



# VALUING CANOLA AND CAMELINA BIODIESEL BYPRODUCT MEAL AS A LIVESTOCK PROTEIN SUPPLEMENT

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## Introduction

Oil seed crops are receiving increased interest in eastern Washington from farmers looking to introduce a new crop alternative into their rotation and for their market potential to produce biodiesel. Cropping system benefits from growing oil seed crops include improved soil conditions, weed control, higher cereal crop yields following the oilseeds, and increased market diversification (Sowers et al. 2012).

Oil seed crops grown in the Pacific Northwest over the last 30 years include soybeans, sunflower, safflower, flaxseed, crambe, rapeseed, mustard, canola, and camelina. Canola and camelina are particularly interesting because of their potential to produce biodiesel. A byproduct of canola and camelina biodiesel production is a protein rich byproduct meal. Byproduct feedstuffs such as canola and camelina meal may be a cheaper source of protein and energy than conventional feeds.

This report evaluates the market value of canola and camelina byproduct meal as a livestock feed protein supplement and discusses their feed properties and limitations. The first sections of the report briefly review Washington canola and camelina production, processing and their nutrient profiles. The next sections present the least-cost ration formulation and input substitution principles used to estimate canola and camelina meal values. The last sections of the report evaluate the accuracy of the market value estimates to actual prices reported in the Pacific Northwest and offer summary conclusions.

## Canola Production

Canola acreage in eastern Washington has increased rapidly since 2011 (Figure 1). This represents an annual growth rate of 52%. In 2011 and 2012 canola ranked 39th in value of production for all crops produced in Washington.

Table 1. Washington State canola statistics<sup>1</sup>

	2011	2012	2013	2014
Total Value of Production	\$4.5 million	\$7.4 million	\$12.1 million	\$11.2 million
Acres Planted	10,500	15,000	37,000	51,000
Average Yield (lb/acre)	1,900 lb	1,800 lb	1,700 lb	1,200 lb
Washington Production (cwt)	199,500	270,000	629,000	612,000
Price (\$/cwt)	\$22.60	\$26.10	\$21.50	\$18.40
Meal Production (National) <sup>2</sup>	771,000 tons	830,000 tons	855,000 tons	1,088,000 tons
Meal Price (\$/ton)	\$268	\$338	\$364	\$364

Sources: <sup>1</sup>(USDA, NASS); <sup>2</sup>(USDA, ERS)

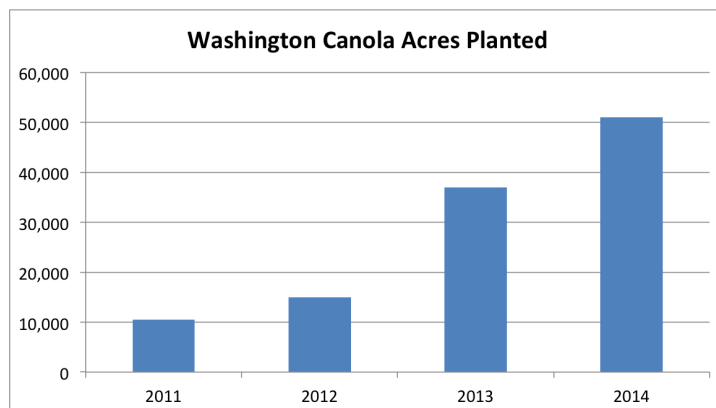


Figure 1. Washington canola acres planted.

Table 1 shows an overall increase in production and price for both seed and meal. From 2011 to 2012 the farm-gate value of production increased 64.2% due to increased acres planted and a higher market price. Although yield decreased over the time period reported in Table 1, production increased due to an increase in acres planted. The national meal production and price are provided as the last two rows of the table.

**farm gate value.** The price or value a farmer receives for a commodity when it leaves the farm after marketing costs have been subtracted.

## Camelina Production

Historically, camelina has been cultivated in Europe for food, medicine, and as a source of lamp oil. It grows well in semiarid regions like eastern Washington (Sowers et al. 2012). The high OMEGA-3 linoleic acid content of camelina oil makes it an attractive component in oil-based food products such as margarine and salad dressings.

