Institute for European Environmental Policy

BIOFUELS AND ILUC – Q&A

Answers to common questions surrounding the debate in Europe on Indirect Land Use Change

Prepared by:
Institute for European Environmental Policy (IEEP)
11 Belgrave Road
IEEP Offices
Floor 3
London, SW1V 1RB
United Kingdom

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Biofuel ExChange:
Pursuing change in biofuels policy and developing alternatives

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Corresponding authors: Ben Allen (ballen@ieep.eu)

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For more information: www.ieep.eu/minisites/pursuing-change-in-biofuels-policy-developing-alternatives/

Institute for European Environmental Policy
11 Belgrave Road
IEEP Offices
Floor 3
London, SW1V 1RB
Tel: +44 (0) 20 7799 2244
Fax: +44 (0) 20 7799 2600

Brussels Office
Quai au Foin, 55
Hooikaai 55
B- 1000 Brussels
Tel: +32 (0) 2738 7482
Fax: +32 (0) 2732 4004

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ACRONYMS

ABE	Acetone-Butanol-Ethanol
CAP	Common Agricultural Policy
DDGS	Dried Distillers Grains with Solubles
DLUC	Direct Land Use Change
EFA	Ecological Focus Area – as proposed in COM(2011)627/3
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FAME	Fatty Acid Methyl Ester
FQD	Fuel Quality Directive
FSS	Farm Structure Survey
GHG	Greenhouse gas
GTAP	Global Trade Analysis Project
ha	Hectares
IFPRI	International Food Policy Research Institute
ILUC	Indirect Land Use Change
Mha	Million hectares
LUCAS	Land Use Cover Aerial Frame Survey
MEP	Member of the European Parliament
Mtoe	Million tonnes of oil equivalent
NGO	Non-governmental Organisation
NREAP	National Renewable Energy Action Plan
OSR	Oilseed rape
RED	Renewable Energy Directive
REDD	Reducing greenhouse gas Emissions from Deforestation and forest Degradation in developing countries
RVO	Recycled Vegetable Oil
toe	Tonnes of oil equivalent

EXECUTIVE SUMMARY

This report is set in the context of the European Commission's proposal to mitigate indirect land use change (ILUC) impacts from transport related biofuels. For this purpose a range of amendments to the Renewable Energy Directive (RED) and the Fuel Quality Directive are proposed. These are generally welcomed, at least as a basis for discussion, by those who accept the ILUC is a problem but they do have potentially wide ranging implications.

The Commission's proposals (COM(2012)595) has brought a number of different actors together to debate a complex and wide ranging policy, one that covers multiple sectors and policy areas. The ILUC dossier is being discussed currently in both the European Parliament and the Council of Minsters with parallel discussions taking place among different stakeholders. For the ILUC proposal to lead to an agreed way forward it is important to have a common understanding of the key points of the debate and what they mean to different interests and individuals.

There remains a great deal of uncertainty surrounding the Commission's brief proposals with a lack of information around definitions, implications and expectations. This has lead to a number of frequently conflicting statements put forward by different stakeholders in response. While not exclusively, many of the arguments concern the role of biofuels and their impacts on the agricultural sector. Some of the simpler statements being made on this topic can either be misleading or obscure the need for a more subtle and balanced discussion. Though brief, this document tries to disentangle some of the statements that have been and continue to be made in the current debate and to contribute to an informed discussion by political decision makers.

ILUC and land in the EU

Q1 – Is there enough land on which to grow biofuels in the EU? *Possibly but there are consequences. Modelling studies that predict the expansion of cropland…*

Q2 – What are the implications for food production? *There are certainly trade-offs between using an area of land to grow a biofuel feedstock (often with resulting co-products that can be used for animal feed) and growing food for direct human consumption…*

Q3 – What about marginal or unused land? *There is some limited scope for this, but there are significant constraints and potential drawbacks. Agricultural land can be considered marginal or on the edge of viability for normal production for a variety of reasons…*

Q4 – Can we rely on future yield increases to mitigate ILUC? *This is uncertain and will vary between regions of the world. Yield increases can be achieved for some crops grown as feedstocks…*

Q5 – Do increased crop prices result in increased yields and production? *In some circumstances but not invariably. Sustained increases in prices over time can be expected to drive land use change where this potentially can be realised…*

Q6: How do higher demands for first generation biofuels affect food prices? *In a variety of ways. In principle, if there is a rise in demand for crops that can be used either for food or biofuel feedstocks prices can be expected to rise…*

Q7 – Will plans to 'green' the CAP result in ILUC? *The greening plans, including 'Ecological Focus Areas' are still being finalised but they are not expected to have any significant ILUC impact. The European Commission's proposals for the Common Agricultural Policy…*

The role of co-products in mitigating ILUC

Q8 – Do co-products have a role in mitigating ILUC? *Yes, up to a point, where useful co-products can be derived from feedstocks dedicated to biofuel production. But there are complications and it is not simply a case of substitution...*

Q9 – Does the IFPRI study consider the use of biofuel co-products as animal feed? *Yes, co-products are an integral part of the IFPRI model. However, one question that is asked is …*

Q10 - Will the Commission's proposed cap on conventional biofuel supply lead to a lack of protein-rich co-products and increased feed imports? *No not necessarily. Protein-rich co-products are already produced from…*

Biofuel feedstocks and the agricultural sector

Q11 – What are the existing uses for the EU oilseed rape output? *Largely for biofuels, but the market potential for expansion in the food industry exists...*

Q12 – Does oilseed rape play an important role on farms as an agricultural break crop? *Yes but there is a range of other crops that could do the same or even a better job…*

Q13 – Would reduced support for biodiesel be seriously disruptive for EU agriculture? *No. There would be adjustments to be made in some countries but farmers switching to other crops would continue to get payments for each hectare under the CAP…*

Q14 – Will ILUC policy adversely affect employment in the agricultural sector? *Unlikely. The Commission's impact assessment that accompanies the ILUC proposal is clear….*

Biofuels and sustainability risks

Q15 – Why not tackle ILUC by preventing Direct Land Use Change (DLUC) in areas where it would be inappropriate? *In principle, preventing direct land use change in sensitive areas, such as land that is important for biodiversity and soils with a high carbon stock, at a global scale and for all land-using sectors would be a robust solution …*

Q16 – Do ILUC factors attribute environmental problems in third countries to European farmers who produce in an environmentally friendly way? *No, although some people have perceived it this way. The evidence that production of additional biofuel feedstocks in different parts of the world…*

In discussing the answers to these questions we have raised some of the issues that lie at the heart of the debate surrounding the future of biofuels in the EU. They touch upon a range of different sectors including agriculture, (transport) energy, waste and trade amongst others and the answers are not always straightforward, even when the general principles are fairly clear.

Some questions have unambiguous answers, others are more conjectural, and several assumptions need to be made to address them. We have tried to indicate the key assumptions that we have made in answering some of these questions and have added references in a number of cases. In many areas the evidence is good, but it is not complete, nor is it likely ever to be so. It will therefore be necessary to assume a degree of caution and as part of this, to focus at least some of the policy response on ensuring that sufficient (environmental) safeguards form part of the final agreed text.

A good understanding of different sectors, the issues that relate to them and the evidence and studies used to inform models and decisions will help both to foster integrated thinking and build a robust policy to deal with ILUC and other impacts of large scale production of first generation biofuels.

1 INTRODUCTION

This report is set in the context of the European Commission's proposal to mitigate indirect land use change (ILUC) impacts from transport related biofuels. For this purpose a range of amendments to the Renewable Energy Directive (RED) and the Fuel Quality Directive (FQD) are proposed. These are generally welcomed, at least as a basis for discussion, by those who accept the ILUC is a problem but they do have potentially wide ranging implications.

Following the Commission's proposal on Indirect Land Use Change (ILUC) tabled on 17 October 2012, stakeholders are debating the merits and weaknesses of the proposed legal text. Questions related to ILUC and discussions on ways of mitigating it are cross disciplinary touching upon agriculture, (transport) energy and trade amongst others. The purpose of this briefing is to investigate the uncertainties surrounding the current debate, provide clarity where possible and highlight areas for future research.

Clearly there are many such uncertainties and without attempting to rationalise all sectoral interests in the ILUC debate they cannot all be dealt with simply. In this briefing we focus on four different areas: landuse; co-products and food crops; the agriculture sector; and other wider sustainability aspects of biofuels. These are explored through a series of questions that have been raised during the debate and some suggested answers. The answers to some questions are fairly clear, others raise uncertainties and require more research. The briefing is aimed particularly at those involved in the current debate on the use of biofuels in Europe and the policies involved, particularly concerning land use change.

Before delving into specific questions, the broader issues of ILUC, biofuels and their land requirements are introduced first.

