Economic Impacts of Biodiesel Production on the Soybean Sector, Revisited

Introduction
Soybean producers have enjoyed record setting soybean prices the past few marketing years (Figure 1). While the driving forces behind these new price levels are multi-faceted and complex, they can be attributed to basic economic fundamentals of supply and demand. This is further complicated by the fact that soybean prices are not only impacted by the supply and demand of soybeans, but also by the supply and demand for soybean oil and soybean meal. Macro-economic factors such as the energy price bubble, increased world-wide demand for protein subsequently followed by the global economic recession, and the devaluation of the U.S. dollar have all significantly impacted demand and thus prices for soybeans, soybean oil, and soybean meal.

An important positive force impacting soybean prices has been the increased biodiesel production for which soybean oil has been the largest single feedstock. The amount of soybean oil used for biodiesel production has increased significantly since the 2004 marketing year (MY04)¹. This has helped support the higher soybean oil prices, which in turn elevated soybean prices received by soybean producers. In the real world, many factors work together to drive soybean prices and it is not readily apparent how much of the price changes come from a single factor such as biodiesel production. In this paper, we estimate how soybean producers have benefitted in the past and will continue to benefit from biodiesel production in the future.

Analysis Approach
The recent supply and demand events have not impacted soybean, soybean meal and soybean oil prices in isolation. They have occurred either simultaneously or have been affected by additional factors. As a result, a direct corollary cannot be drawn between a single demand factor such as increased biodiesel demand for soybean oil and increased soybean prices. To evaluate the impact of a single market force, all other forces need to be held constant. This is accomplished by using a partial equilibrium model to evaluate the economic impact of a single supply or demand factor — in this case, the increase in soybean oil demand for biodiesel. A partial equilibrium model evaluates the impact of a single economic event on one sector of the economy in isolation of other economic sectors. For this analysis, we use USB’s partial equilibrium model called the Value Chain Analysis (VCA) model to help us understand the impact of changes in soybean oil demand on oil prices, soybean prices and supply, meal prices and supply, and then ultimately, exports. This supply and demand model focuses on the U.S. soybean complex, therefore not accounting for changes in other sectors such as other domestic oilseeds, corn, or non-U.S.

¹ The marketing year for soybeans is from September through August of the following year. The marketing year for soybean oil and meal begins in October and ends in September of the following year.
markets. In other words, this analysis looks at the impacts of changed domestic soybean oil demand only, without any other forces impacting oil, meal and soybean demand, supply and prices.

Interpreting the results is augmented by understanding the basic economic principle behind soybean co-products – when demand for one co-product increases, the price of the other co-product decreases, with everything else equal. In other words, if no other forces impact the markets, increases in soybean oil demand would actually cause meal prices to decline. This inverse relationship is due to the fixed relationship between the volume of soybeans crushed and the amount of oil and meal produced from the crush. If more soybeans are crushed to meet increased oil demand, more meal will be produced as well. When this happens, simple supply and demand economics kick in, and the price of meal will decrease because of its increased supply.

Soybean Estimated Processed Value (EPV) is the sum of the meal, oil and hull product values when a bushel of soybeans is crushed. Figure 2 shows how soybean prices have risen and fallen with EPV over time, underscoring their economic relationship.

If the price of oil increases and the other prices and yields are held constant, EPV will increase, implying that soybean prices will also increase. However, if the oil price increase is a result of new oil demand (with no corresponding increase in meal demand), co-product economics will mitigate the impact of the EPV/soybean price increase. This is because an increase in demand for oil will increase domestic crush, putting more meal on the market. The increase in meal supply, with no new meal demand, will cause the meal price to decline. Thus, due to these co-product economics, EPV and ultimately soybean price increases might not be as high as one might expect. This is because only one factor that impacts soybean, oil and meal prices is being considered.

**Historical Benefits to the Soybean Sector**

This analysis provides estimates to answer the questions “What impact has the increase in biodiesel production had on soybean and soybean product prices and volumes with all other market forces held constant?” and “How has this helped soybean producers?”

