THE INTERNATIONAL COUNCIL
ON CLEAN TRANSPORTATION

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RE: International Council on Clean Transportation comments on the Clean Fuel Standard Discussion Paper

These comments are submitted by the International Council on Clean Transportation (ICCT). The ICCT is an independent nonprofit organization founded to provide unbiased research and technical analysis to environmental regulators. Our mission is to improve the environmental performance and energy efficiency of road, marine, and air transportation, in order to benefit public health and mitigate climate change. We promote best practices and comprehensive solutions to increase vehicle efficiency, increase the sustainability of alternative fuels, reduce pollution from the in-use fleet, and curtail emissions of local air pollutants and greenhouse gases (GHG) from international goods movement.

The ICCT welcomes the opportunity to provide comments on Environment and Climate Change Canada's (ECCC) discussion paper. We commend ECCC for its continuing efforts to promote a cleaner, lower-carbon transportation sector that uses less petroleum-based fuels. This proposed program builds upon the impressive steps ECCC has undertaken to promote low-carbon biofuels. The comments below offer a number of technical observations and recommendations for ECCC to consider in its efforts to build this program and maximize the program's benefits in mitigating the risks of climate change and reducing petroleum use.

We would be glad to clarify or elaborate on any points made in the below comments. If there are any questions, ECCC staff can feel free to contact Dr. Stephanie Searle (stephanie@theicct.org).

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ICCT comments on the Clean Fuel Standard Discussion Paper

Introduction

Environment and Climate Change Canada (ECCC) has invited comments on the development of its Clean Fuel Standard (CFS). The recently released discussion paper lays out key considerations and raises questions on how the policy should be designed. ECCC has the potential to achieve significant greenhouse gas (GHG) reductions through changes to its fuel mix with robust policy design and implementation, and can leverage lessons learned from similar policies in other jurisdictions.

The most important concern for ensuring that the CFS achieves the targeted GHG reductions is accounting for indirect land use change (ILUC). Some biofuels appear to have very low GHG emissions based on direct emissions only, but their real impact on climate is much worse. Indirect emissions accounting is crucial to ensure that the CFS supports the best performing alternative fuels over those with high net emissions. It may also be necessary to provide additional policy support for emerging low carbon technologies such as cellulosic ethanol to drive commercialization over the coming decade. Another consideration to safeguard environmental benefits is introducing sustainability criteria to prevent direct land use change and overharvesting of agricultural and forestry residues.

The following sections offer more specific comments. They are organized by the questions presented in the discussion paper.

Questions

1. Are there any considerations that should be taken into account with respect to fuel suppliers being the regulated party?

ECCC might consider the experience in the United States where a request to change the point of obligation for the US Renewable Fuel Standard (RFS) is causing controversy. Several parties have petitioned US EPA to shift the obligation of RFS compliance from fuel suppliers to blenders and distributors. US EPA has proposed to deny these petitions, arguing that changing the point of obligation would increase the complexity of the program and would not result in greater supply of renewable fuels or reduced costs for consumers (EPA, 2016a).

4. Are there cross-cutting barriers (e.g. feedstock supply, technology) to the production and use of lower carbon fuels and alternatives in Canada? If so, please describe.

5. How might the Clean Fuel Standard be designed to address those barriers?

12. What may be needed for transportation to transition to lower carbon fuels?

We respond to questions 4, 5, and 12 together.

Based on the experience of other jurisdictions that have promoted lower carbon fuels, we would expect two main barriers to the production and use of these fuels in Canada: the supply of second generation low carbon fuel, and the ethanol blendwall.

First generation technologies, including sugar and starch based ethanol, biodiesel made from vegetable and waste oils and animal fats, and biogas, have ramped up quickly in response to policy incentives because these technologies are simple and have small capital requirements. Some of these pathways, including waste biogas and some types of waste biodiesel, can offer

high GHG savings but have limited feedstock availability. Deep GHG reductions in the transport fuel mix will require significant volumes of alternative fuels made using second generation technologies and very low carbon feedstocks with greater potential supply, such as cellulosic biofuels.

Other jurisdictions, particularly the US, have not realized the volumes of second generation fuels that were anticipated when biofuel policies were introduced, despite incentives promoting the use of these low carbon pathways. The US RFS includes a sub-mandate specifically for cellulosic fuels. California's Low Carbon Fuel Standard (LCFS) and the EU's Fuel Quality Directive (FQD) both tie credit value to GHG reduction scores, providing greater value to very low carbon fuels. The EU's Renewable Energy Directive (RED) includes double counting and a separate sub-target for advanced biofuels. In addition, US and EU institutions have funneled public funds into research programs, grants and loan guarantees for advanced alternative fuel projects. With these efforts, second generation technologies have continued to make progress from demonstration to low-volume commercial facilities. It is clear, however, that stronger policy support will be needed to fully commercialize the second generation fuel industry.

Feasible technologies for advanced biofuels have existed for years. The main barriers to scaling up the second generation biofuel industry are not technological, but largely financial and political. In contrast to simple, first generation technologies, cellulosic biofuel facilities require hundreds of millions of dollars in capital costs. It has proven difficult for many companies to secure this level of financing for the production of a low-value product in a climate of economic and regulatory instability (E2, 2014; Miller et al., 2013).

What can be learned from these experiences is that supporting the scale up of the second generation biofuels industry will require stable regulatory policy, along with complementary fiscal policy. Canada could restrict the GHG target to advanced alternative fuels only, and/or provide additional financial incentives for advanced low carbon fuels. The EU appears to be adopting this first strategy, as the European Commission's proposal for a 2030 RED includes an ambitious transport target for advanced, non-food based alternative fuels only (European Commission, 2016). Recommendations for fiscal incentives, the second strategy, are further detailed below in our response to Question 33. Incorporating either of these options will help to make sure that the fuels with the highest ability to reduce GHG emissions will be those most incentivized under the program, facilitating deeper decarbonization in the transport sector over the long run.

The second barrier is the ethanol blendwall (the maximum ethanol blend that can be supplied and consumed by conventional vehicles and infrastructure). In controversial rulemakings, the US EPA decided to reduce the overall renewable fuel volume in the RFS program in 2014-2016 due to this problem (EPA, 2013; 2015). In the US, most renewable fuel consumed is corn ethanol at a 10% blend in gasoline (E10). While EPA approved the use of 15% ethanol in gasoline (E15) in vehicles manufactured in 2001 and later (EPA, 2011), the availability of E15 at fueling stations has been limited (Alternative Fuels Data Center), and consumption remains low. Over the past several years, both flex-fuel vehicles (FFVs) that can consume ethanol blends up to 85% (E85) and E85 fueling stations have become more common, but in the U.S., the proportion of fuel consumed by FFVs that is E85 has historically been very low (analyzed in ICCT, 2014). While technological options for supplying higher ethanol blends are readily available (Searle et al., 2014), high installation costs, warranty and certification issues, and low consumer awareness and demand have all contributed to limited consumption of E15-E85

(ICCT, 2014). These challenges have proven intractable in the U.S. context, and are likely to apply in Canada as well.

The ethanol blendwall may also be a barrier to the commercialization of cellulosic ethanol in particular. Cellulosic biofuel companies report that that market limitations of ethanol consumption have slowed investment (Coleman, 2011). Because the U.S. gasoline supply is already saturated with 10% corn ethanol, it is not clear that there will be market demand for additional ethanol produced from low carbon biomass. A possible solution to this problem could be to limit the CFS to advanced alternative fuels only, effectively prioritizing the consumption of cellulosic and other very low carbon fuels over first generation food-based ethanol.

Other measures that can reduce the pressure of the ethanol blendwall include diversifying the alternative fuel mix to the greatest extent possible. Allowing the aviation and marine sectors to opt in to the policy could allow additional non-ethanol fuels to contribute to targets. Broadening the scope of fuels that are supported beyond simply biomass-based and renewable fuels to all very low carbon fuels could increase compliance options while ensuring GHG reductions.

Lastly, it is important to be realistic about the levels of ethanol that can be consumed in the near to medium term and set policy targets accordingly.

13. For rail, marine and aviation, are there considerations that need to be taken into account? Are additional flexibilities or sector-specific requirements needed?

It is not clear what the benefit would be of a sector-specific target for aviation. Alternative jet fuels tend to cost more to produce than alternative road fuels due to additional processing steps required to upgrade ethanol or other types of road fuel to jet fuel. These same processing steps also lead to additional fuel production emissions that reduce the climate benefits of alternative jet fuel (reviewed in El Takriti et al., 2017).

Some studies assume a high share of liquid biofuels used in aviation due to an expectation that road transport will become heavily electrified over the next few decades (e.g. European Commission, 2011a; b; c; ECF, 2010). Even in optimistic electrification scenarios, however, there would still be substantial remaining demand for liquid fuels in passenger vehicles and especially in heavy duty vehicles, which are more difficult to electrify (Pavlenko et al., 2016), and these sectors could likely consume any amount of biofuel that could be produced sustainably on a global scale (Searle & Malins, 2014). Furthermore, the feedstock supply chains, biorefineries, and fuel distribution networks created for road transport over the coming decade could be repurposed for aviation fuel over the longer term if necessary.

It is thus not necessary at present to specifically support the use of low carbon alternative fuels in the aviation sector. Equal or greater GHG reductions can be achieved through use of these resources in the road sector, likely at lower compliance costs. The benefit-to-cost ratio of the CFS can be maximized by making the program as flexible as possible and allowing GHG reductions to be achieved in the least expensive way. Imposing a sector-specific target on aviation would run counter to that goal.

