

# Analysis of high and low indirect land-use change definitions in European Union renewable fuel policy

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## Summary

The European Union's (EU) recast Renewable Energy Directive to 2030 (RED II) includes a 14% fuel supplier target for renewable energy used in transport (General Secretariat of the Council of the European Union, 2018). The contribution of biofuels produced from "high indirect land-use change risk" (ILUC) feedstocks toward this target is limited to 2019 consumption levels in each EU Member State, phasing down to zero by 2030. Biofuels certified as being produced from "low indirect land-use change risk" feedstocks are exempt from this limitation. The European Commission is required to define both low ILUC risk and high ILUC risk biofuels in 2019. This study summarizes published literature on observed land use change impacts of biofuel feedstocks and presents new data analysis to help inform these definitions. We provide specific options for criteria that could be used to define high and low ILUC risk biofuels.

The RED II describes high ILUC risk biofuels as those produced from feedstocks for which a significant expansion onto high carbon stock land is observed. Several commonly

used biofuel feedstocks, including palm oil, are associated with high land use change emissions and negative climate impacts. Published studies using satellite data show that palm oil expansion is strongly associated with deforestation and with conversion and drainage of wetlands with high carbon stocks. According to these studies, 40%–53% of oil palm expansion in Indonesia and Malaysia over the period 1990–2015 occurred on land with high carbon stocks. Based on prevailing trends, high rates of high carbon stock land conversion are expected to continue through 2030. As a result, transport fuels derived from palm oil will continue to present a high risk of exacerbating climate change through 2030. Although comprehensive evidence on other biofuel feedstocks is lacking, there is some evidence that deforestation associated with soy, corn, and sugarcane expansion in South America also may be significant. The available evidence suggests that corn expansion in the United States and rapeseed expansion globally are not associated with high rates of deforestation.

Low ILUC risk biofuels are described in the RED II as those produced from feedstocks that avoid displacement of food and feed crops through improved

agricultural practices or through cultivation of areas not previously used for crop production. If a feedstock such as palm oil is classified as high ILUC risk, some share of palm oil production could still potentially qualify as low ILUC risk and be exempt from the cap and phase out. Counter to the name of the exemption, the provision presents a clear risk of increasing EU palm biofuel consumption without mitigating its especially high ILUC risk effects. We find that, in a business-as-usual scenario, more palm oil is likely to be produced in 2030 on unused, low carbon stock land converted since 2020 than was used for EU biofuel consumption in 2017. Although this palm oil potentially could qualify as low ILUC risk, its production will have been driven by demand for food, feed, and materials, and diverting these resources from other uses to biofuel would cause displacement effects and ILUC emissions. Similarly, farmers continually improve agricultural practices to increase yields to meet demand for food and feed, regardless of biofuel policies. Counting crops produced from yield increases as low ILUC risk, even if compared to a dynamic baseline of increasing yields over time, would credit large amounts of feedstock that would have been produced for use in food and feed. Diverting it to biofuel production would lead to

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ILUC. Our analysis indicates that by 2030, almost as much palm oil could qualify for the low ILUC risk provision under a simplistic interpretation of the agricultural improvements provision as the amount of palm oil currently used in biofuel in the EU, without any specific action having been taken by plantation owners to reduce ILUC impacts. If both the unused land and yield increase options are available with simplistic interpretations, palm oil use in EU biofuel could double from 2017 to 2030 without reducing ILUC at all compared to current practices.

We find that defining specific and robust criteria is critical to ensure that low ILUC risk feedstock production will actually reduce ILUC impacts by being additional to the amount that would be produced in the absence of the RED II, rather than diverting food and feed commodities from other uses. The Clean Development Mechanism (CDM) has a robust protocol for determining additionality of greenhouse gas reductions, and this tool potentially could serve as a model for certifying low ILUC risk feedstock production. Following the CDM example would require that low ILUC risk feedstock be produced using agricultural improvement methods or on types of unused land that are not commonly used in the region, and that they would either not be financially viable in the absence of low ILUC risk certification or that nonfinancial barriers exist to their adoption.

Adopting certification criteria similar to the CDM would provide a clear incentive to produce feedstock on degraded land that would not otherwise be used for agriculture. We estimate that this would create an opportunity to produce at least 1 million tonnes of palm oil each in Malaysia and Indonesia on land colonized by the invasive *Imperata* grass. Cultivating this land for biofuel production would deliver direct environmental and economic benefits to these countries in addition to genuinely reducing ILUC.

## Policy context

The RED II includes a 14% fuel supplier target for renewable energy used in transport (General Secretariat of the Council of the European Union, 2018). Due to concerns about ILUC, the contribution of food or feed-based biofuels to the renewable energy target in transport is capped at 7% of road and rail transport energy or limited to 2020 consumption levels in each Member State, whichever is lower. The RED II includes a further restriction for high ILUC risk biofuels, capping their contribution toward the target to 2019 consumption levels in each Member State, declining to 0% by 2030:

High indirect land-use change risk food or feed crop-based biofuels, bioliquids and biomass fuels produced from food or feed crops for which a significant expansion of the production area into land with high carbon stock is observed, shall not exceed the level of consumption in 2019 in the Member State, unless they are certified as low indirect land-use change-risk biofuels, bioliquids and biomass fuels pursuant to the following two subparagraphs: As of 31 December 2023, this limit shall decrease gradually to 0% by 31 December 2030 at the latest. (General Secretariat of the Council of the European Union, 2018, Article 25, paragraph 1)

This clause can be interpreted in two ways: (1) high ILUC risk biofuels are defined as those produced from feedstocks associated with conversion onto high carbon stock land, or (2) the cap and phase out apply only to the portion of feedstocks defined as high ILUC risk that are associated with conversion onto high carbon stock land. The Commission could thus define the cap and phase out as applying either at the feedstock level (e.g., palm oil globally) or to a subset of a feedstock (e.g., palm oil produced in Indonesia and Malaysia, but not palm oil produced in other countries).

We note that the second interpretation would be inconsistent with the definition of ILUC because indirect effects are transmitted through global markets; however, this interpretation is still possible. This second interpretation implies a two-step classification process: first, identifying high ILUC risk feedstocks, presumably on the basis of economic modelling, and second, identifying a subset of that feedstock that is associated with significant conversion of high carbon stock land. Results are available from recent economic modelling work to estimate ILUC emissions from biofuel feedstocks used in the EU (Valin et al., 2015; Laborde, 2011) and we do not review these ILUC estimates in this study. Instead, we focus on evidence to assist in identifying feedstock expansion on high carbon stock land.

Biofuels certified as low ILUC risk are exempt from the cap and phase down of high ILUC risk biofuels. Low ILUC risk biofuel feedstocks are defined as being produced to avoid displacement of crops used in food and feed:

‘Low indirect land-use change-risk biofuels and bioliquids’ means biofuels and bioliquids, the feedstocks of which were produced within schemes which avoid displacement effects of food and feed crop based biofuels, bioliquids and biomass fuels through improved agricultural practices, as well as the cultivation of crops on areas which were previously not used for cultivation of crops and which were produced in accordance with the sustainability criteria for biofuels and bioliquids set out in Article 26. (General Secretariat of the Council of the European Union, 2018, Article 2, paragraph u)

The RED II requires the Commission to submit a report to the European Parliament and Council and adopt a delegated act setting out criteria for determining high ILUC risk feedstocks and for certifying low ILUC risk feedstocks by February 1, 2019. The

RED II further requires that the report and delegated act be based on the best available science.

This study summarizes published science and presents new analysis relevant to the definitions of both high and low ILUC risk. We assess in particular the evidence for classifying palm oil as a high ILUC risk feedstock and provide suggestions for criteria for certifying low ILUC risk feedstocks.

## Definition of high indirect land use change biofuel feedstocks

### DEFINITION OF HIGH CARBON STOCK LAND

High ILUC risk feedstocks are defined in the RED II as “food or feed crops for which a significant expansion of the production area into land with high carbon stock is observed.” The implementation of this definition depends heavily on how *significant* and *high carbon stock* are defined.

