo: USDA NRCS

Figure 16: Field windbreaks in North Dakota

Photo: Public domain

Trees and shrubs can be used to address soil salinity by reducing groundwater recharge, either by using water in the root zone and reducing 'leakage' to deeper aquifers, or by reducing saline or potentially saline groundwater levels (putting them deeper beneath the ground surface) through roots directly accessing the water table and increasing discharge.

Phytoextraction is an excellent measure to remediate soils from heavy metals like cadmium. In Sweden, willow is used as an excellent crop to reduce heavy metals.

All these measures involve some degree of displacement or reduction of food production. But displacement of unsustainable food production is essential for obtaining sustainable land use (Fig. 17).

Figure 17: Measures to make landscape more sustainable

The right way of thinking is to integrate bioenergy systems as an opportunity to design landscapes that add ecological value. In addition, there are also direct measures to optimise land use in relation to biorefineries, such as reduction of nitrogen and phosphor application by introducing taxation on mineral fertilisers.

All this has nothing to do with the iLUC of biofuels. It is a far larger problem of unsustainable food production. The iLUC of bioenergy looks at a small individual system and thus often loses sight of the overall agricultural dynamics over hundreds of years, which, influenced by many parameters, are much more important.

The right, holistic way to go is to displace unsustainable land use for food, feed and energy and to establish sustainable land-use systems.

ILUC MITIGATION AS ILLUSTRATED IN REGIONAL CASE STUDIES

Birka Wicke, Copernicus Institute, University of Utrecht

Given the interlinkages between economic sectors and activities that enhance iLUC, the key to address ILUC mitigation is a holistic, integrated view on land use for food, feed, fibre and fuels. iLUC mitigation measures benefit the agricultural sector as a whole. It will be shown below, in several different ways, that we need to tackle the entire agricultural sector.

We have several options to mitigate and even prevent iLUC:

- Increase agricultural yields (the focus is on crops, but also includes livestock)
- Use biofuel co-products and by-products
- Increase chain efficiency
- Bring under-used land into production and demarcate land that should not be converted

The first and the last option of the four contribute the most to ILUC prevention and will primarily be dealt with below. The Copernicus Institute analysed and demonstrated these measures in regional case studies in Eastern Europe and South-East Asia, applying different scenarios.

Why was the focus put on the regions? The answer is obvious: if a region can demonstrate that it can produce additional biofuels while guaranteeing other production for food, feed and fibre, and does not expand onto high-carbon-stock land, then biofuel production in that region does not cause iLUC. In all case studies, the potential for increased production is significant, but not in all scenarios.

The approach chosen accounts for baseline projections of food, feed and biofuel demand, and determines how the key iLUC mitigation measures can contribute to meeting the additional biofuel demand under the EU biofuels mandate without undesired land-use change (Fig. 18).

There are a number of top-down models available like MIRAGE from the International Food Policy Research Institute (IFPRI). The applied bottom-up model not only compares the target production with the baseline but also with current production to avoid unsustainable food production. To calculate the biofuel potential from iLUC prevention measures (Fig. 18, point 2), a scenario approach was chosen (low, medium and high) where even the low is better than the baseline. This is to assess how far improvement is possible compared to 'business as usual, and how these different scenarios compare to the future demand projected by MIRAGE.

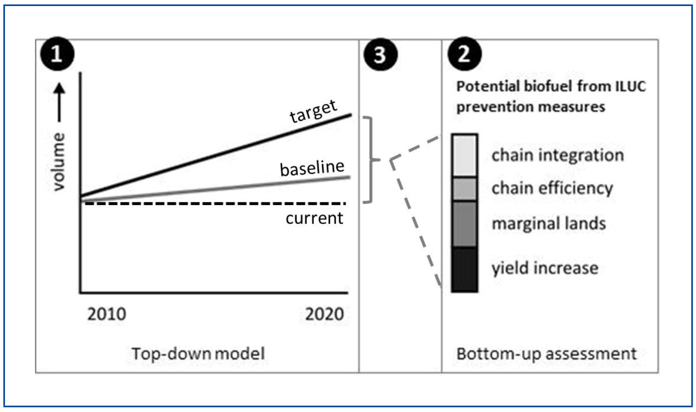

Figure 18: Top-down and bottom-up models

Three case studies were carried out in Eastern Europe: in eastern Romania with rapeseed biodiesel, in Hungary with corn ethanol, and in Lublin province, Poland with miscanthus-based ethanol. A fourth case study was done for northeast Kalimantan, in the Indonesian part of Borneo, with palm-oil biodiesel.

