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Mary Nichols, Chair
California Air Resources Board
1001 I St., P.O. Box 2815
Sacramento, CA 95812

RE: Indirect land use in the proposed California Low Carbon Fuel Standard

Dear Ms. Nichols,

Monsanto recommends that the indirect land use change component as described in the "Proposed Regulation to Implement the Low Carbon Fuel Standard" produced by the California Air Resources Board (CARB) be delayed until a scientifically accepted method to estimate indirect land use change is developed. As a large number of other scientists have pointed out (Simmons et al., 2009), methods to estimate indirect land use change are still at a very early development stage. The models are very dependent on assumptions used, poorly reflect the world today and do not adequately address the complex issues underlying land use change. Given the considerable difference of scientific opinion, inclusion of the indirect land use change based on current methods would penalize both first and second generation biofuels based on one set of opinions rather than a sound science-based measure.

As you continue to improve methods to estimate indirect land use change, we request that you consider the three modifications suggested below. Our comments are based on the documents produced by CARB and also a more detailed description of the methods used by Tyner et al published in January of this year. References are provided at the end of the document.

We have three main suggestions, outlined in more detail on the following pages:

1) **Yields should be treated as a time-dependent variable**, similar to the way emissions due to indirect land use change are treated.

2) **Yields on "new" crop land are significantly underestimated** and the elasticity of crop yields with respect to area expansion should be raised to at least 0.75.

3) **Value selection for time-dependent variables is inconsistent** and should be corrected to reflect the intent of the regulation to reduce carbon intensity of transportation fuels by 10 percent relative to 2010.

Sincerely,

Mike Edgerton
Biofuels Technology Lead

1) Yield should be treated as a time-dependant variable. Crop yields have increased in the US and the rest of the world for many decades at different, but predictable rates. However, CARB is treating yield as a fixed value, selecting yield averages from specific time ranges. In contrast, CARB has taken another time-dependant value, emissions from land use change and used a time accounting method. The rationale provided by CARB for using a time accounting method is that "Indirect land use change emissions vary over time. Goal is to determine a single, non-varying, value for the carbon intensity of a biofuel."

Crop yields should be treated similarly to indirect land use change (iLUC) emissions as both values "vary over time". In the case of crop yields, it may be more appropriate to use an NPV method rather than the simple annualization proposed for iLUC emissions as future yields are less certain than present yields. Similar time frames should also be considered for the iLUC and yield values as both values are changing over the amortization period.

2) Yields on "new" crop land are too low. The draft standard assumes that "almost all of the land that is well-suited to crop production has already been converted to agricultural uses, yields on newly converted lands are almost always lower than corresponding yields on existing crop lands." This is represented in the model by the "elasticity of crop yields with respect to area expansion" being set at 0.5, suggesting that yields on "new" crop land are 50% of yields on existing crop land.

In explaining the rationale for the choice of this value CARB states that "little empirical evidence exists to guide the modelers in selecting the most appropriate value. Based the best available professional judgment of those with experience in this area, the modelers selected a value of 0.50 for their central case."

While empirical evidence is in short supply, there is some data that can be used to guide an estimate for elasticity of crop yields with respect to area of expansion. Tyner et al (2009) suggest that land use change is likely to be centered in three major areas: Temperate developed countries (US, Canada and EU27 34%), Sub-Saharan Africa (20%) and South America (13%). In the European Union, crop yields on land taken out of production as part of their mandatory set-aside program has been reported to yield ~ 75% of near by "average" crop land (Vannini et al., 2008). In Brazil, State average soybean yields are highest in Mato Grosso, the State which has seen the largest increase in soybean area. This is outlined in more detail in the appendix, but on whole the available evidence would suggest that 0.75 is a better starting choice for the elasticity of crop yields with respect to area of expansion.

3) Value selection for time-dependent variables is inconsistent. The model for land use change proposed by CARB contains several important variables that change over time. However, the GTAP model requires single values for many of these. Selection of some of the single values appears to be inconsistent with the intent of the Low Carbon Fuel Standard and also somewhat arbitrary.