We can take some guidance on the definition of land with high carbon stock from Article 26, paragraph 3, of the RED II, which defines high carbon stock land as having the following status in January 2008 and no longer having that status after conversion:

- (a) wetlands, namely land that is covered with or saturated by water permanently or for a significant part of the year;
- (b) continuously forested areas, namely land spanning more than one hectare with trees higher than five metres and a canopy cover of more than 30 %, or trees able to reach those thresholds in situ;
- (c) land spanning more than one hectare with trees higher than five metres and a canopy cover of between 10 % and 30 %, or trees able to reach those thresholds in situ, unless evidence is provided that the carbon stock of the area

before and after conversion is such that, when the methodology laid down in part C of Annex V is applied, the conditions laid down in paragraph 7 of this Article would be fulfilled. (General Secretariat of the Council of the European Union, 2018, Article 26, paragraph 3)

Tropical peat soils, which are generally permanently saturated with water, are thus clearly included in the definition of wetlands and thus count as high carbon stock land. Forest, both pristine (undisturbed, or primary) and disturbed (or secondary), should generally fit the definition of *continuously forested areas* as noted in paragraph (b) and should thus also count as high carbon stock land. Mature timber plantations also likely generally meet the criteria in paragraph (b).

Other land types are less clear. Shrubland and savannah sometimes have intermittent tree cover and likely generally meet the criterion for at least 10% canopy cover in paragraph (c) and sometimes the criterion for at least 30% canopy cover in paragraph (b). For example, the cerrado has been defined as having 10%-60% canopy cover (Eiten, 1978). Shrubland and savannah without this requisite level of canopy cover may still have carbon stocks similar to or higher than the land type described in paragraph (c), however. It seems likely that these clauses from the RED II were written with European landscapes in mind. According to a European Commission decision on land carbon stock calculations, carbon stocks in European forests with more than 30% canopy cover range from 26–93 tonnes of carbon per hectare (tC/ha) (Official Journal of the European Union, 2010). This suggests that in general, land with 26 tonnes dry biomass per hectare or more may be considered high carbon stock. The same Commission decision identifies carbon stocks for tropical and subtropical shrubland as ranging from 37–53 tC/ha. These

Commission estimates suggest that in general, shrubland in tropical and subtropical countries—including all areas where palm oil is cultivated and many areas, such as Brazil, where soy is grown—has carbon stocks similar to European forest with canopy cover greater than 30%, and thus should count as high carbon stock land according to the intent of the RED II sustainability criteria.

### AVAILABLE DATA ON OBSERVED LAND USE CHANGE IMPACTS

High ILUC risk feedstocks are defined in the RED II as those “for which a significant expansion of the production area into land with high carbon stock is observed.” The interpretation of this definition requires data on the type of land on which the expansion of various biofuel feedstocks historically has occurred. The most comprehensive published literature on observed historical land use change impacts of biofuel feedstocks has focused on palm oil, in part because the vast majority of palm oil is produced in the relatively contained areas of Malaysia and Indonesia. We also review research on the observed land use change impacts of other crops, including soy, corn grain, sugarcane, and rapeseed.

#### *Palm oil*

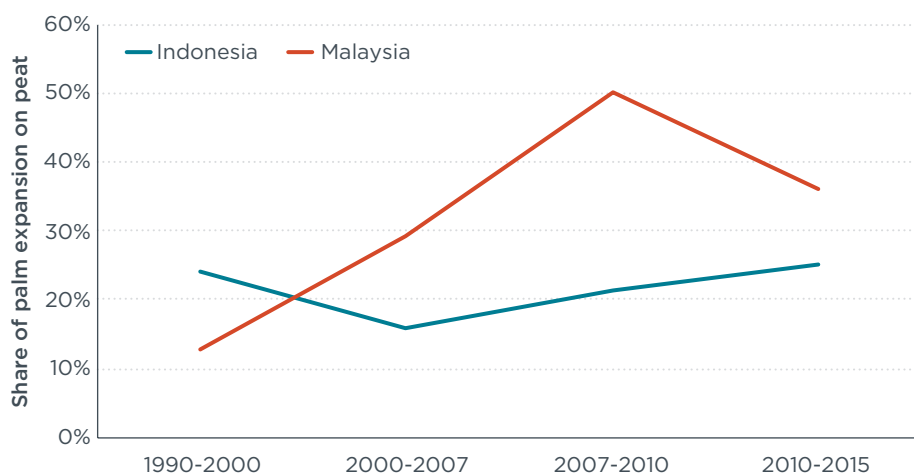
Two recent studies have used satellite data to comprehensively analyze the land cover types onto which palm plantations have expanded in Indonesia and Malaysia. The results of these studies are summarized in Table 1. Gunarso, Hartoyo, Agus, and Kileen (2013) reported on land conversion over the period 1990–2010 in Indonesia and Malaysia. Austin et al. (2017) provides more recent data for 1995–2015 in Indonesia only, and reports land conversion for each 5-year interval. Total land use change from 1995–2015 is shown in Table 1. A large fraction (26%–42%) of the historical expansion of oil palm in Indonesia and Malaysia has been on

forested land, mostly secondary forest that has regrown following disturbances, such as logging. A similarly large share (35%–38%) of oil palm expansion has taken place on land previously used for agriculture and managed forestry, including annual crops, and plantations such as rubber and timber. Austin et al. (2017) finds that only 1% of total oil palm expansion is onto timber plantations; Gunarso et al. (2013) does not separate timber from other types of plantations. The remaining oil palm expansion has been mainly on scrubland, including some on peat soils; grassland; savannah; and bare land, specifically bare soil or rock. Gunarso et al. (2013) notes that bare land often includes recently deforested areas and portions of plantations undergoing replanting procedures. Bare land thus likely represents a mixture of converted forest and agroforestry; the conversion rates of these land cover types to palm oil are thus likely underestimated in Table 1. Gunarso et al. (2013) finds that 22.5% of oil palm expansion from 1990–2010 in Malaysia occurred on bare land, but only 1.2% in Indonesia. This classification problem thus primarily affects the data for Malaysia. Austin et al. (2017) reports bare land in the same category as scrubland and savannah, but a separation in these categories was provided by Kemen Austin (personal communication, November 7, 2018).

The conversion of peat soils saturated with water to palm plantations results in very high land use change emissions because peat oxidation following drainage releases large amounts of CO<sub>2</sub> (Page et al., 2011). Miettinen et al. (2012) and Miettinen, Shi, and Liew (2016) specifically analyzed the rate of palm expansion onto peat soils in Indonesia and Malaysia over time intervals spanning 1990–2015. We compare the area of palm expansion onto peat soils reported in these studies with the total increase in palm plantation area in each country using harvested area data from the United States Department of

**Table 1.** Summary of data on land cover types of palm plantation expansion in Indonesia and Malaysia.

Land cover type converted to palm plantations	Indonesia		Malaysia
	Austin et al. (2017) (data spanning 1995–2015); Thousand hectares (share of total land conversion)	Gunarso et al. (2013) (data spanning 1990–2010); Thousand hectares (share of total land conversion)	
Secondary (disturbed) forest	2230 (25%)	1746 (27%)	1365 (42%)
Primary (undisturbed) forest	116 (1%)	397 (6%)	5 (0.2%)
Swamp and swamp scrubland	1226 (14%)	411 (6%)	5 (0.2%)
Scrubland (including grassland in Gunarso et al.)	1120 (12%)	1268 (20%)	15 (1%)
Bare land	674 (7%)	74 (1%)	731 (23%)
Savannah	52 (1%)	N/A	N/A
Agriculture, agroforestry, and timber plantations	3451 (38%)	2388 (37%)	1128 (35%)
Other	138 (2%)	102 (2%)	7 (0.2%)
<b>Total</b>	<b>9007</b>	<b>6387</b>	<b>3252</b>



**Figure 1.** Share of palm plantation expansion on peat soils in Indonesia and Malaysia calculated from Miettinen et al. (2012), and Miettinen, Shi, and Liew (2016).

Agriculture's Production, Supply and Distribution (PSD) database (USDA, n.d.) and summarize these results in Figure 1. Over the most recent time period, from 2010–2015, we find that 25% and 36% of palm plantation expansion occurred on peat soils in Indonesia and Malaysia, respectively. In contrast, Austin et al. (2017) reports 20% of palm expansion on peat soils in Indonesia (some amount of peatland is classified as categories

other than “swamp and swamp scrubland” in both Austin et al., 2017, and Gunarso et al., 2013). The main methodological differences between Miettinen et al. (2012), Miettinen, Shi, and Liew (2016), and Austin et al. (2017) are that Miettinen et al. (2012) and Miettinen, Shi, and Liew (2016) measured changes in mature palm plantation area while Austin et al. (2017) included areas prepared for oil palm cultivation but not yet planted,



and the studies used different peat soil extent maps.