Mitigating iLUC while increasing crop yields

The potential to **mitigate iLUC with increased crop yields** was studied in all cases. To illustrate how the approach works, only the region of eastern Romania is described below.

The first step of the process is an assessment of yield developments of all possible cultures. For 2020 a production volume is fixed based on MIRAGE projections. Figure 19 illustrates the varying yields of rapeseed in three scenarios and how these compare to past yield trends in other countries. In a second step, the land area that could be made available for biofuel production (through yield increases) is calculated.

To provide a range of potential yield increases, a low, middle and high-yield development scenario was formulated based on, for example, historic yield trends in Romania, best counties in eastern Romania and neighbouring regions, or projections for the maximum attainable yield. Fig. 19 shows the yield development of rapeseed in the different regions as an example. Even a low-yield scenario has a high effect on available land, whereby 11% of the National Renewable Energy Action Plan energy goal could be covered, even though it was assumed that rapeseed is grown only every fourth year as part of crop rotation. Similar projections have been done for all major crops.

All model calculations demonstrated that increasing yields has a huge potential to reduce the land area needed for meeting the baseline demand for food crops; hence there is a considerable amount of land available for biofuel production. Of course, the selected case studies focused on the most promising regions, which are expected to see large increases in production in the near future. But regions with already high yields also have the potential to increase yields further, albeit with less dramatic changes.

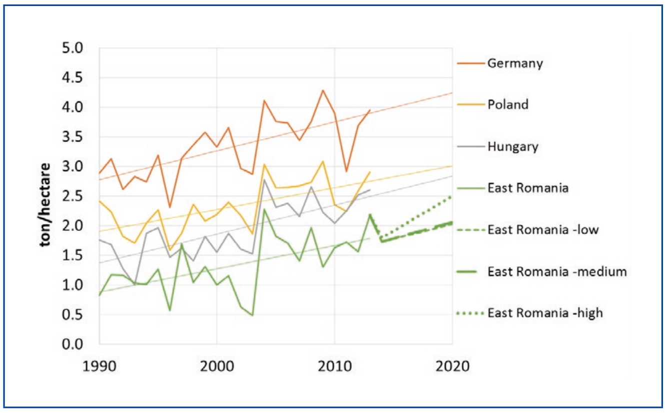

Figure 19: Rapeseed yields in different East European regions

Mitigating iLUC through using underused land and land zoning

The second option evaluated to mitigate iLUC was the **use of underused land and land zoning**. The approach is different from the previous one because it is not about getting higher yields from existing land. The target is to find out if non-agricultural land is available and suitable for biofuel production without touching excluded land such as forests, wetlands, protected areas, etc. The effect is showcased for northeast Kalimantan in Southeast Asia. The approach included the following steps:

1. Assessment of the type of land potentially available (degraded, abandoned, marginal, unused, etc)
2. Definition of the optimal plot size (what size shows the best economy, 2, 5, 10 or more hectares?)
3. Suitability for growing biofuel crops
4. Land zoning (carbon stocks, protected areas, current use)
5. Assessment of yields on under-used land

In Kalimantan, degraded land has the highest potential for biofuel production. Unfortunately, the Renewable Energy Directive (RED) does not properly define what degraded land means, hence it is difficult to measure it in the field. Questions like 'Can we use degraded forest, Imperata grasslands (Cogongrass) or deforested land not in use?' had to be answered rather arbitrarily. The World Resources Institute (WRI) has developed the *Suitability Mapper* in order to help identify potentially suitable sites for sustainable palm oil production. The tool was applied to assess under-used land areas in this case study. The criteria applied are given in Table 2.

Table 2: Criteria for suitability and availability in the Kalimantan case

Scenarios and settings	Low	Medium	High
Slope and elevation	Optimal growth conditions	Conditions where additional measures are needed	WRI default settings
Rainfall			
Soil drainage			
Land cover	Existing agriculture may not be displaced		

Peatland was excluded and, as a buffer of at least 1000m, a conservation area was applied in all scenarios. While a tool like the Suitability Mapper can indicate potential areas for development, it is important to verify if the area is really available. The World Resource Institute has verified the model result of a case study in west Kalimantan; it found that only 40% of the calculated area is available in reality. The same percentage was applied for the case study in NE Kalimantan. However, the actual proportion needs to be determined by field checks. Assuming 40% availability, the production increase could still be very high even in the low scenario; currently 0.4m tonnes are produced in the region, which could increase up to 3.4m tonnes on the additional 0.85m hectares underused land even in the low development scenario. The models showed that in Kalimantan underused land has the highest potential for additional palm oil production compared to the other measures.