There are then two policy design options that would treat emissions reductions in the road and aviation sectors equally. The first is to treat all transport sectors (or possibly including the building and industrial sectors) equally in the same fuel pool and require a certain level of GHG reduction over that entire pool. The second is to only make the road transport sector obligated under the CFS and allow aviation to opt-in (i.e. aviation could generate credits through use of low carbon fuels, then sell those credits to obligated parties in the road sector). The

fundamental question in deciding among these two choices is whether the entire cost of the program should fall on road users only, or if it should be spread out among aviation users as well. Even if aviation were an obligated sector, we would likely still see lower penetration of alternative jet fuels compared to alternative road fuels because the latter are more cost competitive with conventional fuels. We would then expect to see a transfer of funds from the aviation sector to the road sector as airlines purchase credits oversupplied by road fuel suppliers.

Whether Canada decides to include aviation and marine as obligated sectors or allows them to opt-in to the CFS, it is critical to consider the total volume of the obligated fuel pool when setting the GHG reduction target. There are limitations to the supply of sustainable, low carbon fuel (including but not limited to feedstock supply, investment uncertainty in second generation technologies, blending constraints, and fuel supply infrastructure constraints), and it would not be possible to meet the same per liter or per megajoule level of GHG reduction for all transport sectors combined as for the road sector only.

29. Should emissions related to indirect land-use change be considered in the lifecycle analysis? If so, what basis should be used to assess these emissions? If not, are there alternative methods that could be employed to address significant carbon intensity values along the lifecycle?

Indirect land-use change (ILUC) emissions are currently recognized by a variety of jurisdictions that have in place different types of fuels regulations, including: the United States (RFS), California (LCFS), Oregon (CFP), and the European Union (FQD and RED). This reflects two important considerations: one, that there is substantial recognition of the impact of biofuels on land-use within the scientific community; and two, that this effect is large enough that it warrants inclusion in the assessment of biofuels' role in reducing net carbon emissions within fuels policies. The International Council on Clean Transportation believes that the inclusion of ILUC within Canada's proposed CFS will help to ensure that the fuels incentivized by the program will achieve meaningful GHG reductions relative to petroleum.

Failure to account for ILUC will, at best, result in real emission reductions that are lower than they appear on paper, and lower than Canada's policy goals. At worst, it could incentivize pathways that are actually worse for climate than fossil gasoline. Especially since credits will be awarded on the basis of GHG reductions for each fuel type, ILUC accounting is critical to ensure that the policy incentivizes truly low carbon biofuels. If established, first generation food-based biofuels are treated equally with pathways associated with very low indirect emissions, such as corn stover ethanol, there will be no policy signal to invest in these technologies that are currently more expensive than food-based ethanol but have a much greater potential to deliver real and deep carbon reductions in future decades.

While there is uncertainty with respect to the exact quantification of emission factors to utilize in the assessment of ILUC for biofuels, there is a strong recognition within the scientific community that economic modeling is the best method of assessing this potential impact. The field of ILUC modeling has refined its methodology and continued to improve since the first studies on this topic were released nearly a decade ago, though different modeling approaches continue to utilize different parameters and assumptions, leading to divergent results. This range of results has fueled debates on the inclusion of ILUC emissions in policy. Despite this, there is consensus within the scientific community that ILUC emissions from food-based biofuels are

non-zero and may be significant enough to change our understanding of the net carbon impact of biofuels (Joint letter to the European Commission, 2011). Among the various scientific studies that has assessed the ILUC emissions associated with food-based biofuels, the clear majority has estimated an impact between 10 and 100 gCO_2e/MJ of fuel (reviewed in Plevin et al., 2015; Malins et al., 2014b). If we instead assume that ILUC has an impact of 0 gCO_2e/MJ because of the uncertainty associated with economic modeling, the ICCT thinks it is surely more incorrect and more risky than utilizing an ILUC factor derived from modeling.

Some critics of ILUC modeling point to a study by Babcock & Iqbal (2014) that argues that ILUC has not occurred over the past several years as global biofuel production has increased. This study makes a common mistake in thinking about indirect effects: failure to compare policy impacts to a baseline. In order to know how much land use change is attributable to a biofuel policy, we must compare a world with that biofuel policy to one without (i.e. the baseline scenario). Perhaps in the baseline, global agricultural expansion would have been slower, or land abandonment faster, than what has happened over the past several years. The truth is that it's not possible to measure ILUC because we will never know what would have happened in a world without biofuel policy. This is why the best option to assess ILUC impacts is to use economic models that can predict global land usage in a policy scenario versus a baseline scenario. A fuller critique of Babcock & Iqbal (2014) is attached to these comments in the Appendix.

Excluding the ILUC impact of food-based biofuels may not only reduce the GHG benefits of fuel policies, but it may also undermine the certainty and stability of those policies. For example, consider the case of the EU's RED (requiring 10% blending of renewable fuels in transport fuels by 2020; European Union, 2009a) and the Fuel Quality Directive (requiring a 6% reduction in the GHG intensity of the transport fuel mix in 2020; European Union, 2009b). At their outset in 2009, ILUC emissions were not included in either policy's GHG accounting. Instead, the European Commission was instructed to investigate ILUC and introduce a proposal of how to address it at a later date. Subsequent studies using the MIRAGE model indicate that ILUC emissions from food-based biodiesel undermined the GHG benefits from substituting petroleum diesel with biodiesel. However, by the time these findings were published in 2011, both the RED and FQD had been in place for several years, stimulating investment in the nascent, first-generation biofuel industry. The ensuing public debate amongst the European Union, the first-generation biofuel industry, and environmental groups lasted four years and added great uncertainty to the future of these policies. The ILUC directive, which was finalized in 2015, required reporting of ILUC emissions but did not include them in GHG accounting when determining fuel eligibility or contribution to the 6% GHG reduction target in the FQD. Instead, the ILUC directive dealt with the issue by capping the contribution of food-based biofuel feedstocks to the RED and introducing a subtarget for advanced biofuels. This resulted in widespread criticism of the EU's failure to account for ILUC the first time around; consequently, the European Commission's proposal for the 2030 RED does not allow food-based biofuels to count towards the renewable transport target at all (European Commission, 2016; Bitnere, 2017). This example shows the risk of ignoring a potentially large source of emissions for biofuels, as public outcry and ongoing debate resulted in a mix of policy uncertainty about the inclusion of ILUC that was only partially offset by the introduction of policy amendments halfway through the lifetime of the policy.

Accounting for ILUC in Canada's CFS would avoid the pitfalls of the EU's initial RED and FQD approach. Canada could further minimize policy uncertainty by using a similar approach for encouraging transparency and stakeholder engagement to that of the California Air Resources

Board (CARB) in support of its own Low-Carbon Fuel Standard (LCFS). California's ILUC modeling took place in two stages: an initial phase in 2009, and a second round in 2015 during the re-adoption of the LCFS following a court challenge to the program. The California process for ILUC assessment is a model for public engagement and expert scrutiny. CARB staff selected the model used, the Global Trade Analysis Project (GTAP-BIO) model developed at Purdue University, in consultation with subject matter experts, (CARB, 2015b). ILUC modeling is highly dependent on the quality of the data and assumptions that go into the model (the key inputs that account for most differences between different ILUC modeling studies are reviewed in Malins et al., 2014b). Following the adoption of LCFS in 2009, CARB also convened an expert workgroup in 2010 to discuss key factors that affect ILUC, including agricultural yield improvements, land conversion emission factors, and price elasticities of demand for various commodities (CARB, 2015b). This group held a series of meetings to refine and improve the modeling of ILUC factors in advance of the re-adoption of the LCFS in 2015. The expert working group included members of other government agencies involved in fuels policies, as well as a diverse mix of representatives from academia, government agencies, industry and environmental groups.

While ILUC modeling may be a complex endeavor, accounting for ILUC through alternative methods such as prohibiting direct agricultural expansion does not avoid or reduce ILUC associated with fuels policies. ILUC is market-mediated and occurs when land already in use for agriculture is diverted to biofuel production, thus raising the price of that commodity and incentivizing global agricultural expansion in response. Directly limiting land expansion to produce biofuels within Canada would not halt this indirect effect. Similarly, ILUC cannot be mitigated through agricultural management practices. The ICCT reviewed such "low ILUC" methodologies and concluded that no "low ILUC" certification scheme can adequately ensure that biofuel feedstock is produced additionally to what would have occurred in the absence of the policy (El Takriti et al., 2016). It is thus not possible to use these certifications to demonstrate that no ILUC occurred.

The ICCT recommends that ECCC utilize an economic model to assess ILUC emissions and develop estimates proportional to the size and scale of the proposed Canadian CFS policy. For the purposes of the CFS, the demand shock should be equivalent to the projected volume of biofuel production in response to the policy, split out by feedstock and region (e.g., North American corn, Brazilian Sugarcane). The results from this modeling exercise, in units of gCO_2e/MJ, would then be added to the direct life-cycle emissions for each fuel type certified under the CFS in order to determine that fuel's percentage GHG reduction relative to the petroleum baseline. This methodological decision would make Canada's proposed policy consistent with best practices from other jurisdictions and accurately account for biofuels' life-cycle emissions according to the scientific consensus. This would help ensure that the CFS would not incentivize fuel pathways with high indirect emissions that undermine the program's GHG goals; furthermore, accounting for ILUC from food-based biofuels would help steer the program towards advanced biofuels made from wastes, residues and energy crops that offer the highest GHG reductions and are better-positioned to provide a longer-term alternative to petroleum as the transport sector continues to decarbonize.

Lastly, it is important to understand that non-land based feedstocks can also cause indirect emissions. Typically, wastes, residues, and by-products are not attributed upstream emissions and are assumed to be very low carbon feedstocks. Examples of such materials include: tallow, used cooking oil, corn oil pressed from distillers grains, palm fatty acid distillate (PFAD), molasses, corn stover, small branches from timber harvesting, black liquor, tall oil, and sawdust.