### Soy

A large number of studies have assessed land conversion patterns for soy plantations, but generally on a much smaller geographical scale than the studies on oil palm reviewed above. In the Brazilian state of Mato Grosso, which includes part of the Amazon rainforest, Macedo et al. (2012) used satellite imagery to find that soy expansion occurred 26% on forest and 74% on pasture over the period 2001–2005. This study also found that direct deforestation impacts declined over time; over the period 2005–2009, soy expansion occurred 9% on forest and 91% on pasture. This result is in line with other studies using satellite imagery that find lower rates of forest conversion to soy following an agreement among major soy companies—the “soy moratorium”—not to trade soybeans produced in deforested areas in 2006 (Rudorff et al., 2010). However, the data on deforestation used by Macedo et al. (2012) from the Program for the Estimation of Deforestation in the Brazilian Amazon (PRODES) does not record clearing of forest patches smaller than 6.25 hectares, nor does it record clearing of dry or secondary forest. Richards et al. (2016) found that when these types of clearing were included, using a different monitoring tool, recent deforestation rates after 2008 were double or triple the rates reported by PRODES. This suggests that recent soy expansion onto forest may be significantly higher than reported in Macedo et al. (2012).

Moreover, Arima et al. (2011) and Barona et al. (2010) both linked soy expansion onto pasture with pasture expansion onto forest in some areas of Mato Grosso and neighboring states, indicating that the net impact of soy expansion on deforestation is greater than the direct soy-forest conversion rates. Similarly, Fehlenberg, Baumann,

Gasparri, and Piquer-Rodriguez (2017) found a strong correlation between forest conversion to pasture and soybean expansion elsewhere in the Chaco region of Argentina, Paraguay, and Bolivia, suggesting that soy indirectly drives deforestation in these areas as well.

Other studies have reported soy area expanding in areas where deforestation has taken place. Camara et al. (2017) observed continued deforestation as well as the expansion of soy and corn in Mato Grosso through 2015. Other studies have documented significant forest loss in other areas where soy cultivation has expanded, including in other areas in Brazil (Brown, Koppe, Coles, & Price, 2005) and Argentina (Zak, Cabido, Caceres, & Diaz, 2008). Baumann, Piquer-Rodriguez, Fehlenberg, Gavier Pizarro, and Kuemmerle (2016) found that forest loss in the Chaco region is caused primarily by cropland expansion. In a pan-tropical study, Gibbs et al. (2010) found that more than 70% of agricultural expansion in South America occurred on converted forest from 1980–2000, where the main expanding land uses were for pasture, soy, and sugarcane. Le Polain de Waroux et al. (2016) found that in general, agribusiness tends to favor expansion in places with less stringent deforestation policies; these authors argue that conservation policies in one region have leakage effects in others.

There also is evidence that soy expands significantly onto the Cerrado forest, a dry forest in Brazil often described as savannah. Gibbs et al. (2015), using satellite imagery, found that whereas expansion of soy onto Amazonian rainforest fell dramatically following the soy moratorium, soy expansion onto the Cerrado forest, which is not covered by the soy moratorium, remained high, ranging from 11% to 23% during 2007–2013. Filho and Costa (2016), using satellite remote sensing, found that from

2000–2014, 2.4 million hectares of a total 6.1 million hectares (39%) of soy expansion in the Cerrado biome was on native vegetation. While it is difficult to disentangle the effect of the soy moratorium on deforestation rates, soy still seems to be linked both directly and indirectly with the conversion of forest and savannah.

### Sugarcane

The situation with sugarcane expansion is similar to that of soy, but with less relevant evidence available. There is a prohibition on expansion of sugarcane on Amazon forest in Brazil, the Plan for Preventing and Controlling Deforestation in the Amazon (PPCDAm) (Richards et al., 2016), and indeed there appears to be little direct conversion of forest to sugarcane. Using satellite remote sensing, Adami et al. (2012) examined sugarcane expansion in the southeast part of Brazil, where 90% of the country’s sugarcane production takes place, and found that only 0.6% of sugarcane expansion over the period 2000–2009 was on previously forested land. The majority of sugarcane expansion (69.7%) was on pasture. Jusys (2017) reported an indirect link similar to that of soy between sugarcane expansion and deforestation over the period 2002–2012 using a statistical method and inferred that sugarcane expansion onto pasture has pushed pasture expansion onto forest. Supporting this conclusion, Sparovek et al. (2008) found lower pastureland area and higher cattle density in the central area of sugarcane expansion in southeast Brazil from 1996–2006, and inferred that sugarcane expansion in this area has competed with pasture. In southeast Brazil, areas of sugarcane expansion had similar rates of forest loss as neighboring areas with less sugarcane expansion, suggesting sugarcane was not directly driving deforestation in these areas. However, when looking at peripheral areas of sugarcane expansion in more northern regions in Brazil, Sparovek

et al. found greater forest loss in areas with sugarcane expansion compared to those without, and concluded that in these peripheral areas, sugarcane may be driving direct deforestation.

Although existing legislation in Brazil has been successful at least in avoiding direct deforestation from sugarcane, this situation could worsen. In April 2018, the Brazilian senate voted on a bill to end the ban on Amazon conversion to sugarcane (Gabbatiss, 2018). Brazil's recently elected president, Jair Bolsonaro, has indicated an interest in rolling back protections for the Amazon as well (Wallace, 2018). A change in policy could result in increased direct conversion of forest to sugarcane in the future.

### **Corn (maize)**

There is evidence that corn (maize) causes limited deforestation in the United States, but may be more strongly associated with deforestation in tropical regions. Land conversion from corn expansion has been assessed using satellite remote sensing in the United States by Lark, Salmon, and Gibbs (2015) and Wright, Larson, Lark, and Gibbs (2017). Lark et al. (2015) found that over the period 2008–2012, 3% of total crop expansion in the United States—most of which was for corn grain production—occurred on forest, 77% on grassland, 8% on shrubland, 8% on idle cropland, 2% on wetlands, and 2% on other land types. Wright et al. (2017) similarly found that most land use change in close proximity to corn ethanol refineries was from grassland to cropland, with much smaller amounts of land conversion from forest, shrubland, and wetlands to cropland. The rate of forest and

shrubland conversion to corn in the United States, although significant, is much lower than the observed conversion rates for palm and soy reviewed above.

However, it is possible that corn expansion may occur more heavily on deforested areas in the tropics. For example, the increase in corn area occurring simultaneously with forest loss in Mato Grosso as observed by Camara et al. (2017) suggests that corn, as well as soy, may contribute significantly to deforestation in South America. Corn often is double cropped with soy in Brazil, so these two crops together drive cropland expansion. Sixty percent of Brazil's production increase in corn in the 2000s came from Mato Grosso, the Amazon frontier state (Galford, Soares-Filho, & Cerri, 2013). Corn expansion also has occurred in areas with high deforestation in Laos, a southeast Asian country (Wildlife Conservation Society Lao PDR Program and GIZ, 2015).

### **Other crops**

A study commissioned by the EU Directorate-General for the Environment estimated deforestation impacts of various crops across large regions by data inference, rather than satellite imagery (Cuypers et al., 2013). This study assessed the extent of forest conversion to cropland over the period 1990–2008 and attributed this to various types of crops according to the relative extent of crop expansion over that time period in each country. This is a rough approach that is not able to precisely distinguish deforestation impacts of different crops. It also does not separate direct from indirect land use change.

Nevertheless, it may be helpful as an indication of the degree to which various crops are associated with deforestation. We compare these estimates of deforestation in each region with data on total expansion of each crop over this time period from the Food and Agricultural Organization of the United Nations (FAOSTAT, n.d.) in order to estimate the share of expansion that occurs on forest in each crop. We summarize these estimates in Table 2, excluding crops with less than 1 million hectares total expansion in each region from 1990–2008 due to poor data resolution.

