A Review of CARB's Second Approach to Modeling Indirect Land Use from Expanded Biodiesel Production

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Background

In response to input received over the 30 day comment period under the Third Notice of Public Availability of Modified Text and Additional Documents and Information, CARB revised the model runs utilized to calculate the carbon intensity of soybean based biodiesel in the United States. These re-runs were intended to resolve some modeling inconsistencies, and the base model used for the corn ethanol calculations was modified by researchers at Purdue University, to be able to handle changes in biodiesel production. The greenhouse gas results obtained are quite similar to those previously presented. However, the two model runs showed inconsistent results in the amount of land use conversion and the type of land converted. Considering these critical inconsistencies, the coincidental similarity in net emissions should not be viewed as validation of either modeling attempt.

We were asked in the previous comment period by the National Biodiesel Board to help them understand the modeling results presented by CARB in the publication titled "Land Use Change Effects for Soy Biodiesel" and to make any recommendations based on the results of our study. We drew five main conclusions from that analysis:

1. The CARB approach to estimating land use change is not consistent with actual agricultural land use changes in the United States since 1996.
2. The restrictions imposed by use of the Constant Elasticity of Transformation supply function are not consistent with the data used to estimate the land transformation elasticity.
3. Although GTAP cannot explicitly account for double cropped acres, the yield elasticity with respect to price can be adjusted to account for the expansion of double cropping in response to increased crop demand.
4. There is no empirical support in Brazil for the assumption that yields in Brazil on new land are lower than yields on old land. For the United States, large overall acreage declines and significant shifts between crops since 1996 suggest that one parameter cannot capture important differences between crop yields on new land.
5. The biodiesel byproduct results modeled by CARB are difficult to rationalize because of discrepancies between the U.S. and rest of world price impacts and the limited price impact in the United States.

Each of these points were fully developed and carefully documented in a series of papers provided as attachments to the comments from the National Biodiesel Board. The observations made in our previous analysis are still valid, and the modifications made by Purdue did not address any of them. Hence, these points need to be reiterated.

Analysis of the new runs

Given that the document titled "Land Use Change Effects for Soy Biodiesel and Renewable Diesel" indicates that important modifications were done to the model for it to be able to better represent the soybean complex, including market effects of soybean meal, we focus here our remarks on this part of the model.[1] In particular we analyze the market price changes associated changes in production and consumption, and land covers displaced by the expansion of the soybean area. Scenario A is used to illustrate the analysis performed. The resulting price changes of vegetable oil, soybeans, and biodiesel co-product (soybean meal) for this scenario are presented in Table 1.[2]

Relative Prices Changes in the US cannot be Supported in Equilibrium

Results for the U.S., presented in Table 1 indicate that, as expected, increases in the demand for vegetable oil increases (in this case for biodiesel production), lead to higher prices of both soybeans and of soybean oil. Also, given that more soybeans are crushed for the oil, additional supplies of meal are pushed to the market, and a price decline is needed to find buyers.

Thus, while the direction of the change in prices for the U.S. is reasonable, the relative magnitude of these changes are not consistent with an equilibrium relationship between

[1] This is stated as the second bullet in page 2 of the document which reads "The model did not account for market effects of oilseed meals and therefore an external adjustment for soy meal co-product credit was required".

[2] The Table 2 price changes were obtained from Air Improvement Resource, Inc who replicated the results of the CARB analysis. We focus on the soybean sector as this is the complex explicitly modeled. Crush yields used in the model are obtained from this sector as page 5 of the documents states "In addition, the US average oil extraction rate from oilseeds (i.e., produced vegetable oil / oilseeds used) is equal to the oil extraction rate from soybean (i.e., produced soybean oil / soybeans used)."

soybeans, soybean oil and soybean meal. This lack of an equilibrium relationship calls into question the validity of the new model runs

Most U.S. and world soybeans are crushed. The crush demand for soybeans is a derived demand. That is the demand for most soybeans is derived from the demand for soybean oil and soybean meal. Thus the profitability of the crushing activity is the key driver of the demand for soybeans. This profitability is usually measured by the crush margin, which is simply the

