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BRAZILIAN SUGARCANE INDUSTRY ASSOCIATION
ETHANOL • SUGAR • ENERGY BRAZIL

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VIA ELECTRONIC MAIL

Mary D. Nichols
Chairman, Air Resources Board
Headquarters Building
1001 I Street
Sacramento, CA 95814

Reference: *Comments on Developments in Land-Use Change Analysis (LUC) For The Low Carbon Fuel Standard (LCFS).*

Dear Chairman Nichols:

The Brazilian Sugarcane Industry Association (UNICA) welcomes the opportunity to provide specific comments on the September 14 LCFS Land Use Change Workshop meeting's documents, which the staff of the California Air Resources Board (CARB) published on September 14, 2011.

After a brief introduction of UNICA (I), the comments and suggestions of this letter will focus on (II) Interim Report on Calculation of ILUC values for LCFS fuel pathways by Wallace Tyner et al.; (III) Agro-ecological Zone Emission Factor Model by Richard Plevin, Holly Gibbs, James Duffy, Sahoko Yui, Sonia Yeh; and, (IV) Conclusions.

Given our extensive experience with and knowledge of sugarcane biofuels production, and given our direct and significant interest in the successful implementation of California's Low Carbon Fuel Standard (LCFS) program, we request that CARB carefully and thoroughly considers the comments of this letter as it continues to improve the development of the LCFS program.

I – INTRODUCTION

The Brazilian Sugarcane Industry Association (UNICA) is the largest organization representing sugar, ethanol, and bioelectricity producers in Brazil. UNICA's members are responsible for more than 50% of all ethanol produced in Brazil and 60% of overall sugar production. UNICA's priorities include serving as a source for credible scientific data about the competitiveness and sustainability of sugarcane biofuels. The association works to encourage the continuous advancement of sustainability throughout the sugarcane industry and to promote ethanol as a clean, low carbon, reliable alternative to fossil fuels. In fact, gasoline is now the alternative fuel in Brazil, with more ethanol consumption than gasoline. In terms of sustainability, sugarcane ethanol production uses about 1.5% of Brazil's arable land and reduces greenhouse gases (GHG) by 90%, on average, compared to conventional gasoline. Moreover, thanks to our innovative use of ethanol in transportation and biomass for power cogeneration, sugarcane is now the number one source of renewable energy in Brazil, representing 18% of the country's total energy needs. And this industry is expanding existing production of renewable, bioplastics and, with the help of innovative companies here in the United States and elsewhere, are beginning to offer bio-based hydrocarbons that can replace carbon-intensive fossil fuels.

II – INTERIM REPORT ON CALCULATION OF ILUC VALUES FOR LCFS FUEL PATHWAYS BY WALLACE TYNER

We provide below several comments with the objective to improve GTAP version used by Tyner et al (2011)[1]. Our comments follow two paths: (i) to guarantee that GTAP assumptions, as much as possible, can be confirmed by real evidences specifically with respect to the agricultural sector in Brazil (as Tyner et al. have recognized when comparing their results with the ones from Ferreira-Filho and Horridge 2011[2]); (ii) to discuss the merit of the sensitivity analysis performed considering that they are strongly based on assumptions and not in real evidences.

A – SENSITIVITY ANALYSIS WERE PERFORMED INDIVIDUALLY BUT THEY ARE INTERLINKED

Although the sensitivity scenarios were performed individually, only analyzing them in conjunction is it possible to understand its real implications. A typical example is the sensitivity analysis on transformation elasticities. Reducing transformation elasticity among crops has reduced land use changes because less cropland is lost (a stronger effect is perceived in the sugarcane ethanol scenario than in others). Intuitively, it is well known that competition among crops is high (Tyner et al. confirms that suggesting the use of -0.75 rather than -0.5). However, due to the fact that more cropland-pasture is lost in the lower transformation elasticity scenario, more pasture is converted relative to forestland with respect to the higher elasticity scenario. Higher transformation elasticity, therefore, would make sense only if the constant elasticity transformation (CET) between cropland and pasture is higher than the CET between agricultural uses and forest.

Unfortunately, the GTAP land use tree assumes equal CET for the transformation among forest, pasture and cropland (see comment B below). Assuming that a unique CET for forest-pasture-cropland is not representing the reality, because shifts from pasture to crops are much more intense than from pasture to forest, it is hard to guarantee that the sensitivity analysis on transformation elasticity is providing correct results.

B – SENSITIVITY ANALYSIS OF LAND COVER CHANGES WITH RESPECT TO CHANGES IN FOOD DEMAND INDUCED BY HIGHER FOOD PRICES DUE TO BIOFUEL PRODUCTION

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[1] Tyner, Wallace E; Gollub, Alla; Taheripour, Farzad. Calculation of Indirect Land Use Change (ILUC) values for Low Carbon Fuel Standard (LCFS) Fuel Pathways. Interim Report. September 2011. CARB Contract 10-408

[2] Ferreira-Filho, J.B. and M. Horridge, Ethanol Expansion and the Indirect Land Use Change in Brazil, in 2011 GTAP Converence 2011: Venice, Italy.

An important limitation of this approach is related to the lack of information on how food prices affect farmers' income versus food consumption in developing countries. Any increase in agricultural prices, despite the negative impact on food prices in general, should have a positive impact on the income of farmers. Considering that most of the poverty in developing countries is located in rural areas, and is related to lower levels of income of rural households, it is difficult to know the net effect on poverty from increase in agricultural prices without a global picture (or economic model) on consumption expenses and income sources for different consumers classes and commodities[3].

