The Market Effects of Low-Oligosaccharide Soybeans

David Shively
Graduate Research Assistant
Department of Agricultural & Applied Economics
University of Missouri
143 Mumford Hall
Columbia, MO 65211
dwsmt4@mail.missouri.edu

Joe Parcell
Professor
Department of Agricultural & Applied Economics
143 Mumford Hall
University of Missouri
Columbia, MO 65211
(573) 882-0870
parcellj@missouri.edu

Selected Paper prepared for presentation at the Southern Agricultural Economics Association (SAEA) Annual Meeting, Dallas, Texas, 1-4 February, 2014

© 2014 by David Shively and Joe Parcell. Readers may make verbatim copies of this document for non-commercial purposes by any means, provided this copyright notice appears on all such copies
The Market Effects of Low-Oligosaccharide Soybeans

David Shively and Joe Parcell

Abstract

Research suggests that soybean meal derived from low-oligosaccharide (LO) soybeans could displace more expensive products in young pig and poultry diets without a loss in efficiency. This raises questions about the market effects and division of surplus throughout the soybean meal value chain. This study addresses these questions.

*Keywords:* soybeans, low-oligosaccharide, identity preserved, pork

*JEL Classification:* Q11, Q13

Introduction

Oligosaccharides are carbohydrates that can interfere with proper digestion, especially in monogastric animals. Conventional soybeans contain the oligosaccharides raffinose and stachyose. When the soybeans are crushed and processed these oligosaccharides remain in the soybean meal, and are subsequently fed to animals. If the oligosaccharides are removed or significantly reduced, it can result in improved digestibility and consequently increased feed efficiency in a variety of livestock feeding operations, particularly pork, poultry, and aquaculture. The objective is twofold: (1) to determine the market effects of the adoption of LO soybean technology on the demand and price of soybeans; and, (2) to determine whether the necessary potential
profitability exists to justify investing in the development of such a technology including the need for identity preservation. For the current study pork will be the focus of the livestock industry adoption.

The current methods for removing oligosaccharides from conventional soybean meal are quite expensive, relatively inefficient, and results in a product that has serious palatability issues as a feed. For these reasons, several entities have made efforts to develop soybean varieties which naturally exhibit reduced levels of oligosaccharides. These LOSBM products have the same consistency and palatability traits as conventional soybean meal. The LOSBM soybeans must be identity preserved from all other varieties of soybeans at every step along the supply chain, from producer to processor. Identity-preserved products such as this result in significant transaction costs to each individual along the value chain, thus a price premium must exist, and the price premium must be significant enough to compensate entities for incurring these costs. The question then becomes, how significant can these price premiums for identity-preserved LO soybeans be without eliminating the viability of LOSBM as a cost effective feed component.

The concept of a soybean meal that is more efficient as a feed presents some interesting questions. What could the market effects and possible ramifications be? If adopted, will this increase in efficiency result in higher demand for soybean meal as it is substituted for other more expensive or less efficient feed options? Could this increase
in efficiency lead to a cannibalization of the soybean meal market as less meal is
necessary to reap the same benefits? The poultry study conducted in Perryman,
Olanrewaju, and Dozier suggests that it is likely some combination of these outcomes. In
their study less soybean meal was required in the ration due to the increased efficiency,
but there were still some displacement effects on other more expensive sources of
protein. The current study will seek to build upon the current body of knowledge to
answer these questions, and develop a clear picture of the end-user value available to
soybean production and processing system. Along with genetic suppliers, seed dealers,
farmers, soybean handlers, and processors will require compensation for the added
costs of identity-preservation and the risk of yield reduction from producing a
commodity different from conventional soybean.