Using this same approach, we also can estimate the share of rapeseed expansion on forest in Canada, the world's largest rapeseed producer, according to FAOSTAT. According to Natural Resources Canada (2018a), 1.2 Mha of forest was lost from 1990–2015, and 41% of this was from cropland expansion (Natural Resources Canada, 2018b). Using FAOSTAT data on changes in area of crops in Canada, we estimate that rapeseed was responsible for 53% of total cropland expansion, and thus we infer that it was responsible for 53% of forest conversion over that time period. Using this estimate, 5% of rapeseed expansion in Canada from 1990–2015 was onto forestland. There is some evidence that the actual share of rapeseed expansion onto forest may be less than this; the canola-growing region in Canada, mostly in southern Alberta, Saskatchewan, and Manitoba (Canola Council of Canada, 2015), is generally distinct from the areas of forest loss, which cover most of the rest of the country (Global Forest Watch, 2018).

**Table 2.** Estimated share of crop expansion onto forest in major world regions from 1990–2008, calculated from Cuypers et al. (2013).

Region	Soybeans	Maize	Sugarcane	Sorghum	Oil Palm	Sunflower	Rapeseed
Sub-Saharan Africa	-	59%	-	20%	-	-	-
Central/South America	55%	41%	87%	-	-	-	-
Southeast Asia	4%	10%	-	-	64%	19%	8%

**Table 3.** Summary of estimates of the share of expansion of major crops on high carbon stock land (%)

	Soybeans	Maize	Sugarcane	Sorghum	Oil Palm	Sunflower	Rapeseed
<b>Based on satellite imagery or remote sensing</b>	9%-39%	3%	0.6%	-	40%-53%	-	-
<b>Based on data inference</b>	4%-55%	10%-59%	87%	20%	64%	19%	5%-8%

Table 3 summarizes the literature reviewed above, providing the range in estimates of the share of crop expansion onto high carbon stock land for several major crops. The first row summarizes estimates from studies that use satellite imagery or remote sensing to track the expansion of a specific crop onto exact areas that were previously forest or savannah. The second row summarizes estimates based on data inference, which is to say inferring crop expansion onto forest because reported statistics show an increase in cultivation area of a crop in the same general area where forest loss has been detected. The data in both rows summarize estimates from studies in different regions and time periods and often using different methodologies; this contributes to high variation among estimates. Generally, estimates based on satellite tracking are likely more accurate.

### PROJECTION OF LAND USE CHANGE FROM OIL PALM EXPANSION

Based on the data reviewed above on oil palm expansion onto various land types, we project the rate of oil palm expansion onto high carbon stock land in Indonesia and Malaysia. Indonesia and Malaysia account for roughly 90% of global palm oil production, so focusing on land use changes in these two countries provides a fairly accurate representation of global land conversion for palm oil calculated using data from the USDA PSD database.

In Table 4 we first classify the land use changes to palm plantations observed from 1995–2015 in Austin et al. (2017) for Indonesia and from 1990–2010 in Gunarso et al. (2013) for Malaysia, counting primary and

secondary forest, timber plantations, and wetlands as high carbon stock land. In a separate column, we include “shrubland and savannah” in this category as the classification of this kind of land in the context of the RED II is unclear. This category also includes grassland in Gunarso et al. (2013) and so may slightly overestimate the share of shrubland in Malaysia, but as “shrub and grasslands” represents only 0.5% of palm expansion in Malaysia in that study, this effect is minimal. The first row presents the historical share of palm expansion onto high carbon stock land for Indonesia and Malaysia as well as showing this share aggregated over the two countries. Overall, 40% of palm expansion in these two countries occurred on high carbon stock land from 1990–2015, increasing to 50% if “shrubland and savannah” is included.

The second row shows our projection for the share of expansion onto high carbon stock land over the period 2015–2030. Austin et al. (2017) presents land conversion for each 5-year period from 1995 to 2015 and demonstrates that the share of forest conversion in Indonesia has declined over that period, whereas the share of oil palm expansion on shrubland and savannah has slightly increased. In our projection for Indonesia, we assume that the rate of land conversion for each land type will continue linearly from 1995, and then estimate the future share of expansion on high carbon stock land. It is important to remember that the data used in this analysis does not reflect trends in smallholder plantations, and that historical trends in land conversion could change in the future. Indonesia has had a forest moratorium in place since 2011 but this does not appear to have affected deforestation rates,

and no penalties have been issued for noncompliance. In 2016, the country introduced a 5-year palm moratorium to prohibit the expansion of palm plantations on a larger extent of forest than the area covered by the forest moratorium. However, as with the forest moratorium, it is not clear if any enforcement mechanisms exist (Kharina, 2016). We thus do not adjust our projection for these policies. For Malaysia, conversion data are not available for different time intervals, and so we simply assume the same future share of conversion on high carbon stock land as the historical share for 1990–2010. Overall, we project 30% of palm expansion over 2015–2030 to occur on high carbon stock land, increasing to 43% if shrubland and savannah classification is included.

For illustrative purposes, in rows 3 and 4 of Table 4 we estimate the share of all harvested palm area occurring on high carbon stock land converted since 2008 in 2015 and 2030, respectively. This is to show the proportion of palm oil produced in Indonesia and Malaysia that would not meet the basic sustainability criteria in Article 26 (paragraphs a-c). In 2015, 12% of all palm plantation area would have been on high carbon stock land converted since 2008 (16% if shrubland and savannah were included). By 2030, this share grows to 17% (24% with shrubland and savannah included) because we expect palm expansion on high carbon stock land to continue in that time frame. For this calculation, we use data on total harvested palm oil area in 2015 from the government of Indonesia (as cited in Lokadata, 2016) and from the USDA PSD database for Malaysia. We project 2030 global palm oil demand by

**Table 4.** Historical and projected conversion of high carbon stock land to palm plantations based on data in Austin et al. (2017) and Gunarso et al. (2013).

	Indonesia		Malaysia		Indonesia + Malaysia	
	Excluding shrubland	Including shrubland	Excluding shrubland	Including shrubland	Excluding shrubland	Including shrubland
<b>Historical share of expansion on high carbon stock land</b>	40% (1995-2015)	53% (1995-2015)	42% (1990-2010)	42% (1990-2010)	40% (1990-2015)	50% (1990-2015)
<b>Projected (2015-2030) share of expansion on high carbon stock land</b>	29%	43%	42%	43%	30%	43%
<b>Share of 2015 palm area on high carbon stock land converted since 2008</b>	14%	19%	8%	8%	12%	16%
<b>Projected share of 2030 palm area on high carbon stock land converted since 2008</b>	20%	29%	8%	8%	17%	24%

linearly extrapolating historical palm oil production from 2000-2018 (USDA PSD, n.d.) and adjusting to account for Indonesia's expected biodiesel mandate increase to 30% ("Indonesia accelerates use," 2018). Palm oil demand in India, China, and Pakistan—three of the four largest palm oil consumers globally—is expected to continue growing (Koe, 2018; Ravi, 2018; "Lack of policy support," 2018). Our projection assumes EU palm oil imports remain roughly constant in order to demonstrate the expected land use change impacts in a scenario where palm oil use in biofuel is not meaningfully restricted by RED II implementation.

The RED II states that high ILUC risk feedstocks have "significant" observed expansion onto high carbon stock land, and the exact meaning of significant is not defined within the directive. However, the available data strongly suggest that a high share of oil palm expansion is on high carbon stock land.

### Definition of low indirect land use change biofuel feedstocks

Biofuel feedstocks certified as low ILUC risk are exempt from the cap and phase out required for high ILUC risk feedstocks in the REDII. The interpretation of low ILUC risk will thus have important consequences for the net impact of the high ILUC risk provision in the implementation

of this directive. The RED II text defines low ILUC risk feedstocks as those which "avoid displacement effects...through improved agricultural practices, as well as the cultivation of crops on areas which were previously not used for cultivation of crops" and that meet the sustainability criteria in Article 26. The intention behind this provision was likely to encourage the additional production of biofuel feedstocks in a way that does not impact commodity markets and thus does not cause ILUC. The demonstration of additionality is critical to ensure that biofuel feedstock credited as low ILUC risk does not displace commodities used for food, feed, and materials and thus does not contribute to ILUC. In this section, we review the additionality requirements in the Clean Development Mechanism (CDM) as a key precedent for this kind of test. We then review in detail the low ILUC risk definition in the RED II and explain how, if this definition is interpreted in a way that does not ensure additionality, this provision would almost certainly cause significant ILUC emissions, rendering the high ILUC risk provision meaningless. Interpreting this definition in a way that ensures feedstocks certified as low ILUC risk actually reduce ILUC impacts compared to business-as-usual will be critical to achieving environmental benefits from the high ILUC risk provision in the RED II.