According to the CARB staff report "Proposed Regulation to Implement the Low Carbon Fuel Standard Volume I", the California Low Carbon Fuel Standard requires incremental reduction in the carbon intensity of fuels such that "The allowable carbon intensity of transportation fuels decreases each year, starting in 2011, until the carbon intensities of gasoline and diesel transportation fuels in 2020 are each reduced by 10 percent relative to 2010." This suggests that 2010 should be selected as the baseline year.

A closer look at the land use change model used by CARB shows that a number of different years are being used for baseline values.

Gasoline – Gasoline is assumed to contain 10% ethanol by 2010. This assumption requires there to be large volumes of ethanol to be produced at the start of the timeframe covered by the LCFS. This is consistent with the DOE-EIA's estimate of 2008 US ethanol production of 9.2 billion gallons.

Ethanol production – Ethanol production is assumed to be at 1.5 billion gal/yr at the beginning of the period modeled. This appears to be due to the selection of 2001 as the baseline year in the Global Economic Model. However, this is inconsistent with the assumption that 2010 gasoline will have 10% ethanol and the observation that 9.2 billion gallons of ethanol were produced in 2008. Rather than using 2001 ethanol production levels as the baseline, ethanol production at the start of the LCFS should be used as the starting assumption. Using 2001 as the baseline year appears to be back charging prior production increases to ethanol produced in 2010 and beyond.

Global Economic Model – 2001 was used as the base line year in the global economic model. This is stated as "The 2001 GTAP database builds on the most recent global harvested crop land and land cover data base representing the combined efforts of the United Nations Food and Agricultural Organization (UN-FAO), the International Food Policy Research Institute (IFPRI) and the University of Wisconsin Center for Sustainability and the Global Environment (SAGE)". This is a technical requirement for the model, but does not justify the selection of 2001 ethanol production levels as the baseline assumption. Rather 2010 ethanol production levels should be used if "the carbon intensities of gasoline and diesel transportation fuels in 2020 are each reduced by 10 percent relative to 2010."

Crop yields – At least for the corn and sugarcane models, yield averages from the 2006-2008 crop years were substituted for the 2001 crop yields as there as been significant increases in US corn and Brazilian sugarcane yields between 2001 and 2008. There are two main issues here. First, all crop yields should be treated the same. Yields of other crops have also increased in this time period and it's not clear that higher sugarcane yields are included in the corn model and vice versa. Second, yield is a time-dependent variable with the values increasing in a predictable manner over time. Rather than selecting crop yields at a specific year some form of time averaging should be used to pick a representative yield over the time in question. Using 2006-2008 yield averages is likely to underestimate crop yields in the 2010 to 2020 period covered by the LCFS.

Appendix 1 – Crop yields on "new" farmland

Temperate developed countries. The European Union has operated a mandatory "set-aside" program which requires farmers to keep 10% of their land out of food production. Farmers are allowed to choose which land to keep out of production, resulting in less productive land selectively being removed from production. A European Commission funded study on the set-aside found that yields on fields farmers included in the set-aside varied from 50-95% of farm average yields, with an average yield on the set-aside land of 70-75% when compared to farm average yields. This represents the yield potential of the bottom 10% of agricultural land in the countries affected by the set-aside program. Tyner et al suggest that land use change for the EU, US and Canada will require a 1-2% increase in crop area for these countries. If the yields reported on the set-aside area are representative on yield on the bottom 10% of land in highly developed agricultural countries, this would justify using an elasticity of crop yield with respect to area of expansion of at least 0.7-0.75 for these regions.

Key reference: http://ec.europa.eu/agriculture/eval/reports/setaside/fulltext_en.pdf

South America. Unlike the US and European Union, there is still considerable land that is "well-suited to crop production" that has not yet been brought into production in South America, particularly in Brazil. Soybean yields in Brazil and Argentina at least match those seen in the United States (USDA 2008). At the same time soybean production area has doubled over the past decade. If this new land were as unproductive as CARB's 50% productivity number suggests, yield parity with the US would be impossible. Rather, the high yields observed in these countries would justify setting the elasticity of crop yield with respect to area of expansion at 1.0.

In addition to high soy yields, double cropping is common in the Central region of Brazil, with some 12 million acres typically planted in corn following the harvest of the soy crop. Yields on the second crop (called safrinha crop) are lower than full season crops, but represent an important source of grain that may not be captured in the CARB

model. With soy yields equal to the US and the addition of a second corn crop, a newly converted acre in Brazil will be higher in overall productivity than an acre of soy in the US.