Table 3: Translation of developed free surface into biofuel potential

	Hungary (corn)	E. Romania (rapeseed)	NE Kalimantan (palm oil/CPO)
Current production (Mt)	7.2	0.28	0.4
Additional iLUC free production by 2020: low–high (Mt)	2.5-7.3	0.2-1.9	2.4 – 8.1
MIRAGE projection 2020 for EU biofuel target (Mt)	0.9	0.15	0.18
Ratio iLUC free potential: MIRAGE projected production (low–high)	3–8	1 – 13	13–45

Analysis shows that additional biofuels can be produced without displacing other uses and functions. However, there is hard work ahead to achieve the calculated result. Yield development is a key measure in all case studies, with a focus on all crops of the entire agricultural sector. It is essential to increase knowledge and capacity-building (e.g. seed quality, fertiliser use, and machinery), and to improve availability and access to high-yield seeds, planting material, fertiliser and technology (incl. capital). Without incentivising investments – e.g. with long-term contracts or price guarantees – nothing will move forward.

A pre-condition for increased integration of unused land is to improve information on land use, cover and soil (spatially and temporally detailed), and to improve monitoring so as to enable more informed decisions on land zoning.

The simple take-home message is: iLUC can be prevented if an integrated perspective on land use for food, feed, fibre and fuels is taken, and productivity and resource efficiency is increased in the whole production chain.

PASTURE INTENSIFICATION AND DOUBLE-CROPPING AS MECHANISMS TO MITIGATE ILUC

André Nassar, Director Agroicone

The calculations of iLUC factors are based on two steps: step one is the estimation of iLUC per surface unit, and step two is the translation of iLUC into GHG emission. Some models integrate both steps and others don't.

The results of step one tend to overstate iLUC because they are very conservative as regards yield improvement. In addition, they use global equilibrium models (general or partial), even though there are some attempts to use allocation procedures based on historical data. The models have been strongly improved, but are still incomplete.

For step 2, different models are available; some are spatially explicit, and others not. Since global models do not always consider the types of land converted (only the amount of conversion on forests and pastures), emissions models allocate 'iLUC per ha' over types of 'non-productive' land.

Independent of calculation models, there are a number of primary measures (Table 4) that can significantly mitigate iLUC (with a focus on Brazil):

- Reducing deforestation over time through policies, monitoring, command-and-control sanctions, land-use planning, zoning (but out of the scope of bioenergy systems)
- Increasing the yields of individual crops, induced by technological improvement or price-induced
- Making land more productive by reducing yield gaps on crops, increasing productivity in grass-fed cattle systems and integrated systems: double-cropping and crop-livestock
- Developing crops suitable for marginal, degraded or low-precipitation lands

The introduction of soy/corn double-cropping brought essential advantages in Brazil. It started with the development of short-cycle soy varieties, allowing corn to be planted after soy; 100% no till is applied in areas where 90% of the corn-planted area is rain-fed. The system is very efficient in energy use and carbon footprint reductions. Potassium and phosphorus use was optimised with minimal nitrogen fertiliser addition because soy does not require nitrogen. Unfortunately, it requires herbicides for the no-till cultivation. The system has saved around 9M ha in the last 10 years, with reduction of the first crop area (around 3M ha) and increase in the second crop (6M ha). Currently, each additional 1ha of soy leads to a yield reduction corresponding to 0.17ha in first-crop corn but to a yield increase corresponding to 0.50ha in second-crop corn. The improvements of ecological factors are considerable (Fig. 20).

Table 4: Options for mitigating iLUC

Options	Opportunities/weaknesses
Reducing deforestation	• Very important but long term • Requires government empowerment • Much broader agenda than biofuels • Models are shy in this issue
Increasing the yields of individual crops	• Can bring positive effects in the short term • But rate of yields increase in crops is decreasing (contribution is low) • GMO • Model capture that effect
Reducing yields gaps on crops	• It can have huge effects • Require capacity building • Long term • Models capture but tend to be conservative
Increasing productivity in grass-fed cattle systems	• **It can have even larger effects given that 2/3 of agricultural land is used for grazing** • **Models are conservative and pasture intensification is a consequence not a driving force (CETs and competition elasticities are not calibrated to achieve real pasture intensification**
Integration systems: double-cropping and crop-livestock	• **It is a reality but it is not captured by models.** • **Short term**
Developing crops suitable for marginal, degraded or low precipitation lands	• Long term • Probably will have lower effects than pasture intensification

The second most important factor is pasture intensification. Roughly two-thirds of the world's agricultural area is occupied by pastures and meadows. The repartition between natural and planted/managed grassland is not known. However, there is good data available on Brazilian regions that can increase pasture productivity.