### ADDITIONALITY IN THE CDM

Few policies have attempted to require the demonstration of additionality for receiving incentives. The CDM has a robust procedure in place for demonstrating additionality for all greenhouse gas (GHG) reduction projects before approval and crediting can take place. This procedure requires project proponents to demonstrate that the project would not have taken place in a baseline (business-as-usual) scenario without CDM crediting; this ensures that CDM crediting is supporting GHG reductions that would not otherwise have occurred. CDM's process provides an instructive, internationally recognized precedent for the criteria to determine low ILUC risk biofuels in the EU.

CDM projects must follow the "Tool for the demonstration and assessment of additionality" (CDM Executive Board, n.d.a). The main steps are:

1. Demonstrate that the project is not legally required by mandatory local laws and regulations; and
2. Perform one of the following:
  - a. Investment analysis: demonstrate that the project is unlikely to be financially attractive in the absence of CDM crediting; or
  - b. Barrier analysis: demonstrate that there is at least one barrier preventing implementation of the proposed



project in the absence of CDM crediting; and

3. Common practice analysis: demonstrate that similar activities are not observed in the region.

If the assessment for any of these criteria is negative, the project is determined not to be additional and does not receive approval by the CDM Executive Board, the decision-making body for all project approvals.

There are specific protocols for each analysis. For the investment analysis, the project proponent must calculate an appropriate financial benchmark (such as weighted average costs of capital) assuming an internal rate of return that is standard for the industry (CDM Executive Board, n.d.b). Analyses must show that the project is cost viable with the expected revenue from the sales of CDM credits generated from the project, but not cost viable without CDM credit sales, in order to be approved.

The barrier analysis may be completed as an alternative to the investment analysis. It is used to identify non-cost barriers to implementing the project. This can include, for example, non-cost investment barriers (e.g., capital is not available in the host country), technological barriers, or lack of infrastructure. The project proponent must explain why access to CDM credit support would allow these non-cost barriers to be overcome.

For the common practice analysis, the project proponent must identify the main measure or technology in the proposed project that would reduce GHG emissions and calculate the share of similar projects in the region that use this measure or technology (CDM Executive Board, n.d.c). If this share is greater than 20%, or if more than three projects in the region use the measure or technology, the protocol determines that the measure or technology is “common practice” and the project application would thus be deemed not additional.

The CDM additionality methodology could be applied to identify low ILUC risk crop production. The first step would likely never apply because it is unlikely crop production is ever legally required. An investment analysis could be used to show that the cultivation of an area of land or the adoption of an agricultural improvement method would be cost viable only with policy support. For this analysis, project proponents, which is to say farmers and plantation owners, could assume a higher commodity selling price if low ILUC risk certification is granted compared to the prevailing commodity price in the region. Alternatively, the barrier analysis could be used to demonstrate that the project would not occur without policy support, for example because the land is contaminated from industrial activity and food production on that land is not allowed by regulation, or because the land is colonized by invasive species such as the *Imperata* grass that is difficult to eradicate. The common practice analysis could be used to show that either the type of land in the proposed project is not commonly used for agriculture, for example *Imperata* grassland, or that the agricultural improvement method is not commonly used in the region. The CDM additionality tool could be an effective method for demonstrating that biofuel feedstock production would not have taken place in the absence of the RED II and thus does not displace crops used for food, feed, and materials.

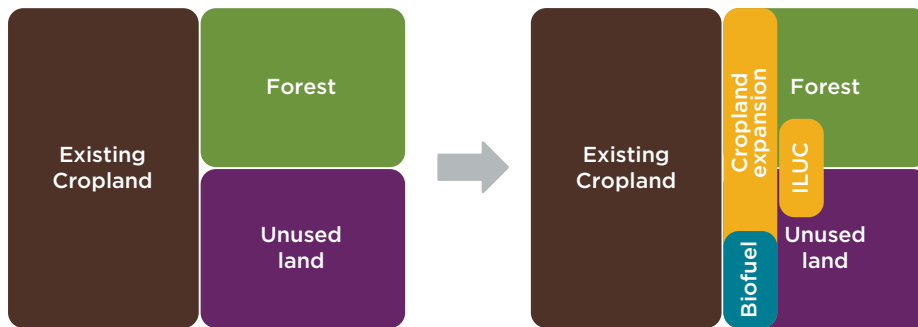
### UNUSED LAND

In this section, we analyze the part of the low ILUC risk definition relating to unused land and assess the associated ILUC risk level if robust criteria to certify low ILUC risk feedstocks are not set. The second part of the definition of low ILUC risk feedstocks describes land that was not previously used for agriculture and is not high carbon stock or highly biodiverse land as defined by

Article 26. Although we argue above that tropical shrubland should count as high carbon stock land for the purposes of defining high ILUC risk feedstocks, it is not clear whether shrubland would meet the more specific criteria for canopy cover in Article 26. Biofuel feedstocks grown on converted shrubland, as well as grassland, could thus qualify as low ILUC risk under this definition.

The problem with this provision is that biofuel feedstock produced on newly converted shrubland and grassland is not necessarily additional. Palm oil area is expanding rapidly to supply growing demand for food and livestock feed across the world. From 2020 to 2030, we project global palm oil production to increase by more than 40%. In a business-as-usual scenario, 1360 thousand hectares in Indonesia and 160,000 hectares in Malaysia will be converted from grassland, shrubland, savannah, and bare land to oil palm plantations (25% and 23% of total palm expansion in Indonesia and Malaysia, respectively), to meet growing global demand for food, feed, and materials. This calculation follows the same linear trends described in the section “Projection of land use change from oil palm expansion” above. Assuming palm oil is classified as a high ILUC risk feedstock, this entire amount of palm oil could plausibly qualify as low ILUC risk under the RED II definition because it will be grown on land not previously used for agriculture and that could meet the sustainability criteria in Article 26.

Diverting palm oil from use in food and feed would impact the global palm oil commodity market, increasing palm oil prices, and probably also prices of other vegetable oils, and lead to increased land conversion to palm oil compared to a scenario where no palm oil is used for EU biofuel consumption. Much of this resulting indirect increase in land conversion would occur on forest and peatland, following our projected



**Figure 2.** Schematic illustrating the effect of diverting feedstock produced on unused land to biofuel production without requirement for additionality (adapted from Dehue et al., 2010).

trend in Table 4. This problem is illustrated in Figure 2. Using feedstock from unused land areas that would have been converted to cropland anyway (the blue square taken out of the yellow rectangle) leads to indirect and uncontrolled cropland expansion (yellow rectangle labelled “ILUC”) that will take place at least partly on forestland. Diverting palm oil grown on low carbon stock land that would have been converted to palm oil production in the absence of biofuel demand thus has a very similar impact to business-as-usual sourcing of palm oil from the general commodity market and does not meaningfully reduce ILUC.

The low ILUC risk exemption in the RED II could even plausibly allow increased use of palm oil in EU biofuel consumption compared to the present. We estimate the amount of palm oil that would be grown on the amount of newly converted, low-carbon stock land from 2020–2030 estimated above. We factor in the expected age class distribution from these areas in 2030 following data from Ling (2012), as cited in USDA Foreign Agricultural Service (2012). Oil palm trees generally do not produce harvestable oil until the third year, and then produce lower-than-average yields in years 3–6. After this point, oil palm trees produce higher than average yields until around year 20, when yields begin to decline. In the year 2030, we expect the average yield of oil palm on areas converted

since 2020 (3.3 t/ha) to thus be lower than projected overall average yields in Indonesia and Malaysia (4.5 t/ha) in 2030. Following this methodology, we estimate that 4.9 million tonnes of palm oil could be produced in 2030 on land qualifying as low ILUC risk. This is greater than the 3.9 million tonnes of palm oil used in biofuel in 2017 in the EU (Transport & Environment, 2018). The provision for counting palm oil on unused land as low ILUC risk could thus inadvertently allow an increase in the amount of palm oil used in EU biofuel and the associated ILUC emissions.

