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BRAZILIAN SUGARCANE INDUSTRY ASSOCIATION
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April 11, 2014

VIA ELECTRONIC MAIL

John Courtis
Manager, Alternative Fuels Section
California Air Resources Board
1001 I Street
Sacramento, CA 95814

RE: UNICA's Preliminary Comments on Revised Indirect Land Use Change Values

Dear Mr. Curtis:

The Brazilian Sugarcane Industry Association ("UNICA") appreciates the opportunity to provide comments on the California Air Resources Board's (CARB) Low Carbon Fuel Standard's (LCFS) revised indirect land use change (iLUC) values, which were first presented at a workshop on March 11, 2014.

UNICA is the largest representative of Brazil's sugar, ethanol, and bioelectricity producers. Its members are responsible for more than 50% of Brazil's ethanol production and 60% of Brazil's sugar production. UNICA's priorities include serving as a source for credible scientific data about the competitiveness and sustainability of sugarcane biofuels. UNICA also works to encourage the continuous advancement of sustainability throughout the sugarcane industry and to promote ethanol as a clean, reliable alternative to fossil fuels. Sugarcane ethanol production uses less than 1.5% of Brazil's arable land and reduces lifecycle greenhouse gas ("GHG") emissions by up to 90% on average, compared to conventional gasoline. Also, thanks to our innovative use of ethanol in transportation and biomass for power cogeneration, sugarcane is now a leading source of renewable energy in Brazil, representing over 15% of the country's total energy needs. The industry is expanding existing production of other renewables products and, with the help of innovative companies here in the United States and elsewhere, is beginning to offer bio-based hydrocarbons that can replace carbon-intensive fossil fuels and chemicals.

We believe the CARB staff has made a number of improvements to update the iLUC modeling under the LCFS. These changes are consistent with the scientific progress in understanding iLUC dynamics, stakeholder input from a range of experts, and the Board's 10-49 resolution issued on November 18, 2010. While we have been given limited time to sufficiently review and validate the Global Trade Analysis Project (GTAP) modeling involved in this latest update, we submit the following preliminary comments. As we have done in the past, we will continue to engage with CARB staff to provide additional input and feedback on the LCFS.

We applaud CARB staff for their continued efforts to apply sensitivity analysis, increase the robustness of the analysis and reduce the uncertainties of the results. These changes are consistent with some our comments during the 2009 rulemaking. (See our various letter, starting in February 2009, all of which are available at http://sugarcane.org.)

While the sugarcane ethanol iLUC values were reduced, by CARB staff's own admission during the workshop they are significantly higher than those in other programs, such as the federal Renewable Fuels Standard (RFS). This is quite different for the other two major pathways, soybean and corn, where the revised iLUC values between the RFS and LCFS are much more aligned.

Given the inherent complex nature of such modeling exercises and their assumptions, UNCIA has relied on outside experts to help us replicate the CARB iLUC models and validate the results. With the support of various experts, including Angelo Gurgel of Fundação Getúlio Vargas and Marcelo Moreira of Agroicone, we have identified specific areas where CARB staff should reevaluate its revised model and calculations to better represent the dynamics of the Brazilian agricultural and bioenergy production.

As we have done in the past, we provide in this letter specific and data-driven comments for CARB staff to consider in its evaluation. In this preliminary letter our comments are focused on the model data assumptions, methodology, and other key factors underlying the GTAP runs made by CARB.

1. Constant Elasticity of Transformation

The current Constant Elasticity of Transformation (CET) Land Supply Function in the GTAP model version used by CARB considers the decision to convert land to forest, pasture, and cropland in one single nest. Contrary to what occurs in the real world, this means that forest and pasture land is converted immediately to cropland under a single transformation elasticity function. As described by Taheripour and Tyner (2013), this implies the same economic costs, or flexibility, to move from pasture or forest to cropland. We know from simple observation the conversion from forest to cropland is usually more expensive than from pasture to cropland, particularly in Brazil, we have empirical evidence to support this view.