Planted/managed pastures in Brazil cover 115M ha (of which 10M is considered degraded land). In addition there is 60M ha of perennial grassland used for cattle-raising. Productivity is growing but is still below the potential. Pasture intensification means that grass-fed cattle fattening has the potential to produce more meat per unit of land, without increasing cattle herd, but reducing the pasture area. It is a function of better-breed animals, managed pasture, rotation grazing and some specialisation (calf crop, yearling, finishing).

Nevertheless, the results achieved are considerable. Livestock production (kg meat per ha) remained constant while the need for pasture dramatically dropped (Fig. 21).

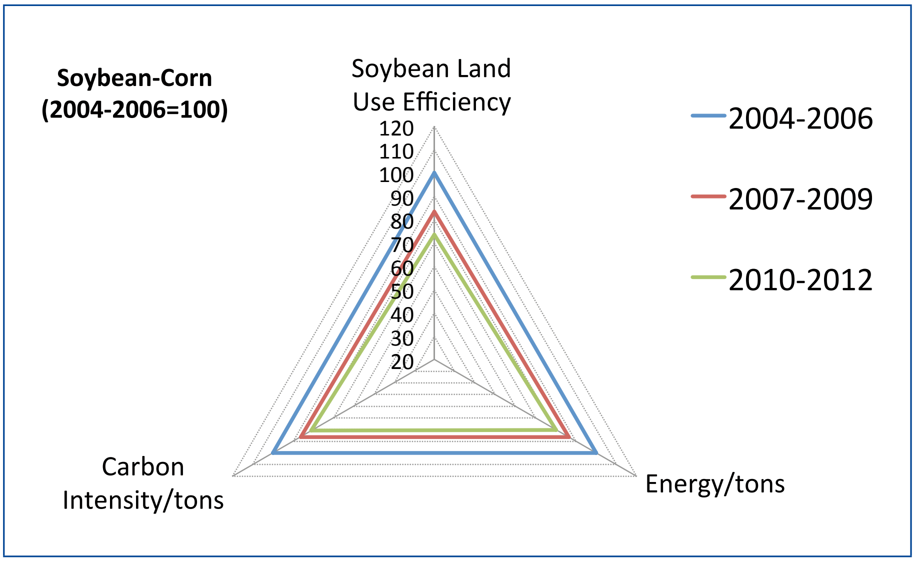

Figure 20: Soy-corn system environmental indicators

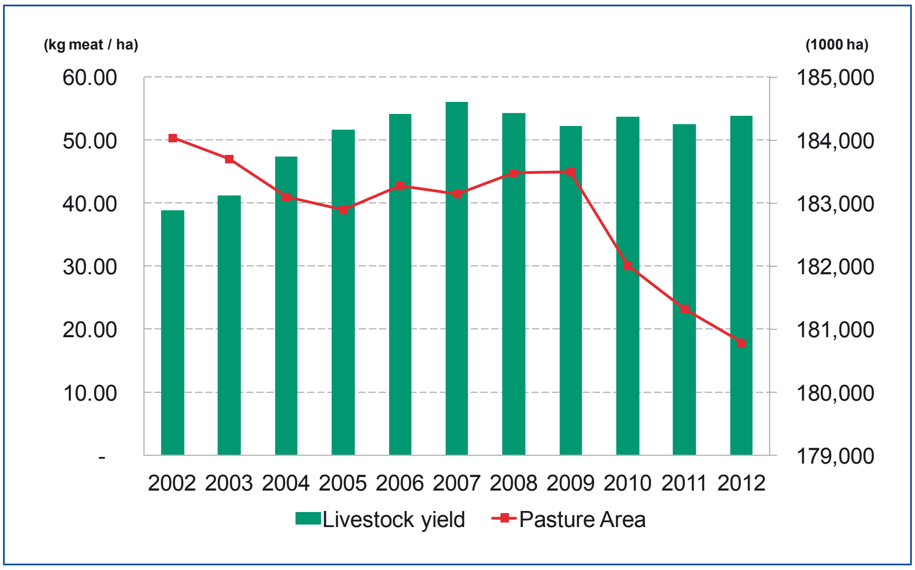

Figure 21: Livestock yield improvement in Brazil

Based on this analysis, the message to policymakers is simple and clear: Instead of setting a cap, give industry more room for making improvements towards zero iLUC emissions.