1.1 ILUC explained

Increased demand for land based biofuels made from agricultural crops affects demand for cropland on which the feedstocks are to be grown, assuming stable or, more realistically, increasing future demand food and livestock feed. This increased demand can be accommodated to a certain extent and in some places by intensification of current land use or it can lead to more land being taken into production. Assuming higher yields will not keep pace with increasing demand, which is anticipated to be the case at least in the majority of Europe, there are three ways in which the land demands for biofuels can be met:

- conversion of existing crop land from current production to meet the biofuel need either through the growth of a new crop or through an existing crop being diverted to a different use, ie wheat no longer used for food but as a biofuel feedstock;
- conversion of land that is currently under pasture or another form of livestock management for feedstock production; and
- conversion of land currently not used for agricultural purposes.

In the case of the former two options, ie conversion of land that is currently used in some way for agriculture, there is the potential for indirect land use change consequences as current production activities are displaced to other areas to make way for biofuel feedstocks, resulting in increased greenhouse gas (GHG) emissions.

The Commission's proposal includes the potential to take account of ILUC impacts directly through the use of ILUC factors. Their purpose would be to take into account the emissions from indirect land use change caused by different groups of crops as part of the GHG life-cycle calculations required by the RED sustainability criteria. Oil seed crops (for biodiesel) are attributed much higher emissions than cereals and sugar crops (for bioethanol), for the purposes of the reporting requirement in the proposed Directive. In other words ILUC factors could have a significant influence over whether or not certain biofuels (based on their feedstock) meet the minimum GHG saving requirement requirements of the RED. However, in the official proposal they are downgraded to reporting items only.

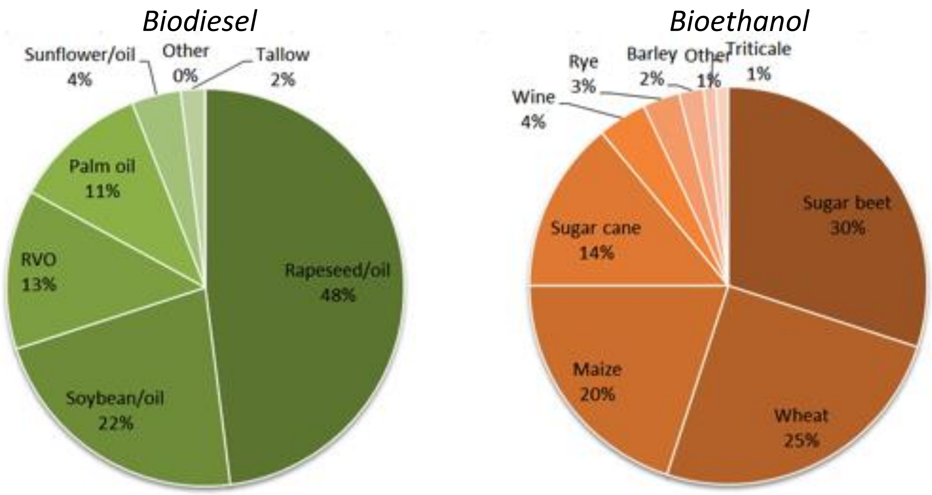
Before exploring some of the uncertainties and questions surrounding the ILUC debate, it is worth setting out some basic information about biofuels, their feedstocks and land requirements in the EU. This provides the background to some of the questions that follow, especially those concerning agriculture and wider land use.

1.2 Current and projected importance of different biofuel crops in the EU

Biofuels, principally bioethanol and biodiesel in Europe, often are divided into two broad categories, conventional and advanced. Conventional biofuels currently dominate consumption in the EU and globally. They are produced from agricultural feedstocks that could otherwise be used for food and livestock feed production and use conventional methods in the production process such as distillation or direct oil extraction. Advanced biofuels occupy a much smaller market share and are produced using more modern conversion technologies such as enzymatic digestion or thermochemical conversion. These advanced processes can utilise a wider range of feedstocks beyond food and feed crops (although this is not always the case).

Figure 1 shows that rapeseed/oil dominates the market for biodiesel destined for EU consumption, amounting to over half of the total feedstock used. The resource base is more diversified for ethanol, with sugar beet, wheat, maize and sugar cane dominating current markets.

Figure 1: Shares of feedstock for biofuels consumed in the EU in 2010



Source: *Own calculation based on* (COM(2013)175)*, Tables 7 and 8.* ***Note:*** *The left-hand panel shows the feedstock split for biodiesel, the right-hand panel for ethanol. RVO is recycled vegetable oil. The majority of biofuel feedstock consumed in the EU comes from EU sources (~64 per cent) with around 36 per cent imported, largely from North and South America and Indonesia.*

The quantities of the principal agricultural feedstocks used to produce biofuels in the EU in 2007 are shown in Table 1[1]. These are compared to the global production level of a given crop. Vegetable oils (derived from rapeseed, soybean and palm oils) used for biofuel production in the EU amount to a significant 5.3 per cent share, while the share for wheat was negligible at 0.5 per cent.

Table 1: Use of feedstock commodities for biofuel production in the EU in 2007

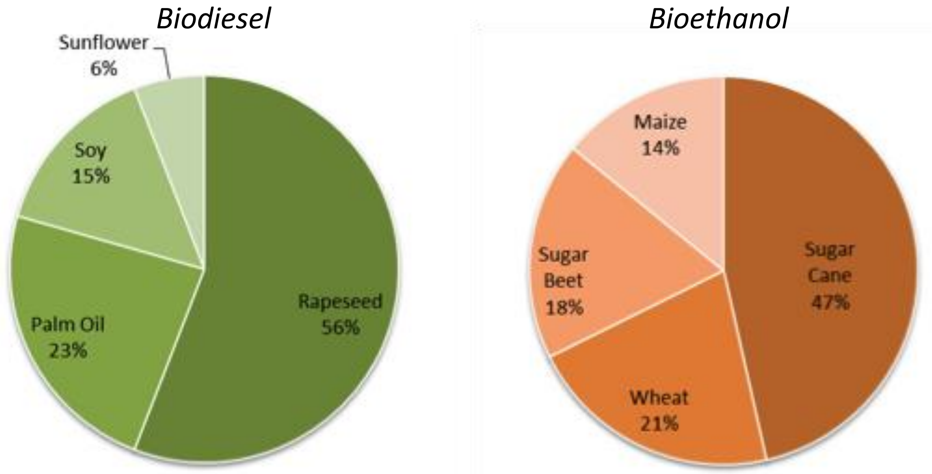
	Use for biofuel production in the EU (1000 tonnes)	Global production (1000 tonnes)	Share of global production (%)
Wheat	2,851	591,833	0.5%
Sugar beet	9,281	244,237	3.8%
Vegetable oils	5,698	106,517	5.3%

Source: *Based on OECD, 2008 (p78).* ***Note****: The quantities of feedstock used for biofuel production in the EU (first column) may include imports and domestic feedstocks and are used to produce biofuels that may either be domestically consumed or exported.*

Looking ahead at potential usage in 2020, Figure 2 based on a recent IFPRI study (Laborde, 2011) shows a continued dominance of rapeseed in the biodiesel market. The EU market for ethanol is projected to become more heavily reliant on sugar cane in the run-up to 2020, accounting for almost half of all feedstock. These projections are in line with the shares and absolute volumes of biodiesel and ethanol that Member States anticipate using in 2020 (according to the National Renewable Energy Action Plans (NREAPs)). Of course actual consumption in 2020 will depend on the evolution of policy and the market response during this time.

Projections from IFPRI and other studies show that without a change in policy, the EU will continue to be heavily reliant on biodiesel production in 2020. Other major biofuel using countries, such as the USA and Brazil, will have an increasing reliance on bioethanol.

Figure 2: Shares of feedstock for biofuels expected to be consumed in the EU in 2020



Source: *Own calculation based on Laborde (2011), Table 3.* ***Note:*** *The left-hand panel shows the feedstock split for biodiesel, the right-hand panel for ethanol. Percentages from Laborde's Table 3 are recalculated taking the setting of biodiesel=100 per cent and all ethanol=100 per cent (instead of all biofuel=100 per cent as in the original table).*

[1] These figures are now nearly five years old with the overall use of feedstock commodities expected to have increased since the implementation of the Renewable Energy Directive in 2009.

