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I reviewed the Memorandum ("Memo") written by Alex Farrell and Michael O'Hare to the California Air Resources Board dated January 12, 2008. The Memo details some interesting calculations of greenhouse gas emissions from land use changes prompted by increased biofuels production. I offer some observations and comments pertaining to the sensitivity of the presented calculations:

The general methodology applied in the spreadsheet is based on dividing a one time emissions release from land use change (LUC) of grassland, primary forest, or secondary forest (rows 56 to 71 on the spreadsheet's "Assumptions" sheet) to ETOH acreage by a) the ethanol productivity of the land and b) an assumed amortization time frame of 20, 30, and 100 years.

First, the assumed ethanol yield (taken from the "Supporting Online Material" of the cited Science paper by Righelato and Spracklen) is 8.4 Mg/ha or an equivalent of 133.8 bu/acre. This is a relatively low yield compared to the average yields of 151 bu/acre in 2007, 149 bu/acre in 2006 and certainly not reflective of the 2004 yield of 160 bu/acre (USDA, 2008).

Second, not only is this a fairly low yield, the one time LUC emissions are also spread over this yield assumption over the selected time periods (20,30, and 100 years) as if this low yield is a constant going forward. The following illustrates the sensitivity of this assumption: At the yield of 133.8 bu/acre (8.4 Mg/ha) the temperate grassland to corn ETOH conversion (spread over 30 years) yields a LUC adder of 68 gCO2e/MJ of ethanol produced in the supplied spreadsheet (cell "K22" on the "Direct Conversion Emissions" sheet, low estimate case). Since yields are often assumed to reach 300 bu/acre by 2030 (see Hudson, 2007, Monsanto Business Week article, 2007), it is reasonable to assume an average yield of 250 bu/acre (15.7 Mg/acre) over the next 30 years, in which case the 68 gCO2e/MJ drops down to 36 gCO2e/MJ.

Third, life cycle analyses using GREET and GREET's small LUC adder mentioned in the Memo (of 0.9 g/MJ) have shown that ethanol produced in a modern natural gas fired ethanol plant result in GHG emissions of approximately 55-65 gCO2e/MJ (with gasoline at about 95 gCO2e/MJ). This means adding an additional 68 gCO2e/MJ vs. 36 g/MJ for LUC makes a significant difference. Moreover, in life cycle analyses, a co-product credit is assigned to the DDGS produced from corn ethanol. Since ethanol is now assumed to come from converted temperate grassland, a higher DDGS co-product credit reflective of this LUC needs to be determined and taken into account (i.e. the one time LUC emissions are amortized over the productivity of the land which includes ethanol and DDGS produced form that land). The GREET model likewise derives co-product credit inclusive of (albeit small) land use change effects (see GREET V1.7, "ETOH" sheet, rows 140-143).

Fourth, the calculations are based on the assumption that any one acre of corn grown for transportation fuel prompts an acre of LUC somewhere. The Memo acknowledges that economic modeling "not yet available" could show a "less than a hectare-for-hectare" induced effect. The reader of the Memo should realize that the calculations in the spreadsheet reflect the conservative assumption of a one for one LUC induction. As mentioned in the Memo, GREET uses a 0.5 substitution effect of pasture land converted per acre of corn.

Finally, yield increases will likely reduce the acres needed for food production and therefore reduce LUC from food production. To the extend that these LUC reductions are offset by ethanol production one must keep in mind that yield increases going forward may likely be driven by GMO (genetically modified organisms) seeds. As pointed out clearly in the recent BusinessWeek article from 12/17/2007, companies like Monsanto (if not Monsanto itself) are leading the way. However, the article stresses the point that Monsanto focuses "exclusively on seeds for agribusiness, ones that produce such goods as animal feed, ethanol, and corn syrup" (page 037). In other words, without agribusiness (including and dominated by ethanol) there may be much less of an expected yield increase to be realized both by agribusiness and direct food production. The yield increases driven by agribusiness may reduce the acres needed for food production and therefore reduce LUC impacts from food production as well.

Hopefully, the above observations and comments are helpful and further a meaningful discussion regarding LUC from biofuels.

References:

"Monsanto: Winning the Ground War", BusinessWeek, December 17, 2007, pp. 035-041.

"2007 Corn Crop a Record Breaker, USDA Reports Cotton, Rice Yields Hit All-Time Highs", United States Department of Agriculture, News Release, January 11, 2008.

"Could Corn Become a Good Second Generation Energy Crop? —Spreadsheet on the Impact of Very High Corn Yields by 2030", presented at the 2007 Biobased Industry Outlook Conference, Ames, Iowa, November 6, 2007 by Bill Hudson, ProExporter Network.