Session 4: Global aspects of iLUC mitigation

MODELLED VS OBSERVED LAND-USE CHANGE – WHY THE DIFFERENCE?

Don O'Connor, (S&T)² Consultants Inc.

A number of different economic models have been used to estimate the indirect land-use emissions from an expansion of biofuel feedstock production. All of these models project an increase in cropland and a decrease in forests and pasture areas in the region that requires the biofuel and in other parts of the world. Many modellers have resisted any attempt to reconcile the model results with the real-world observations. While this resistance was perhaps justified in the first few years of expanded biofuel use, there is now a significant amount of data available, and it doesn't match the model results.

Before entering the details we need some definitions:

- *Cropland:* Land that has been cleared for growing crops, including land that may have been fallow in the past five years – FAO calls it arable land
- *Harvested Area:* Cropland that produced a crop; in a double-crop system, the harvested area is counted each time a crop is produced in a year
- *Harvest Frequency:* Ratio of harvested area to crop land
- *Idle Land:* Difference between Cropland and Harvested Area

Why are models and reality different? Most iLUC models have used a mixture of land types. Harvested area is provided by the crop produced. Most models assume that an increase in harvested area requires an equivalent increase in cropland. However, the available data on land-use change shows that there has been no significant change in the amount of cropland in those parts of the developed world where there has been a significant expansion in biofuel production and use. The primary reason for the discrepancy between the models and reality is that the models have not properly accounted for cropland that is not being fully used to produce at least one crop per year. Many models have a full accounting for cropland and for the harvested area, but do not reconcile these two different quantifications. The difference between the two land accountings is generally idle land. It may be in fallow as part of a traditional rotation, it may have been temporarily converted to seeded pasture to allow the soil to rebuild, or it may be part of a setaside program. There are a few exceptions, and the models have been slowly adding some land categories that fall into the gap between cropland and harvested area. The model GTAP added a little bit of idle land in the US and, no surprise, more land was available for other uses like biofuels, and iLUC emissions dropped significantly.

From 1961 to 2009 the harvested area in the world increased by more than 30%, while the cropland increased by about 12% only (Fig. 22). Of the increase in harvested area in the last decade, 75% came from increased harvest frequency. We are making better use of existing land through increased double-cropping, reduced summer fallow, and reduced cropland pasture (cropland temporarily in pasture).

Since the models equate a change in harvested area with an equal change in cropland, they grossly overestimate the real-world impact. We have to realise that the world land-use change patterns are not homogenous.

Specific examples from Canada show that cropland peaked in 1989 (Fig. 23). Since then it has decreased by 9%, but the harvested area in annual crops has increased by 6%. There has been an increase in harvested area due to a reduction in summer fallow and seeded pasture. The result coincides with increased adoption of no-till agriculture and the emergence of canola/

rapeseed as a major crop. This has led to a large build in soil carbon. Double-cropping is not a factor in Canada due to the short growing season.

In the United States, cropland decreased in the past decade despite a large increase in biofuel production. In addition to changes in seeded pasture and fallow area, there has been an increase in double-cropping in the US. Due to the high crop prices, there has been an economic advantage to producing two crops on the same land each year in those areas where the climate supports double-cropping. Idle land has slightly decreased.

Changes in diets, increased crop yields and improved livestock feeding efficiency are overwhelmingly offsetting population increases and higher food consumption rates in the US. Beef-meat consumption peaked in 1978, at over 90 pounds per person, but has declined since by more than 30%. The net impact is a reduction in the land required to supply livestock feed. During the same period, poultry-meat consumption increased by a factor of two, from 34 to over 70 pounds per person. Until 1978 the land for livestock feed production remained unchanged in spite of increased population, due to better efficiency in livestock production and higher yields. Since then, the land demand for feed has decreased due to changing dietary patterns, and the excess land has been used for biofuel production.

In conclusion, most iLUC models overestimate iLUC emissions because they don't properly account for cropland that is not fully used. All regions of the world are making more productive use of existing cropland, and in consequence, the surface per person needed to produce enough food and feed is decreasing (Fig. 24).

