COMMENTS ON INDIRECT LAND USE CHANGE REVISIONS
FOR THE
LOW CARBON FUEL STANDARD DEVELOPMEN

Prepared For:

National Biodiesel Board

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GREET 2014

The National Biodiesel Board is generally supportive of using the latest tools available for the determination of the carbon intensity of the various fuel pathways. We believe that the LCA models should be open and transparent and would thus support the use of the Excel version of GREET 2013 over the .net version of the model as it is more transparent.

The models are only as good as the data that goes into them and while GREET 2013 has updated data for some pathways, the data for other pathways needs to be improved or aligned with data that CARB has developed as it developed some of the same pathways. The NBB would be happy to work with CARB in developing GREET 2013 so that it is representative of biodiesel consumed in California.

There is also the issue that not all of the CARB approved pathways are included in GREET 2013. For example, the used cooking oil and corn oil biodiesel pathways are not included in the model. As CARB works to develop GREET 2013, we would recommend that a single model be developed that has all of the additional pathways in the one model. This will make it easier for new pathways to be added in the future and will help to insure that there is more consistency between the pathways.

As the pathways are developed with the new GREET model, there is the opportunity for CARB to be more consistent with the treatment of co-products and system boundaries across all fuels. We continue to believe that when mass or energy allocation is used the system boundaries for co-products have a tendency to be truncated and exclude the impacts of the co-product use. In some cases the impact of this can be significant. For example, the biodiesel pathways have used energy allocation for the glycerine co-product, but because CARB have also included the emissions from the combustion of fossil carbon in the methanol used in the production of the biodiesel, this means that the carbon in the glycerine is biogenic. If the glycerine is used as a fuel to displace a fossil fuel, there will be emission reduction achieved by using a biogenic fuel rather than a fossil fuel that is not reflected in the biodiesel pathway.

Indirect Land Use Change Emissions

CARB is proposing a number of changes to the ILUC modelling that has been previously been carried out. The NBB is pleased that its previously expressed concerns regarding errors in the soybean biodiesel ILUC modelling have been addressed and that the new preliminary value is much lower and in line with the estimates for other feedstocks. However, the NBB believes that much more work is required on the GTAP model before it will produce realistic estimates of land use change. Our views on some of the issues that CARB has requested input on are provided below.

Land Pools

The NBB supports any effort that is made to expand and update the land pools within GTAP. This is particularly important for idle/fallow/abandoned cropland as we believe that the data shows that this is the first land that comes back into production to meet increased demand and yet, with the exception of a portion of this land in the United States and Brazil, the GTAP model has no method to access this land and instead converts forest land and pasture land to new crop production. This significantly overestimates the GHG emissions from land use change.

The cropland pools that are currently in GTAP are shown in the following table. The crops column is the total cropland in the model. The CRP land is only included for the United States and it is not active in the model that CARB is using. There is cropland pasture area for the United States and Brazil, but this category exists for many other regions in the world. The harvested area is from the GTAP model and is the sum of the area for all of the segregated crops. Net cropland not in crops and the net double cropped areas are calculated from the area in crops less CRP less cropland pasture less the harvested area. If the calculated value is positive it indicates that some cropland is idle or in cropland pasture

and if the value is negative, then some of the land is being used to produce multiple crops in one year. Even after accounting for CRP in the United States and cropland pasture in the US and Brazil, there is almost 200 million hectares (approx. 500 million acres) of agricultural land that is not in production that could be brought back into production. It must be remembered that the biofuel shocks that CARB is modelling require less than 2 million hectares of new cropland, 1% of the idle cropland available in the GTAP model.