Most of these materials have other uses, however, and are not available for alternative fuel production without consequences (ICF, 2016). For example, molasses is used in livestock feed and yeast production. If all molasses in Canada were diverted from these uses to produce biofuel, additional raw materials must be produced to replace it. Perhaps more corn would be incorporated in livestock feed to make up the shortfall in calories, and the yeast industry would switch to using sugar beets. This increase in demand would raise prices of corn and sugar beets, in turn driving ILUC. Globally, these indirect effects would result in substantial levels of additional GHG emissions and would, to some extent, undermine the climate goals of the CFP if not accounted for. The indirect emissions for each of the examples given above, as well as other feedstocks eligible for support in the European Commission's proposed 2030 RED, are assessed in Searle et al. (in press).

30. Should all credits be generated through lowering emissions within the fuel lifecycle (i.e., in the full supply chain and use of the fuel) or should the Clean Fuel Standard consider credits from other types of projects?

Allowing credits from non-fuel related projects would run counter to the goal of creating a fuel-specific GHG target. GHG abatement may be less expensive in electricity and other sectors compared to transport. One potential reason for creating a fuel-specific target is to ensure that long-term GHG reductions occur in the transport sector. If all sectors are treated equally, one could imagine a situation where GHG reductions occur only in heat and power because GHG abatement is less expensive in this sector compared to transportation. Yet further GHG reductions would then be required in the transport sector – and we may not be technologically ready to achieve that quickly enough at that point in time. Above, we argued that it is not necessary to create an aviation-specific target now in order to enable the usage of low carbon aviation fuels in future decades, because much of the same infrastructure can be repurposed. This may not be as true for fuels vs. heat and power. For example, refining the technology for solar panels does nothing to advance second generation biofuels. Even if greater demand for low carbon heat and power drove the creation of cellulosic biomass supply chains (which may not be likely, as energy crops, for example, are not highly profitable; Petrenko & Searle, 2016), the technology for producing heat and power from these feedstocks (i.e. combustion) is much simpler and very different from the technologies needed to process them into fuel. In particular, second generation low carbon fuels using emerging technologies may need years or even decades to scale up production. Even when a technology is proven at the laboratory or pilot scale, scaling up to a commercial sized facility presents many challenges (E2, 2014). For example, production at DuPont's commercial sized facility in Iowa has been very slow to ramp up (EPA, 2016b). Deep decarbonization of the fuel mix in future decades will likely require technologies such as cellulosic biofuel, which is why it is important to support these technologies with a fuel-specific GHG reduction policy, and also within that, with support for second generation technologies specifically.

Another question is whether GHG reductions in fossil fuel production and refining should be eligible to generate credits. Improvements in oil drilling and refining can deliver GHG reductions and lower the carbon intensity of fossil gasoline. However, it is difficult to determine if projects that reduce refining and upstream emissions would have taken place in the absence of a low carbon fuel policy, and thus if the policy is actually driving those emission reductions. For example, if flaring reduction projects at oil production sites globally were eligible under Canada's CFS, emission reductions from these projects could exceed the GHG reduction goal of the

policy and thus fail to incentivize low carbon renewable fuels; it is possible that the policy's goals could be met on paper entirely from flare reduction projects that would have happened anyway (Malins et al., 2014a).

If improvements at refineries and oil drilling sites are to be made eligible under Canada's CFS, it is advisable to limit the eligibility of such emission reductions to the upstream portion of the fossil comparator baseline for each fuel supplier. This is the approach taken by the EU for eligibility of upstream emission reduction projects in its Fuel Quality Directive (European Union, 2015; 2016). In the EU, upstream emissions from producing and refining petroleum are around 10 gCO_2e/MJ. If a fuel supplier achieved very high emission reductions through projects such as flaring and venting reduction at petroleum drilling sites and efficiency improvements at refineries, that supplier would not be able to claim a reduction greater than 10 gCO_2e/MJ for its total fuel supply. A final consideration, noting the difficulties above, is that allowing crediting of upstream emission reductions could require significant regulatory resources for accounting and verification.

31. Should a safety-valve be included to cap compliance costs? How would such a safety-valve work?

32. What additional flexibility or compliance mechanisms could be provided to facilitate compliance and minimize potential negative impacts while achieving the overall goals?

We respond to questions 31 and 32 together.

ICCT recommends following the approach taken by California (Wade, 2016) for its Low Carbon Fuel Standard. In years in which there is a deficit in credit generation across all parties, California facilitates the Credit Clearance Market. Parties with excess credits pledge to sell a certain number of credits on the market. California sums all available credits and allocates them to obligated parties with credit deficits in proportion to those deficits. There is a maximum of $200 per tonne CO_2e (adjusts annually for inflation) for which credits can sell on the Credit Clearance Market, although credits may sell for lower prices. Obligated parties are allowed to carry forward any remaining deficits penalty-free, although they must repay deficits within five years and any outstanding deficits are increased at a rate of 5% per year. A maximum penalty of $1,000 per tonne CO_2e can be levied against obligated parties who fail to meet their obligations. Importantly, obligated parties cannot buy out their obligations; there is no option to purchase credits from the state of California. We bring attention to this point because it is important in the success of California's policy: because fuel suppliers must eventually meet their obligations, the GHG reduction targets of the program are ensured. This type of system is a robust way to contain compliance costs while maintaining the integrity of GHG reduction goals.

33. Could other policies facilitate the deployment of lower carbon fuels and technology to markets?

As discussed above under Questions 4, 5, and 12, strong incentives for second generation alternative fuel pathways are needed to support the scale-up of these technologies from the laboratory to commercial production. Because technologies such as cellulosic ethanol have very upfront high capital costs and a long operating lifetime, investors seek stable returns over many years in order to pay back that initial debt and generate profit. Although there is reason to

believe that that second generation alternative fuel costs will decline in future years due to economies of scale and streamlining of feedstock supply chains (e.g. Peters et al., 2016), at present advanced fuels are significantly more expensive than fossil fuels and cannot be viable without strong policy support (Pavlenko et al., 2017). Investors must expect a long-term profit in order to invest in these projects, relying upon both sales revenue and policy support in their calculations of project viability (i.e., a pro forma). One cannot simply add up the nominal support of various incentives, however: in California, the combined value of LCFS credits, RFS Renewable Identification Numbers (RINs), and the second generation biofuel producers tax credit should in theory be enough to support profitable cellulosic ethanol companies, but actual production has been very low (Pavlenko et al., 2016). Investors are slow to support these types of projects because they do not consider these policies to be stable enough, and thus counting on their support is risky. For example, the US second generation biofuel producers tax credit, which reduces the tax liability of cellulosic biofuel companies for every gallon of biofuel produced, has a history of expiring every 1-2 years and then being reinstated, sometimes retroactively. Cellulosic ethanol plants require 2-3 years for construction, and thus it is not guaranteed that a new project beginning at any point in time would receive this subsidy at all. Because LCFS credit and RIN prices are variable, there is no guaranteed level of price support and so investors heavily discount average credit prices when determining whether a project is likely to be profitable. The result of this policy discounting is that few second generation alternative fuel projects have attracted enough investment to cover their high capital costs (Pavlenko et al., 2016; Miller et al., 2013).

There are two important lessons to take away from the US example. The first is that if Canada's CFS is structured similarly to California's LCFS, with market-determined credit prices and allowing first generation food-based biofuels to compete with second generation fuels for support, it likely will not provide strong enough support to drive a significant increase in volumes of cellulosic biofuel and other second generation fuels. Additional supporting incentives directed specifically at second generation technologies would be necessary; California is moving in this direction by considering an additional support mechanism for very low carbon fuels (CARB, 2016).

The second lesson is that policy uncertainty (related to value or duration) reduces the effectiveness of policies that aim to grow the second generation alternative fuels industry. ICCT has outlined a proposal for a novel financing mechanism for second generation fuel pathways in the Californian context that would mitigate uncertainty in other low carbon fuel policies (Pavlenko et al., 2016). This proposal is based on the Contracts for Difference program in the UK, which supports renewable electricity projects. In a Contracts for Difference program, companies bid for a minimum price floor in a reverse auction, wherein the "winning" bidder is the one whose project requires the lowest price floor (and thus, the smallest guarantee). The companies that win the auction enter a long-term contract (minimum 10 years) with the government in which the government guarantees the agreed price floor. If and when the market value of fuel, including the value of other policy incentives, drops below the price floor, the government pays out the difference to the company. The government could even require that companies pay back into the program when the market price of fuel exceeds a certain threshold, allowing the program to grow and support more projects. A Contracts for Difference program would thus act similarly to an insurance program, guaranteeing companies will generate enough revenue to repay capital debt and mitigating the uncertainty in other policies. ICCT's analysis has found that a Contracts for Difference program would be more cost effective than more traditional subsidies or grants programs (Pavlenko et al., 2017).

While some first generation biofuels can offer GHG reductions sufficient to meet modest GHG reduction targets in the early years of a policy (when ILUC is accounted for; see comments on ILUC above), very low carbon fuels such as cellulosic ethanol will likely be necessary to drive deeper carbon reductions in the medium to longer term. Canada may thus consider introducing additional policy incentives specifically for very low carbon fuels in order to support the development and scale up of these technologies. The Contracts for Difference approach could be one option to consider as a cost-effective financing mechanism for these technologies.

37. What would be the benefits or drawbacks to phasing in carbon intensity reductions under the Clean Fuel Standard? What approach to phasing in carbon intensity reductions would be most effective and why?