To answer this, this paper assesses a scenario that assumes soybean oil use for biodiesel production remained at the same level for the 2005 through the 2009 marketing years as it was for MY04. The increase in biodiesel production was driven by several factors,
including the blenders’ tax credit (in effect from January 2005 through December 20092) and the Renewable Fuel Standards (RFS) mandated biodiesel volume. This scenario depicts what would have happened if the blenders’ tax credit had not been in place and RFS mandated volume requirements did not exist.

Figure 3 and Table 1 illustrate the actual use of soybean oil for biodiesel production (AKA methyl esters) and other uses along with the price of soybean oil on a marketing year basis since MY04.

**Table 1. Annual U.S. Domestic Soybean Oil Consumption by Use**

<table>
<thead>
<tr>
<th>Use (MM lbs)</th>
<th>'04</th>
<th>'05</th>
<th>'06</th>
<th>'07</th>
<th>'08</th>
<th>'09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edible products</td>
<td>17,418</td>
<td>17,120</td>
<td>16,147</td>
<td>15,916</td>
<td>14,282</td>
<td>13,698</td>
</tr>
<tr>
<td>Methyl esters</td>
<td>455</td>
<td>1,331</td>
<td>2,697</td>
<td>3,245</td>
<td>1,917</td>
<td>1,682</td>
</tr>
<tr>
<td>Other inedible products</td>
<td>747</td>
<td>776</td>
<td>464</td>
<td>381</td>
<td>340</td>
<td>281</td>
</tr>
<tr>
<td>Crude soybean oil price (cents/lb)</td>
<td>23.8</td>
<td>23.3</td>
<td>31.8</td>
<td>52.7</td>
<td>32.4</td>
<td>35.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>'05</th>
<th>'06</th>
<th>'07</th>
<th>'08</th>
<th>'09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edible products</td>
<td>94%</td>
<td>89%</td>
<td>84%</td>
<td>81%</td>
<td>86%</td>
</tr>
<tr>
<td>Methyl esters</td>
<td>2%</td>
<td>7%</td>
<td>14%</td>
<td>17%</td>
<td>12%</td>
</tr>
<tr>
<td>Other inedible products</td>
<td>4%</td>
<td>4%</td>
<td>2%</td>
<td>2%</td>
<td>2%</td>
</tr>
</tbody>
</table>

Sources: Census Bureau and USDA/ERS

USB’s Value Chain Analysis (VCA) model is used to understand the impact of the reduced soybean oil demand on the soy sector, holding everything else constant. Based on results from this model, Table 2 reports the estimates of the incremental changes from the base case if the demand for soybean oil used for biodiesel production had not increased beyond the MY04 production levels.

**Table 2. Estimated Change from Base Case of Assuming No Growth in Biodiesel Production**

<table>
<thead>
<tr>
<th>Resulting Change in:</th>
<th>'05</th>
<th>'06</th>
<th>'07</th>
<th>'08</th>
<th>'09</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean Oil Price (cents/lb)</td>
<td>(4.2)</td>
<td>(10.3)</td>
<td>(12.5)</td>
<td>(7.8)</td>
<td>(6.8)</td>
<td></td>
</tr>
<tr>
<td>Soybean Meal Price ($/T)</td>
<td>16.22</td>
<td>40.10</td>
<td>48.31</td>
<td>30.66</td>
<td>27.60</td>
<td></td>
</tr>
<tr>
<td>Soybean Price ($/bu)</td>
<td>(0.09)</td>
<td>(0.22)</td>
<td>(0.27)</td>
<td>(0.16)</td>
<td>(0.13)</td>
<td></td>
</tr>
<tr>
<td>Soybean Acres (MM)</td>
<td>0.0</td>
<td>(0.4)</td>
<td>(1.1)</td>
<td>(1.4)</td>
<td>(0.8)</td>
<td>(3.7)</td>
</tr>
<tr>
<td>Production Sector Returns</td>
<td>(269)</td>
<td>(662)</td>
<td>(834)</td>
<td>(498)</td>
<td>(401)</td>
<td>(2,664)</td>
</tr>
</tbody>
</table>