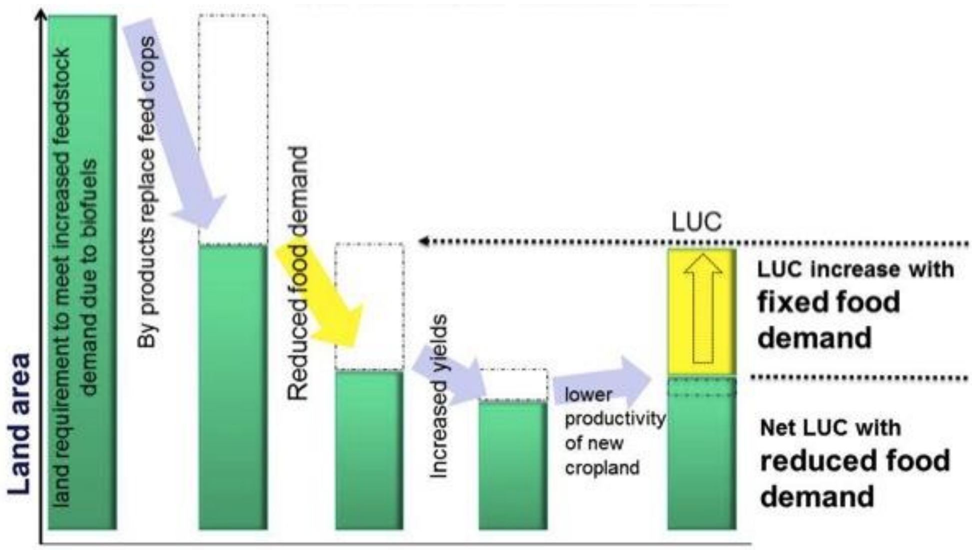
1.3 Land used for biofuel feedstock production

Between 2008 and 2010 the volume of biofuels consumed in the EU increased by 39 per cent, reaching 13 Mtoe and accounting for 4.27 per cent of total transport energy. The total area of land required to grow the feedstock needed in 2010 was 5.7 Mha. Of this, 3.2 Mha (57 per cent) was within the EU and 2.4 Mha (43 per cent) outside (Ecofys *et al,* 2013). Only 0.18 Mtoe of EU biofuels used in road transport was produced from waste and residues[2] compared to 12.38 Mtoe coming from other sources, primarily food and feed crops.

Looking forward, if we take the expected volume of biofuel use in 2020 from the National Renewable Energy Action Plans (NREAPs) produced by governments within the EU we see a significant increase in the land requirements for biofuel feedstock production. Using an estimated average cropland requirement per unit of biofuels consumed in the total EU of 0.438 ha/toe of biofuel[3] and combining this with the predicted EU biofuel consumption in 2020 (29.6 Mtoe according to the NREAPs) the global land requirement for EU biofuel use in 2020 would be about 12.96 Mha, an increase of 7.3 Mha over 2010 levels. This is commensurate with the current overall land demand for biofuel feedstock and the increase in biofuel consumption that would be needed to meet the 10 per cent target for renewable transport energy set out in the Renewable Energy Directive. Based on the current mix of EU and external land use for biofuel feedstock production (57 and 43 per cent respective) an *additional* 4.1 Mha of land would be required within the EU and 3.1 Mha outside. These estimates are commensurate with those arrived at in other studies such as Bowyer (2011).

Of course these figures represent only a crude assessment, with yield fluctuations and improvements, changes in crop type, unknown demand response from increased food prices and the use of co-products potentially reducing overall land requirements, and the potential changes in biofuel pathways having an impact also (see Figure 3).

Figure 3: Impact of external factors on land for biofuel feedstock production



Source: (European Parliament, 2012 based on a presentation by DG JRC-IET)

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[2] As set out in Article 21.2 of the Renewable Energy Directive (Directive 2009/28/EC).

[3] based on the amount of biofuels consumed in the EU in 2010 (13 Mtoe) and the total land estimated for their production (5.7 Mha).

A number of modelling studies have sought to account for these influencing factors and estimated the amount of potentially *additional* cropland conversion from other uses that will arise as a result of EU biofuel policy. These range from 1.73 to 1.87 Mha globally in 2020, depending on the scenario (Laborde, 2011). Most of this additional cropland is expected to come from outside of the EU, with only six per cent of global expansion or 105,000 - 118,000 ha expected to take place in the EU.

Advanced biofuels, or those that do not require additional land to produce the base feedstock, are offered as one solution to meeting this increased land demand. However, to date their adoption in the European market has been limited (~1.3 per cent of 2010 transport energy) (COM(2013)175). They vary in nature and some have notable drawbacks; care needs to be taken when incentivising their uptake further (Kretschmer *et al,* 2013a).

Clearly there are significant differences between the overall additional EU land requirements by 2020 in absolute terms (7.3 Mha) and the smaller amount of land required once the use of co-products and other factors are taken into account (1.87 Mha). Further differences are seen with different models and studies (see European Parliament, 2012; Edwards *et al,* 2010). These differences are to be expected and relate to the range of assumptions underpinning the different modelling approaches. This has led to much uncertainty in the current debate. It is clearly important to understand the impact of such assumptions and whether or not they will materialise in reality or if they are masking a much greater land use impact. We consider the role of co-products and how they are accounted for in the IFPRI model in section 3.

2 ILUC AND LAND IN THE EU

This first set of questions and answers addresses various issues related to whether there is enough land to grow sufficient crops both for food and much more fuel in the EU in response to policy targets. For example is there significant potential from unused land to grow biofuel crops and can we rely on future yield increases to provide a sufficient supply of crops?

Q1 – Is there enough land on which to grow more biofuels in the EU?

Possibly but there would be consequences. Modelling studies that predict the expansion of cropland that would occur as a result of an unchanged EU biofuel policy show clearly that more land will be needed for crop production as a result of biofuel policy than would have been needed in the absence of the policy. For example a *conservative* estimate[4] of an additional 1.73 - 1.87 Mha of global cropland could be needed in 2020 in order to fulfil EU biofuel targets (Laborde, 2011). Out of this total global land use change, between 105,000 ha and 118,00 ha is predicted to be located within in the EU. However, increasing demand for biofuels is not the only factor putting pressure on land in the EU and globally. Continuing urban development, food production, recreational space, as well as the abandonment of land and desertification all play a role in the wider land use dynamic (Hart *et al,* 2013; Allen *et al,* 2013). The question therefore remains as to whether or not this additional biofuel land requirement can be absorbed into the current agricultural land area in the EU and whether is can be achieved in an economically and environmentally viable way[5].

In theory it can. In the EU, the area of agricultural land (including cropland) has been decreasing gradually over the past two decades. A range of existing modelling studies suggest that these trends are set to continue, at least until 2020 and possibly 2030 (see Hart *et al,* 2013). The amount by which this land is predicted to decrease varies significantly[6]. However, based on trends seen over the last two decades, a decline of up to two per cent could be realised by 2020. Therefore the use of agricultural land for biofuel feedstock production could, *'in theory'* be incorporated within the existing cropland area. Some studies suggest that even when the increased production of biofuel crops is taken into account the area of agricultural land in the EU is expected still to decrease over the period 2008 to 2020.

However the anticipated decrease in agricultural land area in the EU rarely will take the form of abandonment of 'good' arable land that could be brought back into productive use relatively easily. Instead most of the land from agriculture will have been redeployed for urban or forest uses and it would be difficult to make a transition back to agriculture. There are of course cases where agricultural land is simply abandoned; over time developing into scrub and forest communities, but in the short term could be brought back into arable crops. However, while the drivers of agricultural land abandonment in the EU are varied, including economic pressures, changes in farm structure and expansion of both urban forest uses and climatic shifts there are some consistent patterns (Keenleyside and Tucker, 2010; Pointereau *et al,* 2008). Farmland transferred to urban uses often includes highly productive

[4] Taking into account the use of co-products and significant increases in crop yield increases.
[5] Imports will continue to contribute to the EU biofuel feedstock base.
[6] Depending on the assumptions used in different models such as continuation of existing policies etc.

arable soils. However, where conversion to forestry occurs it is usually on lower yielding, often more marginal, agricultural soils since economic returns from forestry tend to be much lower than from farming and there is little incentive to use good land for growing trees. Where farmland is abandoned, typically growing into scrub, it is usually because it is difficult to make any income from agriculture. Usually the land in question is steep or very dry, has poor soils, consists of small patches or is in remote access or for some other reason is not attractive to farm in a commercial setting. Abandonment and encroachment are not evenly distributed and the land affected is not likely to be available in significant blocks or with the characteristics needed for commercial production. Many of the soils in question will be poor (Box 1). Therefore the potential to use the land that has left agriculture for various reasons to grow biofuels is questionable, as are the yields that might be produced.

Box 1: Agricultural land in the EU

Agricultural land in the EU consists broadly of two types: cropland, which can be further subdivided into permanent crops, such as olive groves and orchards, and a very much larger areas of arable crops; and grazed lands. Grazed land, mainly grass but including other vegetation, particularly in the Mediterranean can be further subdivided into rough pasture and other semi-natural vegetation that is grazed, through to improved pastures that are fertilised, ploughed and re-seeded on a regular basis.

The distribution of these types of agricultural land has been shaped not only by agronomic conditions but also by the economic, environmental and social history of the EU and its Member States. Much of this distribution relates to the topographic, climate and soil conditions, with semi-natural or rough grazing land occupying generally the poorer soils or more inaccessible locations and arable croplands occupying more fertile low lying areas.

Q2 – What are the implications for food production?