It is important to set interim targets for years ahead of the target year to provide predictable and stable policy support. The EU's FQD applies in the year 2020 only, and it is optional for Member States to set interim targets for earlier years. Very few Member States have done so, and as a result most Member States are not yet on track to meet the FQD target for 6% reduction in the GHG intensity of the road transport mix (van Grinsven & Kampman, 2015). Setting linear increases in GHG reduction or designing the required reductions to accelerate over time are both accepted approaches. California's schedule for annual GHG targets for the LCFS includes slightly faster GHG reductions in the later years of the program compared to the earlier years (CARB, 2015a). The more relaxed annual targets in the early years of the program enable fuel suppliers to "bank" credits from over-compliance, which can be used to meet obligations in later years of the program, when the targets are more difficult to meet.

38. Fuel production and use can have impacts, both positive and negative, on sustainability. What are these key impacts for fuels used in Canada? Are these impacts different from fuels produced domestically than for imported fuels? Should these impacts be addressed in Canada's Clean Fuel Standard?

The primary goal of Canada's CFS is climate mitigation through reduction of GHG emissions related to its fuel mix. Accounting for all GHG impacts and designing the policy to only incentivize fuels that reduce GHG emissions are thus critical to achieving this goal. Accounting for ILUC and other indirect emissions from the use of wastes, residues and by-products is an important part of this. It is important to understand, however, that ILUC accounting only completes the picture if there is no *direct* land use change. Depending on the type of land converted, direct land use change can generally be expected to result in higher GHG emissions than indirect land use change because the market forces that mediate ILUC when existing agricultural land is used to meet biofuel demand can be expected to reduce the overall impact through some degree of demand reduction (e.g. people eating less food because food prices have risen) and yield increase (e.g. farmers applying more fertilizer as a result of price increases).

The way other jurisdictions have dealt with this problem is by using sustainability criteria to prevent direct land use change and then accounting for ILUC. The EU and US have used very different approaches to do this.

The EU RED and FQD include sustainability criteria prohibiting the use of land that was considered highly biodiverse, to have high carbon stocks, or to be peatland in 2008. In principle,

the direct conversion of land that does not meet these criteria would be allowed. EU biofuel suppliers are required to track the origin of their feedstock and certify that it was grown on land that meet these criteria. The EU accredits verification bodies (e.g. International Sustainability & Carbon Certification, ISCC), and these bodies certify biofuel feedstock supply. Certification is required for any volume of biofuel to qualify for support under the RED and FQD. This approach provides relatively strong assurance that these policies are not causing direct land use change of high carbon stock and highly biodiverse land. On the other hand, there is some administrative burden on biofuel suppliers and regulators. It is also important to point out that the GHG savings calculations for the RED and FQD incorrectly omit direct land use change emissions when allowable direct land use change occurs, and that these policies only require reporting of ILUC.

The US RFS uses a very different approach. Under the RFS, no direct land use change is permitted. Only land that was in agricultural use in 2007 can be used to produce biofuel feedstock. The RFS does account for ILUC. Unlike the EU, US EPA does not require biofuel suppliers to certify their feedstock. Instead, EPA uses an “aggregate compliance” approach. As long as total US agricultural area does not increase compared to the 2007 baseline, EPA assumes that no direct land use change has occurred. If total agricultural area does exceed this baseline, EPA would re-evaluate this compliance approach. This approach minimizes administrative burden but has been criticized by environmental organizations for not adequately preventing direct land use change (e.g. NWF, 2013).

Canada could consider including sustainability criteria in the CFS to prevent or minimize direct land use change emissions using either of these frameworks or a new approach. In any case, the most important action for minimizing the total land use change impacts of the CFS is to include ILUC accounting.

Canada could also consider adding sustainability criteria for the harvest of agricultural and forestry residues for use in biofuel production. These materials include wheat straw, corn stover, corn cobs, small branches and treetops and are often described as “wastes.” Some amount can be sustainably collected and used for biofuel, but it is important to retain some residues in the field or forest to protect soil from erosion, contribute soil carbon formation, return some nutrients to the soil, and add soil water retention capacity (reviewed in Searle & Malins, 2016; Allen et al.., 2016). Overharvesting of residues can lead to soil carbon loss and lower yields in subsequent harvests, and could thus undermine the climate goals of the CFS. For example, Valin et al. (2015) estimate that the soil carbon loss from complete residue removal would add 16 gCO_2e/MJ to the lifecycle emissions of wheat straw ethanol and 17 gCO_2e/MJ to that of biofuel from forestry residues, but postulate that partial residue removal would not result in any additional emissions.

No jurisdictions currently include sustainability criteria limiting the harvest of agricultural and forestry residues, but the issue is increasingly seen as important. Three prominent corn stover ethanol projects in the US have voluntarily restricted stover removal rates for fields supplying feedstock to limit negative impacts on soil health (reviewed in Kemp, 2015). In the EU, the Commission’s proposal for a 2030 RED includes new sustainability criteria for forest biomass. The removal of any forest biomass, including residues, must take place with consideration of protecting soil quality.

Canada could consider regulating residue removals for biomass used in the Clean Fuel Program by requiring biofuel or feedstock suppliers to create and adhere to a sustainable management plan. An example could be the approach DuPont took with their Nevada, Iowa facility. DuPont worked with the US Department of Agriculture’s Natural Resource Conservation

Service to determine sustainable removal rates at a field level for all fields supplying corn stover to their cellulosic ethanol plant (Kemp, 2015). This was done with regards to several physical and climatic factors, including residue production rates, soil type, slope, and precipitation, as well as management practices such as tillage. No two fields are the same, and the level of residue retention necessary to maintain soil carbon and fertility can vary significant depending on local conditions (Allen et al., 2016). Canada could consider requiring biofuel or feedstock suppliers to work with a government agency, or with accredited third party verification bodies, to develop similar management plans. It would be necessary for either a government agency or a third-party verification body to monitor approved projects and ensure that the management plans are followed in practice. In order to reduce administrative burden, Canada could consider creating an optional default management plan, for example: mandatory retention rates of 7 tonnes per hectare for agricultural residues and no removal on fields with slope exceeding 4 degrees. Suppliers could then opt to follow these default rules without having to develop a field-level management plan based on local conditions.

Including this kind of sustainability criteria for agricultural and forestry residues would provide assurance that fuels incentivized by the CFS are providing expected environmental benefits.

39. What are the lessons from other jurisdictions that have implemented low carbon fuel regulations which could inform the development of the Clean Fuel Standard?

Throughout these comments we have referred to the experiences of promoting low carbon fuels in the US, California, and the EU. There have been lessons learned from these jurisdictions related to many of the questions posed in the discussion paper. Here, we emphasize two points in particular:

1. Address ILUC and other sustainability challenges up front and transparently. Because ILUC accounting was not included in the EU RED and FQD when these policies were introduced, it became politically impossible to do so later, after investments had already been made in first generation biofuels. As a result, these policies have incentivized fuel pathways with higher lifecycle GHG emissions than petroleum, undermining EU climate goals, and exacerbating uncertainty in the future of biofuel policy support. In contrast, the US and California included ILUC accounting from the beginning of the RFS and LCFS and have not faced public backlash over this decision specifically. California's extensive stakeholder engagement and a publically transparent ILUC modeling process have strengthened credibility of the ILUC values it uses. Sustainability criteria that limit direct land use change and over harvesting of agricultural and forestry residues are also environmental issues that would be more easily addressed at the beginning of a new policy, before investments are made in unsustainable pathways.
2. Strong, predictable, and long-term policy support will be needed to foster a transition from first generation biofuels to the second generation of cellulosic ethanol and other technologies that can deliver deep GHG reductions in Canada's fuel mix decades into the future. All of the policies from other jurisdictions have incorporated elements increasing support for very low carbon fuels, yet none of these policies have succeeded in driving substantial volumes of second generation fuels. It is likely that additional policies, such as a Contracts for Difference program, will be necessary to attract investment to second generation facilities. Successful ramp up of fuels such as cellulosic ethanol will make it more feasible to meet ambitious GHG reduction targets in later years

of the CFP.

Literature cited

Allen, B., Baldock, D., Nanni, S., & Bowyer, C. (2016). Sustainability criteria for biofuels made from land and non-land based feedstocks. Institute for European Environmental Policy. Report for the International Council on Clean Transportation and the European Climate Foundation. Retrieved from: http://www.theicct.org/sites/default/files/publications/IEEP(2016)%20sustainability%20criteria%20for%20biofuels%20post%202020.pdf

Alternative Fuels Data Center. "E15." U.S. Department of Energy Office of Energy Efficiency and Renewable Energy. Retrieved from: http://www.afdc.energy.gov/fuels/ethanol_e15.html

Bitnere, K. (2017). The European Commission's Renewable Energy Proposal for 2030. Washington DC: International Council on Clean Transportation. Retrieved from: http://www.theicct.org/sites/default/files/publications/RED%20II_ICCT_Policy-Update_vF_jan2017.pdf

California Air Resources Board (CARB). (2015a). Low Carbon Fuel Standard: Final Regulation Order. Retrieved from: https://www.arb.ca.gov/regact/2015/lcfs2015/lcfsfinalregorder.pdf

California Air Resources Board (CARB). (2015b). Detailed Analysis for Indirect Land Use Change. Appendix I. Retrieved from: https://www.arb.ca.gov/regact/2015/lcfs2015/lcfs15appi.pdf

California Air Resources Board (CARB). (2016). Public workshop on the development of FY 2016-17 funding plan for low carbon transportation and fuels investments and air quality improvement program (AQIP): Discussion document. Retrieved from http://www.arb.ca.gov/msprog/aqip/meetings/040416_discussion_doc.pdf