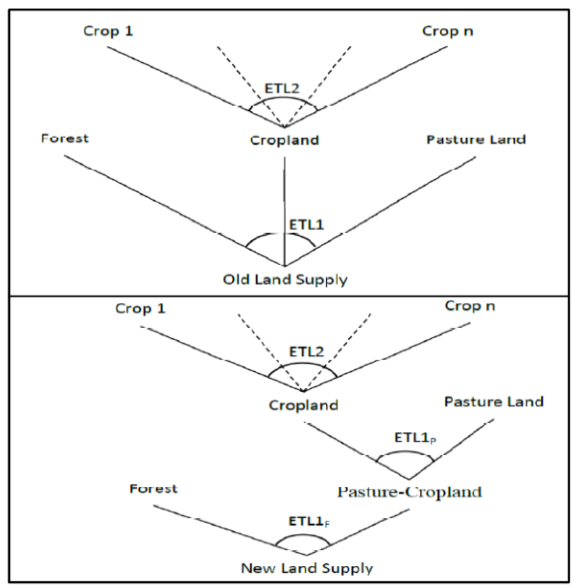
Babcock and Carriquiry (2010) have used the baseline share of returns to land of different types in the CET functions in the GTAP model to determine the "own" and "cross" price elasticities of land cover type. In their analysis, these respected scholars show that the calculated elasticities are not consistent with empirical estimates. As example, they calculated the cross price elasticity of forest land in the United States with respect to crop returns of -0.174, which means a 10% increase in crop returns decreases forest land by 1.74%. But this responsiveness is 35 times as great as the maximum response of forest land to crop returns over a 15 year time period using the response of forest land to changes in “own” forest returns, as estimated by Lubowski (2002) and Lubowski, Plantinga, and Stavins (2006). This indicates GTAP exaggerates how much forestland is converted to cropland in response to increased crop prices.

In another study, Barr et al. (2011) have estimated the elasticities of aggregate supply of cropland in U.S. and Brazil. They find land-use elasticities to be considerably inelastic with respect to U.S. prices and a sharp decrease of such elasticities in Brazil in recent years. In the case of Brazil, they observe a much lower elasticity after including the pastureland in the total agricultural land, suggesting that the increase in cropland is due mostly to the conversion of pastureland than forestland, particularly when looking at data from the most recent years.

Based on these two independent studies, we strongly urge CARB staff to reconsider the CET land supply function by nesting the distinct decision of conversion of forestland and pasture to cropland.

In addition, Taheripour and Tyner (2013) not only discuss the differences in costs to convert pasture to cropland from converting forest to cropland (i.e., arguing that considering forest, pasture, and cropland in the same nest ignores these differences) but they also perform changes in the GTAP model to accommodate this approach. They change the two-level decisions in the traditional CET land supply three to a three-level decision function, as shown on Figure 1 on the right.

Figure 1. New and old land supply trees in GTAP-BIO model.



This approach is the same used by Al-Riffai et al. (2010), where the CET function has two levels of substitution with two different elasticities of transformation. The upper level considers the substitution between forestland and total arable land, with country specific elasticities ranging from 0.1 to 0.13 while the lower level considers the substitution between pasture and cropland, which elasticities vary from 0.02 to 0.25. This approach allows a more accurate calibration of CET elasticities to estimate “own” and “cross” price elasticities of Lubowski (2002), Lubowski, Plantinga, and Stavins (2006) and Babcock and Carriquiry (2010).

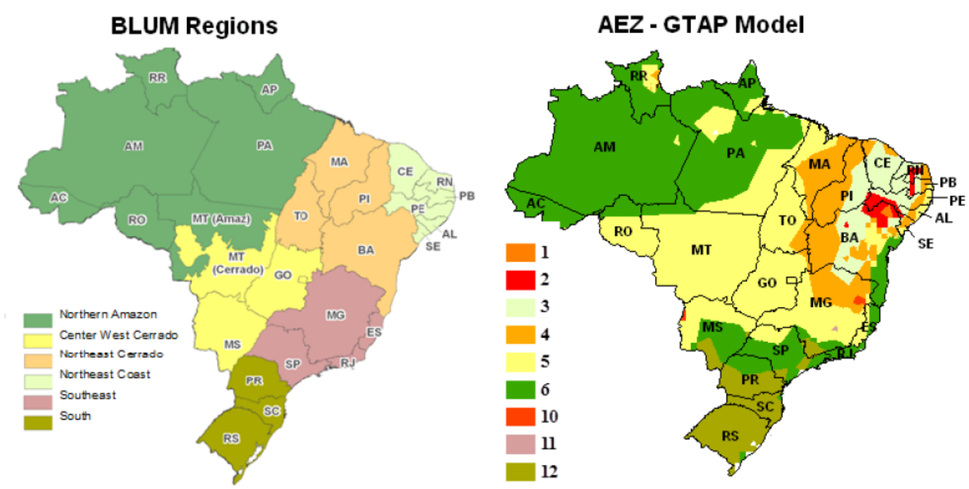
Nassar et al. (2012) calculated land expansion elasticities for six Brazilian regions by merging observed deforestation data from satellite imagery and profitability data. The study, which is an update to the Brazilian Land Use Model (BLUM), found that land supply elasticities — at least for the Brazilian case — are much lower when observed data is considered. Oladosu et al. (2012) developed a method to compare land expansion elasticities used in GTAP-DEPS and BLUM, which recognizes that elasticity calculated by Nassar (2012) are considerably lower than the ones used in GTAP-DEPS and that GTAP should be revised using observed deforestation data.