Options to address this problem: The most direct way to address this problem is to follow the likely intention of the low ILUC risk provision by requiring operators to demonstrate that production of the low ILUC risk feedstock is truly additional to what would have been produced on that land in the absence of EU biofuel demand. The CDM methodology for demonstrating additionality, described above, could be effective in this regard. In particular, the “barriers analysis” could be used to demonstrate that the unused land would have remained unused in a business-as-usual scenario, or the “investment analysis” could show that conversion of the unused land would not be profitable without biofuel incentives. The “common practice” analysis could be used to prevent crediting of feedstock on the type of shrubland, grassland, and bare land that we

expect palm oil to rapidly expand on in the future. Using the CDM protocol would ensure that only land with real barriers to cultivation, such as *Imperata* grassland, could be used to produce low ILUC risk feedstock.

An alternative methodology was developed by Ecofys specifically for the determination of additionality for crop cultivation on previously unused land. This methodology is described to identify Responsible Cultivation Areas in Dehue et al. (2010), which presents three options for demonstrating that biofuel feedstock produced on previously unused land is additional:

- The project area is located in a region in which no additional agricultural development takes place or is foreseen (except for biofuels).
- The project area has certain characteristics that form a barrier to its development into agriculture and thereby make its development in the next years unlikely in absence of the biofuel project.
- The project area is located in a region that has a large [to be defined] unused potential of land with similar characteristics as the project area. (Dehue et al., p. 18)

The benefit of requiring demonstration of additionality is shown in Figure 3. Because biofuel feedstock cannot displace cropland expansion that would occur in the baseline scenario (yellow area), it must be grown entirely on unused land that would otherwise have remained unused (blue rectangle) and thus won’t displace crop production for food and feed. ILUC is thus effectively avoided.

Palm oil grown on unused grassland or shrubland in Malaysia and Indonesia clearly would not meet the first criterion because a large amount of additional agricultural development

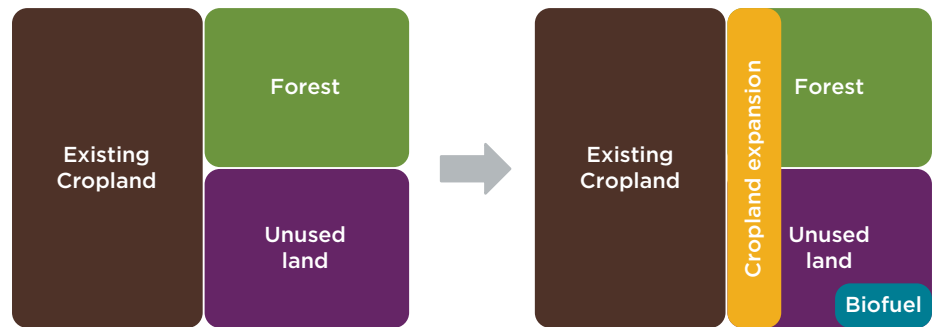
is strongly expected. Nor would it be likely to meet the third criterion because the overall prevalence of non-forested land in Indonesia and Malaysia is low. Less than 2% of total land area in Indonesia and less than 1% of land area in Malaysia is naturally grassland or shrubland, according to the Terrestrial Ecoregions of the World database (World Wildlife Fund, 2012). Limited areas of land in these countries potentially could qualify as additional under the second criterion if they have clear barriers to cultivation, such as *Imperata* grassland or contaminated land. If degraded or contaminated land were to be used for palm oil production for EU biofuel consumption, this very likely would be additional and would avoid ILUC. Overall, following the criteria proposed by Dehue et al. (2010) would be an effective strategy for reducing unintended ILUC from the low ILUC risk definition in the RED II.

Other measures that would limit ILUC from low ILUC risk feedstocks include:

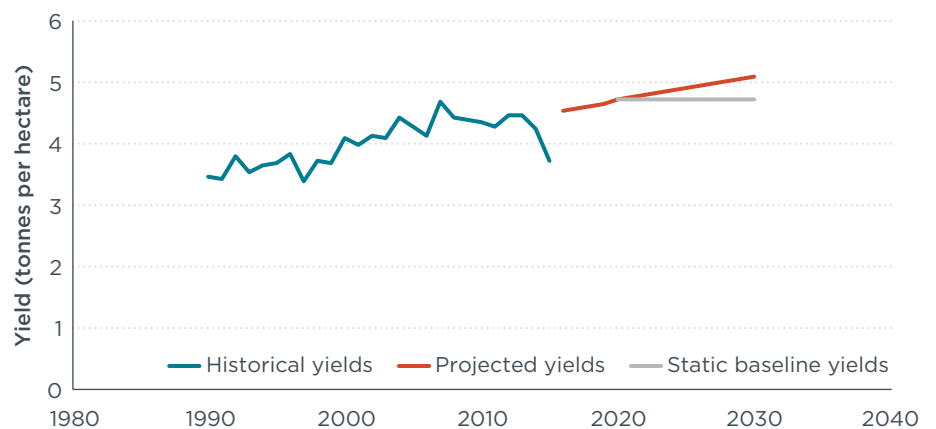
- Counting tropical shrubland as high carbon stock land for the purposes of the sustainability criteria in Article 26;
- Requiring that eligible land areas have been continuously unused for agriculture since 2008 (to avoid certification of land in a replanting cycle);
- Strictly enforcing Article 26 sustainability criteria prohibiting the use of high carbon stock land converted in 2008 or later.

### IMPROVED AGRICULTURAL PRACTICES

This section analyzes the part of the low ILUC risk definition referring to improved agricultural practices, and similarly to the section on unused land, assesses the ILUC risk if this definition is interpreted in a simple way without robust criteria. The first part of the definition of low ILUC risk feedstocks is crops that “avoid displacement effects...through



**Figure 3.** Schematic illustrating the use of unused land for biofuel feedstock production with requirement for additionality (adapted from Dehue et al., 2010).



**Figure 4.** Projected yield increase compared to a static yield baseline for Malaysian palm oil.

improved agricultural practices.” This clause likely was intended to mean practices that lead to additional biomass production that would not have been produced in the absence of EU biofuel demand. Effectively, this option refers to increasing yields on existing agricultural land.

Crediting yield increases that would have happened anyway will not reduce ILUC. Crop yields generally increase over time due to technological improvements. Figure 4 shows historical palm oil yields in Malaysia, which have increased steadily over time except for a poor year in 2015. Assuming this trend continues, the “projected yields” line shows continued yield increases to 2030. If any yield increases over the period 2020–2030 are counted as low ILUC risk in the RED II, the difference between the projected yields line and the static baseline yields line

would qualify without any additional action being taken to further increase yields specifically to reduce ILUC. In effect, the RED II would credit palm oil production that would have taken place anyway and that would have supplied demand in food, feed, and materials. Diverting that business-as-usual palm oil production from those other uses will increase palm oil demand and cause ILUC.

The Roundtable on Sustainable Biomaterials (RSB) presents a methodology for comparing actual yields to an increasing baseline yield as part of its Low ILUC risk Module in an attempt to address this problem (RSB, 2015). We examine the effect this methodology would have if applied to the RED II. To qualify as low ILUC risk using this option, operators must demonstrate that yields on their cropland increase more than an increasing dynamic

baseline. This calculation is illustrated in Figure 5. Farm A's dynamic baseline yields (dashed line) start with the observed yields at that farm in year 0 and follow the same average level of annual yield increase as historically observed at similar farms in the region ("Historical regional average yields"). Any observed yields at Farm A above this dynamic baseline qualify as additional in RSB's calculation and can be certified as low ILUC risk.

The problem with this option is similar to that for unused land: above-baseline yield increases are not necessarily additional. Mathematically, 50% of farms will achieve yield increases higher than the average yield increase in any particular region in any particular year. In the absence of biofuel demand, we still would expect around 50% of farms in any particular year to produce some amount of feedstock that RSB would certify as low ILUC risk, without those farms taking any action to improve yields over what would have happened anyway. In the absence of biofuel demand, all of the crops produced at these farms would have a market in food, feed, or materials. Displacing some of this crop for biofuel production thus would reduce the amount available for other uses, raising commodity prices and causing ILUC. Similar to the unused land provision alluded to in the RED II low ILUC risk definition, using RSB's yield increase option would unintentionally result in ILUC.