Coleman, B. (2011). Testimony to the U.S. Senate Environment and Public Works Committee. Retrieved from: http://www.ethanolrfa.org/policy/documents/advanced-ethanol-counsil-executive-director-brooke-coleman-testifies-u-s-senate-environment-and-public-works-committee/

El Takriti, S., Malins, C., & Searle, S. (2016). Understanding options for ILUC mitigation. Washington DC: International Council on Clean Transportation. Retrieved from: http://www.theicct.org/sites/default/files/publications/ILUC-Mitigation-Options_ICCT_nov2016.pdf

El Takriti, S., Pavlenko, N., & Searle, S. (2017). Mitigating international aviation emissions: Risks and opportunities for alternative jet fuels. The International Council on Clean Transportation. Retrieved from: http://theicct.org/mitigating-intl-aviation-emissions-risks-and-opps-alt-jet-fuels

Environmental Entrepreneurs (E2). (2014). E2 Advanced Biofuel Market Report 2014. Retrieved from:

https://members.e2.org/ext/doc/E2AdvancedBiofuelMarketReport2014.pdf;jsessionid=8065B88268126FE7D22CD8C116B01B59

European Climate Foundation (ECF). (2010). Roadmap 2050: A Practical Guide to a Prosperous, Low-Carbon Europe [Technical analysis]. Retrieved from http://www.roadmap2050.eu/attachments/files/Volume1_fullreport_PressPack.pdf

European Commission. (2011a). A Roadmap for Moving to a Competitive Low Carbon Economy in 2050. Directorate-General for Climate Action (DG CLIMA). Retrieved from http://ec.europa.eu/clima/policies/strategies/2050/documentation_en.htm

European Commission. (2011b). 2050 Energy Strategy. Directorate-General for Energy. Retrieved from https://ec.europa.eu/energy/en/topics/energy-strategy/2050-energystrategy

European Commission (2011c). "A Roadmap to a Single European Transport Area— Towards a More Competitive and Resource Efficient Transport System". Directorate General for Mobility and Transport. Retrieved from http://ec.europa.eu/transport/themes/strategies/2011_white_paper_en.htm

European Commission. (2016). Proposal for a Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources (recast). Brussels: European Commission. COM(2016) 767 final.

European Union. (2009a). Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. Brussels: Official Journal of the European Union L140/16.

European Union. (2009b). Directive 2009/30/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC. Brussels: Official Journal of the European Union L140/88.

European Union. (2015). Council Directive (EU) 2015/652 of 20 April 2015 laying down calculation methods and reporting requirements pursuant to Directive 98/70/EC of the European Parliament and of the Council relating to the quality of petrol and diesel fuels. Brussels: Official Journal of the European Union L107/26. Retrieved from http://eur-lex.europa.eu/eli/dir/2015/652/oj/eng/pdfa1a

European Union. (2016). Guidance note on approaches to quantify, verify, validate, monitor and report upstream emission reductions. Retrieved from https://ec.europa.eu/clima/sites/clima/files/guidance_note_on_uer_en.pdf

ICF International. (2015). Waste, Residue and By-Product Definitions for the California Low Carbon Fuel Standard. Report for the International Council on Clean Transportation. Retrieved from: http://www.theicct.org/sites/default/files/publications/ICF_LCFS_Biofuel_Categorization_Final_Report_011816-1.pdf

International Council on Clean Transportation (ICCT). (2014). Comments on "2014 Standards for the Renewable Fuel Standard Program" Notice of Proposed Rulemaking (EPA–HQ–OAR–

2013– 0479; FRL–9900-90-OAR). Retrieved from: http://www.theicct.org/sites/default/files/ICCT%20comments%20on%20RFS2%202014%20RVO.pdf

Joint letter to the European Commission. (2011). International Scientists and Economists Statement on Biofuels and Land Use. Organized by the Union of Concerned Scientists. Retrieved from: http://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/International-Scientists-and-Economists-Statement-on-Biofuels-and-Land-Use.pdf

Kemp, L. (2015). Cellulosic ethanol from corn stover: can we get it right? Natural Resources Defense Council. Retrieved from: https://www.nrdc.org/sites/default/files/corn-stover-biofuel-report.pdf

Malins, C., Searle, S., Baral, A., Galarza, S., & Wang, H. (2014a). Reduction of upstream greenhouse gas emissions from flaring and venting. Report by the International Council on Clean Transportation to the European Commission Directorate-General for Climate Action. Retrieved from: https://ec.europa.eu/clima/sites/clima/files/transport/fuel/docs/studies_ghg_venting_flaring_en.pdf

Malins, C., Searle, S., & Baral, A. (2014b). A Guide for the Perplexed to the Indirect Effects of Biofuels Production. Washington DC: International Council on Clean Transportation. Retrieved from: http://www.theicct.org/sites/default/files/publications/ICCT_A- Guide-for-the-Perplexed_Sept2014.pdf

Miller, N., Christensen, A., Park, J.E., Baral., A., Malins, C., & Searle, S. (2013). Measuring and addressing investment risk in the second-generation biofuels industry. Washington DC: International Council on Clean Transportation. Retrieved from: http://www.theicct.org/sites/default/files/publications/ICCT_AdvancedBiofuelsInvestmentRisk_Dec2013.pdf

National Wildlife Federation (NWF). (2013). How EPA is Letting the RFS Become a Driver of Land Conversion. Retrieved from: http://www.nwf.org/~/media/PDFs/wildlife/farm%20%20bill/RFS_factsheet_v1_10-11-13.pdf

Pavlenko, N., Searle, S., Malins, C., & El Takriti, S. (2016). Development and analysis of a durable low-carbon fuel investment policy for California. International Council on Clean Transportation. Retrieved from: http://www.theicct.org/sites/default/files/publications/California%20Contracts%20for%20Difference_white-paper_ICCT_102016.pdf

Pavlenko, N., Searle, S., & Nelson, B. (2017). A comparison of contracts for difference versus traditional financing schemes to support ultralow-carbon fuel production in California. International Council on Clean Transportation. Retrieved from: http://www.theicct.org/CfD-versus-traditional-financing-schemes-ultralow-carbon-fuel-CA

Peters, D., Alberici, S., & Passmore, J. (2016). How to advance cellulosic biofuels. International Council on Clean Transportation. Retrieved from: http://www.theicct.org/how-advance-cellulosic-biofuels

Petrenko, C. & Searle, S. (2016). Assessing the profitability of growing dedicated energy versus food crops in four European countries. International Council on Clean Transportation. Retrieved

from: http://www.theicct.org/assessing-profitability-growing-dedicated-energy-versus-food-crops-four-european-countries

Plevin, R.J., Beckman, J., Golub, A.A., Witcover, J., & O'Hare, M. (2015). Carbon Accounting and Economic Model Uncertainty of Emissions from Biofuels-Induced Land Use Change. Environmental Science & Technology 49(5): 2656-2664.

Searle, S., Posada Sanchez, F., Malins, C., & German J. (2014). Technical Barriers to the Consumption of Higher Blends of Ethanol. The International Council on Clean Transportation. Retrieved from: http://bipartisanpolicy.org/wp-content/uploads/sites/default/files/files/ICCT_Ethanol.pdf

Searle, S., & Malins, C. (2014). A reassessment of global bioenergy potential in 2050. Global Change Biology Bioenergy 7(2): 328-336.

Searle, S., & Malins, C. (2016). Waste and residue availability for advanced biofuel production in EU Member States. Biomass and Bioenergy 89: 2-10.

Searle, S., Pavlenko, N., El Takriti, S. & Bitnere, K. (in press). Potential GHG savings from a 2030 GHG target with indirect emissions accounting for the EU. Washington, DC: International Council on Clean Transportation.

US Environmental Protection Agency (EPA). (2010). 40 CFR Part 80 Regulation of Fuels and Fuel Additives: Changes to Renewable Fuel Standard Program; Final Rule. EPA–HQ–OAR–2005–0161; FRL–9112–3. Retrieved from: https://www.gpo.gov/fdsys/pkg/FR-2010-03-26/pdf/2010-3851.pdf

US Environmental Protection Agency (EPA). (2016a). Proposed Denial of Petitions for Rulemaking to Change the RFS Point of Obligation. Retrieved from: https://www.epa.gov/sites/production/files/2016-11/documents/420d16004.pdf

US Environmental Protection Agency (EPA). (2016b). 40 CFR Part 80 Renewable Fuel Standard Program: Standards for 2017 and BiomassBased Diesel Volume for 2018. EPA–HQ–OAR–2016–0004; FRL–9955–84– OAR. Retrieved from: https://www.gpo.gov/fdsys/pkg/FR-2016-12-12/pdf/2016-28879.pdf

US Environmental Protection Agency (EPA). (2013). 40 CFR Part 80: 2014 Standards for the Renewable Fuel Standard Program. EPA–HQ–OAR–2013–0479; FRL–9900–90– OAR. Retrieved from: https://www.gpo.gov/fdsys/pkg/FR-2013-11-29/pdf/2013-28155.pdf

US Environmental Protection Agency (EPA). (2015). 40 CFR Part 80: Renewable Fuel Standard Program: Standards for 2014, 2015, and 2016 and Biomass-Based Diesel Volume for 2017. EPA–HQ–OAR–2015–0111; FRL–9939–72– OAR. Retrieved from: https://www.gpo.gov/fdsys/pkg/FR-2015-12-14/pdf/2015-30893.pdf

US Environmental Protection Agency (EPA). (2011). Partial Grant of Clean Air Act Waiver Application Submitted by Growth Energy To Increase the Allowable Ethanol Content of Gasoline to 15 Percent; Decision of the Administrator. EPA–HQ–OAR–2009–0211; FRL–9258–6. Retrieved from: https://www.gpo.gov/fdsys/pkg/FR-2011-01-26/pdf/2011-1646.pdf

van Grinsven, A. & Kampman, B. (2015). Assessing progress towards implementation of the ILUC Directive. Report prepared for the International Council on Clean Transportation. Retrieved from:

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http://www.theicct.org/sites/default/files/publications/CE_Delft_4H38_Assessing_progress_towards_implementation_ILUC_dir.pdf

Appendix

Overview

Babcock and Iqbal (2014) (henceforth 'B&I') sets out to assess actual land use changes that have occurred globally since the mid-2000s and compare these observed changes to model predictions generated in regulatory analyses of indirect land use change by the US EP and California ARB. The work was financially supported by the Renewable Fuels Foundation and the Bioindustry Industry Center. The study presents thee main findings:

1. Harvested area as reported by FAOstat and other agricultural statistics may be a poor indicator of total agricultural area in many countries.
2. For countries outside Africa, the study finds that more land use change has occurred at 'intensive' than the 'extensive' margin.
3. It s difficult to draw any categorical conclusion about whether model results reflect actual outcomes because of the lack of a counterfactual when considering real data.