Based on the latest available studies, we urge CARB to consider utilizing the Taheripour and Tyner (2013) approach to represent the CET land supply in its updated version of the GTAP model to calculate iLUC values under the LCFS.

2. AEZ definition

The Agro-Ecological Zones (AEZ) classification in GTAP is based on climate and length of growing period. In the case of Brazil, these regions have a similar distribution of the different biomes of Brazil, as shown in the figure below. The figure below also shows regional classification of land use in the BLUM model, a partial equilibrium model for Brazil dealing with land use changes and agricultural production. The six regions in BLUM are based on a combination of agricultural production homogeneity and biomes of Brazil.

Brazilian Regions in BLUM compared with AEZ used in GTAP



Source: Oladosu *et al*. (2012)

As Oladosu's work confirms, GTAP's AEZ representation for Brazil has an important limitation for the simulation of land use changes in the country. The majority of AEZ 6 is characterizing the tropical Amazon forest, which is located mostly in the States of Acre (AC), Amazonas (AM), Roraima (RR), Para (PA) and Amapa (AP) in the northern regions of the country. However, there is a considerable share of AEZ 6 in the Central-South part of the country, mostly in the São Paulo (SP) state. The São Paulo state is the major sugarcane and ethanol producer state in the country. Today more than 50% of the sugarcane area is located in Sao Paulo state, which is responsible for more than half of the ethanol production. At the other hand, the northern states together account for less than 0.3% of the area and production of sugarcane and its products.

This is similar to suggesting that California's Imperial Valley and Florida's Everglades should be counted as one region!

The extensive and inconsistent nature of AEZ 6 in Brazil, which covers both the largest sugarcane production area and the world's largest tropical rainforest raises two critically important points.

First, the model results in the conclusion that sugarcane biofuels expansion in will directly convert swaths of the Amazon tropical rainforest to sugarcane, which is completely unsubstantiated since the Amazon region is not suitable for sugarcane production and extremely distant from the main consumption centers and trade routes. From a farm-level point of view, it is preposterous to assume that farmers would expand production by converting land in the other side of the country where the yields and cost would be inconsistent with the most basic business terms.

Second, this distortion in the AEZ and the CET land transformation function leads to excess of forest conversion to cropland. The CET transformation functions have a property that makes it easy to convert land use categories that are more abundant and harder to convert than scarcer land use types. In other words, the highly exaggerated sugarcane ethanol shock applied by CARB on their model in GTAP converts too much forest in AEZ6 to cropland. Of course, this would not occur if AEZ6 were more accurately drawn, separating the Amazon in the extreme north of the country from the sugarcane areas in southeastern Brazil. When we tried to replicate CARB's results in GTAP, there is a disproportional increase in forestland conversion in AEZ6 for any biofuels shock simulation. As this is the region of larger unprotected forest cover in the country, one could argue that such larger forest change is expect there. However, these disproportionate absolute changes in forestland that GTAP produces in this region are a result of the incongruent AEZ 6 boundaries that mix two very different regions in terms of economic and environmental dynamics.

As the role of any model is to capture and represent as best as it can some real-world phenomena, the representation of AEZ6 for Brazil is just not adequate. One possible solution is to subdivide the AEZ6 for Brazil in at least two different AEZs, which would avoid the problem described above. However, as we recognize changing AEZ is not an easy task, *we strongly recommend that CARB reduce the size of the shock and breakdown the CET land transformation function, as suggested above and consistent with Taheripour and Tyner (2013), to ameliorate the unintended consequences of the model.*

3. Cropland-Pasture Elasticity

Cropland-Pasture yield elasticity (PAEL) accounts for increases in productivity of cropland pasture areas resulting from increase in land rents. CARB has used values between 0.1 to 0.6 in the U.S. and between 0.1 and 0.3 in Brazil. While there is a general lack of estimates about these parameters, we have strong evidence suggesting higher elasticities in Brazil. More importantly, there is no scientific basis for CARB to use lower PAEL numbers for Brazil compared to U.S. ones. Quite the contrary, ample studies support the use of higher elasticities for Brazil.

Martha Jr. et al. (2012) shows empirical evidence about the dramatic change in the pattern of cattle production in Brazil since 1950s. During the period from 1950 to 1975, cattle production in Brazil expanded based on extensive production. However, after that period and through the early 2000s, increasing productivity gains in cattle farming dramatically changed the nature of the industry, as evidenced by the 79% growth in beef production. Without these productivity gains, this cattle production increase would have represented about 535 million hectares (about 1.3 billion acres) in land conversion.