Region	Cropland	CRP	Cropland Pasture	Harvested Area	Net cropland not in Crops	Net double cropped
						Hectares
USA	175,807,007	14,046,000	25,024,000	127,989,000	8,748,007	
EU27	124,830,687			115,729,000	9,101,687	
BRAZIL	60,724,257		23,573,000	62,830,000		-25,678,743
CAN	39,573,515			33,514,000	6,059,515	
JAPAN	3,680,435			4,185,000		-504,565
CHIHKG	140,644,611			160,840,000		-20,195,389
INDIA	171,418,998			186,799,000		-15,380,002
C_C_Amer	56,671,461			26,687,000	29,984,461	
S_o_Amer	58,603,527			56,585,000	2,018,527	
E_Asia	5,190,174			4,852,000	338,174	
Mala_Indo	71,571,068			35,999,000	35,572,068	
R_SE_Asia	53,207,433			60,163,000		-6,955,567
R_S_Asia	46,956,517			43,712,000	3,244,517	
Russia	124,542,334			81,229,000	43,313,334	
Oth_CEE_CIS	111,522,274			94,998,000	16,524,274	
Oth_Europe	933,565			1,160,000		-226,435
MEAS_NAfr	53,633,308			49,933,000	3,700,308	
S_S_AFR	211,016,073			175,792,000	35,224,073	
Oceania	33957545			42,181,000		-8,223,455
Total	1,544,484,789	14,046,000	48,597,000	1,365,177,000	193,828,945	-77,164,156

Source: GTAP

In the United States the difference between harvested area and agricultural land is composed of CRP, cropland pasture, fallow land and area that has a crop failure. The USDA data is shown in the following table.

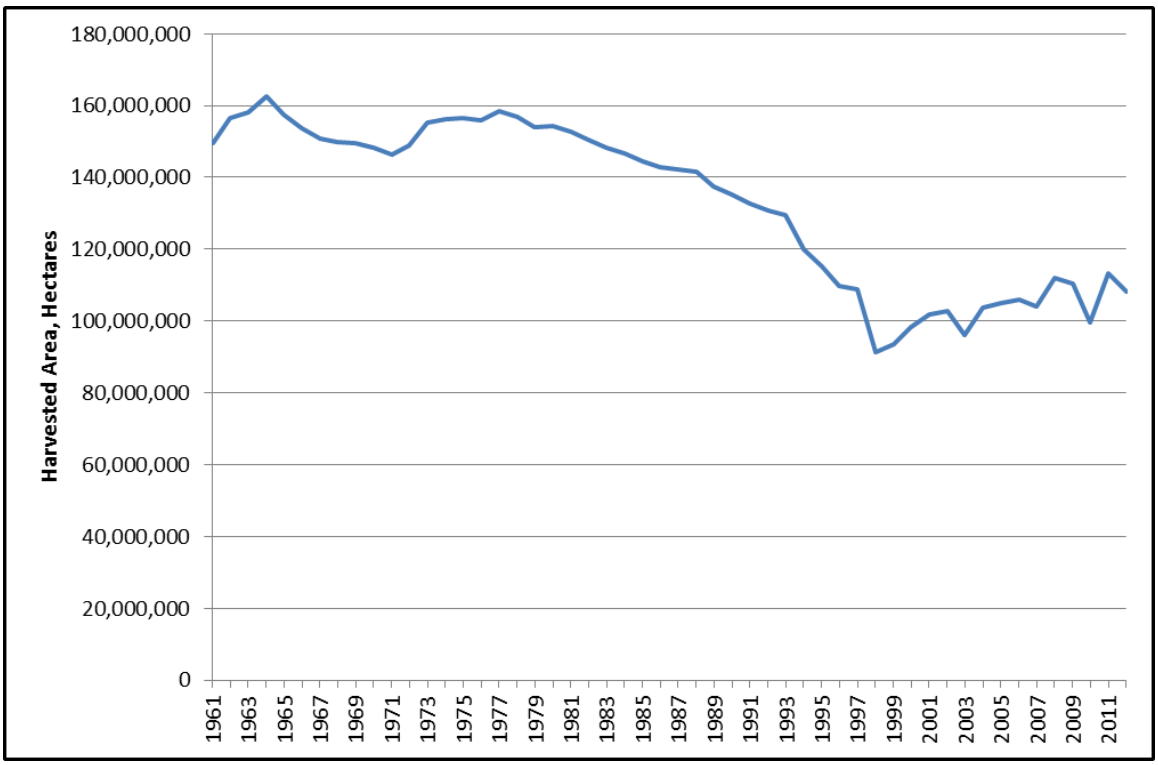
	2002	2007	2004 GTAP
	1,000 Hectares		
Harvested area	122,470	125,300	127,989[1]
Failed crop area	6,910	3,000	
Fallow (summerfallow)	6,670	6,340	
CRP	15,080	15,250	14,046
Cropland Pasture[2]	24,501	14,470	23,573
Total	175,631	164,360	175,807

Source: Major Uses of Land in the US. USDA

[1] This could include some double cropping area.
[2] The methodology was revised for 2007 and some cropland pasture was reclassified as pasture.