The authors argue that the importance of responses at the intensive margin (beyond the 'pure' yield response) has not been adequately considered by regulators assessing likely indirect lad use change emissions due to increased biofuel production. The conclusion by the authors is that existing estimates of ILUC factors are too large "because they are based on models that do not allow for increases in non-yield intensification of land use."

Overall, the case made is convincing that there are responses at the intensive margin, notably double cropping, that are not explicitly considered in ILUC studies. However, the paper shows a readiness throughout to interpret ambiguous data as supporting the claim that most land use change occurs at the intensive margin when other interpretations might be available. Having correctly emphasized the limitations of agricultural land use data, the paper does not give adequate discussion to the possibility that some of the data differences B&I attribute to intensification may in fact simply represent differences in quality or methodology for collecting statistics. Without a more systematic assessment of the extent to which reliable conclusions can be drawn by differencing the datasets used, the conclusions may be stated too strongly. Similarly, in several cases B&I present narrative justifications for assuming that changes in harvested area reflect intensification and not extensification. These justifications are not always compelling. For instance, for Indonesia where statistics show 1.4 million hectares of increased rice harvest B&I claim that "given that Indonesia is one of the world's most densely populated countries, and 1.4 million hectares represents a 12% increase in harvested production, it is unlikely that a significant portion of this 1.4 million hectares is new land." Given, however, that this increase in reported rice area coincides with a larger 2.5 million hectare increase in palm area (of which several hundred thousand hectares represented expansion on peatland with very large ILUC implications, as shown by Miettinen at al., 2012), it is difficult to accept this hypothesis without supporting evidence. Conversely, in Africa when considerable extensification is found by B&I, there is an excessive readiness to conclude that this extensification cannot be linked to international markets. While elements of the case presented are reasonable and correct (many parts of Africa are indeed unusually insulated from world market commodity prices) this does not apply to all of Africa.

A key element missing from the analysis that would support stronger conclusions on the validity of existing ILUC analyses is a systematic assessment of the extent to which land use change

sat the extensive margin are responsive to commodity prices (and hence increased agricultural demand) and to what extent intensification may have been driven by factors other than demand (such as knowledge transfer or government action). As B&I recognize, ILUC modeling requires comparing a scenario with biofuel demand to a counter-factual scenario without it. The paper does not provide any quantified assessment of the extent to which additional demand due to biofuels may have been driving intensification in the markets discussed. To return to the example of Indonesia and double or tripping cropping of rice, it was widely discussed during the food price crisis in 2008 that rice prices had relatively little exposure to corn demand for ethanol, and thus many commentators argued that changing rice prices must be largely independent of biofuel demand. In Argentina, B&I conclude that the area of double cropped soy has been determined largely by changes to Argentinian government policy, not by international demand. These cases do not preclude the possibility that biofuel led price changes are driving intensive land use change, but they also do little to support an argument that crop intensity is strongly driven by biofuel demand.

B&I also do not consider the possibility that the possibility of intensive land use change has been implicitly characterized in existing ILUC models within the traditional price induced yield parameter. Discussing iLUC modeling by CARB, Babcock et al. (2011) concluded that "if the long-run price-yield elasticity not accounting for double cropping is set at 0.175, and if South America and the United States are the countries that contribute the most incremental commodity production in response to higher prices, then a mid-point value of 0.25 for the price yield elasticity seems reasonable." It Indeed, the possibility of a cropping intensity response to biofuel demand has been invoked on several occasions in the California discussion in defense of the overall price-yield elasticity used in the models.

In conclusion, this paper places legitimate emphasis on crop intensity as a factor in determining land use responses to expanded biofuel demand, but without further analysis to confirm various assumptions presented in the paper, and further assessment of the extent to which crop intensity responds to price for different cropping systems, it is premature to make any firm assertion about whether land use change data since the mid-2000s suggests that existing ILUC estimates are too high, or indeed too low.

Detailed comments

Biofuel and food prices: The paper notes that "In the mid-2000s prices … increased dramatically due to growth in demand for food and biofuel producers, underinvestment in [agriculture] … and poor growing conditions in major producing regions." The paper takes it as read that biofuel demand, as s contributor to agricultural commodity demand, has been one driver of increased prices in recent years. They quote estimates that 36% of corn price increase from 2006 to 2009 and 34% of corn price increases from 2006 to 2012 respectively were attributable to the corn ethanol mandate.

China and double cropping: In the section on China, the paper notes a claim that cultivated land area was reducing in China in the early 2000s and that this reduction was only halted by government action. On this basis, it is argued that underlying economic forces must have been driving reduced land area, and therefore that increases in harvested area to 2012 could only be attributable to increased harvest intensity. This argument is plausible but not compelling, not least because the data referenced only runs up to 2008. Estimates of absolute double cropped area are further derived by comparing FAOstat harvested area values to Chinese Ministry of Land Resources data for 'cultivated area. This comparison is problematic. Firstly, it is normal for

there to be fairly significant inconsistencies between FAOstat and other land data sources. These differences could be due to systematic methodological differences in reporting or categorization of land uses, or other data issues. One should therefore be cautious about the interpretation of differences between data sources. More troubling than this, the paper simply assumes no increase in cultivated area from 2008 to 2012. This is not adequately robust in the context of the inference being made in this paper about total double-cropped area change in this precise period.

Africa and double cropping: In the section on Sub-Saharan Africa, B&I note that "a lack of access to technology and capital is one defining characteristic of traditional agriculture in sub-Saharan Africa" and asserts that hence "there is no evidence that double cropping is widely adopted." While it is certainly plausible that the authors are correct that double cropping is less common in Africa than in the other regions considered, this reasoning is inadequate and is not supported by any reference associating levels of double cropping with access to capital, nor with an adequate recognition that not all agriculture in Africa is traditional. OECD-FAO (2009) note that from 1961-1963 to 2006-2007 about half of the increase in harvested area in Africa was actually attributable to increased multiple cropping index, which contradicts the above claim from B&I.

Data issues: On page 12, the paper notes that for the U.S. they have chosen to use a different data source in the calculation of total land use than is used for other reasons. The justification is that the sum of FAO arable land plus permanent crops shows a marked shrinkage over the period of interest, related to changes in temporary pasture (it is unclear from the paper whether these are 'real' reductions or a shift in classification). This is likely a reasonable data choice, but it emphasizes the considerable risk of misleading results when conducting differencing on this type of land use data.

Indonesian rice multiple cropping: The paper claims that the major source of increases in harvested rice area is an increase in irrigation that has allowed increased multiple cropping of rice. The case presented against interpreting harvested area increases and extensification is that Indonesia is a densely populated country, and that the areas required were large – this is unconvincing on its own. It is unquestionably true that rice is often double or triple cropped in Indonesia. However, it is not clear whether the interpretation of the data given by this paper is correct. In 2012, USDA in a 'commodity intelligence report' reported[1] that about 70% of lowland rice is double cropped. On this basis, one would expect to see reported harvested area be very considerably higher than reported cultivated area. However, USDA data on cultivated area (USDA FAS World Agricultural Production reports) has cultivated area only marginally below FAOstat reported harvested area. This could imply that USDA is reporting harvested area rather than total cultivated area in the World Agricultural Production Report, which would be consistent with data from the aforementioned commodity intelligence report purporting to show Indonesian data on the area of rice at each harvest in 2011, which add to about 11 Mha, with only 6 Mha of rice in total. However, we were not able to confirm this data in the Statistics Indonesia dataset,[2] and other sources (including satellite mapping) support the conclusion that total cultivated area is of the order of 10 million hectares.[3] This implies that it is in fact incorrect to assume that the

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[1] http://www.pecad.fas.usda.gov/highlights/2012/03/Indonesia_rice_Mar2012/
[2] http://www.bps.go.id/
[3] E.g. , Redfern, Azzu, & Binamira, (2012); Lee, Moniac and Daratista (2012); Frederik and Worden (2011)

FAOstat harvested area data counts each harvest separately. If this pattern of data reporting may be repeated in other regions, it would undermine the conclusions of the paper, as they are predicated on the assumption that all double-harvested areas are double counted in the FAO stat data.

China and the soy trade: On page 13, the paper asserts that Chinese soy demand has been a major driver of land use decisions in the U.S., Argentina and Brazil over the past decades. This is consistent with trade data from FAOstat, as shown below in Figure 1, and with the expectation that soy area is largely driven by protein demand.