There are certainly trade-offs between using an area of land to grow a biofuel feedstock (often with resulting co-products that can be used for animal feed) and growing food for direct human consumption. For example the feed wheat that is used for bioethanol production[7] tends to be grown on land that is suitable to grow wheat for direct human consumption and can thus be compared. For example, the agricultural land used to produce the 1.1 million tonnes of feed wheat required for one UK bioethanol plant, and a considerable quantity of co-products, could instead be used to provide the yearly per capita direct wheat consumption (as flour in food etc)[8] of over 16 million people if used directly for human consumption (Kieve, 2012; FAO, 2012b). A further discussion on co-products and their potential to mitigate ILUC can be found in Section 3.

Q3 – What about using marginal or 'unused' land?

There is some limited scope for this, but there are significant constraints and potential drawbacks. Agricultural land can be considered marginal or on the edge of viability for normal production for a variety of reasons. These can be economic, environmental, or agronomic or some combination of all of these. Therefore it is important to be clear from what perspective the land is being assessed as 'marginal', whether or not it is marginal in other terms and whether the relevant considerations are permanent or just temporary. Many argue that there are areas of marginal agricultural land on which it is possible to grow biofuel feedstocks without impacting on existing crop production. However, it is far from

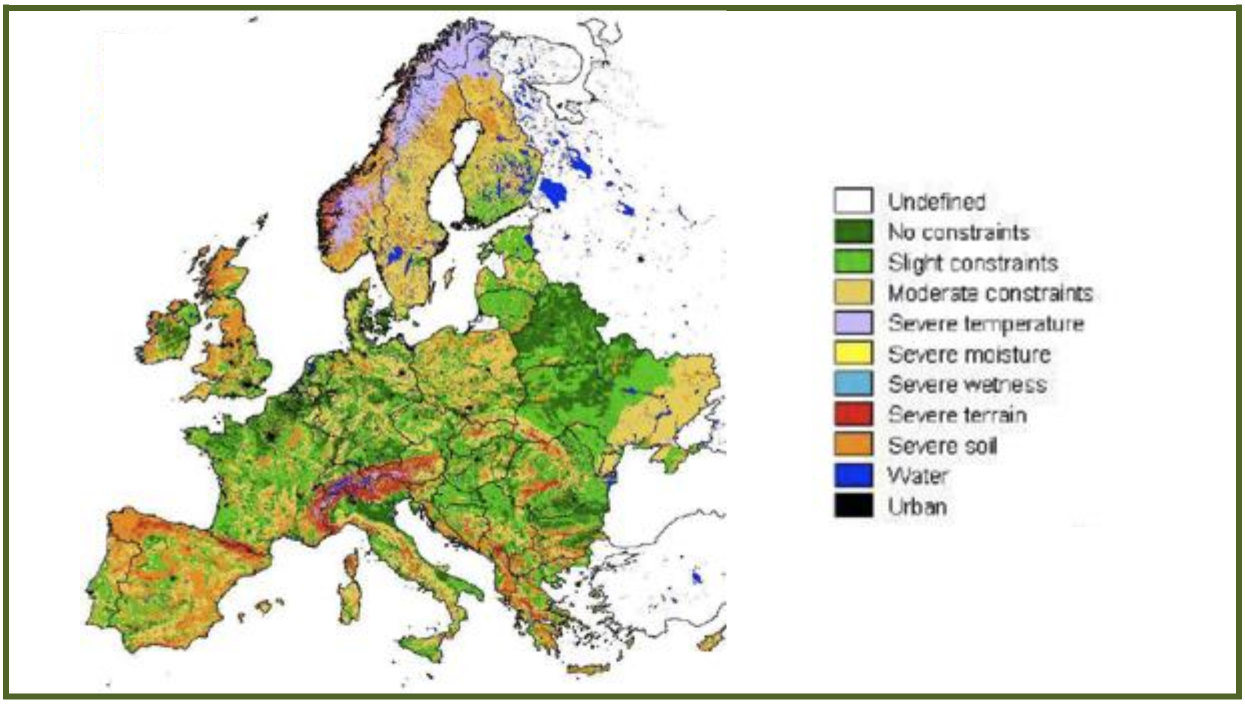
[7] With the resulting animal feed co-products such as Dried distillers Grains with Solubles (DDGS)
[8] Based on estimated world average of 67.5kg/yr per capita food wheat consumption (taken from FAO, 2012a).

clear how much of this land exists and the feasibility of using it for biofuel feedstock production.

When most people talk about marginal agricultural land they are referring to the marginal economic returns that are to be had from such land. This relates to the quality, scale and position of the land and its relative productivity or the ease at which crops can be grown (due to slope or accessibility issues for example). There is no question that there are considerable areas in this category, particularly in the uplands and mountains and in some places land will come in and out of production in response to market signals. However, from an environmental perspective this land may not be marginal but instead providing a range of services to society. These ecosystem services, such as carbon storage, water filtration or providing space for nature are often provided from economically marginal land precisely because these areas are not exploited for another purpose (Allen *et al,* 2013; Hart *et al,* 2013).

There exists currently no pan European data source that identifies the scale of marginal land particularly the portion that might be suited to commercial scale cropping rather than simply grazing. We thus rely on fragmented data to try to pinpoint such areas. Marginal land is often very dry, wet, steep, rocky or simply difficult to get to. These characteristics are illustrated in Figure 4 that shows around one quarter of the EU land area is subject to some form of severe constraints on rain-fed agricultural production[9]. It should be noted that much of this land is under some form of use other than agricultural production, predominantly forestry.

Figure 4: Map of constraints on rain-fed agricultural production in the EU



Source: FAO/IIASA, 2007 as quoted by Eliasson, 2007.

[9] Constraints include climatic, soil, terrain and wetness factors.

There are also larger areas of agricultural land that are classified in some surveys as 'unused' although it may be difficult to determine what this comprises exactly. Data on such areas is sparse and there are a variety of estimates using different definitions and categories of land. Using the Farm Structure Survey (FSS) and the Land Use Cover Aerial Frame Survey (LUCAS) datasets, Hart *et al* (2013) suggest that around seven per cent of land in the EU-27, within agricultural areas, is not being used currently[10] for agricultural production (between 11 and 12 Mha although there may be grazing or other forms of management in a light form). Those Member States with proportions greater than the EU-27 average are predominantly found in Mediterranean, Baltic and Scandinavian Member States where constraints on rain-fed agricultural production are high. Again, describing these areas as simply 'unused' is misleading.

Within the farmed landscape itself there are more scattered areas of either marginal or agriculturally unused land. These take the form of hedgerows, ditches, field corners and other patches that cannot be accessed by modern machinery. These are highly important for biodiversity and other ecosystem services and may well account for between two and five per cent of the total arable land currently, with big variations between regions.

The growing of bioenergy feedstocks at a reasonable cost generally depends on an ability to obtain where there is usually a need for a high yield per hectare. Commercial production on 'marginal' land therefore seems unlikely on any scale. In future it is possible that biofuel prices may rise and there would be increased economic incentives for agricultural landowners to utilise more productive land for feedstock production. If production was somehow diverted to solely marginal land this would likely result in 'sub-optimal' yields and thus much larger land requirements (Bryngelsson and Lindgren, 2013). Much greater use of nutrients and other agricultural inputs would be required with risks to water and soil quality as well as wider environmental consequences.

Q4 – Can we rely on future yield increases to mitigate ILUC?

This is uncertain and will vary between regions of the world. Yield increases can be achieved for some crops grown as feedstocks, particularly in the developing world. Lower increases in yields seem likely in Europe and intensification of crop production is subject to constraints, for example on water supply. New technology and better practice may help to provide similar levels of output from a reduced area. However, the demands from agricultural land are increasing. A growing global population, dietary changes, recognition of the importance of respecting environmentally sustainable farming practices in the EU and an increasingly volatile climate raise questions as to whether future yield increases could help to mitigate ILUC.