Martha Jr. et al. calculate that, despite a 21% decrease in cattle ranching area, the expansion on beef production during the decade from 1996 to 2006 was a result of a 122% increase in productivity, driven mostly by animal performance but, to a lesser extent, increased stocking rate. These are not theoretical projections. They reflect the official agricultural census data collected in Brazil. This official, and highly reliable public data set, shows that pasture area has decreased from 178 million hectares in 1996 to 172 million hectares in 2006 while the Brazilian cattle herd increased from 153 million heads to 170 million. During the same period, the cattle-stocking rate increased from 0.86 to 0.99 per hectare, a considerably low figure underscoring the considerable productivity improvements possible for Brazilian cattle ranching. As the history of U.S. agriculture can attest, these productivity gains are possible through improved breeding techniques, supplemental nutrition, forage quality, and general management.

Higher stocking rate and beef production during this period confirms that pasture yields improve when more pastureland is released for crops and other uses. In other words, pasture yields respond strongly to cattle price changes. Conversely, the low level of pasture intensification reinforces the argument that CARB's modeling must recognize that there remains considerable room for improvements in terms of pasture intensification in Brazil.

We again present below an empirical analysis of the pasture yield, as measured by the stocking rate, response to prices that has been calculated by Agroicone back in 2009. In sum, their analysis, now corroborated by the aforementioned studies, indicated that pasture yield price elasticity in Brazil is 0.6, which is significantly higher than the crop yield elasticities used in the GTAP scenarios presented during the recent workshop at CARB.

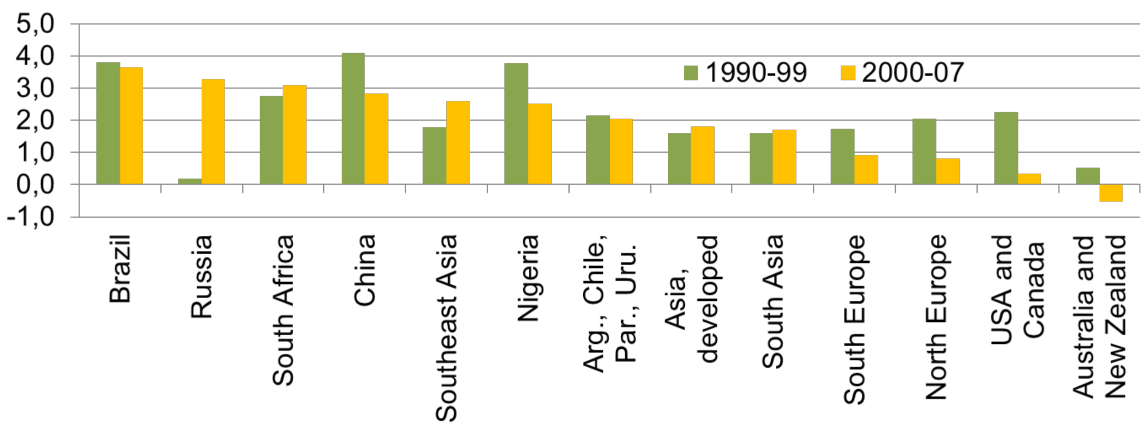
Result for Pasture Yield with respect to Real Prices, in logarithm[1]

	Coefficient(1)	t-Statistic	Probability
Real Price (2)	0.60	8.83	0.000000
Dummy for High Yield (3)	0.64	12.62	0.000000
Constant	-2.26	-9.46	0.000000
R-squared	0.92		
Adjusted R-squared	0.90		
Number of Observations	28		

Notes: (1) Using Pesquisa Pecuaria Municipal (PPM) for cattle herd and pasture area from Agricultural Census (1996 and 2006), both from IBGE.; (2) Real prices for 1996 and 2006 for 14 Brazilian Regions. (3) Dummy variable for regions that had yield higher than one in 1996.
Source: Agroicone, underlying data and regressions available upon request.

Alston et al. (2010) finds that Brazilian agriculture registered the fastest growth in factor productivity across the globe (3.81% a year) in the period 2000-2007, as seen in the chart below.

Growth in Total Factor Productivity in agricultural sector (% per year)



Source: Alston *et all* (2010)

This is explained by strong improvements in livestock yields as presented in the table below.

Livestock yield indexes in Brazil (2002-2012)

	2002	2012	Variation	CAGR (%)
Pasture area (1000 ha)	184,037	180,785	-3,252	-0.14%
Herd (1000 Head)	185,349	213,239	27,890	0.98%
Meat production (1000 MT)	7,139	9,748	2,609	2.64%
Livestock yield (kg of meat/ha)	39	54	15	2.78%
Milk production (1000 liters)	24,172	33,996	9.824	3.6%
Milk production per cow (liters/cow)	1,286	1,479	193	1.4%

Sources: IBGE, UFMG, INPE, BIGMA Consulting, Agroicone

[1] As we did during the 2009 rulemaking process, we can provide any information regarding the results presented in this table for CARB, as well as the data and the regressions used to estimate the parameters.