Another limitation of this approach is related to the lack of reality of the approach itself and of its results. This shock will have the impact of requiring relatively more land expansion to accommodate more food production (or avoid increases in food prices). It will increase carbon emissions from land and the emissions factors of biofuels. However, there is no guarantee that, in the real world, a higher emissions factor in the LCFS will effectively contribute to reducing (or preventing the increase in) food prices. If the LCFS wants to prevent higher agricultural prices, it needs to deal with that directly, not indirectly, since it is a carbon policy program and not a food policy program. The idea of simulating land use changes at same time as keeping food consumption constant, just to get a higher emission factor, is known in the economic literature as a "second best" policy approach to a policy problem. In this case, the policy problem is related to higher food prices and lower food consumption from increasing demand for land from biofuels. But second best policies create other effects and distortions (as to reduce the potential agricultural profit, as mentioned before), since it does not act directly on the problem.

It is also important to notice that any other policy regarding fuels will also have indirect impacts on food consumption, since they alter relative prices of goods and rents from primary factors in the economy, and as so, can change income revenues and its distribution. Why should only biofuels receive a punitive approach based on its indirect impacts on food demand due to indirect impacts on land use, if no other fuel source is subject to this kind of measurement? This approach translates to a double penalty for biofuels, given the penalties already imposed by ILUC. If ARB pursues such approach, in order to keep the methodology consistent, we would like to suggest that all other fuel pathways should be re-estimated, considering that any effort to increase their production to meet LCFS standards should assume that food consumption -which is affected by relative prices of energy, inputs, and outputs of any changing sector in the economy, as also by changes in relative revenues from labor, capital and natural resources, which generate income for families- must be kept constant at reference or benchmark levels. In other words, not only indirect land use changes of biofuels should be assessed by computable general equilibrium models as GTAP, but also, any indirect effect (on prices, food consumption and anything else) from the expansion in production of any other fuel, since all have general equilibrium impacts on the economy. And also, to make the methodology consistent among alternative fuels, food consumption should be constant to all.

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[3] Several studies have investigated the relationship between changes in agricultural prices and changes in income distribution and poverty in a general equilibrium context and considering policies that have impacts on relative prices of agricultural goods and household incomes. Those studies have shown that increases in agricultural prices may reduce poverty in developing countries due to changes in income revenue of those people working in agricultural sectors and receiving rents from land use. See as example: Cline (2003), Hertel, Keeney e Valenzuela (2004), Harrison *et al.* (2004), Ferreira Filho e Horridge (2006), and Ferreira Filho et al. (2010).

We also identify another problem in the approach of constant food consumption regarding the way the sugarcane ethanol shock is implemented. The report affirms that the sugarcane ethanol shock is simulated through the imposition of subsidies in ethanol production in Brazil and in ethanol consumption in U.S. imports. A subsidy in the production of a specific good has the general equilibrium effect of increasing the output of such product, decreasing its relative price, and as consequence, increasing the relative price of other products. It has the general effect of decreasing overall consumption and welfare level in the country imposing the subsidy. Also, as the government needs to divert some of its budget to cover the subsidy, it may be the case that it is decreasing its expenditure with transfers to households and with public goods in the economy and income generated from its activities.

Considering how this shock was simulated, it is expected that the sensitivity scenario that keeps food consumption constant, will force a greater cropland expansion that is related to the effects of the subsidies applied to simulate the increase in production in Brazil (overall reduction in consumption, as explained in the previous paragraph), and has nothing to do with the impact of the expansion of biofuels *per se*. The increase in biofuels production and exports in Brazil observed in the last ten years was not caused by subsidies in production nor by reduction in trade barriers to international trade. This means that, the land expansion calculated in the sugarcane biofuel scenario when food consumption is kept constant, is overestimating the impact of the shock due to the artificial imposition of subsidies to simulate the shock. A better approach to simulate the shock would be to just remove or reduce the U.S. import tariff until reaching 1 billion of gallons in exports to the U.S., without introducing a domestic policy in Brazil. Another alternative would be just to shock the production of biofuels as done by the GTAP group in the first version of the LCFS.

C – SENSITIVITY ANALYSIS ON LAND COVER CHANGES WITH RESPECT TO ENDOGENOUS PRODUCTIVITY INCREASE IN CROPLAND PASTURE

The introduction of the cropland-pasture land use category (Birur et al. 2010[4]) requires more analysis and more experiments to allow us to understand if that category makes sense for the Brazilian case. Our interpretation of Birur et al. is that cropland-pasture in Brazil is a low-productivity pastureland, therefore it is more sensitive to be converted to crop than pasture land[5]. Cropland-pasture in Brazil, according to our interpretation, is equivalent to degraded pastures. If that interpretation is correct, and evidences indicate that at least 50% of the pastures located in Amazon and Cerrados biomes are in process of degradation[6], cropland-pasture area can potentially be much higher than the 23.5 million ha suggested by Birur et al.

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[4] Birur, D. K.; Hertel, T. W.; Tyner, W. E. IMPACT OF LARGE-SCALE BIOFUELS PRODUCTION ON CROPLAND-PASTURE AND IDLE LANDS. Paper prepared for the presentation at the Thirteenth Annual Conference on Global Economic Analysis “Trade for Sustainable and Inclusive Growth and Development”, Bangkok, Thailand, June 9-11, 2010.