In the developed world there is no evidence of an increase in cropland, but there has been some increase in harvested area thanks to more double-cropping, less summer fallow and less crop pasture/seeded hay.

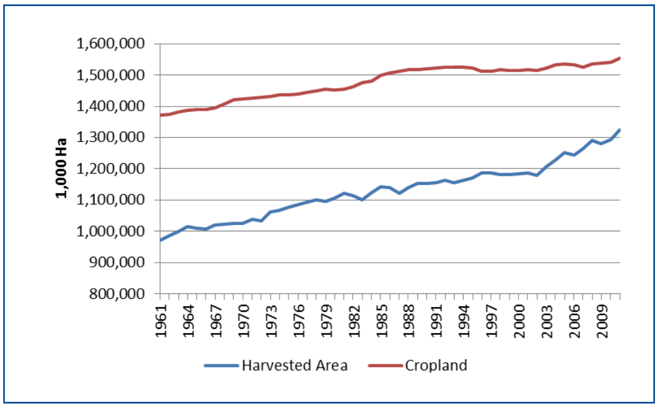

Figure 22: Global cropland change

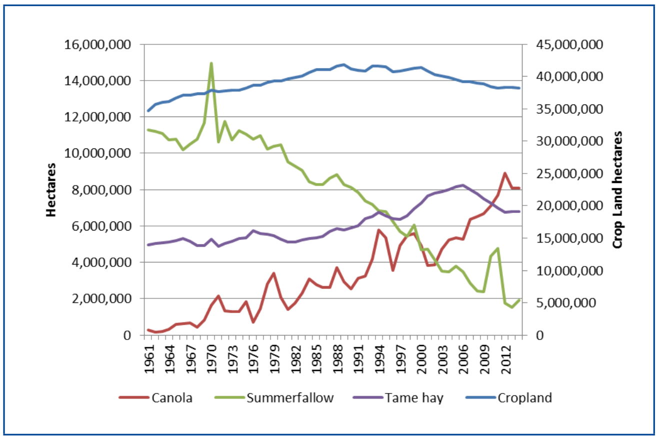

Figure 23: Development of agricultural land in Canada (tame hay is the same as cropland pasture in the USA)

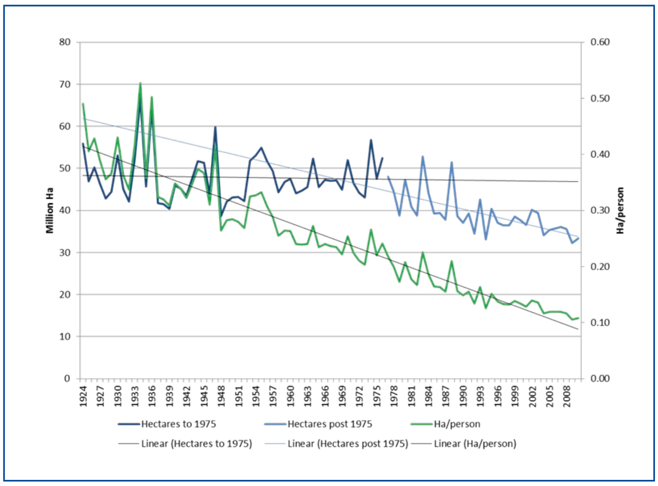

Figure 24: Impact of current trends in agricultural practice on land demand

REDD+

Danae Maniatis, UNDP Consultant

The UN-REDD program is the United Nations collaborative initiative on Reducing Emissions from Deforestation and Forest Degradation (REDD) in developing countries. The programme was launched in 2008 and builds on the convening role and technical expertise of the Food and Agriculture Organization of the United Nations (FAO), the United Nations Development Program (UNDP) and the United Nations Environment Programme (UNEP). The UN-REDD program supports nationally led REDD+ processes and promotes the informed and meaningful involvement of all stakeholders, including indigenous peoples and other forest-dependent communities, in national and international REDD+ implementation.

REDD+ holds the promise of multiple benefits for climate, development and conservation in the forest sector at national and global levels. The UN-REDD programme supports countries in realising these benefits from forests and REDD+ through support of their national REDD+ programmes and targeted support. As countries advance their REDD+ readiness and develop national strategies to address drivers of deforestation and forest degradation, the cross-linkages with the other sectors and themes within national development planning become apparent. It is crucial, therefore, to strengthen national multi-sectoral ownership of the REDD+ agenda, if REDD+ is to meet the expectation for deep change. Such comprehensive change includes ensuring that REDD+ provides benefits for development, including but not limited to poverty alleviation and gender dimensions.