The GTAP model must capture such phenomena — high response of pasture yields to prices changes in Brazil — in order to have a scientifically defensible model.*We strongly urge CARB staff to increase the Cropland-pasture elasticity to 0.6, consistent with the figures used for the U.S. as this would allow a more realistic cattle intensification response in the livestock production in Brazil from changes in the pasture area available, which is consistent with the increase in productivity observed in the last several decades in this sector.*

4. Elasticity of Crop Yields with Respect to Area Expansion

We support CARB's decisions, consistent with the expert group recommendation, to use the GTAP version that varies the value of Elasticity of Crop Yields with Respect to Area Expansion (ETA) by region as documented in Tyner et al. (2010). We believe this was one of the most important directional improvements of the modeling approach to estimate emissions intensity from renewable fuels. Nevertheless, based on recent data, we believe there is room for improvement in CARB's ETA calculations.

Daubermann et al. (2014) show there is little to no reduction in yields when cropland expands in Brazil. They formulate several econometric models to investigate the former hypothesis made by CARB that have assumed the conversion of forestland and pastureland to cropland in Brazil decreases yields. Daubermann et al. indicate that yields do not decrease under the expansion of cropland area in the country. Moreover, econometric models tested not only rejected any reduction in yields associated to cropland expansion but also suggested the opposite — expansion of cropland has occurred together with increase in yields.

An easy explanation for this is the observation that new cropland areas in Brazil are cultivated with the same or improved technologies as traditional cropland areas. As the soil properties and climate conditions do not differ between new and traditional areas, these new areas can easily reach, or as the census data shows, sometimes overcome the yields of traditional cropland areas. However, as the current GTAP ETA numbers are based on the Terrestrial Ecosystem Model (TEM), the current and improved management practices and technological advances during the cropland expansion are ignored.

Similarly, using soybean expansion in Brazil, as an example, Babcock and Carriquiry (2010) performed a statistical measurement of the hypothesis of whether yields on new land are lower than on old land. The hypothesis failed by the statistical test, meaning that one could not affirm that new land brought into production has lower yield than old land. On the other hand, they observed that those regions with a higher growth in land have a higher growth in yield. This study is supported by Fisher et al. (2002) where the authors used AEZ and land cover information to estimate that 19% (464 million hectares) of world land with rain-fed cultivation potential was still under forest ecosystem at the time. About half of this land (237 million hectares) is classified as very suitable land.

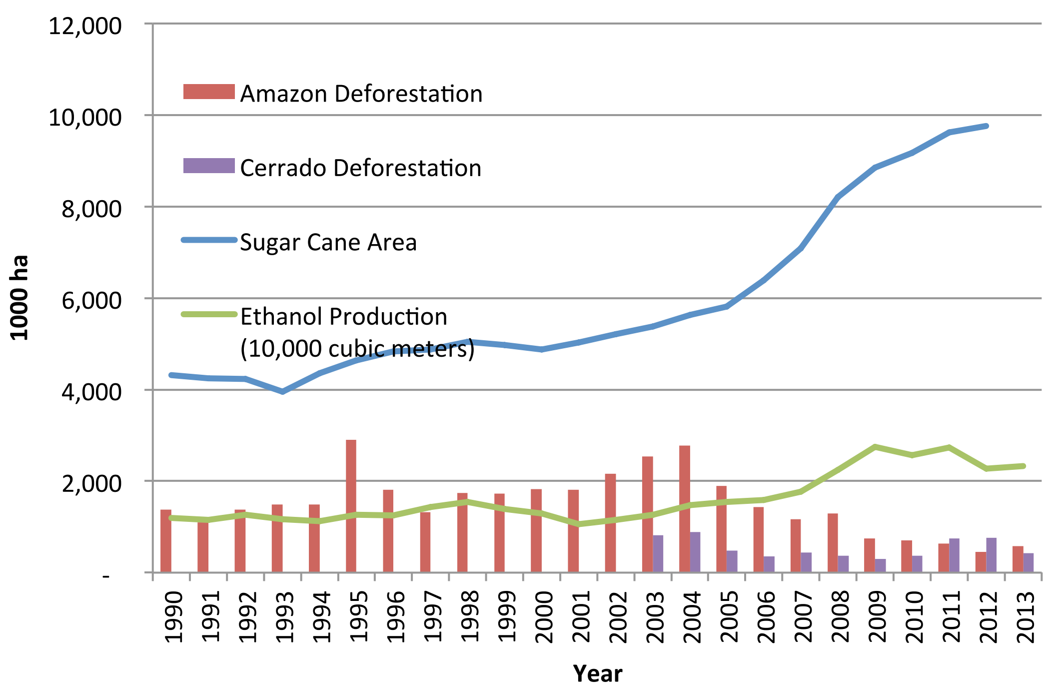
In short, the aforementioned studies corroborate our prior recommendation that CARB should correct its ETA for Brazil to be near or equal to 1 in all AEZs in the country. We would recommend that during the sensitivity analysis, CARB continue to vary them from 80% and 120% of this value to ensure robust results.