[5] As a secondary comment, GTAP database has 175.5 million ha with pasture and 23.5 million ha with cropland-pasture. However, Birur et al., quoting ORLN data, lead us to interpret that the 23.5 million ha of cropland-pasture is already included in the 175.5 million ha of pastures.

[6] DIAS-FILHO, M. B. Degradação de pastagens: processos, causas e estratégias de recuperação. 3. ed. Belém: Embrapa Amazônia Oriental, 2007. 190 p.

Although we still need to improve our understanding about that land use category, its introduction has created a situation that helps GTAP to better represent the dynamics of the Brazilian agricultural sector. Cropland-pasture category has more flexibility than pasture to switch to cropland. Therefore it is an indirect way to promote more competition between cropland and pasture than the current GTAP land supply in which forest-pasture-cropland have the same CET. In that sense, we see the introduction of the land category as an important improvement in GTAP.

If it is in ARB's interest, UNICA is willing and able to collaborate providing data and analysis for Tyner et al. in order to improve GTAP assumptions on cropland-pasture dynamics and assumptions. One issue that is still unclear is why it was assigned a lower value for the endogenous yield elasticity related to cropland-pasture in Brazil than in the U.S. Since the U.S. livestock production is significantly more intensified than in Brazil, this country has higher potential to increase yields under higher prices than the U.S. At minimum, the same value for the price to yield elasticity should be assigned to both countries.

D – SENSITIVITY ANALYSIS OF LAND COVER CHANGES WITH RESPECT TO YIELD-TO-PRICE ELASTICITY

The comments and suggestions of this item are based on the *Technical Report to the ICCT: Empirical Evidence on Crop Yield Elasticities* by Steve Berry and Wolfram Schlenker[7]. On this report, Berry develops a well-conducted econometric work, based on the same approach that Roberts and Schlenker (2009[8], 2010[9]) developed in the past. They conclude that, if there is some yield response in agricultural production due to changes in prices, it is too small and does not sustain the price-to-yield elasticity of 0.25 used by the GTAP model. Based on their findings, they suggest values closer or smaller than 0.1.

However, there is some degree of disconnection between what Berry and Schlenker have estimated and what the GTAP assumes as price-to-yield elasticity. Berry and Schlenker's approach departs from the premise that there is an exogenous technological trend governing most of the changes in yields, and such trend is completely independent from changes in prices. This approach then allows the authors to estimate the response in yields due to changes in prices and climate conditions solely, avoiding the interference of the exogenous technological trend.

The technological trend in agricultural productivity is well known and documented. However, one important aspect of it, not well investigated in the literature, is how much of such trend is a medium-to-long-term answer to higher demand for agricultural production and food consumption. In other words, would such trend be observed if population growth was null and

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[7] Berry, Steven and Schlenker, Wolfram. Technical Report for the ICCT: Empirical Evidence on Crop Yield Elasticities. (2011)

[8] Roberts, M. J., and W. Schlenker . World Supply and Demand of Food Commodity Calories, *American Journal of Agricultural Economics*, 91(5), 1235–1242. (2009)

[9] Roberts, M. J., and W. Schlenker. Identifying Supply and Demand Elasticities of Agricultural Commodities: Implications for the US Ethanol Mandate, Working Paper 15921, NBER. (2010)

per capita income was constant? Or looking at the opposite, would we expect public and private sectors to invest more in agricultural research and development if food scarcity becomes a present threat to the economy and societies? Thinking about the answers to these questions, Berry and Schlenker are just estimating short run (or yearly) responses to changes in crop prices, which have nothing to do with possible technological development and adoption by farmers due to increasing food demand (which is reflected on medium-to-long run changes in crop prices). Also, it is important to consider that farmers have little capacity to respond in a current production year to higher prices, adding more fertilizers or chemical defensives isn't an option. When such higher prices become expected or certain, most of their decisions about these inputs would have already been made and cannot be reverted. It doesn't seem rational that after facing continuous increases in prices year after year, farmers wouldn't try to increase the amount of inputs (not only fertilizers) per area or even adopt higher yield production technologies.

So, when Berry and Schlenker assume the exogenous technological trend as completely independent of medium-to-long term changes in prices, they automatically set the model to measure short run changes in yields due to changes in prices, which are, of course, close to zero. But what the GTAP model is concerned about, when considering a yield-to-price elasticity, are the medium-to-long term answers of the agricultural sector due to changes in price trends, what is related to the rate of technological development and adoption of higher yield practices. If there is no yield-to-price elasticity, as suggested by Berry and Schlenker, it would be necessary to include the technological time trend in the GTAP model, correcting the final output about land use changes to consider how much this technological trend would have increased the yields in the time horizon being considered in the GTAP runs.

Other papers have tried to estimate the trend of technology growth in agricultural production. For example, Reilly and Fuglie (1998)[10] have estimated that there is an increase of around 1% per year in yields, and for some crops and periods this increase could reach 3%. If we consider the data and trends plotted in Figure 1 of Berry and Schlenker study, we would get trends between 1.3% to 1.45%, higher than the 1% agriculture average long term yield growth reported by Reilly and Fuglie (1998). If Berry and Schlenker had assumed only 1% as the exogenous technological trend in yields, and allowed the residual fraction of that trend to capture changes in prices, how would their estimates change? In other words, the estimate of the yield-to-price elasticity will be highly influenced by the assumption about the size of the exogenous trend in crop yields, what may be also thought and investigated in a slightly different way, if we think about what is the time horizon related to the estimation of the elasticity. So, to estimate the price-to-yield elasticity it is necessary to design the econometric model to represent the appropriate time horizon represented in the model for such parameter. It would also be useful to investigate how much of the long run trend of increasing yields is due to changes in food consumption, and to changes in long run trends in changing prices.