Table 1. Percent Change in Prices for Soybean and Soybean Products for Scenario A

	Oilseeds	Crude Vegetable oil	Protein meal
		Cveg_Oil	Veg. Oil. ByProduct
	%Change	%Change	%Change
1 USA	2.69	14.48	-44.30
2 CAN	0.75	1.36	0.57
3 EU27	0.50	0.54	-0.39
4 BRAZIL	0.58	0.45	0.43
5 JAPAN	0.25	1.14	1.36
6 CHIHKG	0.38	0.45	0.47
7 INDIA	0.18	0.22	0.06
8 LAEEX	0.76	1.03	0.87
9 RoLAC	0.71	0.48	0.55
10 EEFSUEX	0.19	0.08	0.27
11 RoE	0.32	0.35	0.90
12 MEASTNAEX	0.16	0.11	0.68
13 SSAEX	0.30	0.37	-0.54
14 RoAFR	0.33	0.18	0.40
15 SASIAEEX	0.92	0.28	1.33
16 RoHIA	1.08	1.03	1.72
17 RoASIA	0.45	0.32	0.37
18 Oceania	0.81	0.10	1.26

revenue obtained from selling the products from a bushel of soybeans minus the market price of soybeans. An example of the calculation, including implied margins for the 2007/08 marketing year is presented in table 2. Notice that the crush margins calculated here do not include costs, other than the procurement of soybeans. In particular, the calculations do not include other operating or fixed costs. Thus, a positive margin does not indicate profits, only the potential for generating them. On the other hand, negative margins indicate the industry is losing money.

Crushers who have a negative crush margin will quit crushing soybeans so we know that this cannot represent an equilibrium relationship.

For the 2007/08 marketing year depicted in Table 2, margins were between 0.84 $/bu and 1.22$/bu. Monthly crush margins for the Sept-2001 to Aug-2008 period are presented in Figure 1. These margins oscillated in the $0.52-1.50/bu range, with an average of $0.87/bu.

Table 2. Crush Margins for the 2007/2008 Marketing Year (Sep./Aug.)[1]

	Yield (lbs/bu)			Price			Revenue		Cost	Margin
				Oil[2]	Meal[3]	Hulls[4]			Soybean[5]	
	Oil	Meal	Hulls	($/cwt)	($/ton)	($/ton)	Oil ($/bu)	Meal+Hulls ($/bu)	($/bu)	$/bu
Sep.	11.4	43.9	3.5	36.9	254	108	4.2	5.8	9.07	0.91
Oct.	11.4	44.2	3.5	38.1	255	122	4.3	6.0	9.44	0.88
Nov.	11.6	44.4	3.5	42.7	256	126	4.9	6.5	10.32	1.07
Dec.	11.5	44.4	3.5	45.2	257	136	5.2	7.2	11.23	1.17
Jan.	11.6	43.8	3.4	49.8	258	137	5.8	7.5	12.16	1.09
Feb.	11.5	44.0	3.4	56.7	259	140	6.5	7.9	13.35	1.03
Mar.	11.7	44.0	3.5	57.3	260	150	6.7	7.6	13.12	1.14
Apr.	11.6	44.0	3.5	56.6	261	141	6.6	7.5	12.92	1.14
May	11.5	44.1	3.5	58.3	262	111	6.7	7.4	13.24	0.84
Jun.	11.6	43.9	3.6	62.4	263	125	7.2	8.8	14.99	1.05
Jul.	11.6	44.1	3.5	60.5	264	152	7.0	9.4	15.16	1.22
Aug.	11.7	43.9	3.6	50.8	265	153	6.0	8.1	12.88	1.14

[1] The hulls values are usually omitted from the margins calculations. These products contributed 0.23 $/bu on average for the year. [2] Crude, tanks, f.o.b. central Illinois; [3] Decatur, 48 percent solvent; [4] Central Illinois, bulk; [5] No. 1 Yellow, Illinois Processor. All data is from the Oil Crops Yearbook 2009, ERS/USDA (http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do?documentID=1290).