Literature Review:

With ever increasing technology in the agriculture sector many commodities are
becoming less and less homogenous as unique varieties are developed to express a
particular trait or set of traits. This increasing differentiation in commodities
necessitates an increasingly complex and specialized supply chain as producers seek to
match consumer demand while maintaining efficiencies (Drabenstott 1999). This results
in a higher degree of vertical coordination throughout the system, as identity
preservation becomes increasingly essential.
When taken to the extreme, this vertical coordination sometimes consists of a single entity taking control of several stages in the process, insourcing steps that have previously been conducted by separate entities. This is more commonly known as vertical integration, and while vertical integration does occur, it tends to be quite capital intensive and is not nearly as prevalent in agriculture as it is in many other industries (Myers et al. 2010). Instead, vertical coordination in agriculture often takes the form of contract production, with nearly 40% of all agricultural production in the United States being governed by some form of contract (MacDonald and Korb 2006). Under this form of vertical coordination a producer commits to the future delivery of a product (or is some cases a service). While the level of detail involved in these contracts can vary widely depending upon the individual characteristics of those entities involved, most contract specifications include expectations of product quality and purity, of pricing structure (often set as a premium above some spot market price) and of delivery options. This type of coordination allows both the producer and the purchaser to reduce or offset market uncertainty and risk in exchange for fewer decision rights.

These types of system changes are not without cost. In order to maintain identity-preservation between separate varieties significant changes must be made. Facilities must be built, expanded, and adapted. Special handling and production procedures must be implemented. Third-party verification and testing capabilities must be in place. All of this means significant capital investment, as well as higher
labor costs. In addition to increased production costs, transaction costs such as contracting and monitoring also increase. In order to justify investing in these measures, a price premium must be in place to offset these additional costs. This study will focus on end-user in the soybean supply chain by assessing the size of the premium livestock (hog producers) are able to pay for the value added product LOSBM. This can then be used to derive the necessary soybean production contract terms and genetic value.

According to transaction cost theory increased asset specificity results in higher transaction costs, and that holds true for this case. As an asset becomes more specific, difference in value between their intended use and the next best option increases. Identity-preserved (IP) soybeans have a significantly higher level of asset specificity than typical commodity soybeans. In addition to increased asset specificity, another factor often emphasized in transaction cost economics becomes quite important, and that factor is risk. There always exists an inherent risk in agricultural production, as so many variables affecting the outcome are beyond the control of individual producers. Drought, floods, natural disasters, all of these can make or break a crop, but even after the crop has been produced and harvested the producer is still subject to price risk. Commodities markets are notoriously more volatile than other product markets such as manufacturing (Jacks, O'Rourke, and Williamson 2011), which leaves producers open to significant price risk. But instead of production or price risk, transaction cost theory
focuses on risk of opportunism and hold-up. This risk factor is magnified as asset specificity increases due to the declining number of possible alternative marketing avenues. If an entity is supplying a highly specialized variety of identity-preserved soybeans there may be only a handful of potential buyers (or in some cases only one, especially after geographical considerations are taken into account), as opposed to commodity soybeans which can be sold at countless locations. Since a homogenous commodity tends to have large numbers of both suppliers and end users the risk to either party associated with opportunism is fairly low. As the products become more specialized the number of producers and end users dwindles, leaving both sides vulnerable to opportunistic behavior (Artz and Brush 2000).

In order to offset some of this risk, decision makers at different points along the agricultural supply chain have been increasing the use contracting as a form of organization (Tsoulouhas and Vukina 1999). Contracts allow all involved parties to come to an agreement upon the allocation of risk, decision rights, and the distribution of value (Sykuta and Parcell 2003). This typically involves a trade-off where one party assumes all or a portion of the risk from the second party in exchange for greater decision rights, a more favorable distribution of value, or some combination of the two. This allows the risk averse decision maker to offset their risk (and some of their potential profit) in exchange for greater certainty in the outcome, while the risk seeking are able to recognize greater potential value, and more decision rights throughout the
process. Contracts are essentially a legally binding agreement wherein the details of a transaction are laid out and agreed upon (Sykuta and Parcell 2003).

An issue that arises is the incompleteness of contracts. Given the limits imposed by imperfect information, bounded rationality, and the vast multitude of possible future outcomes that cannot be predicted contracts are incomplete by nature, and it would in fact be impossible to ever write a truly complete contract (Hart 1993; Williamson 1993). This then leaves the door open for some act of opportunism by one of the parties in the contract (Crocker and Reynolds 1993), even though the prevention of opportunism and the reduction of risk are the chief goals of contracting. The incompleteness of contracts and the often substantial monitoring costs are further contributors to increased transaction costs.

Identity Preservation:

Many recent technological developments in soybeans affect the production side of the equation and result in a homogenous product for the end users. On the other hand, a few of the recent developments, and many more that are currently in the works, effect the potential end uses of the soybeans. When the end user is the target, identity preservation is key in order to receive the benefits of the technology.