Roberts and Schlenker (2010) showed how yield shocks that are due to random weather shocks can also be used to identify supply so past weather shocks can serve as an instrument variable for future prices. However, authors did not test this instrumental variable for individual

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[10] Reilly, J., and K. Fuglie. Future Yield Growth in Field Crops: What Evidence Exists? Soil and Tillage Research, 47: 275-290. (1998)

countries, only for the world, leaving an important uncertainty about the use of this variable in Barry and Schlenker (2011) analysis, especially because price is the key variable for price-yield elasticity estimation.

In addition, according to Barry and Schlenker (2011), and assuming that the instrumental variable can be used for this analysis without any cause-effect loss, it is important to mention that the results for Brazil were completely different from the ones for the U.S. and other countries individually, and also from the results for the world. The interpretation of the results is also misunderstood. First, because Brazil is improving more in yields than in area, and second because new production areas does not necessarily have different yields from the average. Crops, especially soybeans, are expanding over pasture and savannah (Cerrado biome). The conclusion about the Amazon on page 12 is not true, since only 0.25% of total deforestation in 2009-10 was identified with soybean use (see Rudorff et. al., 2011)[11].

E – ABOUT THE CONSTANT ELASTICITY TRANSFORMATION (CET) LAND USE STRUCTURE

The CET land use function in GTAP determines the possibility of land use transformation among cropland, pastureland and forestland, all at the same time under a single elasticity parameter. Given the benchmark share of returns to land of different types, the elasticity dictates the own and cross price elasticities of each land cover type. Babcock and Carriquiry (2010)[12] calculated such cross price elasticities in the GTAP model and found that they are too high in the case of forestland, when compared with the estimates from Lubowski (2002)[13] and Lubowski, Plantinga, and Stavins (2006)[14]. The range of CET elasticities in GTAP was estimated by Ahmed et al. (2008)[15] based on transition probabilities matrix from Lubowski (2002) and Lubowski, Plantinga, and Stavins (2006). The GTAP version used by CARB uses the value of -0.2, which is too high in the case of forestland, since it should be lower than the module of -0.05 based on Ahmed et al. (2008) estimates based on Lubowski et al. (2006). It means that the CET elasticity currently used will generate too much conversion from forestland to cropland in response to biofuels induced crop price increases.

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[11] Rudorff, B.F.T.; Adami, M.; Aguiar, D.A.; Moreira, M.A.; Mello, M.P.; Fabiani, L.; Amaral, D. F.; Pires, B.M. The Soy Moratorium in the Amazon Biome Monitored by Remote Sensing Images. Remote Sensing, v.3, p. 185-202, 2011.

[12] Babcock, B. A. and M. Carriquiry. 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.

[13] Lubowski, R., 2002. Determinants of Land Use Transitions in the United States: Econometrics Analysis of Changes among the Major Land-Use Categories. PhD Dissertation, Harvard University: Cambridge, MA.

[14] Lubowski, R. N., A. J. Plantinga, and R. N. Stavins, 2006. Land-use change and carbon sinks: Econometric estimation of the carbon sequestration supply function. Journal of Environmental Economics and Management 51(2): 135-152. doi:10.1016/j.jeem.2005.08.001.

[15] Ahmed, S. A., T. Hertel, and R. Lubowski, 2008. Calibration of a Land Cover Supply Function Using Transition Probabilities. GTAP Research Memorandum. http://www.gtap.agecon.purdue.edu/resources/res_display.asp?RecordID=2947

This problem could be solved by increasing the flexibility in the CET function, as done by Al-Riffai et al. (2010)[16], 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, and the lower level considers the substitution between pasture and cropland, which elasticities varies from 0.02 to 0.25. It would allow a better calibration of CET elasticities to those own and cross land price elasticities estimates in the literature. It came to our attention that this approach was already suggested by the ARB LCFS Expert Workgroup, and should not be hard to accomplish by the GTAP group.

F – COMPARISON OF MODEL RESULTS AND BRAZILIAN REALITY

F.1- WINTER CROPS AND MULTI-CROPPING

According to table 5 (p. 14) of Tyner et al. (2011), sugarcane expansion leads to a decrease in the area of wheat (-100,679 ha), coarse grains (-163,669 ha) and other agricultural crops. This reduction is reflected by a decrease in national production and exports of those crops. We argue that this approach is not appropriate for Brazilian conditions (or should be at least attenuated) due to the following reasons:

1) Sugarcane expansion should not result in reduction of corn production/exports. In the last decade, second crop of corn have been expanding rapidly, generally using the same area used for soybeans production (during the winter period). Second crop of corn tends to be a very profitable activity, since it does not require additional area and because it benefits from the tillage of soybeans. Since its growing period is reduced, risk (due to whether) is the major impediment for the second crop expansion. Naturally, higher returns tend to compensate risk aversion. Table 1 shows that the decrease of the first crop area is more than compensated by the second crop[17].