In comparing the USDA data to the GTAP land pools, it is apparent that the fallow land and the land that was planted but not harvested is not included. Other than these two land pools, there is some agreement between the cropland and the harvested area and the difference can be reconciled. This sort of reconciliation needs to be done with the other regions in the model before one could expect to get any reasonable estimation of indirect land use emissions.

The largest amounts of idle land in GTAP are in Russia and the Other CEE CIS regions. These are regions where large scale abandonment of cropland occurred in the 1980's and early 1990's with the fall of communism, but where there is now evidence that some of this land is coming back into crop production. In the following figure we show the harvested area for the USSR from 1961 to 1991 and the harvested area in the countries that were formerly part of the USSR after 1991. This information compares quite well with the 60 million hectares of agricultural land that was not harvested in GTAP.



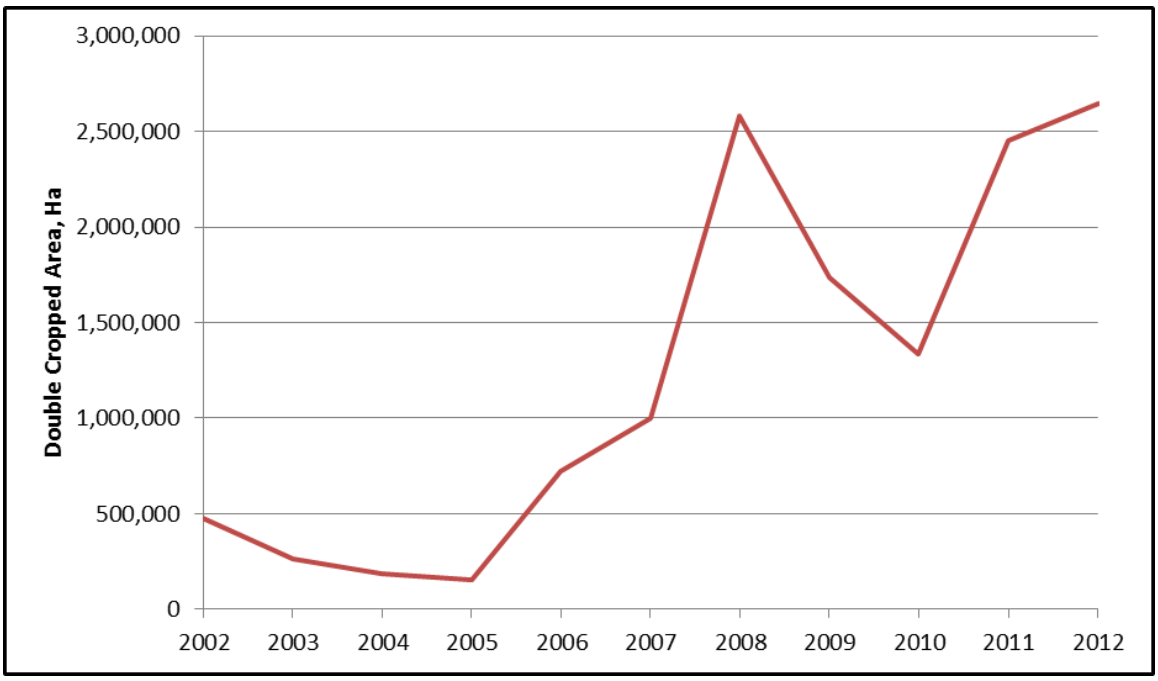
Source: FAO Stats

Between 2004 and 2011, 9.5 million hectares of cropland have come back into production in the former USSR, but in the GTAP model any increase in crop production in this region must come from forest and/or pasture since this abandoned land cannot be accessed by the model. This is a serious shortcoming in the model.