A successful program of identity preservation requires that the soybeans must be carefully handled through each stage of the soybean marketing system in order to
ensure that they are not contaminated with other soybeans which do not meet the same standards. This requires dedicated moving, storing, processing capacity, and equipment capable of testing for contamination, at least for some period of time while both commodity beans and the identity preserved beans are both on hand (Bullock and Desquilbet 2013). It is important to remember that these costs must be incurred at each stage along the supply chain and not just at the farm level (farmer, elevator, and processor) until the final product reaches the end user. For some of the agents along the supply chain such as elevators, this can be quite costly due to the number of different types of grain and the large volume of grain they tend to handle along with their other limitations (size and number of bins, producers in the area, etc.).

**Methods:**

We seek to understand the value proposition to the soybean value chain through understanding the value added to an average hog producer adopting LOSBM. This procedures allows for assessing whether the cost to the system is greater than value. A livestock production budget was constructed within an optimization modeling system. This was a linear programming ration optimization model constructed using Microsoft Excel. Sensitivity analysis was then performed, adjusting the price premium for LO soybean meal over conventional soybean meal in order to simulate rates of use within windows of relative prices between LO soybean meal and conventional soybean meal.
Effectively this simulated the rate of adoption of the soybean technology by livestock producers at various price premiums, and allowed for the estimation of cross price elasticity between the two products.

At the same time a literature review was conducted to determine the costs associated with identity preservation within a commodity, such as would be required with this type of technology. The findings of this review consisted of rough numbers on both-the out-of-pocket costs associated with an identity-preserved product, as well as some estimates of the transaction costs associated with a program of this type.

Model:

In order to examine the viability of LOSBM as a feed ingredient, a model of a farm level feed budget for hogs was developed. The minimum required levels for optimal growth of 15 different key nutrients were identified, focusing on the nutritional requirements of hogs between 10 and 50lbs, as this is the age/weight range where they are most affected by the presence of oligosaccharides in their feed. Next, 27 different feed products and supplements (including both conventional and LOSBM) commonly used in this industry were identified, along with their respective nutrient composition profiles.

Historical monthly price series spanning from January 2010 to October of 2013 were located for each of the feed ingredients, while spot prices were used for the
majority of the supplements (as no historical price data exists for these products). At this point a series of linear regressions were conducted in order to relate the prices of substitute ingredients back to the price of conventional soybean meal. This action made it possible to run a number of different scenarios using different price levels for soybean meal and its substitutes. The one exception to this was LOSBM, the price of which was set up as the sum of a price premium and the price of conventional soybean meal in order to test different price premiums while conducting sensitivity analysis.

Once all of the necessary data had been compiled, a linear optimization model was constructed with the objective function:

$$\min \sum_{i=0}^{n} P_i Q_i$$

where $P_i$ is the price of the $i^{th}$ feed ingredient ($$/ton), and $Q_i$ is the quantity of the $i^{th}$ feed ingredient used (% of final formulation). This equation was subject to the constraints:

$$\sum_{i=0}^{n} Q_i = 1$$

and

$$N_i \geq R_i$$

where $N_i$ is the availability of the $i^{th}$ nutrient in the final formulation, and $R_i$ is the minimum required availability of the $i^{th}$ nutrient in the final formulation.
The resulting model solved to find the cheapest possible feed formulation that satisfied all of the nutritional requirements by providing at least the minimal required availability of each nutrient.

Results:

This results of this research have some interesting implications. The optimization modeling results displayed in Tables 1, 2, and 3 showed that depending upon the availability of different feed ingredients LOSBM can serve as an economically feasible alternative, at some price and premium levels making up nearly 20% of the total feed ration.

The results of the equilibrium displacement model also proved to be positive for those interested in LOSBM. Depending upon the assumed rate of adoption for LO soybeans, the market price for soybeans could rise by as much as 2.5% as a result of increased demand. This is due to the fact that in the optimization modeling, while LOSBM did replace conventional soybean meal, it also replaced other high protein alternatives, resulting in a higher level of soybean meal use.