5. Reduction in Deforestation in Brazil

Over the last decade, Brazil has reduced deforestation rates not only in the Amazon region but also in the savannah areas such as the cerrado. This decade of progress is a result of the success of various anti-deforestation policies in Brazil, such as the Action Plan for Prevention and Control of the Legal Amazon Deforestation (PPCDAM) and the Action Plan for Prevention and Control of the Cerrado (PPCERRADO), and increased global awareness. Moreover, anti-deforestation efforts have benefited from real-time satellite monitoring, which vastly improved the enforcement mechanisms.

At the same time these factors have reduced deforestation, Brazil increased production of biofuels from sugarcane. As shown in the figure below, there is an undeniable negative correlation between ethanol production and deforestation in the period.

Annual deforestation rates, sugarcane area and ethanol production



Source: INPE/PRODES (Amazon), UFG-LAPIG (Cerrado), Unica.

Deforestation (millions of hectares)

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Amazon	2.539,60	2.777,20	1.901,40	1.428,60	1.165,10	1.291,10	746,40	700,00	641,80	457,10	584,30
Cerrado	817,20	890,50	482,20	350,90	444,70	375,70	299,70	372,40	741,50	765,30	423,35

Sources: INPE/PRODES and LAPIG

Recognizing that such simplistic-yet-useful approach does not address the possible impacts outside of the country, UNICA appreciates the additional scrutiny and modeling on a global basis. However, CARB cannot deny the important contribution that effective anti-deforestation policies have had in Brazil, which can be shown to offset the indirect land use changes alleged from biofuels production and should provide some weigh to national actions to limit land use changes.

As discussed before, there was a strong increase in crop yields and in beef productivity in the same period, both of which we believe ought to contribute to lower, or even nullify, the indirect land use impacts outside the country. After all, if policies in California and elsewhere are designed in part to improve the sustainability of our planet, should we ignore the improvements being made as a direct result of said policies for the sake of calculating indirect impacts? UNICA suggests the combination of all these observed reduction deforestation and gains in productivity in the agriculture and livestock sectors has more than offset any supposedly negative impacts increase production of biofuels.

Moreover, given that the average yield and productivity levels in Brazil are far from the highest levels globally, it is reasonable to believe in further increases in production under the current constraints to the expansion of the agricultural frontier. Consequently, the benefits anti-deforestation push has on yield gains is not captured in the GTAP model. An increase in biofuels production due to any U.S. policy simulated in GTAP would promote land use changes inside and outside the country without taking into account the anti-deforestation policy and its impacts on agricultural intensification. It is possible to correct it by changing elasticities and model assumptions, as the ones suggested before in this letter (i.e., CET land supply function with separate nests to represent pasture and forest conversion; higher ETA; and and higher PAEL).

6. Multi-Cropping

It appears that GTAP model does not considers the tropical land-saving technologies such as multi-cropping. For instance, technology development has allowed shortening the soybean growing cycle, which allows harvesting soybeans in time to plant and harvest a corn crop in the last area, in the same year. UNICA highlighted this concern in our comments during the prior rulemaking and strongly urges CARB to evaluate this aspect of modern, tropical agriculture. This is particularly true when global markets signal stronger demand for corn, as was the case in recent years. In fact, as evidenced in Brazil in recent years, the croplands used exclusively for corn (referred locally as the “first harvest”) has decreased while the double- or multi-croping areas that do not require additional area has become the mainstay of the corn economy in Brazil. In fact, in the last year, Brazil surpassed the United States in corn exports while not materially increasing crop area for corn.