Double Cropping

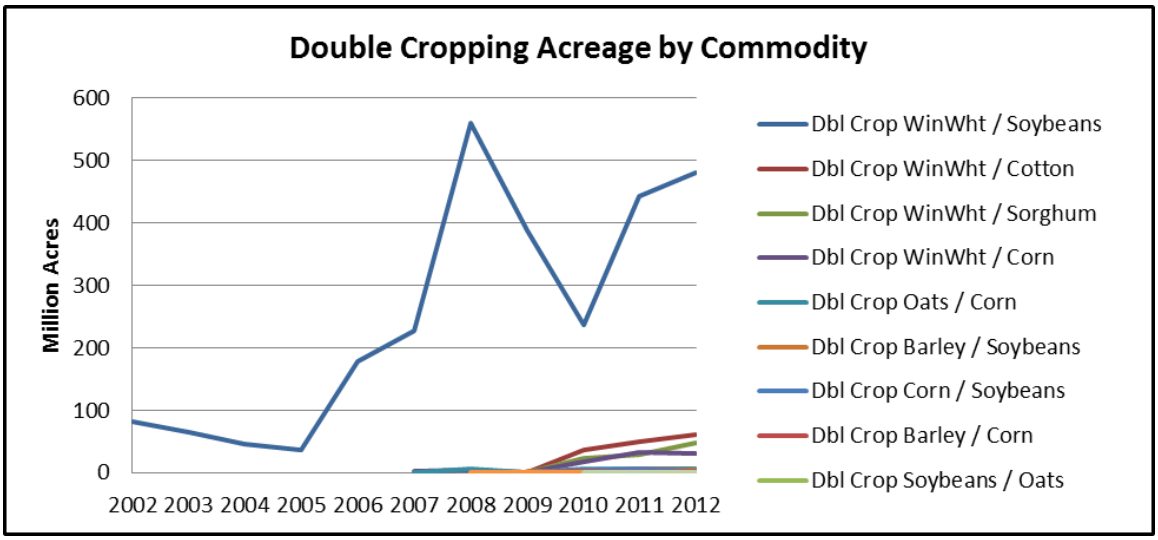
A related issue to the land pools is the issue of double cropping. At the workshop, CARB staff indicated that double cropping has not been taken into account with the model runs that have been done. This is only partially true. As shown in the earlier table, there is at least 77 million hectares of double cropping that is accounted for in the GTAP model. What is not included in the model is any mechanism to change the rate of double cropping.

Changing the rate of double cropping is a potential response to higher prices. We would expect to see an increase in double cropping in the 2004 to 2011 period as crop price increased. Unfortunately, few countries keep adequate records on the quantity of land that is double (or triple cropped). However, there is US data that can be used to analyze double cropping. The double cropped area over the past 10 years is shown in the following figure.

