Comments on "Detailed California-Modified GREET Pathway for Denatured Corn Ethanol" (released April 21, 2008, version 1.0) Draft—For Review

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General

Life-cycle metrics are dependent upon numerous estimated parameters that underpin the calculation. Appropriate references must support all of the data used. The parameters and assumptions used in the CA-GREET model and referenced in the Draft report lack many necessary references and are not transparent. Although it is difficult to tell because of the lack of transparency and adequate citation, we believe the values for inputs and GHG performance of corn-ethanol presented in the Draft are obsolete and are not representative of current farming and ethanol industry practices. Appropriate references are necessary to evaluate the assumptions employed. For example, energy use on farm is from the 1990's, and a more recent value is available and should be employed. Also, the source of the values for energy use at the ethanol plant is not given, but we believe it is from a survey of ethanol plants taken in 2001. Here again there more recent, and more representative values for this parameter and they should be used. The methods used to calculate the co-product credit is also outdated and inaccurate. By employing older, outdated data that so not represent current farming practices, ethanol plant operation, or co-product use, the proposed CA-GREET model does not accurately represent the GHG emissions from the current corn-ethanol industry.

Corn Farming

1. Energy use for farming is indicated in Btu per bushel, or unit yield (Btu/bu) (**Table 1.01**). This is not an appropriate parameter because this efficiency value changes overtime and is dependent on grain yield and a number of known input rates. Changes in farming practices, such as switching from conventional tillage to no-tillage, may reduce energy inputs while having a minimal impact on crop yield. We strongly believe that the underlying parameters that determine the calculated Btu/bu, such as nitrogen and other fertilizer application rates (e.g. lb N / ac), are given as explicit input parameters. This will facilitate evaluation and updating of the model by those interested in such activities. The generic national averages also do not capture regional variability, which are large.
2. The references provided for farm input rates are from 1995-1999 (p. 18, footnotes), and cropping practices have become more efficient since that time (Cassman et al., 2002). Changes in practices have reduced petroleum use in corn production. This increase in efficiency should not be estimated based on a general estimate (e.g. +10%), but changes in cropping practices should be calculated based on actual input rates and crop yields using the most recent available data. For example, input rates for fertilizer and pesticides are available for more recent

years, and energy inputs are available from 2001. A brief by Life Cycle Associates indicates that the 2001 data reduces energy inputs by 33% compared to the estimates used by GREET.

3. Fertilizer inputs are not generally directly proportional to grain yield (e.g. g/bu) (**Table F**), and such parameters are also not commonly used by crop producers. Fertilizer (e.g. nitrogen) input is known on an area basis (e.g. lb/ac), it is associated with regionally variable input rates and uptake efficiencies, and is not accurately accounted for by the parameters employed as a variable in calculations related to yield (e.g. g K2O/bu). Such parameters should be given in units that are consistent with how they are used—in this case in lb/ac.
4. References for the energy intensity of fertilizer inputs sued in the model are omitted in **Table 2.01**. The text indicates that these intensities are relatively constant, but a report by G. Kongshaug (Energy Consumption and Greenhouse Gas Emissions in Fertilizer Production, 1998) documents substantial variability in fertilizer production efficiency. Recent estimates based on current practices, with appropriate references, are needed here. Estimates in **Table 2.02** lack appropriate references. The ethanol yields in **Table 2.03** are not referenced.
5. Nitrous oxide (N_2O) emissions from N fertilizer are assumed to be 2.0% of applied (**Table 2.06**). It lacks an appropriate reference, and is inconsistent with current estimates. While considering 9 parameters from the 2006 Guidelines for National Greenhouse Gas Inventories (IPCC), the BESS model (www.bess.unl.edu) estimates that direct and indirect N_2O emissions from fertilizer are approximately 1.8%--direct N_2O emissions from fertilizer are 1% of applied N is converted to N_2O (IPCC 2006).