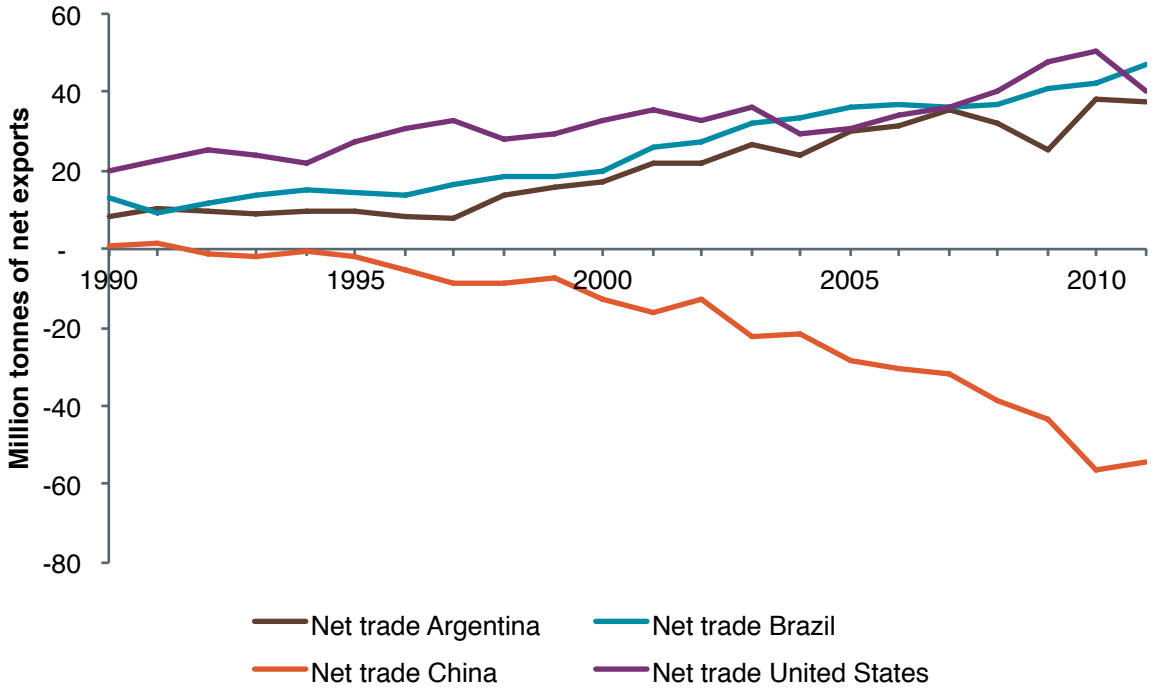

Figure 1: Net soy exports (meal plus beans) since 1990 for U.S., Argentina, Brazil and China

Argentinian double-cropped wheat: The paper notes that in Argentina, increased soy demand was not accompanied by increased double cropping (unlike in Brazil). The explanation is that 'if soybean area needs to increase, less wheat land means less land available for double cropping, thus soybean first area by definition must increase.' This explanation is rather unconvincing – if double cropping (intensification) is indeed a strongly driven response to demand and would have been viable in this case, then it would have been equally possible for Argentina to add considerable acreage of second crop soy after wheat as to replace wheat entirely. The paper argues that changes in government policy to favor soy export over wheat through taxes and subsidies are responsible for preventing economically rational increases in double cropping. However, the source cited (Nogués, 2011) finds that wheat export taxes are still *lower* than those on soy (by 12%), and in fact in 2008 the peak rate of soybean export tax reached 41% during the food price spike. Similarly, the subsidy regime has provided subsidy to wheat mills, not to soybeans, which would generally be expected to encourage more rather than less wheat production. The wheat subsidy was actually subsidized through increased soybean export tax. Aside from taxes and subsidies, Nogués does note that Argentina implemented

quantitative export restrictions on wheat from 2006, whereas soybean exports have not bee regulated in that way. Nogués estimates that the impact of export controls on producer prices has been equivalent to adding 17% to export taxation. In that case, the combined impact of export tariffs plus taxes on wheat producer prices should indeed be greater than that on soy producers. This could have a role in explaining reductions in wheat area (although a perverse one, as the intended purpose of the export restrictions is to guarantee domestic supply, not to reduce production). Overall, the contention by B&I that policy drivers may have contributed to a failure to increase double cropping in Argentina supported by Nogués, but not through the taxes and subsidies B&I point to. More generally, it should be understood that agricultural markets are distorted by policy in many regions. Nogués notes that the possibility to double crop has reduced as single crop soy area has increased, and this increase is also driven by raised soy prices. This provides an example in which increased price (soy prices rose much more than wheat prices coming into 2006) not only has failed to increase double cropping, **but has actively reduced it.** B&I choose not to draw any more general conclusion from this example.

African connectivity to world prices: The one area in which B&I find a clear case of a large extensive land use change but little intensive land use change is Sub-Saharan Africa (SSA). However, they argue that it is unlikely that the extensive change in SSA has been price driven, on the basis that “higher world prices were not transmitted to growers in many African countries.” The main reference for this low price transmission to SSA is from Minot (2011). However, in a simple price comparison, Minot found that the average price increase of food commodities in SSA was 71% of the price increase on the global market. While this clearly suggests a reduced connectivity, it is far from showing that there is no price transmission at all. Indeed, changes in SSA domestic prices were much higher for grains that are used to make biofuel (112% for corn, 111% for wheat) than for other crops (like beans, plantains, that are not traded as much internationally). Minot writes: "highly tradable commodities are more closely linked to international markets, so domestic prices of these commodities tracked the spike in world prices." While the simple price comparison in consistent with good transmission of grain prices from world to SSA markets, more detailed econometric analysis on tradable grains in 62 local markets across 9 SSA countries found only 13 with a statistically significant long-run relationship with international prices. It is important to note that the lack of a statistically significant correlation is not the same as proving that there is no correlation. Minot concludes "that international prices of food grains do have some effect on African markets for rice and (to a lesser degree) maize, but the effect is usually swamped by the dominant effect of weather-related domestic supply shocks." B&I interpret these results as finding “some evidence of a linkage in large urban centers and in coastal markets, which is consistent with markets in cities and in coastal ports being more integrated with world markets. However, … these limited linkages to world prices did not find their way through to rural areas where most crops are grown. … One can conclude that the main driver of land expansion in many African countries was not higher world prices." This strong conclusion about rural vs. urban prices is not well supported by Minot’s discussion. Indeed, Minot does not draw any conclusions about urban vs. rural price linkages and in fact does not discuss this at all. The assertion that world food commodity prices are not transmitted to African farmers *at all* is clearly very much overstated, and not adequately supported by evidence in the Minot paper. There is a considerable evidence base on increasing foreign investment in African land (delineated as ‘land-grabbing’ in some studies), and it seems reasonably clear that deals of this type, which affect considerable areas, are informed by international prices. On the other hand, as noted by many other authors, it is reasonable to conclude that SSA food production is not as responsive to world markets as production in many other regions.

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Comparison of intensive and extensive land use changes: Based on their assessment of changes in cropping intensity, B&I conclude that from 2004-2006 through to 20010-2012 the global intensive land use change was double the global extensive land use change. They note that if one ignores African extensive land use change, then intensive land use changes are 15 times extensive land use changes. This second result is contentious, for one because (as noted above) there is no adequate case to fully disregard all extensive land use change in Africa, and also because there is no comparable scrutiny on the link to price of intensive land use changes in other areas. Given the considerable uncertainty in the way that the comparative values have been calculated and the lack of rigorous demonstration of a causal link between prices and either the extensive or intensive outcomes detailed in the paper, caution is appropriate in any interpretation of the comparison of the values. For instance, while B&I reference the OECD-FAO agricultural outlook 2009 for the claim that "intensive land use change has been the driving force behind higher production levels," this seems to be an overstatement of the results in that report, and is not reflected in the text of the report. Over the long term (from 1961-1963 to 2006-2007), OECD-FAO conclude that about 50% of additional harvested area has come at the intensive margin, and the other 50% at the extensive margin, i.e. at best equal contributions to higher production levels.[4]OECD-FAO also show a rapid global increase in multiple cropping index from 2002 to 2006, before the recent higher prices kicked in (Figure 2). This suggests that there are underlying trends driving cropping intensity other than prices. Finally, the OECD-FAO signal a note of caution about future cropping intensity increase. The report states that 'ever more intensive use of land … through multiple cropping is perceived as a leading factor for land degradation and its longer term productive potential.' It also finds that 'the trends of MCI [multiple cropping intensity] and harvested area … are expected to continue, but at a slower pace.' This report therefore does not provide an adequate basis for a conclusion that in future intensive area change will be the dominant response to price change.