Table 1: Corn 1st and 2nd crop area and production (1,000 ha and ton)

	Crop season	**2000/01**	**2010/11**
Area	1st crop	**10,546**	**7,916**
	2nd crop	**2,426**	**5,922**
	Total	**12,972**	**13,838**
Production	1st crop	**35,833**	**35,926**
	2nd crop	**6,457**	**21,588**
	Total	**42,290**	**57,514**

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[16] Al-Riffai, P., B. Dimaranan, and D. Laborde, 2010. Global trade and environmental impact of the EU biofuel mandate. Final Report, ATLASS Consortium, March 2010. http://ec.europa.eu/energy/renewables/studies/doc/land_use_change/iluc_completed_report.pdf

[17] A full time series of 1st and 2nd crop of corn area and production can be found at http://www.conab.gov.br/conteudos.php?a=1252&t=&Pagina_objcmsconteudos=2#A_objcmsconteudos

Source: Brazilian Ministry of Agriculture

2) Sugarcane expansion should not result in the reduction of winter crops areas, such as wheat. Due to differences between sugarcane and winter crops' land and climate restrictions, they are not produced on the same regions in Brazil. The only possible interaction from sugarcane and winter crops would be though and indirect effect though other crops, such as soybeans. However those other crops are "summer" or "first crop", having different planting and harvesting calendar, so they do not compete with winter crops. Apart from wheat, winter crops includes barley, oatmeal, rye and triticale.

F.2- SOYBEAN AND PADDY RICE AREA REDUCTION

Tyner et al. also found a decrease in soybean and paddy rice area due to the expansion of sugarcane (table 5 of Tyner at al 2011). That result implies that there are other countries that are more competitive than Brazil in those crops, increasing production in substitution of Brazilian production. Both results are questionable.

Why would Brazilian soybean production decrease due to competition with sugarcane if Brazil is a country with high level of technology in soybean production and has more land available for cropping than any other country in the word? Even we assume that there are countries more competitive than Brazil in soy production (lower costs) at the margin, we can expect that Brazil would respond faster than other soybean suppliers. If we look at soybean harvested area in the past 10 years in Brazil, Argentina and U.S. (the three largest soybean producers), we will notice that the area is increasing at a rate of 4.5% a year in Brazil, 5% a year in Argentina and 1.5% a year in U.S. Soybean area's decrease in Brazil, due to sugarcane expansion, should be compensated predominately within Brazil and not outside the country, as found by Tyner et al. Soybean's results indicate that there should be a revision of the Armington elasticities used by GTAP.

Rice production in Brazil is divided in two technologies: irrigated rice and non-irrigated rice. Irrigated rice responds to 60% of total production and has twice the yields of non-irrigated. Irrigated rice is produced in the south part of the country (Pampas biome), in a region that is fully dedicated to rice and rotation with pastures. Land used for irrigated rice has no alternative use because investments in water canals and soil systematization are rice-dedicated.

Non-irrigated rice is produced as a rotation crop for soybean-cotton and is used in recently cleared land before cropping soybean-cotton-corn until soil fertility is improved. It is clear that non-irrigated rice competes by land with soybean-cotton-corn and, assuming that sugarcane displaces them, we can expect an indirect displacement of rice. However, although non-irrigated rice has been historically displaced by other grains, due to the high yields and competitiveness of irrigated rice, production faces a net growth. The conclusion is the same as for soybean; paddy rice area should not be decreasing in Brazil as a result of sugarcane expansion.

F.3 - PASTURE INTENSIFICATION

The GTAP results are estimating a pasture extensification, whereas reality shows pasture intensification in Brazil. Table 2 below shows the change in pasture and cropland pasture estimates from GTAP simulations for the central scenario for sugarcane. As we can see, change in pasture area is around 0.11%. If we include cropland pasture also as pasture, total area change is about 0.44%.

TABLE 2. CHANGES IN PASTURE AND CROPLAND PASTURE AREA (HA)

Land use	Before	After	change (%)
Pasture	175.536.054	175.343.010	-0,11%
Cropland-Pasture	23.573.406	22.885.697	-2,92%
pasture + Cropland-Pasture	199.109.460	198.228.707	-0,44%

Source: GTAP results from Tyner et al. 2011 (sugarcane scenario)

On the other hand, GTAP results show a much higher reduction in livestock and beef production (1.34 and 1.48%, respectively). In other words, beef production and livestock are decreasing from 3.5 to 13.5 times more than pasture area. Observed data in Brazil shows a completely opposite trend during the last decade. As we can see in the following table cattle pasture area reduced in the 1995-2006 period, whereas all production index have a positive variation, being especially significant in the beef production. Different from the GTAP results, production is expanding while area is decreasing.

TABLE 3. OBSERVED TRENDS IN LIVESTOCK SECTOR IN BRAZIL:

Variable	Unit	1995	2006	change (%)
Pasture area (Ag-census)	ha	177.700.472	158.753.865	-10,66%
Cattle herd (Ag-census)	heads	153.058.275	171.613.337	12,12%
Cattle herd (PPM)	heads	158.288.540	205.886.244	30,07%
Beef production CNPC	mil ton	5.251	9.053	72,39%

Source: ICONE, using data from the National Bureau of Statistics (IBGE) and CNPC.[18]

Further, we argue that Tyner et al. assumption of pasture extensification due to area expansion is incorrect for Brazil. Table 4 below presents official pasture data by state from the national bureau of statistics (IBGE). This table shows that 2006 stocking rates are higher than the ones in 1996 in 24 of the 27 Brazilian states. It can also be observed that even in the states where pastureland has increased (in general the states located in the Amazon biome where the expansion was possible due to deforestation), stocking rate has increased as well. States data allow us to affirm that even at the margin pasture productivity always increase, making Tyner et al. assumption incorrect.