Ethanol Production

1. Appropriate references are not provided to support the values associated with the energy use in the ethanol plant (**Table 4.01**). The numbers used are likely to be obsolete and not representative of the current ethanol industry. These numbers have a large impact on the GHG emissions totals from corn-ethanol systems and therefore the source of these data must be fully documented with acceptable citations. Without citations, our best guess is that these values come from an EPA estimate obtained from consulting engineering firms. More recent industry surveys using data from state regulatory agencies and other industry surveys suggest that the values cited in the Draft are too high and that the current ethanol industry is considerably more energy efficient. The efficiencies from these surveys were presented in a recent memo to CARB (March 26, 2008) from Ken Cassman and Adam Liska, and are also used in the BESS model (www.bess.unl.edu).

Co-product credits

1. The co-product credits are inaccurate as designated in **Table 6.05** for a dry mill biorefinery. Our group has recently recalculated co-product credits based on Klopfenstein et al. (2008). The method for calculating these credits is based on current feeding practices and is described in the User's Guide of the BESS model (www.bess.unl.edu). One manuscript is submitted and another is in progress to

describe the GHG credit due to distillers grains based on current feeding practices. Distillers grains plus solubles (DGS) do not replace soybean meal in the majority of cattle diets. The replacement materials for DGS are primarily corn and urea, not corn, oil, and soybean meal (see point 4 below). The displacement method used by GREET model ignores the most accurate and current biological data (e.g. the BESS co-product crediting system based off of extensive biological data and environmental factors) for cattle performance and DGS inclusion level being fed by the feedlot industry.

2. GREET 1.8b, like the other GREET versions, discounts the total co-product credit by 15% since it was originally believed that there would be an oversupply of DGS and therefore the beef industry would have to grow to use up all the DGS. The thought was that this "new beef industry growth" caused by DGS could not be credited. The number they calculated was that a 15% growth was needed to use all the DGS (**Table 6.02**). This assumption is incorrect because the beef industry has not grown with the DGS boom. DGS is being used to replace corn that has been diverted to the ethanol industry from the cattle feeding industry. This means that the 15% discount should be eliminated from the GREET model calculations.
3. Some of the GREET 1.8b calculations for soybean transportation are based on the wrong weight of soybeans per bushel. The cells in columns I and J of sheet BD use a 56 lb bushel weight of soybeans. This number should be 60 lb per bushel. The 56 lb/bu number is correct for corn but not for soybeans. This number is an important part of converting energy values per ton of soybeans to per bushel of soybeans to be compatible with the rest of the model. These calculations are not used directly for co-product calculations, but appear to have been the basis for some of the co-product calculation inputs.
4. The co-product feeding substitution scheme provided by the Draft is underdeveloped and unrepresentative of current feeding practices. The references for **Table 6.02** are for brief, non-peer reviewed, largely undocumented conference presentations (http://www.mncpoe.org/Previous_events/mar13_energy%20forum/Cellulosic%20Ethanol-Tiffany.Mar.13.07.print.pdf, http://www.ddgs.umn.edu/ppt-swine/2005-Shurson-%20High%20quality%20corn%20ddgs.pdf). The EPA document (ref. 11, p.65) does not appear to contain any text on co-product substitution rates (the Draft suggests that 1 ton of DGS substitutes 0.5 ton of corn and 0.5 ton of soybean meal in cattle diets—this could not be found in the document: http://www.epa.gov/EPA-AIR/2007/May/Day-01/a7140a.htm). This substitution assumption is also not supported by a recent USDA survey of use of DGS and related animal feeding studies, as described below.

The Renewable Fuels Association calculated that 82% of biorefineries were dry-mills in 2006 (RFA 2006; this percentage has increased due to recent industry expansion). Dry-mills produce distillers grains co-products instead of corn gluten feed from wet-mills. The National Agricultural Statistics Service (NASS) has released a 2006 survey of beef, dairy, and swine operations on ethanol co-product use for livestock feed (USDA-NASS 2007). The survey was conducted in the Corn Belt for a region that contains 50%, 33%, and 70% of the United States 2006 beef, dairy, and pork production, respectively (USDA-NASS, 2008). In