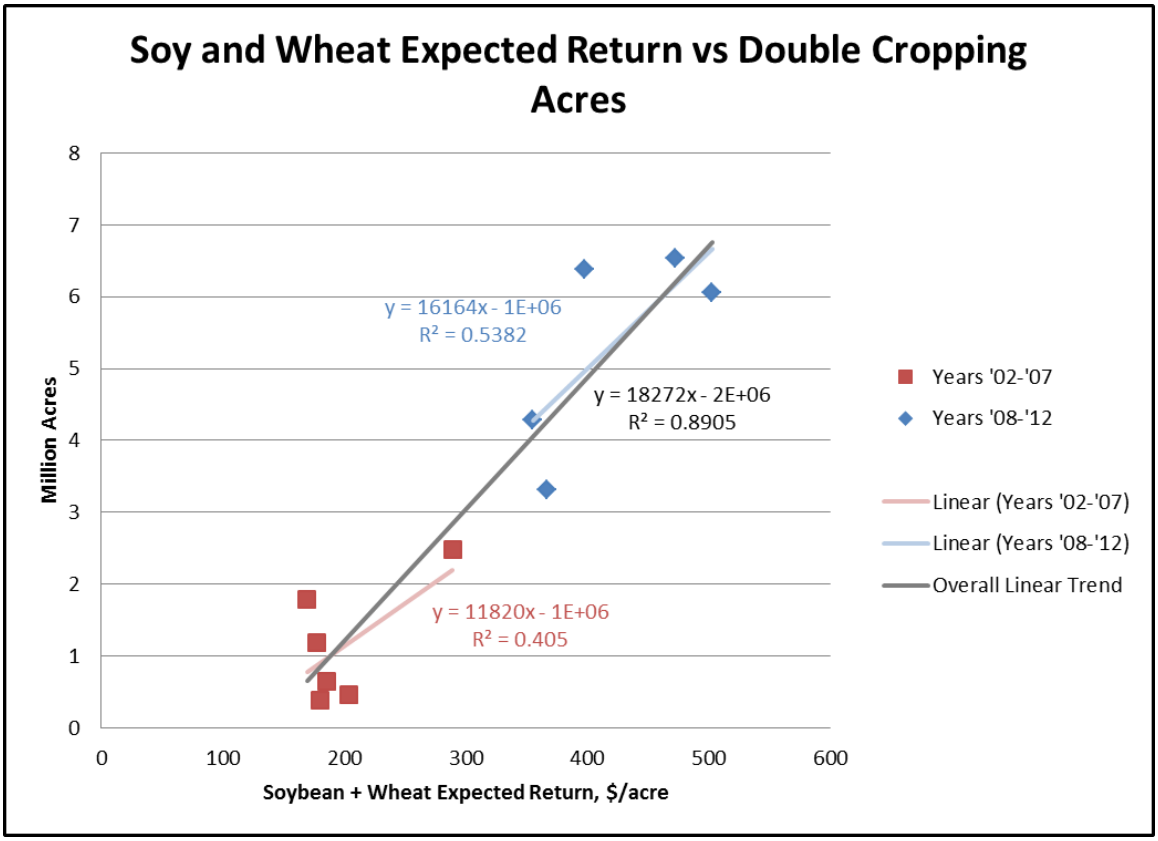


Source: Data from NASS CDL

The area has clearly increased (by more than 2 million hectares since 2004) and this corresponds to a period of higher commodity prices. It is again worthwhile remembering the total new cropland that the model is projecting for the CARB shocks is less than 2 million hectares. Further analysis of the data shows the crops that are being double cropped. This is shown in the following figure.



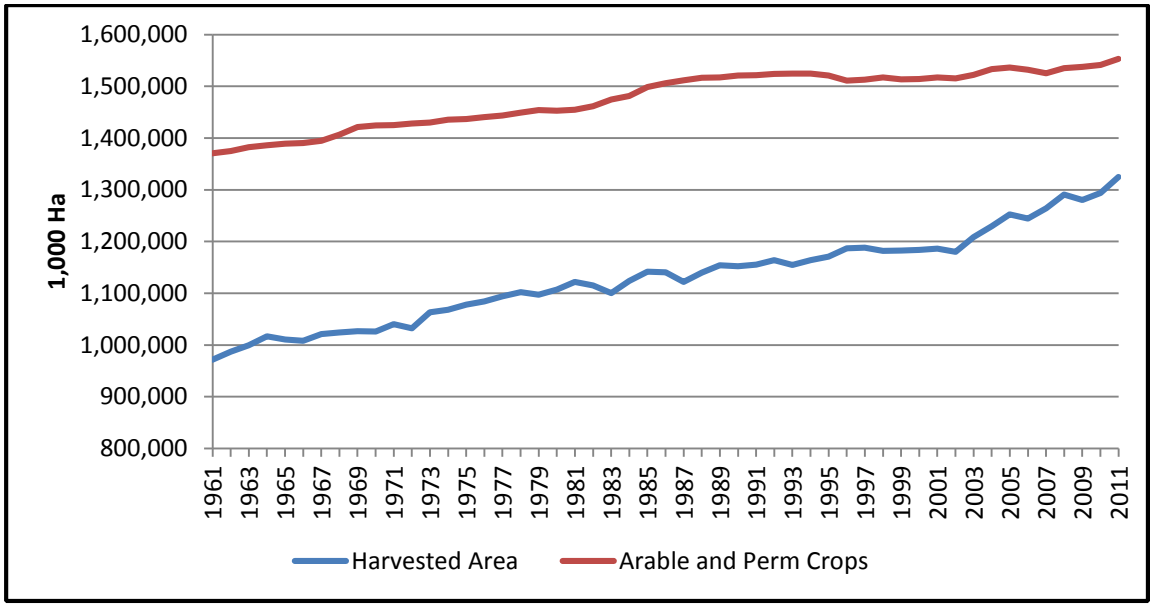
The dominant double cropping pattern is the winter wheat followed by soybean rotation. When the double cropping area is plotted against the expected returns per acre for winter wheat and soybeans the following figure is obtained. There is a very strong relationship that indicates that farmers do respond to price signals and expand the area double cropped when the prices justify such actions.