There are 56 partner countries in Asia-Pacific, Africa, Latin-America and the Caribbean. There are 21 countries with approved funding for UN-REDD programmes; the rest receive project-oriented support. In total, REDD has received US$ 215M from Denmark, the European Union, Spain, Norway, Luxembourg and Japan.

The five core activities of REDD are:

I. Reducing emission from deforestation

II. Reducing emission from forest degradation

III. Conservation of forest carbon stocks

IV. Sustainable management of forests

V. Enhancement of forest carbon stocks

The heart of REDD+ consists of four design elements (Fig. 25). They are all interconnected, and address national leadership, stakeholder engagement and participation. The REDD+ concept is based on all stakeholders from research to policy, even though they all speak a different language.

Figure 25: The four REDD+ design elements

One of the key goals of the REDD+ readiness process is to develop a national REDD+ strategy that identifies policies and measures and results-based actions. This target is achieved in different steps including assessments, multi-stakeholder discussions, risk analysis, reporting and, finally, the formulation of a roadmap leading to the strategy. The policy and framework assessment provides detailed analysis of the nation's natural-resource governance frameworks for its potential to support REDD+ implementation. The work with stakeholders as part of the institutional and concept analysis helps to identify gaps, and to prioritise needs and options consistent with the REDD+ Strategy Roadmap. An important outcome of stakeholder discussion is the identification of the direct and indirect drivers of deforestation and forest degradation. If indirect drivers in a country are not understood, direct drivers are difficult to understand also.

One of the most laborious and difficult steps is the creation of national land-use and land-cover standards. The basis is an overview on unmanaged and managed land, distinguishing between the six classes according to the Intergovernmental Panel on Climate Change (IPCC): forest land, cropland, grassland, wetlands, settlements, and other land. An inventory of forest, biodiversity, agriculture, and socio-economic data benefits a wider range of stakeholders than the forest sector alone. After the land-use inventory has been established, a reporting system of land-use change is to be introduced and monitored. Capacity-building is an important part to assure monitoring.

The road map to a national REDD strategy could include:

- Description of the respective roles and responsibilities of the leading institutions and stakeholders (with a single institution mandated to direct and supervise the overall process)
- Identification of the main steps and corresponding support documents of the programming process (e.g. issue and option paper, investment plan), with adequate regular technical and/or validation processes
- Stakeholder engagement strategy
- Capacity-building plan
- Roadmap of analytical work – integrating work planned under the % year action plan
- Preliminary vision of the positioning of the strategy document in the wider national planning framework (Climate Change, Development, etc)
- Endorsement by the leading institutions and stakeholders, with a common understanding on the way towards the formulation of the strategy

The formulation of a strategy entails a cross-sectoral approach across all ministries (Fig. 26). Only after a strategy has been elaborated and politically accepted can the country ask for financial support. To achieve that in a reasonable amount of time (e.g. within a five-year plan), countries need help. Some countries got great support from Brazil, which was the first REDD+ partner to provide data that had been evaluated and accepted.

It is quite a success for a country when the reporting of land use can be established. It is an even greater success when land-use change is reported and monitored. Addressing iLUC is not an immediate main priority for a country. Proper land management together with capacity-building is already half way to iLUC mitigation and prevention.

Figure 26: REDD+ needs a cross-sectoral approach for success

PANEL DISCUSSION

Moderator: Tat Smith, University of Toronto

Participants: Andreas Pilzecker (European Commission); Kees Kwant (Netherlands Enterprise Agency); Ricardo de Gusmão Dornelles (Director, Department of Renewable Fuels, Ministry of Mines and Energy, Brazil); Corinne Drennan, Pacific Northwest National Lab, USA

Tat Smith began by asking the panellists to give a short statement. He reminded the participants that the goal of the discussion should be to draft a clear message 'in a nutshell', as initially requested by Marie Donnelly – and suggested that they might formulate this as a more personal question: What message are you bringing back to your government?

Short statements by panellists

Kees Kwant: In the Netherlands, pilot projects were funded to show that iLUC can be mitigated. The major message I take home is that we need a holistic view on the whole biomass production, and then iLUC can be prevented. But we will need to prove now to our politicians that it works. The Low Indirect Impact Biofuels (LIIB) methodology might be a way to prove it.