**Observations on Historical Scenario Results**

The following are key observations from the analysis of reduced soybean oil use for biodiesel production from actual soybean oil utilization for MY05 through MY09, holding everything else constant:

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2 A retroactive biodiesel tax credit extension was passed into law for 2010 in December 2010. However, this extension cannot change MY09 production levels and therefore, does not impact this historical analysis.
Soybean Oil Price: As a result of the decreased demand, soybean oil prices would have been lower than they actually were during the period by 4.2 cents per pound in MY05, 10.3 cents per pound in MY06, and so on.

Soybean Meal Price: Soybean meal prices would have actually been higher since a decrease in demand for soybean oil reduces domestic crush and thus the domestic supply of soybean meal. The reduced supply of soybean meal then puts upward pressure on soybean meal prices. The higher soybean meal prices could have cost the livestock industry an additional $1.4 billion in MY07 alone and a total of $4.8 billion from MY05 through MY09.

Soybean Prices: A sustained reduction of 13 to 16 cents per bushel would have been realized by the end of the period. Note that these sustained reductions apply to all U.S. soybeans and not just to those used for biodiesel production.

Soybean Acres: Due to the decreased soybean oil demand, and resulting decrease in soybean price, fewer acres would have been planted to soybeans.

Production Sector Returns: This is an estimate of the change in net returns to the soybean production sector. Thus, over the five year period, soybean producers would have seen their net returns reduced by approximately $2.7 billion.

Future Impacts of Biodiesel Production to the Soybean Sector

A successful and robust biodiesel industry will continue to provide significant benefits to the soybean sector. In this section, we look at how the soybean industry could be impacted if production volumes are decreased from current expectations as a result of changes in policy or other factors.

The biodiesel industry is in its early stages of development; a characteristic of this phase is its vulnerability to several demand and supply factors that could put the biodiesel industry at risk and as a result, negatively impact the soybean industry as a whole. These numerous factors include public sentiment towards biofuels, the fuel supply chain’s integration of biofuels, the mandated volume for biofuels, policies providing economic incentives for biofuel production (e.g., the blenders’ tax credit), and the price and availability of biofuel feedstocks. Policy and regulations have been the largest sources of uncertainty in 2010 for the biodiesel industry. Biodiesel producers had been waiting to see if the blenders’ tax credit that expired in December 2009 would be extended, and for the issuance of the EPA’s final RFS2 program regulations, in addition to rules for new fuel pathways for generating RINs for biofuels produced the latter part of 2010. The reduced biodiesel production witnessed this year is a manifestation of these uncertainties.

However, the unknowns extend beyond 2010. Uncertainty about the continuation of the blenders’ tax credit beyond 2011 still exists. In addition, EISA requires EPA to set the renewable fuel standards each November for the following year. Their ruling will be based on the gasoline and diesel projections issued by the Department of Energy’s Energy Information Administration (DOE EIA). This is in addition to EPA being required to establish standards for biomass-based diesel of a minimum of 1 billion gallons for 2013 and beyond. This additional rule will be based on analysis of the impact of renewable fuels production on the environment, infrastructure, costs and other items.