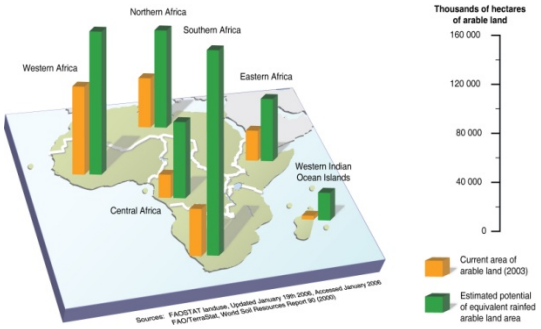
Key references: http://www.pecad.fas.usda.gov/highlights/2008/04/Brazil/
http://www.conab.gov.br/conabweb/download/safra/boletim_ingles_completo.pdf

Sub-Saharan Africa. Sub-Saharan Africa is a very large geographically diverse area that has been aggregated in the report by Tyner et al (2009). The FAO (2001) has described the region as containing 15 major farming systems ranging from cereal-root systems to the more industrialized farming in South Africa. Along with farming practices, yields vary considerably by region from the relatively high yields of South Africa to the low yields of Tanzania and Zimbabwe. Land conversion is also likely to vary considerably by region, with high productive new land being brought into production in some areas, but fallow periods being reduced or already destructive farming practices increasing in other regions. This suggests that a higher resolution estimation of land use change in Africa is needed to estimate an elasticity of crop yield with respect to area of expansion.

While the specifics of land use change are likely to vary by region, it is clear that there is a great deal of potentially arable land in Africa (Figure 1. FAO, 2001, 2003), suggesting that CARB's assumption that "almost all of the land that is well-suited to crop production has already been converted to agricultural uses" is incorrect for the region as a whole. This and the lack of reported resolution in regional land use change estimates appear to make the current choice of 0.5 an elasticity of crop yield with respect to area of expansion for the region unsupportable.

Key reference: ftp://ftp.fao.org/docrep/fao/003/y1860e/y1860e00.pdf

Figure 1. Arable and Land Use in Africa



Hugo Ahlenius, UNEP/GRID-Arendal

References

Objection to "Selective Enforcement of Indirect Effects in CA LCFS" Simmons et al (2009)
http://www.arb.ca.gov/lists/lcfs-general-ws/28-phd_lcfs_mar09.pdf

Land Use Change Model

Land Use Change Carbon Emissions due to US Ethanol Production (2009) Tyner WE, Taheripour F, Baldos U. Revision 3_Draft, January 2009
http://www.agecon.purdue.edu/papers/biofuels/Argonne-GTAP_Revision%204a.pdf

Proposed Regulation to Implement the Low Carbon Fuel Standard (2009) CARB
http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol1.pdf
http://www.arb.ca.gov/fuels/lcfs/030409lcfs_isor_vol2.pdf

Developed Countries

Vannini L et al., (2008) Evaluation of the set aside measure 2000 to 2006. TENDER N° AGRI / 2006–G4–16 (see table 14.1 for yield survey results) http://ec.europa.eu/agriculture/eval/reports/setaside/fulltext_en.pdf

South America

2008 Crop Trip Report (2008) USDA FAS
http://www.pecad.fas.usda.gov/highlights/2008/04/Brazil/

Brasilian Crop Assessment: Grains (2009) National Supply Company. – Brasília (CONAB)
http://www.conab.gov.br/conabweb/download/safra/boletim_ingles_completo.pdf

World Agricultural Production (2009) USDA FAS (see table 11 for bean yields)
http://www.fas.usda.gov/wap/circular/2009/09-02/productionfull02-09.pdf

Agricultural Intensification on Brazil's Amazonian Soybean Frontier (2008) Jepson W, Brown JC, Koeppe M. pg 73-92 In: Land Change Science in the Tropics Millington A and Jepson W, eds. Springer Press

Africa

Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World (2001) FAO and World Bank
ftp://ftp.fao.org/docrep/fao/003/y1860e/y1860e00.pdf

http://maps.grida.no/go/graphic/current_and_potential_arable_land_use_in_africa