The challenge is to identify the best method of incorporating this information into the GTAP model since the best data is available for the United States but more of the double cropped area is found in the more tropical regions of the world. One possible approach is to use different price yield elasticities for different crops depending on their potential for double cropping.

Cropping Harvest Frequency

A recent paper by Ray and Foley[3] took a different approach to the issues of idle land and double cropping. They compared FAO data from 1961 to 2011 on the total harvested cropland and the total cropland. They found that between 2000 and 2011 the harvested land grew four times faster than the total standing cropland. The trends are shown in the following figure.



Using a metric of cropland harvest frequency (CHF)—the ratio of land harvested each year to the total standing cropland—and its recent trends, they identified countries that harvest their croplands more frequently, and those that have the potential to increase their cropland harvest frequency. The authors suggested that a possible 'harvest gap' may exist in many countries that represents an opportunity to increase crop production on existing agricultural lands.

Looking at the data from 2004 (the GTAP base year) to 2011, one finds that 74% of the increase in the area harvested was from increased CHF and only 26% was related to increased cropland.

The authors found that increased production can come from not only cropland expansion and increased crop yields (these two possibilities are included in GTAP), but also from using the existing standing cropland area more frequently each year through:

- multiple cropping (where appropriate),
- leaving less land fallow, and
- having fewer crop failures.

GTAP currently cannot model this third way of increasing the production and yet the data would indicate that it may be the primary way in which the increased demand is met. We think that there could be multiple ways of modelling this impact. It could be simply done outside of the model by reducing the land requirements for the biofuel shock by 75% or it may be possible to do it inside the model, since the idle land by region and AEZ can be determined by difference and the model tuned to provide the appropriate response that aligns with the data. Whichever way is selected, this is an extremely important response mechanism that is currently overlooked in the CARB GTAP modelling system.

[3] Deepak K Ray and Jonathan A Foley 2013 *Environ. Res. Lett.* **8** 044041 doi:10.1088/1748-9326/8/4/044041

Nesting Structure

The Expert Working Group (EWG) studying elasticity parameters in GTAP identified the CET function as something that needed revision. They noted that the method used in GTAP produced a responsiveness to deforestation that was more than an order of magnitude higher than reported in the literature and that it was factually incorrect.

The EWG recommended trying a revised nesting structure with different CET values for pasture and forest (i.e. a nested structure) as a means to address the issue. This would provide more flexibility and allow for better calibration with the available data. The latest version of GTAP has this capacity but CARB has chosen not to use it. This is a very important limitation of the model and the revised nesting structure should be used by CARB.

The rationale for using the revised nesting structure and some results from the revised model were published in a peer reviewed journal. There is no valid reason for not using this advancement in GTAP for estimating the ILUC emissions for various feedstocks.

The issue raised by CARB at the workshop concerning reforestation happening with the revised model is not a reason to avoid using the new model. Almost all GTAP model runs have some reforestation happening somewhere in the world and this is primarily a function of the way that the forest sector is modelled rather than a nesting structure issue. It must be remembered that GTAP does not track land in any sector but rather the economic activity that is happening on that land.