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3 The blenders’ tax credit is only extended through 2011.
Scenario Description

Baseline projections for future production of biomass-based diesel are developed as part of the VCA analysis. These baseline projections include the amount of feedstocks by category, including soybean oil, used for biodiesel production. These assumptions then impact the price and quantity produced and utilized of soybean oil, soybean meal, and soybeans in the baseline projections. Changing policy or other economic circumstances also affect the estimates of future prices and quantities. These baseline projections assume the RFS2 mandated amount of biomass-based diesel fuel is produced in MY11 and beyond. It subsequently assumes that 50% of the domestic biomass-based diesel or biodiesel produced from MY11 through MY15 will be from soybean oil (Figure 4).4

Recent history has shown that policies supporting the production of biodiesel are under constant pressure. What if the mandates are softened? What if the blenders’ tax credit is not extended beyond 2011? What if some other opposition leads to policy changes that reduces the amount of biodiesel production from these baseline levels? Each of these would put pressure on biodiesel production and lower the estimated utilization of soybean oil from the amounts assumed in the baseline. To understand the economic impact of reductions due to these kinds of issues, a generic scenario was constructed that assumes that domestic biodiesel production is reduced by 25% from the projected volume beginning in MY11. It is further assumed that 80% of the reduced production will come from soybean oil-based biodiesel and the remaining reduction impacts the other feedstocks (Figure 5).5

![Figure 4. Baseline Estimate of Biodiesel Production by Feedstock Type](image1)

![Figure 5. Scenario Estimate of Biodiesel Production by Feedstock Type](image2)

The result is that soybean oil demand would decrease by approximately 1.5 billion pounds in MY11 up to nearly 1.6 billion pounds beginning in MY12 (Table 3). Modeling the impact of these reductions delivers the following estimated results:

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4 While current industry use of soybean oil use for biodiesel production is less than 50% of all feedstocks, industry expectations are that soybean oil use will be at least 50% in at least the ensuing five years. This is consistent with USDA’s and FAPRI’s annual baseline projections in which assumptions about biodiesel production are made. For their 2010 baselines, USDA assumed enough biodiesel would be produced to meet the 1 billion gallon mandated volume in 2012, while FAPRI projects that biodiesel in excess of the mandated volume would be produced. USDA and FAPRI estimate the share of soy-based biodiesel to be from 40% to 52%, respectively.

5 This scenario is one of many possible scenarios in which domestic biodiesel production and/or the feedstock shares are varied. Since it is difficult to predict the future with any accuracy given the uncertainties, this scenario is presented as just one possibility.
Table 3. Estimated Impact of Reduced Biodiesel Production

<table>
<thead>
<tr>
<th>Marketing Year</th>
<th>'11</th>
<th>'12</th>
<th>'13</th>
<th>'14</th>
<th>'15</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduction in SBO demand from baseline assumptions (MM lbs)</td>
<td>(1,502)</td>
<td>(1,581)</td>
<td>(1,581)</td>
<td>(1,581)</td>
<td>(1,581)</td>
<td></td>
</tr>
<tr>
<td>Resulting change in:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean Oil Price (cents/lb)</td>
<td>(9.9)</td>
<td>(10.5)</td>
<td>(10.6)</td>
<td>(10.7)</td>
<td>(10.6)</td>
<td></td>
</tr>
<tr>
<td>Soybean Meal Price ($/T)</td>
<td>36.77</td>
<td>36.40</td>
<td>35.50</td>
<td>35.15</td>
<td>34.44</td>
<td></td>
</tr>
<tr>
<td>Soybean Price ($/bu)</td>
<td>(0.21)</td>
<td>(0.28)</td>
<td>(0.31)</td>
<td>(0.33)</td>
<td>(0.33)</td>
<td></td>
</tr>
<tr>
<td>Soybean Acres (MM)</td>
<td>0.0</td>
<td>(0.4)</td>
<td>(0.6)</td>
<td>(0.6)</td>
<td>(0.7)</td>
<td></td>
</tr>
<tr>
<td>Production Sector Returns (Nominal $MM)</td>
<td>(688)</td>
<td>(950)</td>
<td>(1,063)</td>
<td>(1,120)</td>
<td>(1,144)</td>
<td>(4,965)</td>
</tr>
</tbody>
</table>

Observations on Future Scenario Results

Key takeaways from the analysis of reduced future use of soybean oil for biodiesel production from the baseline projection are as follows. As with the historical analysis, these results reflect only the impact of lower soybean oil use, holding everything else constant.