If the EU can produce more crops and associated products from the same area of land, there is the potential to help mitigate ILUC caused by biofuel feedstock production. Plant breeding efforts, combined with improved agricultural knowledge brought significant increases in crop yields in the 1970s and 1980s, in time contributing to a reduction in the amount of arable land farmed in the EU. Despite these improvements, current crop yields are not as high as they could potentially be. This is known as the 'yield gap' (Groot *et al,* 2012; Reynolds *et al,* 2011). Yield improvements, both from plant breeding and other

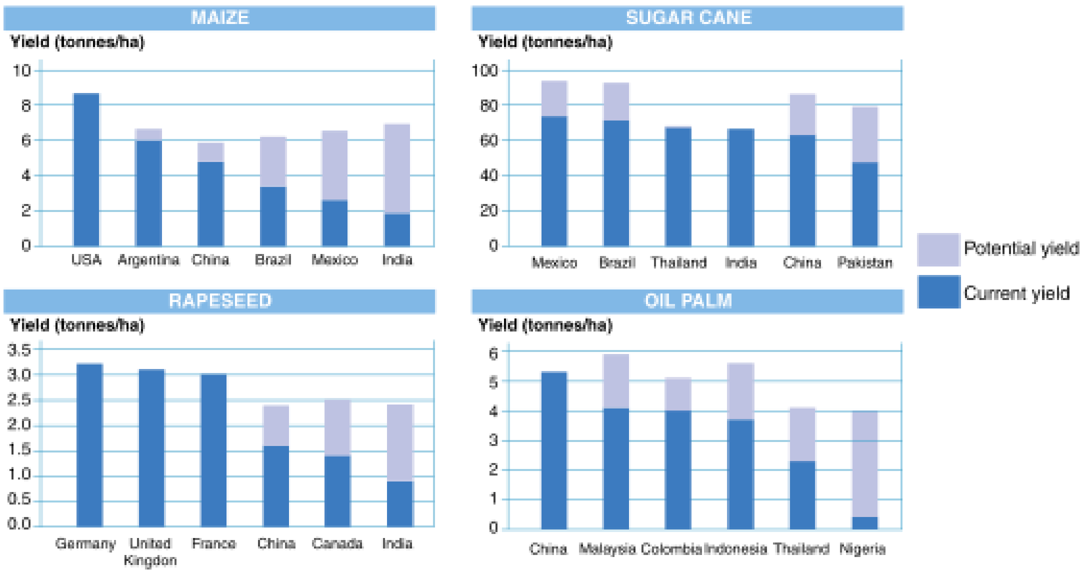
[10] Survey data was recorded from 2007 – 2009.

techniques undoubtedly help improve productivity although this becomes more challenging in systems which already rely on high inputs, including fertilisers and agrochemicals which can create major environmental pressures. There are also good reasons why yield gaps exist, including site-specific constraints such as terrain, soil quality, rainfall, temperature and water availability, to sub-optimal crop management and economic factors (Jaggard *et al,* 2010). Yield gaps may also occur through unpredictable climatic effects such as drought and flooding. Predicting how climatic issues will develop in the next few decades is not a simple process, neither is it easy to predict the response of farmers to it (Jaggard *et al,* 2010). Therefore care should be taken when making assumptions about the potential yield growth estimates when modelling future yield levels. Whatever the response, a sustainable approach to increased production is required, for example in agrochemical use, with implications for the extent of yield growth.

Box 2: Existing and potential yields for key biofuel feedstocks

In some areas of the world, particularly Sub-Saharan Africa, the potential for improving the production of major cereal crops is rather significant (Mueller *et al,* 2012; Kindred *et al,* 2008). Approximately 90 per cent of any future increase in production in these areas is expected to come from yield growth and greater cropping intensity, with the remainder coming from an expansion in the area of land farmed (Hart *et al,* 2013; Bruinsma 2011; OECD and FAO 2010). However, the question remains as to whether or not this increased output will go towards increasing biofuel production or to meet increasing food and feed demands.

Existing and potential yield for key biofuel feedstocks



Source: (Bringezu *et al,* 2009)

For a number of key biofuel feedstocks there are still major improvements that could be made to yields; some in the EU (Beddington, 2010) and more elsewhere in a range of countries and regions outside Europe (Box 2). Crop breeding has the potential to improve potential yields further, through improving tolerance to stresses, improving the yield of components of interest[11] and improvements in the use of inputs such as nitrogen (see for example Kindred *et al,* 2008). However, any increases in yields need to be on a sustainable basis, both to limit any detrimental environmental impacts as well as to maintain the

[11] Such as reducing the ration between the stalk and fruiting body (or ear) of wheat

security of production in the long term. Sometimes this is termed 'sustainable intensification' (see Box 3).

Q5 – Do increased crop prices result in increased yields and production?

In some circumstances but not invariably. Sustained increases in prices over time can be expected to drive land use change where this potentially can be realised, as well as the response of farmers, however, the correlation between prices and yield increases is less certain (ICEDD *et al,* 2013).

The response of crop production to price changes (known as the price elasticity of supply)[12] has been the subject of extensive economic analysis. For example, Roberts and Schlenker (2010) estimate that for a one per cent increase in crop price, crop production would increase by 0.12 per cent. Some economic models such as the Global Trade Analysis Project (GTAP) model anticipate a higher elasticity and thus greater level of production response. Importantly however, Roberts and Schlenker (2010) suggest that at the global level, the bulk of the increase in production is facilitated by the expansion of arable land and only to a limited extent by increased yield (output per unit area). This accords with historical trends where globally expansion of cropland has been more important in increasing feedstock production in developing countries, while yield increases have been the more important source of production increases in developed countries in recent years (Allen *et al,* 2013; Marelli *et al,* 2011).

Fluctuations in prices often will lead producers to alter the amount of inputs used in agricultural production. In many cases higher yields are pursued by increasing fertiliser and agrochemical use and, over a longer period, greater mechanisation, as well as expanding the area of land under cultivation. This is facilitated by additional revenue from higher prices. ILUC models make forecasts of how farmers will respond to increased revenues from crops and the extent to which they will aim for higher yields or a greater area under cultivation.

In the EU, any increases in crop output in future may come from both increased yields along with some expansion of the arable area. However, given the already intensive nature of European crop production, with high fertiliser reliance, further increases in yields can create additional environmental pressures which need to be taken into account (see Box 3). In other parts of the world, it is expected that greater areas of land would be brought into cropping at the expense of other land uses but there will also be yield increases.

Box 3: Intensification and sustainable intensification

Techniques such as increased fertiliser application, will only lead to yield increases to a certain point, before the maximum yield potential, or saturation point, is reached. In the EU, evidence suggests that many farms are operating within these limits, with scope for improvements in some 'less efficient' farms (Groot *et al*, 2012; Kohlheb and Krausmann, 2009). However, there is a significant difference between the higher yields that are thought to be technically feasible and what is realisable in practice, especially if sustainability considerations are taken into account (Hart *et al,* 2013).

Increasing yields can be approached in different ways but where it relies on greater input use and

[12] Price elasticity of supply is a measure used in economics to show the responsiveness, or elasticity, of the quantity supplied of a good or service to a change in its price.

mechanisation it often comes at an environmental cost such as enhanced risks to water quality from fertiliser run off and increased N_2O emission (which has a much greater global warming impact than CO_2). ***If production is increased this should be done in an environmentally responsible way, not least to ensure the environmental sustainability of biofuel feedstocks***. Sustainable intensification[13] involving the use of technologies and practices which have a much lower negative environmental impact than is generally the case now are increasingly seen as the way forward for responsible agriculture (Foresight, 2011; Godfray *et al*, 2010; Royal Society, 2009).

Q6: How do higher demands for first generation biofuels affect food prices?

In a variety of ways. In principle, if there is a rise in demand for crops that can be used either for food or biofuel feedstocks prices can be expected to rise, at least for a period. Volumes of the crops used for food might fall. The scale of these impacts, first on farm commodity prices and then on consumer prices will vary considerably, both according to specific conditions and over time. While the broad effect is clear, the precise interrelationship between agricultural commodity prices and biofuel demand is complex sophisticated economic models have been used to examine the problem (see Box 4).

Box 4: Modelling the impact of biofuels on food prices

Some economic models focus on the impacts of EU (as opposed to global) biofuel policies. Comparing results the most significant commodity price increases are projected for oilseeds and vegetable oils, with anticipated increases in world prices by 2020 typically ranging between eight to 20 and five to 36 per cent, respectively. Wheat prices are projected to increase by between one and 13 per cent. The majority of studies project increases of cereal / maize prices of up to eight per cent and of sugar prices of up to two per cent. One model (ESIM) projects these increases to be 22 and 21 per cent, respectively. At least some of the global studies estimate substantially higher price effects for ethanol crops such as wheat, other cereals and sugarcane.

Since there are significant differences in the results of modelling work, the reasons for this have been under scrutiny in the indirect land use change debate. This has helped to drive improvements in the models, which have evolved over time. Some of the most recent variants are widely considered the most robust. This is most notably the IFPRI study, which projects increases in world rapeseed prices, anticipated to be the most significant feedstock for EU biofuel use in 2020 of around 11 per cent (Laborde 2011). However, this and other studies that model global biofuel policies do not allow one to single out the EU policy impact. This is not ideal, but nevertheless it reflects current circumstances in the sense that EU policies in the real world do not take place in isolation; several other countries have in place biofuel policies as well

Source: (Kretschmer *et al,* 2012)

In short, first generation biofuels, made from food crops such as oilseeds and cereals can have a significant effect on food prices, but with great variations.

Q7 – Will plans to 'green' the CAP result in ILUC?