[4] In fact, it would generally be reasonable to assume that a single crop will tend to achieve a higher yield than a second crop, so it is probable that the extensification

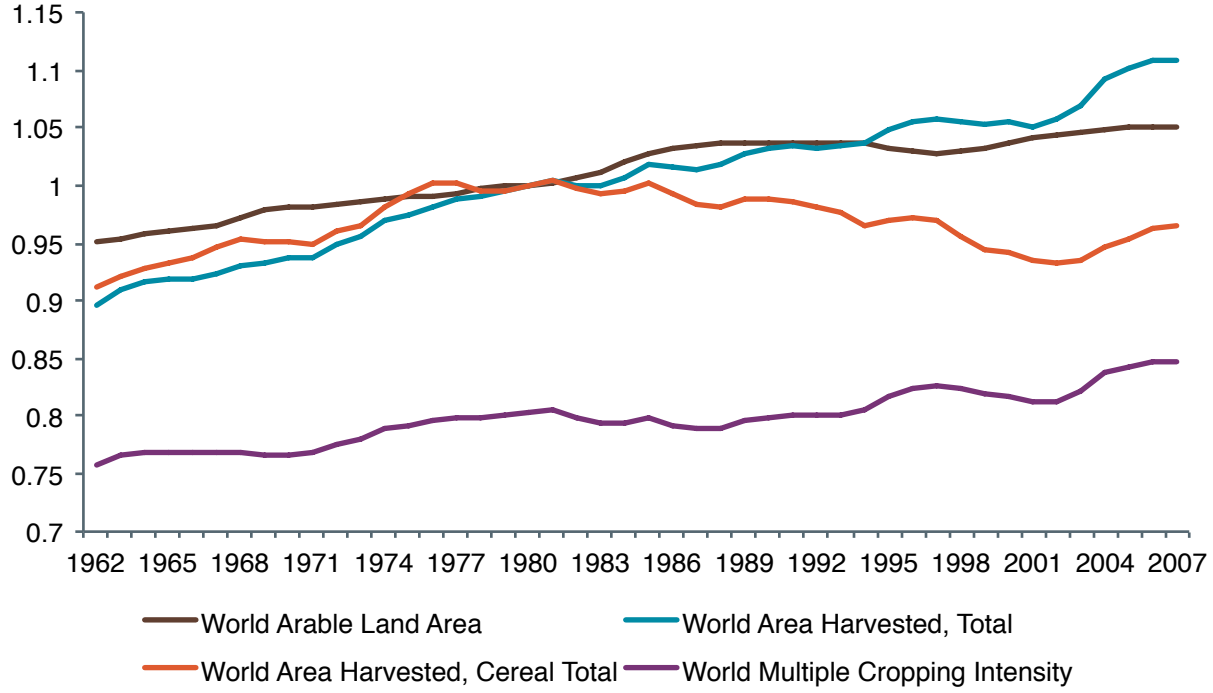

Figure 2: World trend of arable, cropped and harvested land areas and cropping intensity

Comparison of model predictions with actual land use changes: On page 19, B&I discuss what can be learned by comparing their analysis of real world land use changes with model results. One question raised by B&I is the extent to which land use changes are triggered by price changes, rather than other factors. The claim is that if all land use changes are triggered by prices, then model results could fairly be compared directly to real world outcomes, whereas if land use change is completely price independent then no comparison would be possible. This statement is too categorical on both counts, even for these hypothetical cases. Even if it were accepted that price was the sole driver of decision making, the source of demand changes is an important factor in model results. For instance, in modeling of the US corn mandate, all additional demand comes necessarily from the US corn mandate. This leads us to expect the strongest responses within the US system etc., and in the corn crop more than any other crop. In contrast, real world price increase relates to a sum of supply and demand changes through the global system, making it very difficult to decompose the US corn mandate as a price driver from the Australian wheat harvest etc. etc.

On the other hand, even if it were accepted that price is not a direct driver of land use choices, it would not be clear that demand was not a driver of change through other transmission vectors. For instance, expectations of future demand (e.g. for biofuels) may affect land use choices directly, even if not reflected in prices. The conclusion is that for this and other reasons it is very difficult to take results from a model in which a specific baseline and policy scenario are modeled with a single policy difference, and compare those results to real world land use changes driven by innumerable pressures. In the case of model predictions of US land use change, B&I argue that, "The only way that the US land use prediction is consistent with the historical record is if cropland in the United States would have dropped by a large amount in the absence of the large price increase." This is in fact precisely what many analysts would have expected – that in the absence of demand for biofuels, crop area would have shrunk further in

the US, with ILUC emissions resulting to a large extent from 'foregone sequestration' in areas that would otherwise have been allowed to naturally recover vegetation. In another example, B&I state that "the CARD-FAPRI model dramatically over-predicted land use change in Brazil relative to Argentina and other South American countries." In truth, without being able to more accurately decompose the causal links between world prices and land use change in each South American country, it is not possible to draw such strong conclusions. Perhaps US biofuel demand really did drive land use change preferentially in Brazil, while other markets were more strongly affected by Chinese soy demand. B&I have not by any means precluded such an explanation, and many more could be posited. A more legitimate conclusion would have been that the apparent inconsistency between model predictions and real outcomes warrants further examination and should be considered in future model calibration.

B&I do in fact recognize elsewhere in the text that categorical conclusions from this type of exercise are difficult or impossible, observing that "it is not possible to say this prediction is inconsistent with the recent historical data given that we cannot observe what land use would have been without the price increase," and that "it simply is not possible to conclude with certainty that the model predictions have been proven wrong and should be disregarded." The truth is that the thing that any model assesses (a simple change between a policy scenario and a counterfactual) is fundamentally not equivalent to the complex set of drivers of real world land use. The distribution of real world land use changes after a generalized price increase (such as 2007/08) could not and should not be expected to match precisely the land use changes that would be predicted by a model when increasing only corn ethanol demand. Indeed, if it were possible to construct some even a hypothetical 'perfect model' of global agriculture and land use, *we would expect that the model results for ILUC modeling would not be consistent with any particular period of real world land use changes.* It is therefore potentially vexatious and misleading to focus too hard on specific outcomes that differ between model results and real world outcomes, as some such differences would be expected in all cases.

Implications of cropping intensity for ILUC estimates: B&I undertake a comparison of land use changes predicted in some of the GTAP corn ethanol scenarios for the Air Resources Board. Using a decomposition supplied by staff of the US Renewable Fuels Association, they detail predicted changes in total crop area in response to corn ethanol demand, and discuss the fraction GTAP assigns to forest vs. the fraction assigned to pasture. Again, B&I recognize correctly the difficulty of making a direct comparison to what actually happened, "it is not possible to conclude whether the GTAP model prediction that US cropland would be 1.6 million hectares higher due to higher prices is inconsistent with what actually happened." They then, however, speculate on what the implications would be if emissions due to foregone sequestration were different than emissions due to active deforestation, concluding that, "The magnitude of the change in estimated CO_2 emissions from cropland that is prevented from going out of production relative to forest that is converted to cropland is potentially large." This observation is somewhat trivial – certainly, if the emissions assigned per hectare of land use change are inappropriate, this would change the results. Equally, if the emissions from pastureland conversion are lower than the emissions from foregone sequestration, the results would be put out the other way, and indeed foregone sequestration emissions for regrowing forest would be rather higher than typical emissions from grassland conversion, which are higher than emissions from pasture conversion.

The main result related to the B&I analysis that is relevant to our understanding of ILUC emissions is that they have correctly identified that double cropping occurs in many world regions, and that this is not reflected in detail in either the datasets used by ILUC models or in

the ILUC models themselves. Two questions arise from this: is it necessary for double cropping to be implicitly included in ILUC models in order to get make the results meaningful; and does this analysis clearly suggest that existing ILUC estimates have been overestimates.

To the first questions, one way that cropping intensity could be argued to be implicitly reflected is that models allow price based increase in yields, and one could argue that this yield increase can be considered to include cropping intensity. Indeed, Babcock and Carriquiry (2010) recognize that double cropping could be implicitly included in the yield elasticity parameter in GTAP, arguing that "the incentive to double crop soybeans with corn and cotton in Brazil justifies use of a yield elasticity of 0.24 by itself."[5] Based on an argument that double cropping can be reflected in GTAP through the yield elasticity, Babcock et al. (2011) conclude that "if the long-run price-yield elasticity not accounting for double cropping is set at 0.175, and if South America and the United States are the countries that contribute the most incremental commodity production in response to higher prices, then a mid-point value of 0.25 for the price yield elasticity seems reasonable." One could therefore reasonably argue that even though cropping intensity is not explicitly modeled in GTAP etc., that it may be handled adequately through the general yield term. That said, there certainly is a case from this paper to consider adding double cropping more explicitly to future modeling.

As to whether the results presented by B&I provide conclusive evidence that ILUC has been systematically overestimated in the past, the question is not whether double cropping occurs, but whether it is more or less responsive to demand than land area and crop yields proper. This paper provides a basis to believe that cropping intensity may have been inappropriately ignored in the past, but it does not provide any numerically robust insights in to the causal link between increased demand and changed cropping intensity. Without further evidence that the overall magnitude of intensive effects has been underestimated compared to the overall magnitude of extensive effects, it is not possible to draw a strong conclusion.

References

Redfern, S. K., Azzu, N., & Binamira, J. S. (2012); Rice in Southeast Asia: facing risks and vulnerabilities to respond to climate change. Building resilience for adaptation to climate change in the agriculture sector, 23, 295

Frederick, W. H. & Worden, R.L. (2011). Indonesia a country study. Federal Research Division, Library on Congress, Washington DC

Lee, N., Monica, A., & Daratista, I. (2012). Mapping Indonesian paddy fields using multiple-temporal satellite imagery. African Journal of, 7(28), 4038-4044

Nogués, J. J. (2011). Agricultural Export Barriers and Domestic Prices: Argentina during the last Decade. Food and Agriculture Organization of the United Nations, Rome, June. http://www.ucema.edu.ar/conferencias/download/2012/06.15AN.pdf

Babcock, B., Gurgel, A. and Stowers, M. (2010). ARB LCFS Expert Workgroup Final Recommendations From The Elasticity Values Subgroup. Air Resources Board, Sacramento.

[5] Quote taken from

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Babcock, B. A. and M. Carriquiry, 2010. An Exploration of Certain Aspects of CARB's Approach to Modeling Indirect Land Use from Expanded Biodiesel Production. Center for Agricultural and Rural Development Iowa State University Staff Report 10-SR 105, February 2010

Miettinen, J., Hooijer, A., Tollenaar, D., Page, S., Malins, C., Vernimmen, R., ... & Liew, S. C. (2012). Historical analysis and projection of oil palm plantation expansion on peatland in Southeast Asia. International Council on Clean Transportation, 22.