To illustrate what effect this could have, we use county-level corn grain yield and production data from the United States (USDA National Agricultural Statistics Service, n.d.). In reality, there are many farms per county, but this is the finest resolution data we have available. We choose the state of Illinois as an example "region." We apply RSB's methodology to estimate how much corn production would be certifiable as low ILUC risk in a baseline scenario over the period 2007–2016, using 2006 as the baseline

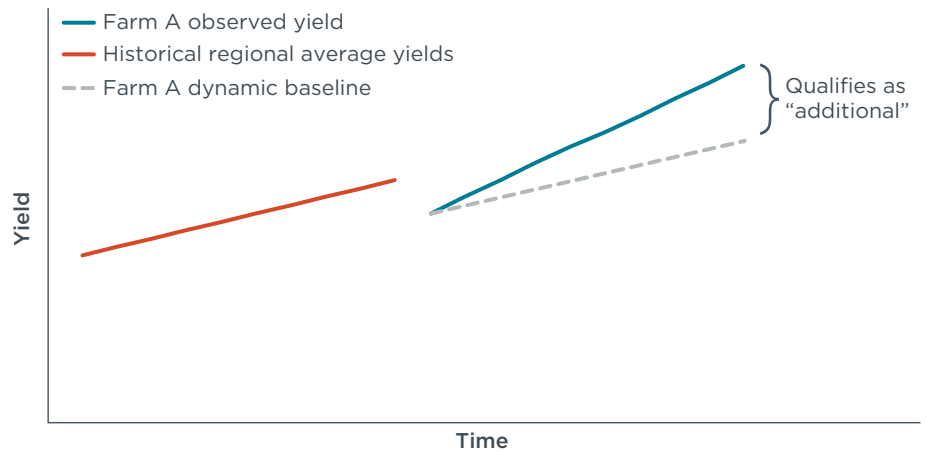


Figure 5. Schematic illustrating RSB's yield increase calculation.

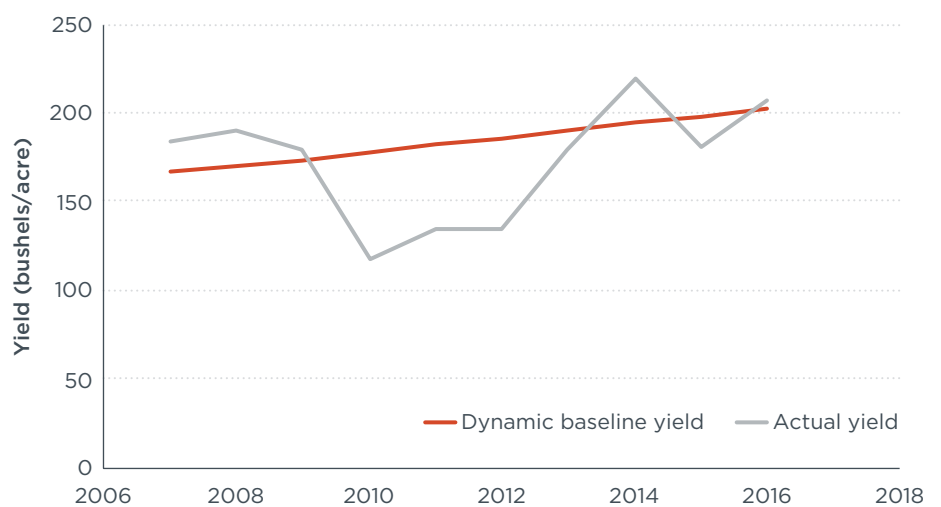


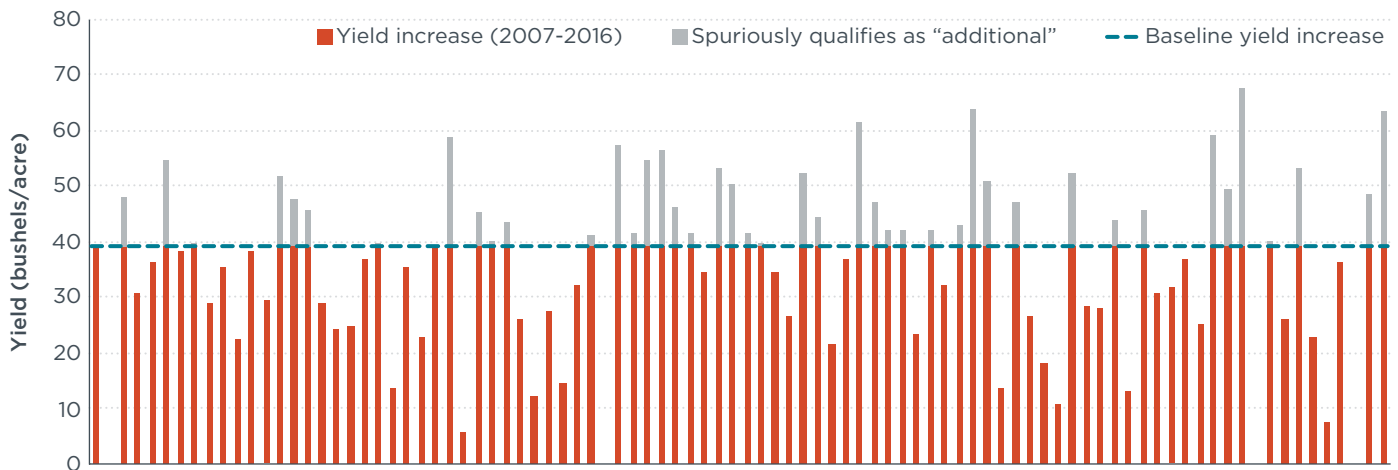
Figure 6. Observed yields compared to a theoretical dynamic yield baseline for 2007–2016 for Hancock County, Illinois.

year and the period 1997–2006 to determine the dynamic baseline trend. RSB's low ILUC risk methodology has not been used by U.S. corn producers, nor are we aware of any other scheme that would specifically incentivize above-baseline yield increases as a result of biofuel demand. Therefore, any observed above-baseline yield increases are random, or at least unrelated to biofuel demand. Figure 6 shows observed versus dynamic baseline yields in Hancock County, Illinois, as an example. In years when observed yields are higher than the dynamic baseline, the difference between the two lines would count as "additional" for certification. In roughly half the years, however, observed yields are lower than the baseline, but

these deficits are not subtracted from the yield surpluses that are credited. In this example, 4% of total corn production over the period 2007–2016 would qualify as low ILUC risk using RSB's methodology.

When we expand this analysis to all counties in Illinois, we find that 3% of total corn production in the state over this 10-year time frame would qualify as low ILUC risk using RSB's methodology. Figure 7 shows the overall yield increase from 2007–2016 in each county in Illinois, compared to the state-level dynamic baseline yield increase indicated by the dashed line. In counties where the column rises higher than the dashed line, this difference would qualify as low ILUC





**Figure 7.** Observed corn yield increase in Illinois counties compared to the baseline yield increases from 2007–2016.

risk in RSB’s methodology. Again, because no corn producers in this region are seeking RSB’s low ILUC risk or a similar certification, the above-average yield increases in these particular counties are happenstance and cannot be attributable to biofuel demand. This means that around 3% of U.S. corn could be certified as low ILUC risk without farmers taking any additional action to improve yields more than they otherwise would have and without actually reducing ILUC.

If we apply our low-end estimate of 3% to global palm oil production, again assuming palm oil is classified as high ILUC risk in RED II implementation, 3.3 million tonnes could spuriously qualify as low ILUC risk in the year 2030, nearly meeting the entire 2017 demand of 3.9 million tonnes palm oil in EU biofuel consumption. This means that if the “improved agricultural practices” clause in the RED II’s low ILUC risk definition is interpreted in line with RSB’s methodology, EU use of palm biofuel could continue at nearly the same level without any action taken to reduce ILUC. This effect is in addition to the amount of palm oil that could be used for EU biofuel from the unused land option alluded to in the RED II low ILUC risk definition.