2006, this area represented 3.2 million head of dairy cattle, 11.3 million head of cattle in 1,000+ head feedlots, and 64.1 million pigs, and a large portion of these animals are fed co-product. Moreover, the larger scale, more innovative producers are the ones adopting co-product feeding (USDA-NASS, 2007; Waterbury et al., 2009). An example of co-product use comes from the Nebraska beef industry. A Nebraska state survey found that 59% of feedlot operations were feeding co-products in 2007 (Waterbury et al., 2009). However, on an animal basis, 91% of cattle on feed were fed co-products. A Texas, Midwest, and Western states feedlot nutritionist survey conducted by Vasconcelos and Galyean (2007) agrees with the Nebraska study by showing 83% of the feedlots used co-products. The respondents in both the consultant study and Nebraska study indicated that distillers grains was the most common co-product used. The nutritionist survey indicated 69% of the 29 nutritionists (consulting for about 69% of cattle on feed in the United States) were feeding distillers grains as the primary co-product in the diet.

Feeding studies have demonstrated that up to 50% of diet dry matter can be replaced with DGS in feedlot diets and improve cattle performance (Klopfenstein et al., 2008). NASS survey data suggests that Corn Belt feedlots feeding DGS have average dietary inclusion of distillers grains at 22% to 31% of the diet (as-is, wet basis). Waterbury et al. (2009) has shown that feedlots are feeding 37% of the diet (as-is) as co-product in Nebraska. Vasconcelos and Galyean (2007) suggest the average co-product inclusion rate on a dry matter basis is 20% with a range of 5 to 50% of diet dry matter.

Research has shown that 20% of dairy diet dry matter can be provided as DGS without hurting performance (Anderson et al., 2006). NASS survey data suggests that the average inclusion of DGS in dairy diets is 10 to 22 percent of the diet (as-is). When the water in the as-is weight is discounted, this amount is about 10% of diet dry matter. The dairy industry has been using DGS as a protein supplement to replace corn and soybean meal in the diet (Anderson et al., 2006). As the inclusion level increases, the corn energy will be replaced with distillers grains for milk production energy.

The swine industry can efficiently use up to 20% of diet dry matter as dry DGS without hurting pig performance (Stein, 2007). NASS data suggest that few swine operations have been feeding DGS, and the average as-is inclusion is about 10 to 11% of the diet for those operations that do feed DGS.

Cumulatively these data suggest that the beef and dairy industries have been the major consumers of DGS produced by dry mills. The beef industry feeds greater inclusions of DGS to more cattle than the dairy industry, even accounting for two steer finishing periods per dairy cow year. However, dairy cattle eat roughly two times the amount of dry matter each day that feedlot cattle eat. This suggests that the dairy industry may be utilizing about the same amount of distillers grains as the feedlot industry. The feedlot industry may have more potential for future increased use of DGS than the dairy industry (Klopfenstein et al., 2008), because the dairy industry does not have as much potential without decreasing animal performance. Although the swine industry has the potential to utilize DGS, the industry has been feeding low inclusion levels and has not been a major consumer of the co-product.

These findings indicate that the beef and dairy industries are the primary systems to model co-product use. While the initial use of DGS was for protein replacement in both beef and dairy diets when the amount of corn used for ethanol was small, with large amounts of corn used for ethanol as is now the case, DGS are used primarily as an energy source in cattle and dairy diets (Klopfenstein et al., 2008; Anderson et al., 2006). Therefore, the DGS can not be completely credited as a protein source as they are in the GREET model. Distillers grains use has been studied more extensively in feedlot cattle than in dairy production (Klopfenstein et al., 2008). Therefore, we can accurately evaluate the feedlot industry, but the dairy industry needs further analysis.

Historical developments in the cattle feeding industry show that part of the DGS co-product credit is the replacement of urea (nitrogen) in feedlot diets and does not include the replacement of soybean meal. By the mid 1960's the ruminant feeding industry recognized that urea was as effective as soybean meal for feedlot cattle protein supplements (Perry et al., 1967; White et al., 1975). Urea supplied dietary protein (nitrogen) less expensively than did plant protein supplements such as soybean meal and therefore became the main nitrogen supplement for feedlot cattle, but co-products can replace urea and a 2007 subsequent survey found wide spread use of ethanol co-products as protein sources (Vasconcelos and Galyean, 2007). Therefore, the BESS model assumes that co-products are used to replace corn and urea in cattle diets and are given a GHG credit for the emissions saved by making this replacement. Details are provided in the BESS model User's Guide (www.bess.unl.edu).

Citations

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