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[18] IBGE data is available at http://www.sidra.ibge.gov.br/; CNPC data is available at http://www.cnpc.org.br/.

TABLE 4. PASTURE DATA, CATTLE HERD AND STOCKING RATES

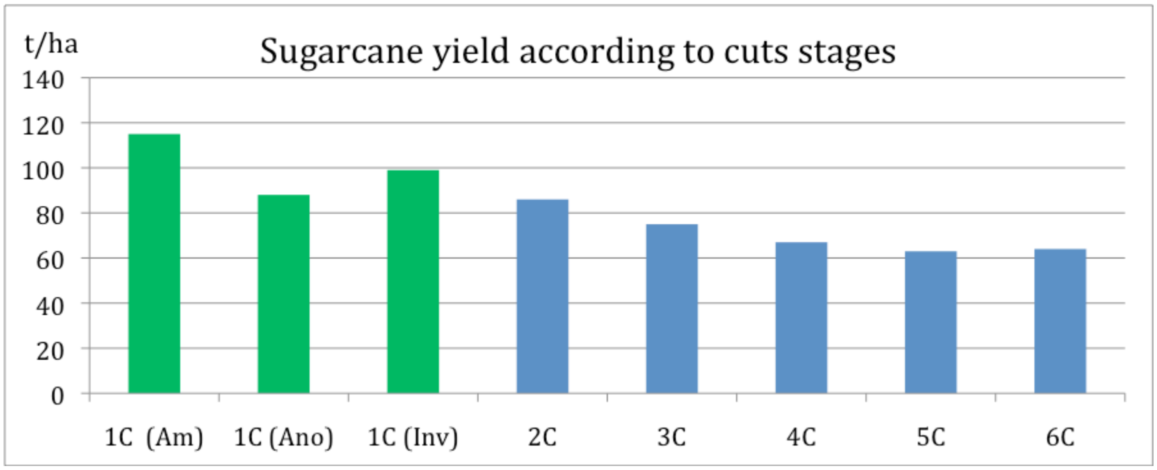
	Pasture 1996 (ha)		Cattle herd (heads)		Stocking rate (heads per ha)	
Year/state	1996	2006	1996	2006	1996	2006
AC	614.214	1.038.725	853.264	2.452.915	1,39	2,36
AL	862.434	871.661	839.482	1.029.352	0,97	1,18
AM	244.978	806.299	733.910	1.243.358	3,00	1,54
AP	528.913	267.063	63.648	109.081	0,12	0,41
BA	14.489.768	12.834.301	9.838.136	10.764.857	0,68	0,84
CE	2.632.120	2.611.528	2.400.457	2.352.589	0,91	0,90
DF	96.447	79.796	115.000	98.740	1,19	1,24
ES	1.821.069	1.340.070	1.816.047	2.119.309	1,00	1,58
GO	19.404.696	15.709.871	16.954.667	20.646.560	0,87	1,31
MA	5.310.553	5.728.628	3.935.754	6.613.270	0,74	1,15
MG	25.348.603	18.039.776	20.148.086	22.203.154	0,79	1,23
MS	21.810.707	20.943.813	20.755.727	23.726.290	0,95	1,13
MT	21.452.061	21.784.734	15.573.094	26.064.332	0,73	1,20
PA	7.455.728	10.825.117	6.751.480	17.501.678	0,91	1,62
PB	1.851.935	1.680.747	1.304.730	1.092.792	0,70	0,65
PE	2.131.003	1.975.367	1.953.629	2.095.184	0,92	1,06
PI	2.398.446	2.690.560	1.729.595	1.838.378	0,72	0,68
PR	6.677.313	4.702.546	9.879.889	9.764.545	1,48	2,08
RJ	1.545.123	1.282.310	1.842.977	2.095.666	1,19	1,63
RN	1.246.218	1.203.399	934.740	1.027.289	0,75	0,85
RO	2.922.068	4.809.887	3.937.291	11.484.162	1,35	2,39
RR	1.542.566	719.653	400.334	508.600	0,26	0,71
RS	11.680.328	9.206.664	13.443.106	13.974.827	1,15	1,52
SC	2.338.909	1.701.519	3.097.657	3.460.835	1,32	2,03
SE	1.153.863	943.413	945.680	1.067.508	0,82	1,13
SP	9.062.254	6.898.987	12.797.505	12.790.383	1,41	1,85
TO	11.078.155	8.057.429	5.242.655	7.760.590	0,47	0,96
BRAZIL	177.700.472	158.753.865	158.288.540	205.886.244	0,89	1,30

Table 4 shows that almost all regions that had expansion in area also experienced improvements in stocking rate indexes. Using one other metric, the data presented in the table above shows that 89% of the area expansion also experienced productivity gains.

It is evident that yield gains in livestock production are significant and should not be omitted, or underestimated. Further, yield extensification from pasture expansion, as suggested by Tyner´s report, is not applicable in Brazil. We would like to suggest therefore the incorporation of relevant yield-price elasticity for the livestock sector; otherwise LUC modeling will always fail to reflect reality.

F.4 - SHORT TERM SUGARCANE YIELD RESPONSE TO PRICE

It seems to us that ARB is not inclined to accept significant yield response to price. However, for sugarcane specifically, ARB should pay close attention to response of yield-to-price changes. As a semi-perennial crop, sugarcane in Brazil is produced in a rotation system, having up to seven harvesting seasons before it is replanted. The figure below shows sugarcane average yield according to the number of cuts in the south-central region of Brazil.



Source: CTC/UNICA.