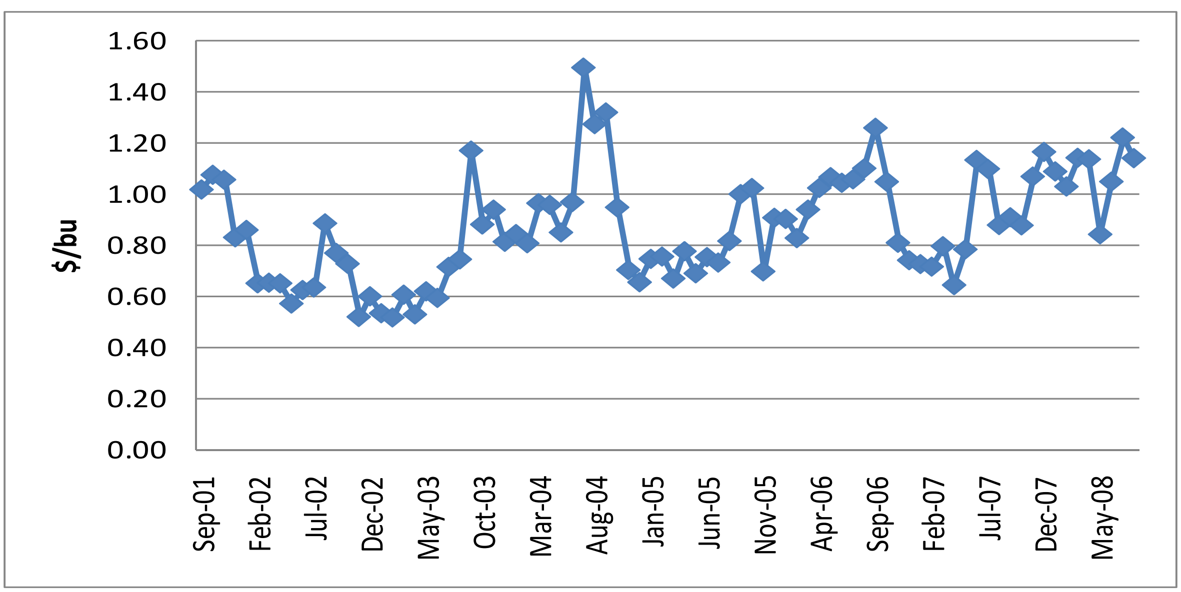

Figure 1. Monthly U.S. Crush Margins.

The price decline in soybean meal from CARB Scenario A is -44%. Because soybean meal accounts for roughly 75% of the soybean mass[3], this magnitude of a price decline indicates a large decline in crush margins. Of course, soybean oil prices increase by 14% but this is not enough to offset the drop in predicted soybean meal prices. Lower crush margins implies (*ceteris paribus*) a reduced demand for soybeans, But a reduction in soybean demand makes no sense because biodiesel demand increases by almost one billion gallons in this scenario.

To show the implications of oil and meal price changes, crush margins were recalculated, modifying the historical monthly prices that were used in Figure 1 for soybeans and soybean products by the changes obtained as a result of Scenario A. Specifically, the prices of soybean and soybean oil were increased by 2.69% and 14.48% respectively. The price of soybean meal is reduced by 44.3%.[4] The resulting margins are plotted together with the historical figures in figure 2.