The greening plans, including 'Ecological Focus Areas' are still being finalised but they are not expected to have any significant ILUC impact. The European Commission's proposals for the Common Agricultural Policy (CAP) post 2013 (COM(2011)625/3) includes the requirement that 30 per cent of direct payments to farmers should be contingent on them carrying out practices beneficial to climate and the environment. More commonly known as 'greening', three practices are proposed: the maintenance of permanent pasture; the

[13] Whereby agricultural output per hectare of land and the level of environmental management increase simultaneously

diversification of arable crop types; and the management of at least seven per cent of eligible, largely arable, land as Ecological Focus Area (EFA) where limited uses are permitted. Ecological focus areas are expected to have only a minor production impact as they are expected to comprise largely of environmental features such as hedgerows and other areas not used currently to produce crops. Further details of the proposal and a discussion about the potential implications and benefits of EFAs, such as improving pollinator numbers and preventing soil erosion, can be found in Allen *et al* (2012).

There has been much debate around what land could be considered as an EFA and sometimes it is viewed, mistakenly, as a form of set-aside by another name. Set-aside refers to a specific production control policy, which was abolished in the CAP in 2008. The Commission's intention for EFAs is clear. They are intended to deliver positive environmental management by means of a range of land uses. Article 32(1) of the proposed regulation describes the types of land which could constitute EFA as '…such as land left fallow, terraces, landscape features, buffer strips and afforested areas[14]…'. Recent studies suggest that these areas occupy already around 3.5 per cent of EU agricultural land.

Many of these types of land cover and management will exist already on the arable farms where EFAs will apply so much smaller areas than the proposed (but not agreed) seven per cent will be retired from active production to meet this requirement. In some situations and on some farms it may be necessary to manage certain areas of productive land as EFA. However, those areas which are likely to be take out of production will be the lowest yielding areas and more marginal in production terms including those which are shaded, stony or waterlogged (Allen *et al,* 2012). Where low yielding areas are retired then ILUC will be correspondingly small, while agriculture should become more sustainable as a result of the greening measures.

[14] as referred to in article 25(2)(b)(ii) of the same regulation

3 THE ROLE OF CO-PRODUCTS FROM ARABLE CROPS IN MITIGATING ILUC

The following questions, address the potential role of co-products from arable crops in mitigating the ILUC impacts of biofuel production from first generation, primarily food crops on a land area basis.

What are co-products?

Co-products are non-waste residues resulting from the production of a main product. They are by-products that have economic value and a potential (or pre-existing) market (Directive 2008/98/EC). Different co-products arise from the feedstocks used to produce biofuels depending on the production pathway. The main co-products accruing from current forms of production are from arable crop are:

- Dried distillers grain with solubles (known as DDGS) derived through a manufacturing process from the production of wheat and maize bioethanol,
- Pulp arising from sugar beet bioethanol
- Rapemeal (oilseed cake) and glycerine from the production of rapeseed biodiesel.

In most cases the biofuel itself is considered the main product from the processing of the feedstock. However this is not always clear-cut. For example over 80 per cent of the world's soya beans are used for livestock feed (Koneswaran and Nierenberg, 2008), with the protein rich soymeal accounting for approximately two thirds of the economic value of a soybean crop (FAO, 2008). Therefore biodiesel made exclusively from soya beans could be considered the co-product of livestock feed production.

What are co-products used for currently?

Two of the three main co-products arising from biofuel production in the EU, DDGS from bioethanol production and oilseed cake from biodiesel, are used as high protein animal feed in the EU livestock sector. In its raw form, crude glycerine the other main co-product from biodiesel production, has a more limited number of existing uses as a result of impurities and requires processing[15]. Refined glycerine can be used much more widely, for example as an additive in the food, cosmetics and pharmaceutical industries to name a few and new uses continue to be developed (Kretschmer *et al,* 2013).

The productive end uses and benefits of co-products need to be given due weight in appraising the sustainability of the main product (Edwards *et al,* 2011). DDGS from corn ethanol for example can be used to displace soy from livestock feed (see Q8). This will improve its sustainability in a lifecycle analysis, reducing the level of direct and indirect land use change associated with the feedstock production. However, other potential end uses of co-products may also have net climate and energy security benefits. For example, the use of DDGS as well as oilseed meal (cake) or sugar beet pulp, for energy/heat production rather than livestock feed is shown to greatly improve the energy balance and greenhouse gas emissions for many biofuel production processes by displacement of fossil fuels (Edwards *et al,* 2011) thus offering a potentially compelling use for such co-products.

[15] However, biomethanol production is possible through thermochemical conversion, which can then be used as a base for fuel of chemical manufacture.

The emergence of advanced biofuel production processes could result in a change to the current mix of co-products produced in the EU. The mix of co-products and the relative quantity produced will largely depend on the particular feedstock and process involved. For example, the potential diversion of feedstock from bioethanol to biobutanol production via the ABE[16] process may result in the production of large amounts of acetone, whereas biodiesel production via gasification and catalytic conversion may result in the production of significant volumes of naptha. However, as the advanced biofuel industry is still at a nascent stage, the composition and volume of associated co-products is still an area of great uncertainty.

Q8 – Do co-products have a role in mitigating ILUC?

Yes, up to a point, where useful co-products can be derived from feedstocks dedicated to biofuel production. *But there are complications and it is not simply a case of substitution*. For example, it is widely recognised that certain co-products in providing protein for livestock have the potential to reduce the net ILUC effects of EU biofuel consumption via the displacement of imported soy in animal feed and the ensuing land use consequences. However, while great hopes are invested in the use of co-products for animal feed so reducing the associated land needs and scale of ILUC, the displacement of established animal feed, including imported soy, will occur only if a number of conditions are met.

The price of co-products used for food often must be lower (or the quality must be higher) than for traditional livestock feeds in order to promote a change from the status quo and an economically viable option for livestock farmers. Second, the quality of the co-product depends on the feedstock and the processing technology. While DDGS from maize has found a wide market in the US the range of co-products in Europe is not the same, the value of the DDGS derived from wheat, oilseed cake and rapemeal from oilseed rape as a livestock protein feed, has been shown to be limited due to the significantly lower nutrient content and higher levels of fibre than alternatives such as soymeal. This issue has been highlighted in several studies, including an analysis for the pig (Jagger, 2008) and poultry (Acamovic *et al,* 2008) sectors in the UK. Such nutritional limitations significantly reduce the potential for displacement of soy by such co-products, therefore reducing their ILUC mitigation potential.

When considering net impacts on land use of different feedstocks, the relative additionality of co-products must be considered also. Would the same or equivalent volume of co-products be created if oilseeds and cereals were used to produce vegetable oil, alcohol and other food or chemical products rather than biofuels?

In the case of ethanol production, there are no unique co-products arising from producing bioethanol for fuel as opposed to other uses. DDGS and oilseed cake would arise from the production of oil and ethanol from oilseeds and grain to meet demand for other end uses (in the food and drink industry etc). In the case of glycerol produced from oil seed rape (OSR), this appears quite specialist to the biodiesel (Fatty Acid Methyl Ester (FAME)) production process as opposed to ordinary vegetable oil production. However, glycerol has limited uses and thus a much reduced ILUC mitigation potential. Therefore, there are very limited volumes of co-products associated with ILUC mitigation arising from first generation

[16] Acetone-butanol-ethanol (ABE) fermentation is a process that uses bacterial Fermentation to produce acetone, normal Butanol, and ethanol from starch.

bioethanol or biodiesel production that would not exist anyway as a result of plant oil and ethanol production for non-biofuel purposes for example in the food and drinks industry etc.

Even if full additionality is assumed, against this evidence and the land use implications of widespread use of co-products are factored in, there is still a degree of ILUC shown in most modelling studies (see Laborde 2011; Edwards *et al,* 2010).

Q9 – Does the IFPRI study on ILUC consider the use of biofuel co-products as animal feed?

Yes, co-products are an integral part of the IFPRI model. However, one question that is asked is whether the IFPRI study models co-products in a scientifically robust way. The IFPRI study was not subject to the standard peer review process that is normal for scientific journal articles. However, an earlier IFPRI study (Al-Riffai *et al,* 2010) paved the way for a prolonged peer-review process not in the traditional sense of the term but one of intensive comments by the range of stakeholders from NGOs and industry, different European Commission DGs and other academics. This 'unofficial peer review' process lead to the publication of the Laborde (2011) study, in which various aspects of the model were improved, among them the representation of demand co-products. For example, recent reports by Malins (2012) and Delzeit *et al* (2011) concluded that the work by Laborde in the 2011 study is consistent with best practice in general equilibrium modelling.

Q10 - Will the Commission's proposed cap on conventional biofuel supply lead to a lack of protein-rich co-products and increased feed imports?

No not necessarily. Protein-rich co-products are already produced from the vegetable oil industry and brewing and distilling industries (see Q8). In addition, dedicated protein crops for animal feed have been grown in Europe for many years, often as a break crop, since long before biofuel policy provided economic incentives for crop use for the production of fuels. As well as current imports more protein feed could be produced in the EU from other sources, such as tannin-reduced faba beans, alfalfa, hempseed etc. Such crops, naturally higher in proteins, could be encouraged in the EU as part of a crop rotation system, with benefits to biodiversity, soil and water (see European Commission, 2012)[17].