The three green bars represent the yield on the first harvest (according to different types of sugarcane rotation systems). The blue bars represent the yield from the second to the sixth cut. It is evident that yield reduces according to the cut stage. When the sugarcane producer decides to renew his sugarcane field, the yield jumps from an average of 65 t/ha to more than 100 t/ha on the same land. However, the agricultural cost of renewing the sugarcane fields is high, and producers tend to renew only the necessary to optimize his sugarcane yields. When the price of sugarcane products is low, producers renew below the ideal levels.

The relationship between new ratoons and ethanol price is presented in the graph below. The green bars represents the share of new ratoons in total sugarcane area and the blue line represents the hydrous ethanol price at constant prices (base in 2000). The relationship between those two variables is quite evident. When ethanol prices are low, producers tend to renew their sugarcane fields less than the necessary, leading to lower yields.

SHARE OF NEW RATOONS OVER TOTAL AREA AND ETHANOL PRICES

Source: ICONE, base on INPE and ESALQ-CEPEA[19].

Based on the comments above, UNICA would like to suggest that price-yield elasticities for sugarcane be kept at 0.25.

III - AGRO-ECOLOGICAL ZONE EMISSION FACTOR MODEL BY RICHARD PLEVIN, HOLLY GIBBS, JAMES DUFFY, SAHOKO YUI, SONIA YEH

The following comments focus on soil carbon emissions factors and AGB accumulation in cropland used by Plevin et al.(2011)[20] to calculate total land use emissions. Considering that Tyner et al. (2011) performed a shock into GTAP for Brazilian sugarcane ethanol both for carbon stocks and AGB accumulation, coefficients used to calculate emissions from the conversion of pasture to cropland in Brazil, as a result of the increasing demand for ethanol, should be specific for sugarcane rather than for a generic cropland.

We provide several arguments below that support the use of specific sugarcane data on SOC stocks and AGB accumulation to evaluate land use emissions that takes place within Brazil. With respect to land use change outside Brazil, considering that it is a function of the replacement of crops displaced by sugarcane in Brazil in other countries, UNICA would agree with the use of generic cropland factors.

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[19] Data on sugarcane area can be found at http://www.dsr.inpe.br/laf/canasat/; time series hydrous prices can be found at http://www.cepea.esalq.usp.br/.

[20] Plevin, Richard J.; Gibbs, Holly K.; Duffy, James; Yeh, Sonia. Agro-ecological Zone Emission Factor Model. University of California, Berkeley, University of Winsconsin- Madison, California Air Resources Board.

A – SOIL CARBON EMISSIONS FROM THE CONVERSION OF PASTURE TO CROPLAND

In order to calculate soil stock change factors from the conversion of pasture to cropland Plevin et al. (2011) relies on IPCC guidelines. Following Harris et al. (2011), the authors assumed "long term cultivated" cropland to apply land use factors and management and input coefficients equal to 1. They assumed half of the factor for the case of cropland-pasture conversion to cropland.

With respect to land use factor, differently from Harris et al. that considered sugarcane a perennial crop, Plevin et al. considered it an annual crop, resulting in carbon loss when pasture or cropland-pasture are converted to sugarcane. Although there are no available empirical studies measuring SOC changes in the transition of pasture to sugarcane, several studies show that sugarcane SOC stocks are similar to pastures (Lisboa et al. 2011[21]; Galdos et al. 2010[22]; Amaral et al. 2009[23]). The correct representation for the case of sugarcane in Brazil would be, therefore, the use of a factor 1 for land use change rather than the factors associated to annual cropland.

With respect to management factor, in the case of Brazil, it is necessary to consider two factors: increasing harvesting with crude sugarcane (no burning) (Novaes et al. 2011[24]; Cerri et al. 2010[25]) and the widespread use of no till systems in grain production (Bolliger et al. 2006[26]; Bernoux et al. 2006[27]; Boddey et al. 2010[28]).

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[21] LISBOA, CAROLINA CARDOSO, BUTTERBACH-BAHL, KLAUS , MAUDER, MATTHIAS AND KIESE, RALF. Bioethanol production from sugarcane and emissions of greenhouse gases – known and unknowns Department of Bio-Geo-Chemical Processes, Institute for Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU), Karlsruhe Institute of Technology (KIT), Kreuzeckbahnstrasse 19, 82467 Garmisch-Partenkirchen, Germany

[22] GALDOS, MARCELO VALADARES; CERRI, CARLOS CLEMENTE; LAL, RATTAN; BERNOUX, MARTIAL; FEIGL, BRIGITTE; AND CERRI, CARLOS EDUARDO P. Net greenhouse gas fluxes in Brazilian ethanol production Systems. Centro de Energia Nuclear na Agricultura, Universidade de São Paulo. GCB Bioenergy (2010) 2, 37–44, doi: 10.1111/j.1757-1707.2010.01037

[23] AMARAL, W. A. N.; MARINHO, J.P.; TARASANTCHI, R.; BEBER, A.; GUILIANI, E. (2008). Environmental sustainability of sugarcane ethanol in Brazil. In: Zuurbier and Vooren (coord.), Sugarcane ethanol: contributions to climate change mitigation and the environment. Wageningen: Wageningen Academic Publishers.