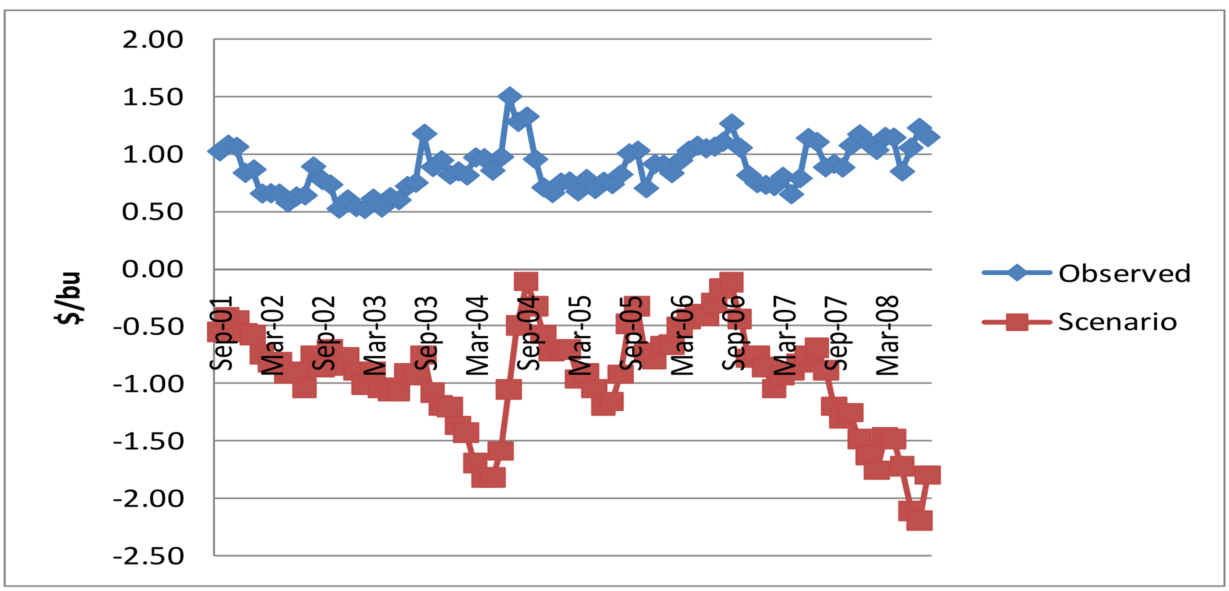

Figure 2. Monthly Crush Margins Observed and Implied by the Price Changes for Scenario A.

[3] Oil and hulls account for about 19% and 6% of the mass, respectively

[4] Given a lack of price change information, the price of hulls is not modified. This would have the impact of over-estimating the scenario margins as expanded crush should depress the price of this by-product.

Figure 2 indicates that the biodiesel demand increase would result in lower margins for all combinations of prices observed in the 84 months considered. Furthermore, crush margins become negative for months if the Scenario A price changes are implemented. Again, it is worth repeating that the Figure 2 margins do not account any costs for crushing other than the seed. Thus sustained economic losses are implied, which is not an equilibrium. Large scale exit would be observed in the industry, which is inconsistent with the increased supplies of vegetable oil needed to produce one billion gallons of biodiesel.

The Large Reduction in Soybean Meal Price is not Transmitted to Markets Abroad

Table 1 indicates that the price of soybean meal in the US declines by 44%. Other countries have a much smaller price response. This lack of price transmission to other countries is not consistent with the fact that soybean meal is a widely traded commodity in an integrated world market with relatively low trade barriers. This integration can be seen in figure 3, which demonstrates shows that soybean meal prices closely track each other in different parts of the world. For the period considered, the correlation coefficient between soybean meal prices in the U.S. and the price of the same product in the other countries is 0.97. This point was already made in the previous round of comments.

