Recommendations from Elasticity Subgroup

Short-Run Recommendations

1. Elasticity with respect to area expansion. CARB should adopt the version of GTAP that varies the value of this parameter by region as documented in Tyner et al (2010).

Rationale: The initial CARB GTAP runs varied the ratio of new land yield to current land yield from 0.5 to 0.75. For each run the particular value of this parameter was fixed across all regions and all crops. No data-based analysis existed that could support any particular setting of this parameter. Since those initial runs, however, some evidence about what this ratio might be has emerged and Tyner et al have developed a data-based method to allow this ratio to vary across regions. Babcock and Carriquiry (2010) found no support for the hypothesis that the yield of newly converted land is less than the yield of existing soybean land in Brazil. UNICA (2009) calculates the ratio between yields in new and old cropland in Brazil as between 0.9 and 1.5. And new analysis of U.S. data conducted as part of this expert workgroup found that counties that expanded cultivated land in response to higher crop prices beginning in 2007 had, on average across crops, about the same yield as existing cropland. This empirical evidence strongly suggests that setting this parameter value at the upper limit of the current range of values (0.75) would dramatically underestimate crop yields on new land. The Tyner et al method uses a bio-process-based biogeochemistry model (the Terrestrial Ecosystem Model - TEM), which is well-documented and has been used in peer-reviewed studies about the patterns of land carbon dynamics across the globe considering multiple factors such as CO_2 fertilization, climate change and variability, land-use change, and ozone pollution. The Tyner et al approach results in yields on new land brought into production that are much closer to yields on existing land. Hence, the Tyner et al method is much more consistent with the (limited) empirical data than what was used in the initial CARB GTAP runs.

2. Yield elasticity with respect to price. Keep the yield elasticity with respect to price at 0.25.

Rationale: There are no good estimates of how yields change with respect to price. Keeney and Hertel reviewed the existing literature, finding values between 0.22 and 0.76, and concluded that the literature supported using a value of 0.25. But the existing literature is dated and thin so this value has little reliability. However, there are sound theoretical reasons for believing that this elasticity is positive, particularly in the medium to long run. Farmers have an incentive to adopt higher-yielding seed technologies with higher prices. They have an incentive to control pest damage more thoroughly with higher prices. And they have an incentive to apply additional fertilizer under higher prices. In addition, higher prices give farmers a greater incentive to double crop. For example, Babcock and Carriquiry demonstrated that the share of U.S. soybean production grown on double cropped acres has closely tracked the price of soybeans (see figure 17 of their report). Because higher prices induce additional production from the same land, it is as if yields had increased. Babcock and Carriquiry conclude that the incentive to double crop soybeans with corn and cotton in Brazil justifies use of a yield elasticity of 0.24 by itself. The smaller share of U.S. double cropping supports a smaller yield elasticity from double cropping

alone. Thus, given a lack of a comprehensive database that can be used to justify how this elasticity should vary across crops and regions in the world, keeping this elasticity at a value of 0.25 seems reasonable. It should be noticed that it is in the conservative lower bound found by Keeney and Hertel.

3. **Combination and range of elasticities in model runs.** CARB should adopt the same range and combinations of elasticities when running any particular biofuel pathway.

Rationale: There is no scientific or empirical evidence to treat a particular biofuel pathway with a different set of elasticities.

Long Run Recommendation

Parameterization of GTAP's CET Function: Develop a better method to increase flexibility in the function that determines own and cross price substitution elasticities across land cover types.

Rationale: The CET function in GTAP has but one parameter. This parameter, together with the baseline share of returns to land of different types, determine the own and cross price elasticities of land cover type. Babcock and Carriquiry demonstrated that this method leads to cross price elasticities that are not consistent with common sense and empirical estimates. For example, the cross price elasticity of forest land in the United States with respect to crop returns is an important factor in GTAP determining how much forest land is converted to cropland in response to biofuels-induced crop price increases. The value for this parameter in GTAP is -0.174: 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 suggests that GTAP's estimate of how much U.S. forest land is converted to cropland in response to increased crop prices is too large.

Adding more flexibility to the CET function to allow better calibration of the own and crop price elasticities is a longer run recommendation because there does not seem an easy and straightforward method of accomplishing this task. A possible approach is to use the same as 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 forest land 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 allows a better calibration of CET elasticities to estimated own and cross price elasticities.

References:

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

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

Lubowski, Ruben (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.

Lubowski, Ruben, Andrew J. Plantinga, and Robert N. Stavins (2006) "Land-Use Changes and Carbon Sinks: Econometric Estimation of the Carbon Sequestration Supply Function", *Journal of Environmental Economics and Management*, 51(2006)

Tyner, W. E., F. Taheripour, Q. Zhuang, D. Birur, U. Baldos, 2010. Land use changes and consequent CO2 emissions due to US corn ethanol production: a comprehensive analysis. Department of Agricultural Economics, Purdue University, Final Report (Revised), July 2010.

UNICA, 2009. UNICA comments on California's proposed Low Carbon Fuel Standard (LCFS) Available at: http://www.globalbioenergy.org/bioenergyinfo/bioenergy-and-climatechange/detail/en/news/19713/icode/