The Commission's proposed five per cent cap on food and feed crops for conventional biofuel production would serve only to maintain the current level of biofuel production, and would permit an increase in some Member States. Therefore, it would not lead to a reduction in protein-rich co-products produced directly in the EU. Furthermore the proposals are for a limit on the production of biofuels from food and feed crops contributing towards the RED target, not for a limit on their production in absolute terms. Therefore protein-rich co-products could still be produced from these same crops but there would be no EU related economic incentives to produce specifically the crops from which they derive.

[17] Alternatively, synthetic amino acid production, via fermentation and enzymatic processes (Leuchtenberger *et al,* 2005), could offer future potential for the large scale displacement of other protein sources from livestock feed. A UN FAO report, for example has suggested that 550,000 tonnes of synthetically produced L-Lysine could displace 18 million tonnes of soybean meal from livestock feed (FAO, 2002). However, further research will be needed to assess the full environmental and health impacts of greatly increasing reliance on the production and use of such synthetic dietary substances.

At the same time, legitimate concerns have been raised in relation to the level of industry confidence in biofuel production that could be expected if there were to be a cap on food and feed crop use for biofuels counting towards national targets under the RED. This and the proposals for a grandfathering clause to be introduced in relation to current production (see Q14 and Peters *et al,* 2011) could lead to impacts on the level of crops grown as a biofuel feedstock. However, as described in Q8 there is significant market potential for vegetable oil production for the food industry from which the same co-products would be produced.

Box 5: Potential for biofuel co-products to displace soy imports

The potential for large-scale displacement of soy by DDGS and other co-products in animal feed is limited by the inferior nutritional profile of such co-products. In the case of DDGS, for example, levels of the essential amino acids lysine and arginine are lower than in unprocessed wheat (Noblet *et al,* 2012) and the sulphur content is significantly higher (Schoonmaker and Beitz, 2012). Rapeseed co-products contain glucosinolates, known to have negative health consequences, particularly for pigs and poultry, which are more sensitive to the compounds. Although glucosinolate levels have been greatly reduced in the varieties of oilseed rape now grown in the EU, the oilseed cake has double the levels present in the rapeseed meal, therefore potentially causing adverse health effects if consumed in large quantities. The addition of iodine to livestock diet can alleviate such concerns. Similarly, the addition of synthetic Essential Amino Acids (EAAs) can compensate for the deficient EAAs in DDGS (Lywood, 2009). However, the extra economic costs involved in such dietary supplementation could further reduce the competitiveness of this product with alternative protein sources.

4 BIOFUEL FEEDSTOCKS AND THE AGRICULTURAL SECTOR

This section is a group of specific agricultural questions relating to crop rotations and farm incomes. In particular we consider claims that a cap[18] on conventional biofuels, such as those derived from oilseed rape (OSR), will lead to a reduction in OSR cultivation in the EU and the impacts this might have on other crop yields. We further consider whether such impacts on the agriculture sector would lead to job losses and a loss of income.

Q11 - What are the existing uses for oilseed rape in the EU?

Largely for biofuels, but the market potential for expansion in the food industry exists. Today, around 67 per cent of the rapeseed crushed in the EU is processed to produce oils for biofuels[19]. The majority of the remaining 33 per cent is used largely in the food sector[20] (for oils and margarines), although this represents a relatively small proportion of oil use in the EU food industry (0.45 per cent) dwarfed by the demand for palm oil (over 65 per cent)[21] (see Box 6). A significant market potential exists in the food industry to replace soyabean oils with alternatives following concerns over import restrictions in relation to Genetically Modified (GM) varieties and the growing debate over the sustainability of palm oil. However, the price premium for rapeseed as a result of biofuel policies has not been favourable to gaining market share at the expense of soya.

Oilseed rape (OSR) has rapidly increased in popularity and area of European farms since the introduction of the lower glucosinalate and lower erucic acid edible varieties in the mid-1970s[22] (IENICA, 2005). OSR was first grown for the vegetable oil and derivatives markets, with the meals and cakes, produced as a co-product during the oil extraction process, used as a protein-rich animal feed. New crop varieties have been developed and introduced over time providing new uses for industrial applications including: anti-friction materials for plastics manufacture; oleochemicals[23]; biodegradable lubricants; and oils.

Since the mid-2000s, biofuels policies, combined with the decline of EU sugar[24] production, a previously more widespread arable crop, resulted in an increase in the amount of OSR grown in the EU. In 2009, 21.4 million tonnes of OSR were grown within the EU (Eurostat 2012). Traditionally, the EU has been self-sufficient in OSR, but since 2004 the accelerated demand for biofuels has led to a trade deficit in OSR (seeds and oil). In 2011, 380,000 tonnes of OSR oil, and 2.47 million tonnes of OSR seeds were imported into the EU (largely from Canada and the Ukraine), just less than 12 per cent of domestic production. Even this was insufficient to meet the range of demands for vegetable oils in other market areas, such as the food sector, with imports of palm oil and soya bean oil increasing at the same time (Malins, 2012). Future predictions suggest that net imports of both oil and seeds will continue to increase, at least until the mid-2020s (Malins, 2012; Laborde, 2011; FAPRI, 2011).

[18] Referring to the proposed five per cent cap on food and feed crops set out in the proposal (reference).
[19] FEDIOL – personal communication.
[20] Only a small proportion of EU OSR is used for industrial applications.
[21] FEDIOL statistics 2011. http://www.fediol.eu/data/1348739622Stat%20oils%202011.pdf
[22] Despite lower glucosinalate and lower euric acid varieties these are still largely too high for direct animal feeding and can only be used as a co-feed when combined with other materials.
[23] Oleochemicals are chemicals derived from plant and animal fats.
[24] leading to an increase in land available for OSR cultivation

Box 6: Palm oil

Palm oil has many desirable features which have increased its appeal to the food industry, including heat stability, resistance to oxidation, solidity at room temperature and smoothness in a wide range of food products[25]. However, the environmental implications of expanding palm oil production, particularly in Asia, are well documented including the expansion of plantations onto peat ecosystems and the resultant release of carbon dioxide (Miettinen *et al,* 2012; Page *et al,* 2011; Sheil *et al,* 2009; Fitzherbert *et al,* 2008).

Expansion of European vegetable oil production has been inadequate to meet biodiesel demand on its own, and palm oil imports have risen dramatically in the same period that biodiesel mandates have been introduced by EU governments (Malins, 2012). Palm oil is produced primarily in Indonesia (~20 Mt) and Malaysia (~17 Mt), which export 82 and 87 per cent respectively of their output.

Q12 - Does oilseed rape play an important role on farms as an agricultural break crop?

Yes but there is a range of other crops that could do the same or even better job. Several studies have shown beneficial effects arising when oilseed rape (OSR) is used as a break crop in a well planned arable crop rotation. Higher wheat yields have been observed following OSR cultivation when compared to continuous grain production, where the rotation is just wheat with other grain crops such as maize (Rieger *et al,* 2008) or following a fallow year (Smith *et al,* 2004). Alternative break crop varieties used to be common in the EU, however, recent research into the harvested areas of other break crops (such as peas, beans, sugarbeet and potatoes) has shown they have largely decreased in area compared to the increased expansion of OSR (see Malins, 2012 based on FAOStat figures). OSR is often seen to be the most profitable break crop, due to the biodiesel market (Twining and Clarke, 2009)[26].

Benefits of a break crop

Research has shown that any agronomic benefits relating to the use of OSR as a break crop in terms of higher cereal yields, would be due mainly to the 'break crop effect', rather than any exclusive properties of OSR as a brassica[27] or particular species of brassica (Smith *et al*, 2004). Research, based on industry experience (Rush, 2012; Kirkegaard *et al,* 2008) and field trials (DEFRA, 2002) has shown that the use of several alternative break crops has resulted in greater benefits to soil structure and fertility as well as higher wheat yields in subsequent wheat crops, and in addition, a far lower requirement for agro-chemical input (Robson *et al,* 2002; Arshad *et al,* 2002). Such break crops include lupins, field peas, faba bean[28] and alfalfa (BIO IS, 2010; DEFRA, 2002). Buckwheat is also shown to be a highly promising break crop, being effective at increasing soil fertility, for instance by sequestration of phosphorus in the soil (Innovation Farm, 2011). Leguminous crops such as field peas, alfalfa and faba beans have the advantage of fixing nitrogen, helping to achieve higher yields in following wheat crops with a greatly reduced need for synthetic nitrogen fertiliser input (see for example Kirkegaard, 2003).

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[25] Food and Drink Federation, pers comm 2013.

[26] Claims of wheat yields falling by one tonne per hectare as a result of abandoning oilseed production have been made (Statements made by the National Union of Farmers (NFU) in England).

[27] Brassica is the term given to a genus of plants belonging to the mustard family. It is also known as the cruciferae family. Subspecies also include common vegetables such as broccoli, turnip and cabbage. http://www.biology-online.org/dictionary/Brassica Accessed 20.02.2013

[28] Faba bean = fava bean = broad bean.