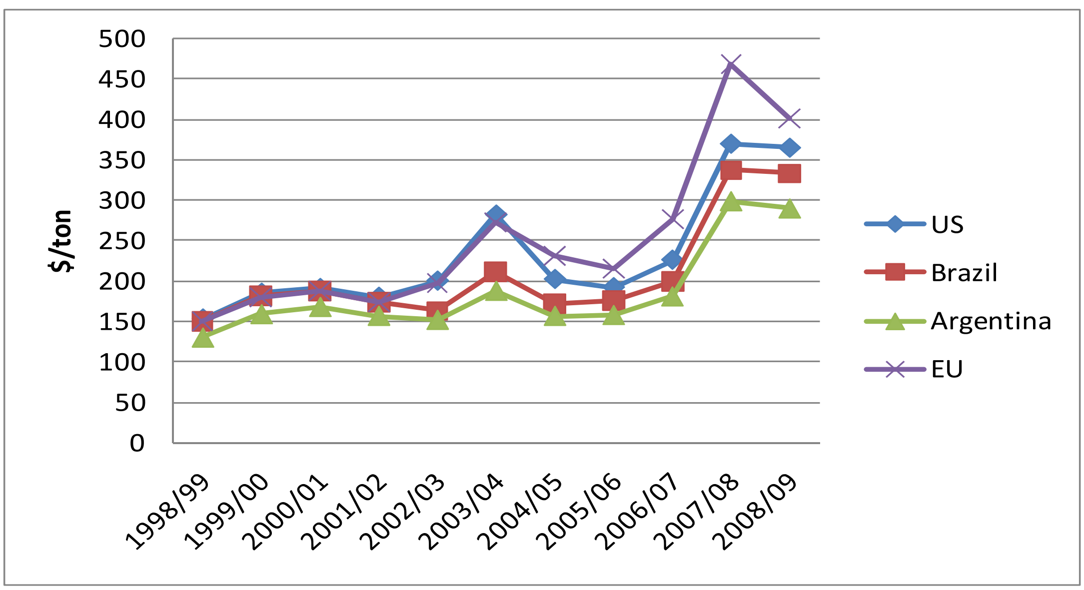

Figure 3. Price of Soybean Meal in Four Different Markets. (Elaborated based on FAS/USDA data. Prices refer to: Decatur, Average Wholsale 48% Protein for the US; Rio Grande, Brazil FOB Bulk Rate 45-46% Protein for Brazil; Pellets, FOB Up River for Argentina, and Hamburg FOB Ex-Mill for the EU.)

Figure 4 presents soybean meal prices for the US and the EU for the same market shown in the previous figure, but over a longer time horizon. To eliminate the association attributable to inflation, both prices were converted to real (base 2000) dollar, using the U.S. GDP deflator. Again, these two series closely follow each other. This means that a 44% decline in the US price would significantly reduce the prices in the EU. If EU prices did not drop, then U.S. meal producers would simply export their meal to the EU. Contrary to the type of integration shown in Figure 3, it is quite surprising that the Brazilian soybean meal price actually shows a small price increase.