Conversely, the results of the literature review were not as positive. For LOSBM to remain a viable option in feed rations, the highest premium above the price of conventional soybean meal that could be charged was $69.75 per ton, which was equal to a premium of $1.53 per bushel of LO soybeans, and this is at the end user. Only a
fraction of this $1.53 would reach the soybean producer as each entity along the supply chain received their cut and was compensated for dealing with identity preservation issues.

Several studies have been done to examine the costs associated with identity preservation at different stages of the value chain. Some estimate that the physical costs at the farm level the costs may range between $0.03 and $0.18 per bushel (Huygen, Veeman, and Lerohl 2004). Similar studies conducted at the elevator level suggest that identity preservation can be expected to cost an elevator between $0.02 and $0.04 per bushel (Hurburgh 1994). Other studies suggest that when opportunity costs are taken into effect (unlike Hurburgh 1994) the economic costs at the elevator level of handling identity preserved grain vary significantly but can be expected to be in excess of $0.15 per bushel, and in most cases exceed $0.35 per bushel (Maltsbarger and Kalaitzndokes 2000).

A number of 2014 IP soybean contracts can be viewed online at websites such as soybeanpremiums.org, which displays a several different contract options throughout the Midwest. Depending upon the traits or variety being preserved, the buyer issuing the contract, and the delivery location the premiums associated with these contracts vary greatly. On the low end some contracts preserving one specific trait such as low linoleic oil are offering premiums around $0.45-$0.60 per bushel. On the high end contracts for specific varieties of soybeans are paying well above $2.00 a bushel, with
some reaching nearly $2.50 per bushel. In the middle are Non-GMO soybean contracts which seem to be paying between $1.00 and $1.50 a bushel.

Conclusions:

Motivated by the current interest in developing LO soybean varieties this study sought to analyze what effects the adoption of this technology would have, and whether the necessary profitability would exist to facilitate this adoption. Despite some indications that this technology could result in the cannibalization of the soybean meal market due to increased efficiency, the results of this study suggest that if LO soybean technology were to be adopted, it would result in slightly increased demand for soybeans, and a slightly higher market equilibrium price.

At the same time, LO soybeans only have an added value of $1.53 on the high end. Research suggests that the costs associated with identity preservation from producer to end user can exceed $0.50 per bushel. This means that once the additional costs are covered, the LO trait only adds approximately $1.00 in value to a bushel of soybeans. Once each entity along the supply chain takes their portion of the added value, the remaining premium paid to the soybean producer will not likely be substantial enough to compete with other soybeans varieties offering much higher premiums. These findings show that under current conditions the adoption of LO soybean technology is extremely unlikely given the numerous other more profitable alternatives for producers.
References:


<http://soybeanpremiums.org/find-a-program/>.


tolerance levels: Non-genetically modified wheat in western

Jacks, David S., Kevin H. O'Rourke, and Jeffrey G. Williamson. "Commodity Price
Volatility and World Market Integration since 1700." Review of Economics and

USDA Economic Information Bulletin No. 9.


Schmitz, Patrick W. "The Hold-Up Problem and Incomplete Contracts: A Survey of
Print.

Sykuta, Michael, and Joseph Parcell. "Contract Structure and Design in Identity-
Preserved Soybean Production." Review of Agricultural Economics 25.2 (2003):
332-50.


Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost ($/ton)</td>
<td>$257.01</td>
<td>$281.74</td>
<td>$284.39</td>
</tr>
<tr>
<td>LO Premium ($/bu)</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.35</td>
</tr>
<tr>
<td>LO Premium ($/ton)</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$15.98</td>
</tr>
<tr>
<td>LO Soybean Meal</td>
<td>16.56%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>22.73%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>20.35%</td>
<td>17.95%</td>
<td></td>
</tr>
<tr>
<td>DDGS</td>
<td>35.00%</td>
<td>35.00%</td>
<td>35.00%</td>
</tr>
<tr>
<td>Milo</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunflower Meal</td>
<td>37.69%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat &amp; Bone Meal</td>
<td>21.80%</td>
<td>22.75%</td>
<td>18.94%</td>
</tr>
<tr>
<td>Limestone</td>
<td>5.00%</td>
<td>5.00%</td>
<td>5.00%</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.45%</td>
<td>0.24%</td>
<td>0.26%</td>
</tr>
<tr>
<td>Threonine</td>
<td>0.04%</td>
<td>0.07%</td>
<td>0.09%</td>
</tr>
<tr>
<td>Methionine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tryptophan</td>
<td>0.02%</td>
<td>0.03%</td>
<td>0.03%</td>
</tr>
</tbody>
</table>

Notes:
1. Unused feed ingredients were left out of tables
2. Feed ingredients limited by availability were excluded from all but the initial iteration
3. Table 1 shows results with a 3-year average price level
Table 2.