Impacts associated with Oil Seed Rape

OSR, by contrast to other break crops, has a heavy demand for nitrogen fertiliser and other agro-chemical inputs which, if not appropriately managed, can lead to a reduction in soil fertility (PAN *et al,* 2012; Kirkegaard, 2003; DEFRA, 2002). The increased practice of rapeseed being used as the only break crop in a short arable rotation has led to widespread increases in pathogen and resistant weed development, leading to heavier reliance on agrochemical use on the crop (Rush, 2012; Twining and Clarke, 2009). Restrictions have been introduced on many of the agrochemical herbicides commonly used on OSR over recent years (see for example Directive 2008/116/EC). The restrictions on the use of these agro-chemicals has lead to doubt as to the economic and environmental viability of OSR as a break crop should further restrictions be introduced or not (Twining and Clarke, 2009) ADAS, 2009. Many studies have shown that the use of alternative break crops, with the restriction of OSR cultivation to once every four or five years in a rotation, would help to overcome many such issues (Agra CEAS and O'Connor and Co., 2002).

Planting of alternative energy crops as a break crop, including hemp and kenaf, could enable farmers to retain access to the bioenergy market. The adoption of other break crops, including energy crops such as hemp (*Cannabis sativa L.*) and kenaf (*Hibiscus cannabinus*) in addition to use of leguminous plants and oilseed crops such as OSR, in well balanced rotation systems, could accrue all the 'break crop effect' benefits and lessen weed and pest challenges, while enabling farmers to retain access to bioenergy markets (Zegada-Lizarazu and Monti, 2011; BIO IS, 2010). Hemp, alfalfa and clover for example, have been shown to have beneficial properties for soil quality and a particularly low need for agrochemical input (BIO IS, 2010; DEFRA, 2002). The choice of break crop will vary depending on regional soil characteristics and climatic conditions. However, the inclusion of a diverse selection of break crops in a balanced (strict) rotation has been shown to help improve soil health and nutrient content, preserve water quality and enable increased subsequent grain yields (BIO IS, 2010; Kirkegaard *et al,* 2008).

The forthcoming Communication from the Commission on sustainable protein production (European Commission, 2012) may help farmers to take opportunities to replace OSR as a break crop whilst still producing a useful protein co-product and an income stream.

Q13 - Would reduced support for biodiesel be seriously disruptive for EU agriculture?

No. There would be adjustments to be made in some countries but farmers switching to other crops would continue to get payments for each hectare under the CAP. Indeed, most production of crops in the EU is no longer linked to direct subsidy support. If production of OSR remains high there are opportunities to diversify markets for the vegetable oil and increase exports.

Beyond this there are alternative arable crops, including break crops that can be produced in Europe. The current profitability of OSR has been inflated by biofuel policy but it is not logical to maintain the effective subsidy purely for this reason. The EU has a trade deficit in vegetable oils and OSR currently (see Q11) and thus there seems to be considerable scope to absorb some of any potential excess supply.

Q14 – Will ILUC policy adversely affect employment in the agricultural sector?

Unlikely. ***The Commission's impact assessment that accompanies the ILUC proposal is clear*** '*While rapeseed and sunflower is excluded, the adverse employment effects within the EU for famers are likely to be limited, as farmers would respond to the shift in demand from rapeseed to cereals and sugar beet. Notably, the main Member States producing rapeseed (i.e. Germany, France, Poland and United Kingdom) are also the main producers of cereals and sugar beet*' (SWD(2012)343). In times of high world market prices for agricultural produce, European farmers are in a position to pursue markets for their produce other than the biofuel sector. The growing of biofuel crops covered only between four and five per cent of agricultural land in the EU in 2008 (Ecofys, 2012) and the Commission is not proposing the complete elimination of this sector, providing certain conditions can be met.

A recent study by Ecofys (2012) considers future employment in the biofuel sector and the impact of certain policy options. Even if the Commission's ILUC related policy proposals are adopted, absolute increases in EU biofuel production (and also jobs) are expected from now up to 2020, although prospects differ by sector. While the ethanol industry could experience further (job) growth if ILUC factors are adopted, the biodiesel industry would suffer contraction, given the higher estimated ILUC emissions from biodiesel and would experience job losses. However, if grandfathering provisions, for existing production are adopted to reduce the impact, job reductions could be minimised, as the report shows[29].

[29] Specifically, Peters *et al* (2011) propose the grandfathering of biofuel installations' average 2010-2012 production levels up to 2020 (grandfathering option '4B' in the report). This option is found to be efficient in protecting the economic interests of the EU biofuel sector and in mitigating ILUC emissions if combined with further policy option that effectively addresses ILUC.

5 BIOFUELS AND GLOBAL SUSTAINABILITY RISKS

This final section reflects on whether addressing ILUC caused by EU policy is tackling the problem at its root or whether there are sustainability risks that go beyond the scope of EU energy policy. Should we tackle land use change at source and are European farmers being penalised unfairly for problems elsewhere?

Q15 – Why not tackle ILUC by preventing Direct Land Use change (DLUC) in areas where it would be inappropriate?

In principle, preventing direct land use change in sensitive areas, such as land that is important for biodiversity and soils with a high carbon stock, at a global scale and for all land-using sectors would be a robust solution to address some of the more environmentally damaging consequences of biofuel production. However, this would require a mechanism to extend sustainability criteria more widely to the full range of land-using activities so that all land use changes[30] are recognised as having potential environmental impacts rather than trying to isolate solely biofuel feedstocks from other crops and land uses. The value of more encompassing and properly applied sustainability rules, extending to more sectors and geographic regions, is highlighted frequently in the scientific and policy literature (see for example Frank *et al,* 2013).

Achieving this in practise and with the agreement of a potentially large number of countries in different parts of the world, is of course much more difficult. Kretschmer *et al* (2013b) highlight some of the existing barriers to land use planning/zoning becoming an effective tool in the short run. These barriers relate to governance structures in the land use sector, the practical challenges of land zoning and sufficient monitoring and surveillance to enforce land zoning decisions.

If European sustainability legislation covers only agricultural biomass that is used for *biofuels* but not for food and feed, and only part of the global market (ie the EU) there is a clear risk of 'sustainability leakage'. Existing cropland outside Europe that complies with EU sustainability criteria may be used for biofuel production destined for the EU market while 'non-compliant land', such as newly deforested land converted to cropland, can continue to be used to supply other markets and uses. This is one of the difficulties of trying to account for land use, including the ILUC in a workable policy.

However, the need to control ILUC remains imperative for biofuels in the way that it is not for other crops. If no account is taken of ILUC the emissions of GHGs from using biofuels can appear to be very much higher than they really are. The main reason for requiring the use of biofuels and effectively asking consumers to subsidise them is to reduce GHG emissions; consequently a clear understanding of their actual impact is essential. This is not the case for food crops that are not being grown in the expectation of a climate benefit.

A mechanism for taking account of ILUC is therefore required even though it will not achieve the objective of guiding local land use decisions, specifically according to sustainability requirements in a way that local policies could in principle achieve. Over time, it should be possible to build up a more robust system of local land monitoring and control and to

[30] Which can be monitored directly as opposed to ILUC for which we will always have to rely on models.

address land use changes in both a transparent and effective way. Progress can be made, for example by using existing mechanisms such as the provisions for reducing emissions from tropical deforestation and degradation (REDD) in an effective way. This would help to protect some sensitive areas. Land use zoning, may, in the long term, offer a more targeted approach to controlling ILUC and DLUC resulting from biofuel feedstock production.

Q16 - Do ILUC factors attribute environmental problems in third countries to European farmers who produce in an environmentally friendly way?

No, although some people have perceived it this way. The evidence that production of additional biofuel feedstocks in different parts of the world to meet demands generated by EU policy is compelling. This has prompted a policy response from the European Commission to try to address ILUC, particularly in the period to 2020. The proposal accepts that the demand for conventional biofuels produced from food and feed crops has had significant impacts. It is entirely appropriate for the Commission to proceed in this way given the EU's responsibilities towards the environment and commitment to reduce GHG emissions. The rules themselves need to apply to any biofuel supply chain, irrespective of where the feedstock was produced. It would be difficult to make the case that European producers should be exempted from concerns about ILUC and treated differently from overseas suppliers in this regard.

Given Europe's dependence on large scale supplies of feedstocks, which could increase over time on current projections, ILUC policy needs to be sufficiently simple to be applicable wherever supplies originate. EU farmers are subject to a number of environmental conditions, including cross-compliance under the CAP. But they are not subject to specific policies related to ILUC and they are able to draw on support from the CAP at a level that is much higher than that available in other parts of the world.

The land use changes arising from a sizeable expansion in biofuel demand do effect GHG emissions and do need to be assessed at a global level. Over time it would make sense to introduce global standards for sustainable production in a way that is being attempted for other commodities.

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