Soybean Oil Price: As a result of the lower demand, soybean oil prices would be lower than previously projected by 9.9 cents per pound in MY11 to 10.6 cents per pound in MY15.

Soybean Meal Price: Soybean meal prices would be higher than projected due to the lower soybean oil demand, thus reducing domestic crush and the domestic supply of soybean meal. Soybean meal prices could increase by as much as $36 per ton, costing domestic livestock producers an additional $4.6 billion for soybean meal purchases over the five year period. These higher meal prices would put further pressure on soybean meal’s declining use in domestic livestock rations.

Soybean Prices: The lower soybean oil demand would decrease soybean prices by approximately 21 cents per bushel in MY11 to 33 cents per bushels in MY15. Note that these sustained lower prices apply to all U.S. soybeans and not only to those used for biodiesel production.

Soybean Acres: Due to the decrease in soybean oil demand and resulting lower soybean prices, fewer acres would be planted to soybeans.

Production Sector Returns: This is an estimate of the change in net returns to the soybean production sector. Thus, over the five year period, soybean producers could possibly see their net returns lowered by approximately $4.9 billion in nominal dollars.

As noted above, these are estimated results, dependent on many assumptions developed for both the baseline projections and the scenario. The VCA analysis evaluates the impact of demand and supply changes (or shocks) on the soy sector in isolation of other market forces impacting the soybean sector and other agricultural sectors such as corn. However, U.S. corn and soybean production, and as a result,
ethanol and biomass-based diesel production, are interconnected. Different assumptions could be applied to the baseline projections to reflect other conditions that could alter the baseline projections. Examples of alternative assumptions include the manner in which soybean production is impacted by soybean price changes and competition from other crops. In addition, different levels of reduced biodiesel production and/or reduced use of soybean oil for biodiesel production could be developed. These alternative assumptions would provide a range of potential economic impact of reduced biodiesel production.

**Summary**
Biodiesel has had a constructive impact on the soybean complex over the last five years due to increased soybean oil demand for biodiesel production. In addition, it is expected that production of this biomass-based diesel will continue to contribute positively to the U.S. soybean industry in the future. The analysis reported in this white paper demonstrates the importance of maintaining a healthy biodiesel industry to maintain strong domestic soybean oil demand, strong demand for U.S. soybeans and ultimately higher soybean prices. In summary:

- Historically, the growth in demand for soybean oil for biodiesel production tended to mask the negative demand impacts resulting from trans-fat labeling.
- Greater soybean oil demand for biodiesel production in the past five marketing years increased demand for soybeans, ultimately leading to higher soybean prices received by producers. When looking at only the impact of increased biodiesel production, biodiesel demand for soybean oil provided an estimated 9 to 27 cent per bushel support to soybean prices over the past five marketing years. This has resulted in approximately $2.7 billion of additional net returns to the production sector. This is in addition to other market forces increasing prices.
- The increased demand for soybean oil has subsequently increased the production of soybean meal, thus lowering soybean meal prices by $16 to $48 per ton from where they would have otherwise been from MY05 through MY09.
- Despite the blenders’ tax credit only being in effect retroactively in 2010, soybean farmers have still benefited from biodiesel production by an estimated $400 to $500 million in MY09 alone.
- Losing just a portion of the demand for soybean oil in the future could have an estimated impact on soybean prices ranging from 21 to 33 cents per bushel. This could negatively impact the soybean production sector by about $4.9 billion in nominal dollars over the next five marketing years.
- QUALISOY-funded analysis suggests that declines in soybean oil demand from trans-fat avoidance will continue for the next couple of years.
- Therefore, a healthy biodiesel industry with the capacity to produce at least the mandated RFS2 volume will provide support to soybean oil demand and ultimately to the soybean complex.

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6 For example, the DOE EIA issued five different cases or baselines (reference, high and low economic growth and high and low oil price cases) in their Annual Energy Outlook 2010.