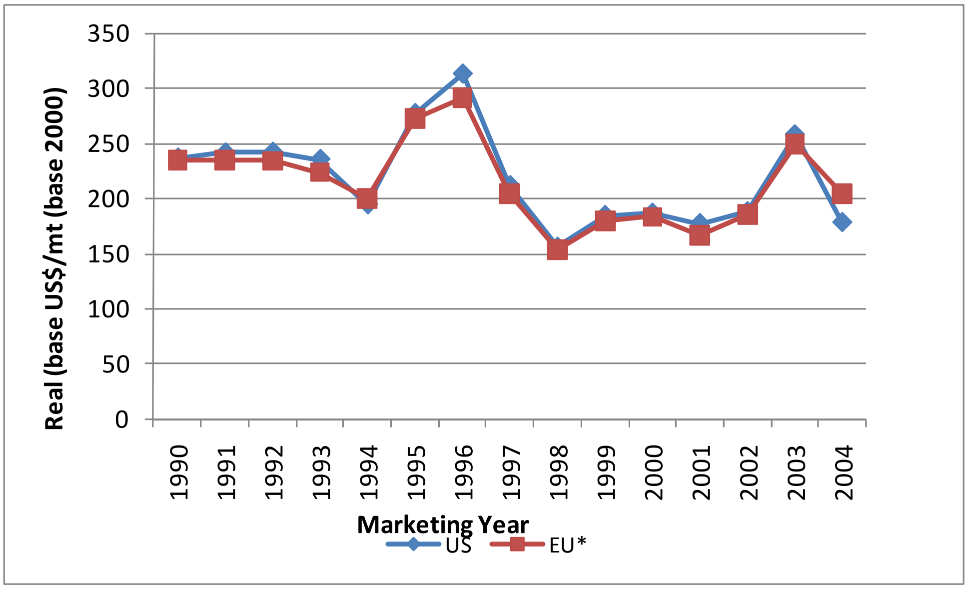

Figure 4. Prices of soybean meal in the EU and US. (Source: Elaborated base on FAS/USDA data. * Decatur (Average wholesale 48% protein) , and Hamburg FOB Ex-Mill for the US and EU, respectively.)

The absence of a strong price decline in Canada, where prices also increase (see Table 1) is also difficult to rationalize. According to FAS/USDA data, Canada relies on imports to supply more than 50% of its domestic consumption.[5] Virtually all (between 97.5%-100%) of these imports originate in the US. These imports averaged 1.2 million metric tons between 2000 and 2009. The Table 1 price changes simply do not reflect the reality of an integrated world soybean meal market.

Crops Expanding More Over Forest than On Pasture in the U.S.

[5] The share of imports is 46% average of the 2000-2002 period, and 59% on average for 2007-2009.

Given that GTAP does not include potentially available idle land, and does not accommodate double cropping as a result of return increases, all the additional crop hectares required are pushed onto either pasture or forest. Results of the new runs indicate that more than 50% (and in one case 72%) of the cropland area expansion occurs over forest cover (see Table 3). This is at odds with the notion that crops can more easily expand over pasture than forest. The relative difficulty of displacing forest is widely acknowledged. For instance, Ahmed, Hertel, and Lubowski (2008) found the own price elasticity for forest at 5 years to be quite low (approximately 0. 005) compared to that of pasture (approximately 0.22). However, and as highlighted in the comments previously submitted, inherent constraints of the functional form used in the land allocation model modifies this large differences. In particular and as was clearly illustrated before, these limitations significantly increase the responsiveness of forest area to crop returns.

Table 3. Area Changes for Different Scenarios (Million Hectares)

	Scenario						
	A	B	C	D	E	F	G
Forestry	-0.12	-0.08	-0.13	-0.12	-0.09	-0.09	-0.08
Crops	0.19	0.13	0.23	0.22	0.13	0.16	0.15
Livestock	-0.07	-0.05	-0.10	-0.10	-0.04	-0.07	-0.07
% Displaced on Forests	63%	62%	57%	54%	72%	57%	53%

Gollub, Hertel, and Sohngen (2007) further confirm the notion that pastures are closer substitutes of crops than forests. These authors write (p.20) "The elasticity between crops and livestock is set to -3—twice larger by absolute magnitude, reflecting the relatively easier conversion of crop land to grazing (as opposed to conversion of agricultural land to forestry and vice versa)."

A rationale for the relatively large expansion over forest would have been if returns to pasture had increased relative to returns to forest given the plunge in the domestic price of soybean meal. The very large decline in soybean meal price is likely to depress the price of beef by lowering costs of production, and cheapening more feed-intensive meats, such as poultry.

However, the magnitude of the cost reduction could have resulted in an increase in profitability of finishing cattle, which given enough time should translate in higher returns to cow calf operations utilizing pastures. This in turn increases the ability of pasture to "fight back" in order to keep area. However this is not observed in the results. Returns to pasture actually declined slightly (-0.2%) in the US in Scenario A, while returns to forest increased by 0.6%.

In summary, the distortion in own and cross price elasticities imposed by the functional form, seem to explain the counter-intuitive results in terms of relative amounts of pasture and forests displaced. But more analysis of the results seems warranted.

Reference:

Gollub, A., T. Hertel, and B. Sohngen. 2007. "Projecting Supply and Demand for Land in the Long Run" Selected paper presented at the American Agricultural Economics Association Annual Meeting, Portland, Oregon, July 29-August 1, 2007.