Options to address this problem:  
Given the evidence that certifying

“above-baseline” yield increases likely would not reduce ILUC for the amount of EU biofuel produced from palm oil, it may be reasonable to disallow this option altogether. If this option is allowed, the CDM methodology for demonstrating additionality presents the most robust protocol available. This methodology could be applied to identify genuinely above-baseline yield increases. The investment analysis could be used to show that adopting a yield increase measure (a new technology or a change in growing practices) would not be profitable in the absence of low ILUC risk certification. Presumably low ILUC risk feedstock could be sold for higher prices than non-certified feedstock. The common practice analysis would be used to show that the yield increase measure had not already been widely adopted in the region. These analyses would be effective at demonstrating that the yield increase measure would not have been adopted in a business-as-usual scenario and thus are genuinely additional, reducing ILUC. For projects that pass the CDM additionality test, a calculation methodology similar to RSB’s could be used to calculate the amount of feedstock credited as low ILUC risk.

The most critical elements to limiting spurious crediting are to:

- Only credit the difference between observed yields and baseline yields, not crediting the entire amount of biomass produced on these areas.
- Require a dynamic baseline that increases over time, rather than crediting any yield increase compared to the yield in year 0 at the certified farm.

Other measures that potentially could reduce ILUC from the improved agricultural practices option include:

- Requiring operators to document a plan detailing precise measures they will take to increase yields. This is an additional criterion in RSB’s methodology and would be required in the CDM methodology.
- Subtracting yield deficits from above-baseline yields in subsequent years to even out random noise. In the example for Hancock County, subtracting yield deficits would reduce spurious crediting from 4% to 2%.
- Requiring that those yield increase measures have not been used on the certified land area in the 5 years prior to the start of certification.
- Requiring that year 0 yields be set as the average of the previous 5 years, to reduce

the incentive for operators to intentionally depress yields in one year in order to increase the amount of certifiable low ILUC risk feedstock produced in subsequent years. This is part of RSB's methodology.

## Opportunities for genuinely additional palm oil production in Indonesia and Malaysia

Implementing criteria for certifying low ILUC risk biofuel feedstocks that are similar to the additionality criteria in CDM (or in Dehue et al. [2010] for unused land) still would allow a potentially large amount of palm oil to qualify as low ILUC risk and be used in the production of biofuel that could count toward the RED II targets. Here, we estimate the amount of palm oil that could be produced on low carbon stock unused land that would truly be additional. It is likely that a substantial amount of certifiably low ILUC risk palm oil also could be produced using genuinely additional yield increase measures, but we are not able to quantify this potential.

Indonesia and Malaysia have significant areas of land where there are clear barriers to agriculture or other land use. In particular, some areas have been colonized by the *Imperata* grass, also known as “alang alang” in Indonesia and “lalang” in Malaysia. This allelopathic grass emits biochemical compounds that are toxic to crops and can quickly overgrow crops, particularly oil palm, which grows more slowly upon establishment than most annual crops (Hairiah, Noordwijk, & Purnomosihdi, 2000). It is generally too labor-intensive to clear land for crop production; one study estimated 800–1000 hours of labor required per hectare, significantly more labor than required to clear forest, and clearing *Imperata* grass is considered impractical for farmers (Ruthenberg, 1976, as cited in

Hairiah, Noordwijk, & Purnomosihdi, 2000). After land is cleared, *Imperata* grass may still invade crops from neighboring areas. It is thus unlikely that areas colonized by *Imperata* grass will be extensively used for the production of palm oil or other crops in the near future. *Imperata* grassland also has low carbon stocks (Hairiah, Noordwijk, & Purnomosihdi, 2000), and so its conversion to oil palm plantations would likely increase overall carbon stocks. Dehue et al. (2010) highlights oil palm cultivation on *Imperata* grassland as an example of “Responsible Cultivation Areas.”

The use of *Imperata* grasslands thus represents a clear opportunity to produce genuinely low ILUC risk palm oil that very likely does not displace palm oil production for other uses or any other crops. There are significant areas of *Imperata* grassland in Indonesia. Garrity et al. (1997) estimated there to be 8.5 million hectares in Indonesia and 200,000 hectares in Malaysia. This land area could produce 28 and 1 million tonnes palm oil in 2030 in Indonesia and Malaysia, respectively, assuming linear yield increases from the present. This is far greater than the 3.9 million tonnes of palm oil used in biofuel in the EU in 2017. There is thus theoretically still an opportunity for Indonesia and Malaysia to increase palm oil exports for use in EU biofuel while genuinely reducing ILUC.

There are other estimates for degraded land more generally in Indonesia. Government statistics from the Indonesian Ministry of Environment and Forestry (2017) estimate 24 million hectares of “critical” land area in 2013. “Critical land” is defined as “lands that are – due to physical, chemical and biological processes – considered to have lost their hydrological and production capacity.” This estimate likely includes *Imperata* grassland, although the Ministry report does not specify more precisely what types

of land are included in this category. Mulyani, Kartawisastra, and Hidayate (2009) estimate 5.5 million hectares of *Imperata* grassland as well as thicket could be suitable for planting soy in Indonesia. This estimate may include natural shrubland with high carbon stocks and so may represent an overestimate of the low ILUC risk land area available. Caroko, Komarudin, Obidzinski, & Gunarso (2011) estimate 300,000 hectares that could be suitable for palm oil cultivation on available critical land and “abandoned land,” which is defined as “land for which use rights have been granted, but the land has not been used as specified in the rights.” Mulyani, Kartawisastra, and Hidayate (2009) and Caroko, Komarudin, Obidzinski, & Gunarso (2011) likely use different criteria to determine land suitability, and there is likely some uncertainty in how much of the available *Imperata* grassland could be productively cultivated for palm oil. Still, taking the 300,000 hectares in Caroko, Komarudin, Obidzinski, & Gunarso (2011) as a conservative estimate, 1 million tonnes of palm oil could be produced in Indonesia on suitable low carbon stock land.

Using *Imperata* grassland for biofuel feedstock cultivation would have clear environmental and economic benefits besides reducing ILUC and associated emissions. Cultivating the land would slow the spread of a problematic invasive species. Growing oil palm on this land very likely would impact biodiversity to a much lesser extent than expansion onto primary or secondary forest (Petrenko, Paltseva, & Searle, 2016). Cultivating this land that otherwise would not be used would create additional agricultural jobs because the palm oil production on this land would be additional to the amount produced for use in food, feed, and materials. Setting low ILUC risk criteria in a way that strongly incentivizes cultivation on degraded land would thus have far-reaching benefits.

## Summary recommendations

It is critical that the European Commission define the high ILUC risk and low ILUC risk provisions in a way that meaningfully reduces the ILUC impacts of biofuels used for compliance with the Renewable Energy Directive. There is strong evidence that palm oil in general drives significant conversion of land with high carbon stocks and should thus be classified as a high ILUC risk feedstock, subject to the cap and phase out in this provision. There is some evidence that soy oil also should be classified as a high ILUC risk feedstock.

Clear specifications are needed in defining low ILUC risk biofuels to ensure that this provision does not allow large amounts of business-as-usual palm oil to be exempted from the cap and phase out of high ILUC risk biofuels. If interpreted in a simplistic way, this provision would

allow enough palm oil to qualify as low ILUC risk to double current levels of palm oil consumption in EU biofuel without any specific actions taken to reduce ILUC impacts. The most important elements are to prevent business-as-usual oil palm expansion on low carbon stock land and production from yield improvements that would have occurred in the absence of biofuel demand to count as low ILUC risk. We recommend that the Commission adopt robust criteria to determine additionality of low ILUC risk biofuel feedstock. The Commission can look to the clear precedent set by the CDM, which requires applicants to demonstrate their project would not be financially or otherwise viable or commonly adopted in the absence of CDM crediting. Similar criteria could be applied to identify biofuel feedstock produced from low carbon stock land that would not otherwise be used and yield increase measures that would not be adopted in a baseline scenario. Alternatively, for identifying unused

land, the Commission could look to the 2010 Ecofys methodology, which would count feedstock grown on low carbon land as low ILUC risk only if the area of this crop is not expected to expand significantly in the region and time period of certification. This criterion would exclude the use of low carbon land for qualifying palm oil as low ILUC risk unless it is degraded or has other clear barriers to cultivation. Without clear requirements that operators take specific actions to reduce ILUC compared to business-as-usual cultivation to qualify as low ILUC risk, the provision for phasing out high ILUC risk biofuels in the Renewable Energy Directive could be rendered meaningless, exacerbating the negative climate impacts of these biofuels. On the other hand, setting criteria for low ILUC risk biofuel feedstocks in a way that strongly incentivizes use of degraded land would have far-reaching environmental and economic benefits beyond reducing ILUC.

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