Corn production in Brazil (1st and 2nd harvest)

Variable	Corn harvest	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Area (1000ha)	1st harvest	9,690	9,381	8,581	9,280	9,686	9,422	8,511	6,864	7,508	6,895
	2nd harvest	3,276	3,030	2,968	3,333	4,082	5,022	4,381	5,043	5,711	7,304
Production (1000 t)	1st harvest	35,028	31,349	27,161	31,485	37,658	39,829	30,705	29,852	33,488	32,819
	2nd harvest	13,299	10,439	7,952	11,177	14,455	19,105	16,367	21,568	22,172	38,254

Source: IBGE

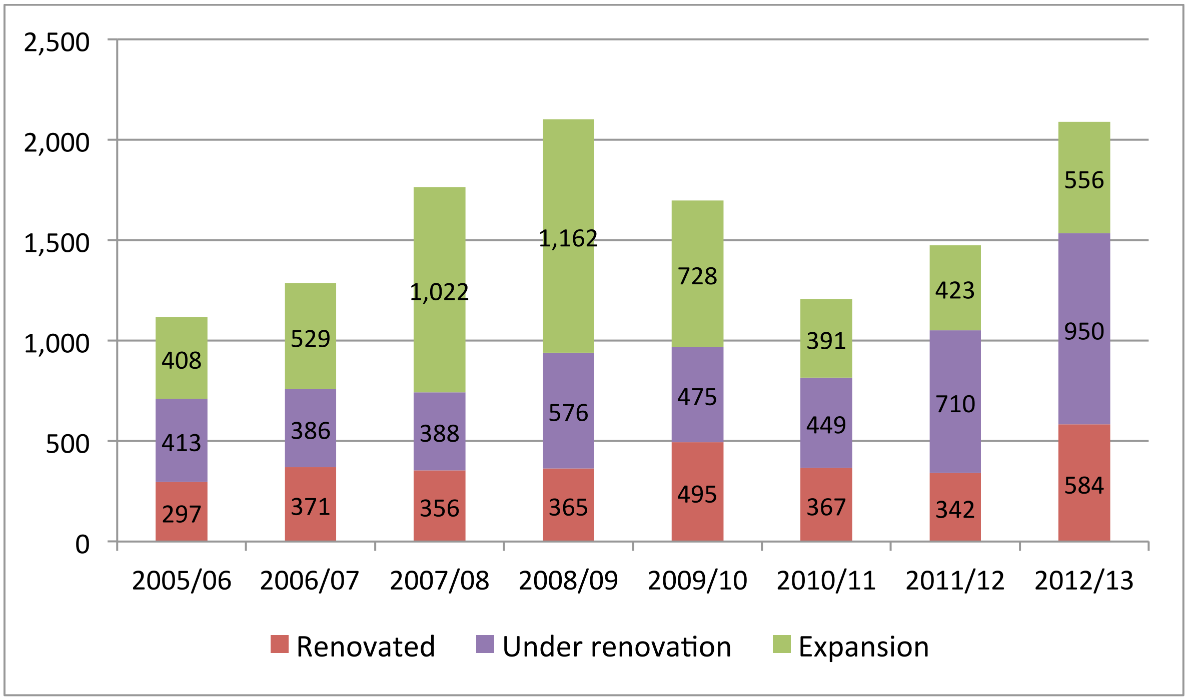
7. Sugarcane Intercropping

Similar to corn double-cropping, the sugarcane area that is being rotated (for soil/crop improvement) is not explicitly cited in the CARB document nor is it evidence in the models simulations to assess impacts on food crop prices and iLUC. Sugarcane area being renewed, however, is well documented: 950 thousand hectares in 2012, see Figure below. The cane ratoon is renewed after five or six years of harvesting. The main objective of this renewal is to recover soil yields and to promote crop rotation.

As we explained in prior correspondence and in our discussions with CARB staff, there are two types of sugarcane seedlings: (1) year and a half (which requires one year and a half to become mature for harvesting); (2) one-year cane and winter cane (these require one year to become mature for harvesting). The year and a half cane is planted in the beginning of the harvesting season and harvested by the end of the season after the next. One common practice is to plant leguminous crop (such as soybean, peanuts or beans) in the year and a half renewal area of cane during the summer.

The renewal of sugarcane plantations increases food production and helps to mitigate the food versus fuel concerns. For instance, if sugarcane expands over pastureland, there will be in an increase production of leguminous crops of about 20% of the sugarcane expansion area due to intercropping. Similarly, if sugarcane expands over grains, the land displacements should be about 80% since there will be about 20% of food crops added as part of sugarcane land management. Of course historical data shows that the vast majority of sugarcane expansion has occurred in pasturelands, as Adami et al (2012) confirm.

Identification of sugarcane areas in Center South of Brazil (1000 ha)



Source: INPE/CANASAT

Unlike corn, wheat and sugar beets, all of which receive credit for avoided iLUC associated to the feed co-product, agricultural products produced in sugarcane area under renewal are counted in the total production of the product but are not considered in association with sugarcane. Sugarcane has no iLUC credit because the co-product is not from sugarcane but as a result of crop rotation.