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost ($/ton)</td>
<td>$174.95</td>
<td>$197.37</td>
<td>$199.03</td>
<td>$199.31</td>
</tr>
<tr>
<td>LO Premium ($/bu)</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.19</td>
<td>$0.24</td>
</tr>
<tr>
<td>LO Premium ($/ton)</td>
<td>$0.00</td>
<td>$0.00</td>
<td>$8.86</td>
<td>$10.93</td>
</tr>
<tr>
<td>LO Soybean Meal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>18.82%</td>
<td>13.47%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DDGS</td>
<td>35.00%</td>
<td>35.00%</td>
<td>35.00%</td>
<td>35.00%</td>
</tr>
<tr>
<td>Milo</td>
<td>15.08%</td>
<td>14.44%</td>
<td>12.81%</td>
<td></td>
</tr>
<tr>
<td>Oats</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunflower Meal</td>
<td>44.78%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat &amp; Bone Meal</td>
<td>19.77%</td>
<td>26.00%</td>
<td>24.67%</td>
<td>21.30%</td>
</tr>
<tr>
<td>Limestone</td>
<td>0.04%</td>
<td>5.00%</td>
<td>5.00%</td>
<td>5.00%</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.42%</td>
<td>0.10%</td>
<td>0.11%</td>
<td>0.14%</td>
</tr>
<tr>
<td>Threonine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methionine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tryptophan</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes:
1. Unused feed ingredients were left out of tables
2. Feed ingredients limited by availability were excluded from all but the initial iteration
3. Table 2 shows results with a 3-year low price level
Table 3.

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost ($/ton)</strong></td>
<td>$354.47</td>
<td>$382.30</td>
<td>$385.70</td>
<td>$386.13</td>
</tr>
<tr>
<td><strong>LO Premium ($/bu)</strong></td>
<td>$0.00</td>
<td>$0.00</td>
<td>$0.63</td>
<td>$1.53</td>
</tr>
<tr>
<td><strong>LO Premium ($/ton)</strong></td>
<td>$0.00</td>
<td>$0.00</td>
<td>$28.47</td>
<td>$69.75</td>
</tr>
<tr>
<td><strong>LO Soybean Meal</strong></td>
<td></td>
<td>11.95%</td>
<td>1.05%</td>
<td></td>
</tr>
<tr>
<td>Soybean Meal</td>
<td></td>
<td>16.04%</td>
<td>17.58%</td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td></td>
<td>26.32%</td>
<td>23.62%</td>
<td>23.36%</td>
</tr>
<tr>
<td>DDGS</td>
<td></td>
<td>35.00%</td>
<td>35.00%</td>
<td>35.00%</td>
</tr>
<tr>
<td>Milo</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oats</td>
<td></td>
<td>12.05%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunflower Meal</td>
<td></td>
<td>28.28%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat &amp; Bone Meal</td>
<td>18.90%</td>
<td>21.00%</td>
<td>18.61%</td>
<td>18.38%</td>
</tr>
<tr>
<td>Limestone</td>
<td>5.00%</td>
<td>5.00%</td>
<td>5.00%</td>
<td>5.00%</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.58%</td>
<td>0.42%</td>
<td>0.41%</td>
<td>0.41%</td>
</tr>
<tr>
<td>Threonine</td>
<td>0.14%</td>
<td>0.17%</td>
<td>0.17%</td>
<td>0.16%</td>
</tr>
<tr>
<td>Methionine</td>
<td></td>
<td>0.07%</td>
<td>0.05%</td>
<td>0.05%</td>
</tr>
<tr>
<td>Tryptophan</td>
<td>0.05%</td>
<td>0.06%</td>
<td>0.06%</td>
<td>0.06%</td>
</tr>
</tbody>
</table>

Notes:
1. Unused feed ingredients were left out of tables
2. Feed ingredients limited by availability were excluded from all but the initial iteration
3. Table 3 shows results with a 3-year high price level