[24] NOVAES, MAIKON R. DE; RUDORFF, BERNARDO F. T.; ALMEIDA, CLÁUDIA M. DE; AGUIAR, DANIEL A. DE. Analise Espacial da Reducao da Queima na Colheita da Cana-de-Acucar. Eng. Agríc., Jaboticabal, v.31, n.3, p.572-583, maio/jun. 2011

[25] Cerri,C. C.; Galdos,M. V.; Maia, S. M. F.; Bernoux,M.; Feigla, B. J.; Powlson, D. & Cerri, C. E. P. Effect of sugarcane harvesting systems on soil carbon stocks in Brazil: an examination of existing data**.** *European Journal of Soil Science*, February 2011, **62**, 23–28

[26] Bolliger,Adrian; Magid, Jakob; Amado, Telmo Jorge Carneiro; Neto, Francisco Skora , Ribeiro, Maria de Fatima dos Santos; Calegari, Ademir; Ralisch, Ricardo; and Neergaard, Andreas de. TAKING STOCK OF THE BRAZILIAN ''ZERO-TILL REVOLUTION'': A REVIEW OF LANDMARK RESEARCH AND FARMERS' PRACTICE. Advances in Agronomy, Volume 91 Copyright 2006, Elsevier Inc.

[27] BERNOUX,Martial; CERRI, Carlos C.; CERRI, Carlos Eduardo P.; SIQUEIRA NETO, Marcos; METAY, Aurélie; PERRIN, Anne-Sophie;SCOPEL, Eric; RAZAFIMBELO, Tantely; BLAVET, Didier; PICCOLO, Marisa de C.; PAVEI, Mariana; MILNE, Eleanor. Cropping systems, carbon sequestration and erosion in Brazil, a review. Agron. Sustain. Dev. 26 (2006) 1–8

In the state of Sao Paulo, which represents 60% of sugarcane area in South-Central region of Brazil, 56% of total sugarcane area is crude harvest according to the State Government[29]. Cerri et al (2010) have estimated a management factor of 1.24 in areas with sugarcane waste retention (mechanized harvest) compared with SOC stocks in areas with harvest burning.

According to the Brazilian No-Till Federation (FEBRAPDP), 25.5 million ha are cultivated in Brazil with no-till practices, which represents about 50% of total grain harvested area. IPCC guidelines indicate a factor of 1.22 for no-till management in tropical wet regimes.

Those figures show that, at least for the case of Brazil, the management factor should be higher than 1. The same conclusion applies also for input factors. Brazilian sugarcane production is at the top in terms of yields worldwide which indicates that a higher than 1 factor should be used (1.11 for high inputs and tropical and wet regimes).

B – CROPLAND ABOVE GROUND BIOMASS AFTER CONVERSION

The estimation of above ground biomass on cropland after conversion of pasture and cropland-pasture is based on net primary production (NPP) of generic C4 crops from TEM model (Tyner et al. 2010). Although Tyner et al. (2010) emphasize that the model has been extensively used to evaluate C dynamics around the globe, they also say that most of parameters in TEM are assigned values derived from literature.

NPP is a measure for biomass content in dry matter. Cropland NPP used in TEM model for Brazil varies from 1.3 to 4.6 Mg C ha^{-1} y^{-1}. Several studies, however, indicates that sugarcane C content in dry matter is much higher than TEM data. Urquiaga et el. (2011)[30] estimated a total dry matter accumulation in Brazilian sugarcane varying from 34.3 to 49.4 Mg ha^{-1} (average of the five cuts). Assuming a mean value of 40.6 Mg ha^{-1} and 50% C content on dry matter, sugarcane accumulates around 20 Mg C ha^{-1} y^{-1}. On average, considering that sugarcane grows linearly, the crop accumulates half of that in the full cycle, 10 Mg C ha^{-1} y^{-1}. Very similar results were also obtained by Robertson et al. (1996) for sugarcane fields in Australia. Those studies show that TEM NPP data should be corrected to reflect more accurately biomass accumulation of sugarcane, which is much higher than the generic C4 crop used in the model.

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[28] BODDEY, ROBERT M.; JANTALIA, CLAUDIA P.; CONCEICAO, PAULO C.; ZANATTA, JOSILEIA A.; BAYER, CIMELIO; MIELNICZUK, JOAO; DIECKOW, JEFERSON; SANTOS, HENRIQUE P. DOS ; DENARDIN, JOSE´ E. AITA, CELSO; GIACOMINI, SANDRO J.; ALVES, BRUNO J.R. and URQUIAGA, SEGUNDO. Carbon accumulation at depth in Ferralsols under zero-tillsubtropical agriculture. Global Change Biology (2010) 16, 784–795, doi: 10.1111/j.1365-2486.2009.02020.x

[29] Projeto Etanol Verde, http://www.ambiente.sp.gov.br/projetos18.php.

[30] Urquiaga, S; Xavier, R. P.; Morais, R. F.; Batista, R. B.; Schultz, N.; Leite, J. M.; Resende, A. S.; Alves, B. J. R.; Boddey, R. M. Evidence from field nitrogen balance and 15N natural abundance data of the contribution of biological N2 fixation to Brazilian sugarcane varieties. Plant and Soil (in press).

IV – Conclusions

We commend CARB for reviewing the GTAP model in an effort to improve its LCFS program in California. We understand this is a great undertaking given the constraint of time and the complexity of the project itself. UNICA reiterates its position that any update to the model needs to take into consideration accurate and realistic data that reflects the current experience and anticipated trends in Brazil.

I hope these comments will contribute to improving the development of the LCFS in California and I remain at your disposal to answer any questions you or your colleagues may have.

Sincerely,

Leticia Phillips

Leticia Phillips
Representative – North America