However, to start with we need some political support to allow the bio-economy to grow. The goal can only be achieved with a market-driven approach. Agriculture, therefore, has to play an important role.

Corinne Drennan: It is rather implicit to most of the iLUC models that certain feedstocks are excluded. In light of our inability to adequately measure iLUC on a global scale, we need robust models. For example, if we want to prove that iLUC can be prevented by implementing best agricultural practices, we need improved models that reflect today's realities.

Ricardo Dornelles: Brazil was some time ago a bad guy and has come a long way since. We have reduced deforestation substantially with a variety of measures such as stringent legislation and collaboration with REDD+ and NGOs. But still we have a lot of antagonists to the deployment of bioenergy. Let's continue to prove that it is a success story, with improved agricultural practice and optimised models, based on the facts we have learned today; but above all let's talk about the success stories.

There is still lots of room to improve, e.g. in policy. Brazil has a ministry for each and every topic bioenergy has to deal with. It is important that there is dialogue at the top level.

There are still too many bad examples of agricultural practice. Let's tackle them and replace them with good practice, and thus convince our adversaries that they are wrong.

Andreas Pilzecker: The EU is reducing the pressure on first-generation biofuels for the time being, but will take the topic up again after 2020. This leaves us some economic room to develop optimised agricultural systems. There is a clear role for agriculture in the development. We have to address biomass as a whole instead of approaching it from the tail, which is biofuel. It is just too small and unimportant to have a significant impact. Best agricultural practice is key to success.

Models are very important to guide the way, but the weaknesses they have mean that they restrain application. Don O'Connor is working on a study to bring more light into modelling.

Discussion with workshop participants

The panellists' statements were followed by an open discussion with the workshop participants. It was argued that, if the EU is not introducing a strong target for transport fuel after 2020, there might be no need for improved models anymore.

There was a clear statement from the audience that advanced biofuels also involve an iLUC risk. Politicians should be made aware that their simple assumption of second-generation biofuels being iLUC-free and therefore sustainable is wrong. Hence, it cannot be taken for granted that policies such as those of the EU will lead automatically to iLUC-free fuels. However, it was argued, the message should be formulated more positively so as to convince politicians that not all biofuels are bad, whether first or second-generation. Legislation should not penalise all of them. We have to prove that with good and easy-to-understand examples.

The contributions showed that key to iLUC prevention is sustainable intensification (sustainsification) of productivity. But intensification needs more fertiliser, and how can we intensify productivity without doing harm (e.g. through over-fertilisation)? And what about biodiversity and intensification? Application of natural fertilisers is mandatory because of the environment, to close the cycle and reduce the need for artificial fertilisers. This also reduces energy consumption due to fertiliser production. The contribution of Göran Berndes (see 'Integrating lingo-cellulosic crops into the agricultural landscape', above) showed that, to ensure sustainable development, including biodiversity and water, part of the land has to be 'sacrificed', as already requested under European legislation. Ecological areas are an integral part of best agricultural practice.

Improvement of yield is ultimately leading to investments. If industry should invest then we need a long-lasting policy. A clear vision for the use of biomass has to be formulated, and it has to be linked to the current situation. This will enable roadmaps to be drawn up.

All stakeholders have to play with open cards and be fully transparent. There is no secret that, even in Brazil, there is still a long way to go. For example, a 20% reduction in land use for cattle production is excellent, but it is not enough to avoid ongoing deforestation. One of the main factors is that the cattle herd is not being increased, but rather being intensified.

Mato Grasso state could lead the way. It has developed a model to achieve zero deforestation by 2020, which can be achieved by 65% cattle fattening with average cattle yield and by 30% fattening with low cattle yield. The problem is how to get this concept across to the very conservative cattle growers. Some municipalities are achieving zero deforestation already in collaboration with NGOs, meatpackers and slaughterhouses.

Conclusions

As a result of the workshop, it became clear that the sustainability discussion cannot be left to the modellers alone but has to include all stakeholders. The participants reached general agreement that any discussion of iLUC should be based on a holistic approach, including production of food, feed, fibre and fuel. If this is accepted, it is evident that agriculture (and forestry) has to play a central role.

Instead of simple legislative limitations on biofuel production, room should be given to the whole biomass production, allowing market-driven, sustainable development. Models will continue to play an important role in guiding and monitoring the sustainable development, but they have to be improved so as to reflect the real-world situation.

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