Price Yield Elasticity

The Elasticity Expert Working group made a number of recommendations with respect to the price yield elasticity depending on the capacity of the GTAP model to accept multiple values for the price yield elasticity. Since there currently isn't a version of GTAP that can accept multiple values, the EWG recommended a value of 0.25 be used.

The EWG studied all of the available literature on this issue up to 2010 when they made this recommendation. Only new information published after 2010 should be considered by CARB if they think that a value different than 0.25 should be used.

As noted earlier, there is considerable double cropping included in the GTAP baseline and there has been an increase in US double cropping of wheat and soybeans as the expected returns for these crops increased. Yet there is no double cropping response in the model. One way to address this would be to use different price yield elasticities for different crops. Soybeans and wheat would use a higher value than corn because they have a much higher potential to be double cropped.

Yield on New Land

CARB has suggested that it is looking at alternative values for ETA (the productivity of new land). One of the recommendations of the CARB Expert Working group was to move to the TEM method that is used in the new version of GTAP. It is not clear what value is being added by varying ETA in the various scenario runs.

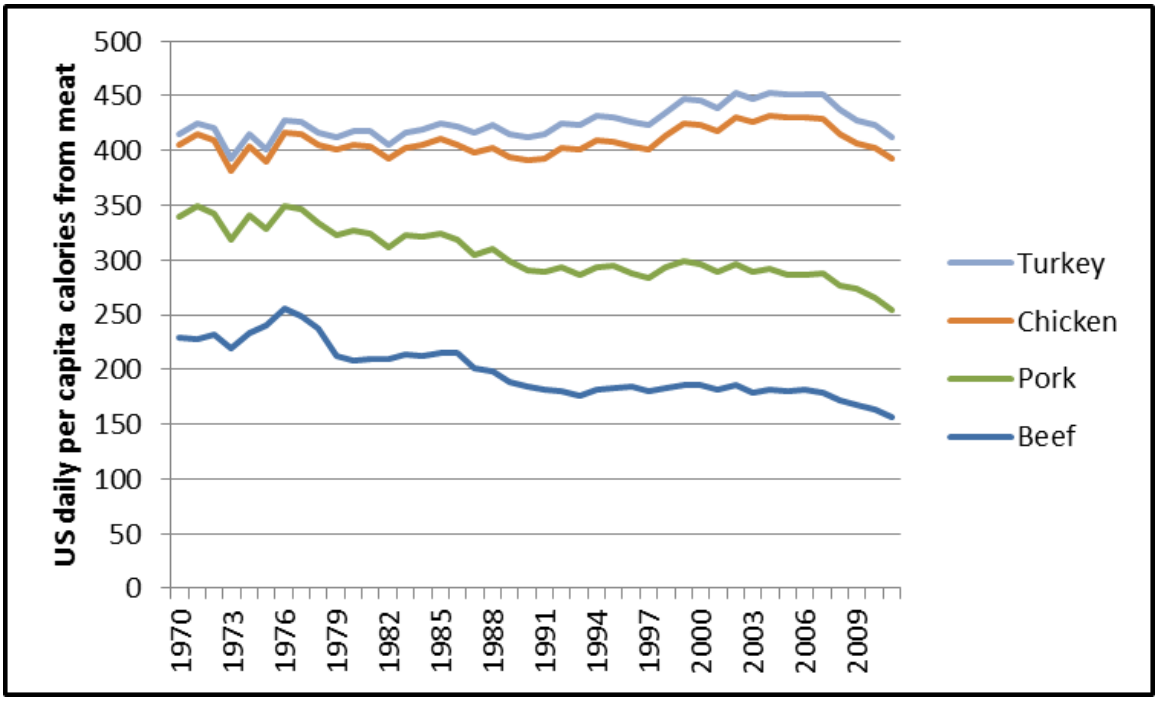
Land Transformation Elasticities

CARB has proposed to change the land transformation elasticities (ETL1 and ETL2) for a few of the regions in GTAP. These values were recently developed using the latest data available to the GTAP developers and CARB should provide their rationale and data for why the proposed values are better. Brazil, Russia and other South America have lower ETL1 values. Brazil, Other South America, the rest of SE Asia, and Sub Saharan Africa have revised ETL2 values.