We urge CARB to treat sugarcane area under rotation the same way as Distillers Grains for corn and wheat since they all promotes the production of food and feed crops all the while reducing iLUC. This contribution of the area under renovation (one-sixth of sugarcane area) has been overlooked in economic models such as GTAP.

8. AEZ-EF model - Land Use Factor for Sugarcane

We applaud CARB's revised modeling for sugarcane in that it now recognizes the semi-perennial nature of sugarcane crop. As multiple studies have confirmed, the higher carbon stocks for sugarcane compared to annual crops cannot be ignored. Amaral et al (2008), Harris et al (2009), Lisboa et al (2010), Galdos et al (2010), and Seabra et al, (2011) clearly substantiate this fact. And, not surprisingly, the AEZ-EF documentation by Plevin et al (2014) states that sugarcane should be considered as a perennial/tree crop with land use factor (F_{lu}) equal to 1 in all temperature regime and all moisture.

However, AEZ-EF model in the Microsoft Excel spreadsheet available on CARB's website appears to have a mistake. Specically in sheet "Tables", F_{lu} is equal to

1 in tropical regions (column F, row 131-136), but is lower than 1 in other latitudes (column F, row 137-148).

We urge that CARB revisit the AEZ-EF model and, if not corrected, explain why F_{lu} is different in the non-tropical regions in its spreadsheets.

9. Mechanized Harvesting and Management Factor for Sugarcane

One important feature about sugarcane production in Brazil is the rapid expansion of mechanized (green) harvesting instead of pre-harvesting burning techniques and how this impact the correct use of Management Factor F_{mg} when following IPCC 2006 recommendations.

Since sugarcane is replanted only every five or six years, the associated soil disturbance occurs with the same frequency in any area mechanically harvested. However, when using pre-burning practices, no coverage is left on the field, which could justify the assumption of "full" tillage F_{mg}. (i.e., F_{mg} is equal to 1 in all regions). When using the green harvesting technique, a thick layer of leaves and stalks is left on the ground after harvesting, leaving almost full soil coverage by residues. SOC accumulation after conversion from pre-burning harvesting to green harvesting has been extensively measured, generating significant consensus in international specialized literature.

Leal et al (2013) presents literature review of such findings, which we provide verbatim:

> *In straw management experiments in Australia, the soil carbon content was 20% higher in the 0e0.1mdepth in areas without burning as compared to burned areas, two years after the beginning of the green cane management. In a long-term experiment (55 years) comparing burned and unburned sugarcane in South-eastern Brazil, carbon concentrations of 22.34 g kg-1 in the cane with straw maintenance, and 13.13 g kg-1 in the burned cane in the 0.2 m soil depth were reported. Razafimbelo et al. described a 15% increase in soil carbon stocks in the 0e0.1 m layer after six years of green cane management, compared to the management with burning. Vallis et al. described a steady increase in carbon stocks in unburned plots, and no change in carbon stocks in a four year period in adjacent burned areas in Australia. In an experiment in South-eastern Brazil, it was reported that an average of 0.32 Mg ha_1 a_1 was accumulated in 12 years in the first 0.2 m depth of an Oxisol due to the maintenance of sugarcane straw on the field. Luca et al reported annual soil carbon increases ranging from 1.2 to 1.9 Mg ha_1 a_1 for the 0e0.4 m layer during the first four years following the elimination of pre-harvest burning. Galdos et al. described an increase of 30% in soil carbon stocks after eight years of conversion to mechanized harvest with maintenance of crop residues on the field.*

UNICA strongly urges CARB to use "reduced till" for management factor whenever green harvesting techniques is used for sugarcane; which would mean that F_{mg} should vary from 1.02 to 1.15.

It is important to notice that according to the Agro Environmental Protocol, discussed in our prior correspondence in 2009, Brazilian sugarcane mills are committed to eliminate pre-harvesting burning in areas with slope up to 12% in 2014. In areas above 12%, the burning practice must be eliminated by 2017. Based on current data available publicly in Brazil, about 89% of areas of Brazil's Center South are harvested using green harvesting techniques, independent of the slope (UNICA, 2013).

* * * * *

UNICA appreciates the opportunity to submit these preliminary comments. We applaud CARB for taking on the difficult task to update the indirect land use change values for all fuel pathways.

UNICA members and staff look forward to the opportunity to continuing to work with CARB to fully achieve the economically and environmentally beneficial goals of the LCFS in California. UNICA is ready to provide further information or answer any questions CARB may have about the substance of these comments or the Brazilian sugarcane ethanol industry.

Respectfully Submitted,

Elizabeth Farina
President & CEO

Leticia Phillips
Representative – North America

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