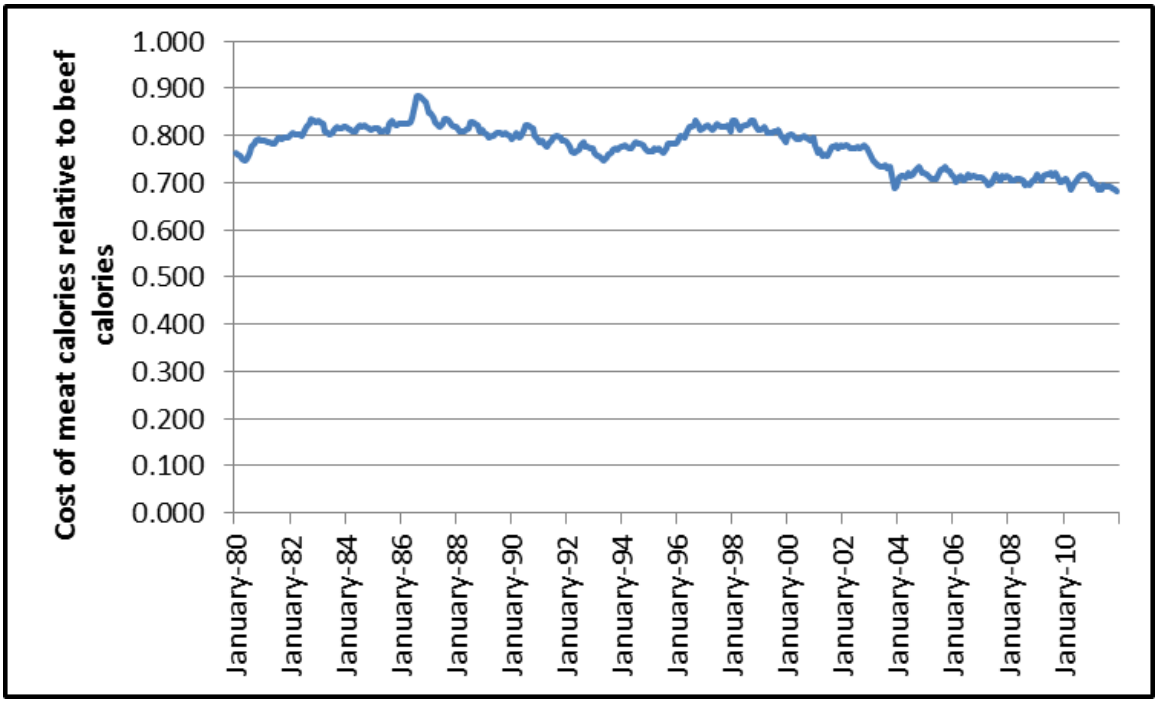
Food Consumption

The NBB supports the approach CARB has used to not try and model a "constant food" consumption scenario. We do not think that GTAP is capable of modelling such a scenario, as it only can model the dollars expended on food and not the calories. There are many ways in which food expenditures can be reduced without impacting calories, such as switching from red to white meats and/or from meats to cereals. Since the model is not capable of tracking the food use in this detail, any attempt to maintain food expenditures will result in decreased modelling precision, not more.

We know that there are continuing changes in what people eat. The following figure shows the changes in calories from meat from the various species over the past 45 years.



Source: USDA

The cost per calorie of each type of meat is different and the carbon footprint is also very different. Keeping food expenditures constant ignores the reality that the composition of the food basket can change to lower the cost while maintaining the same calories. And it doesn't capture the fact that the carbon footprint of the different kinds of food calories are not being captured by the model currently.

The following figure shows the cost of meat calories relative to the cost of beef calories since 1980. Even though meat consumption per capital is about the same now as it was in 1980, the lower cost of poultry (about half of beef prices) and pork (75% of beef price) compared to beef has decreased the cost of the meat calories that people are actually consuming. This is more evidence that a constant food expenditure scenario is not relevant to the real world.