Two kinds of biomass-based diesel fuel qualify as advanced biofuels under the Renewable Fuel Standard. The first is biodiesel. It is made from vegetable oil or animal fats, which are converted to fuel by a chemical process known as 'transesterification'.

Advanced biofuels are fuels that can be manufactured from various types of biomass. Biomass is a wide-ranging term meaning any source of organic carbon that is renewed rapidly as part of the carbon cycle.

Camelina has also been evaluated for its potential as a biofuel and in particular for its application as a jet fuel (Shonnard et al. 2010). In 2013 the Environmental Protection Agency (EPA) issued a final rule on biofuels that qualifies camelina oils as biomass-based diesel or advanced biofuel. The rule clarifies the definition of renewable diesel to include jet fuel (EPA 2013).

**Oilseed Processing.** The primary methods for extracting oil from seeds include pressing and solvent extraction. Initially, the oil seed is cleaned and pre-conditioned then cooked. Pre-conditioning and cooking the seed causes cell walls to rupture and release oils. Pressing then separates about 50% of the oil from the seeds. Once the pressed oil is removed, then the remaining oil is extracted using solvents. At this stage, 99% of the oil is removed from the meal and the solvent is evaporated from the meal at temperatures between 95° C and 115° C. Meal is then granulated to a uniform consistency using a hammer mill and sent to storage (CCC 2011). Current oilseed processors in Washington include:

- Imperium Renewables,
- Independence Energy Co.,
- Inland Empire Oilseeds,
- Natural Selection Farms, and
- Pacific Coast Canola (WSU 2013).

Some commercial processors and home processed oilseeds use a less rigorous process that does not include solvent extraction. This results in a meal byproduct that is higher in oil (fat) content.

## Canola and Camelina Meal Nutrient Profile

Protein supplementation balances animal nutrient requirements and complements low forage quality to enhance the animal's ability to digest forage and to maintain or increase forage intake. Both canola and camelina meal have been studied as protein supplements for beef cattle.

Table 2 presents a comparative nutrient analysis between canola meal, camelina meal, and soybean meal. Soybean meal accounts for 90% of U.S. oilseed production and is the most commonly used protein supplement in livestock rations. The minimum crude protein guarantee for commercial canola meal is 36%. The farm-processed canola meal was about 28% crude protein.

**Farm-processed** canola meal typically has a lower capital investment and is not as efficient in extracting oil than a commercial plant. Therefore, the nutrient profile of farm-processed oilseeds was found to be higher in fat and lower in crude protein.

Table 2 shows crude fat ranging from 1% in soybean meal to as high as 19.5% in farm-processed canola meal. Supplementing beef diets with fat increases the energy density of the feed. The additional calories from fat may increase the value of farm-processed canola because more energy is supplied in the ration. However, high fat levels can depress forage intake and digestion.

Table 2. Nutritional components of oilseed meals

Components*	Camelina	Canola – Farm-processed	Canola – Commercial	Soybean
Crude Protein %	38.5	27.8	41.8	54.3
TDN %	77.65	75.38	72.51	80.06
Crude Fat %	13.0	19.5	3.3	1.0
NEL Mcal/lb	0.88	0.82	0.84	0.97
NEM Mcal/lb	0.96	0.88	0.90	1.05
NEG Mcal/lb	0.64	0.57	0.58	0.72
ME Mcal/lb	1.38	1.29	1.31	1.51

\*Dry Matter Basis

TDN = Total Digestible Nutrients; NEL = Net Energy Lactation; NEM = Net Energy Maintenance; NEG = Net Energy Gain; ME = Metabolizable Energy

Source: Llewellyn et al. 2015



This may not be an issue if producers are supplementing daily because the amount fed can be tightly controlled. However, producers may want to prorate a week's supplement to take advantage of nitrogen recycling and reduced labor. The large amount of fat that enters the rumen during a weekly feeding can negatively affect the utilization of the forage fed (Hess et al. 2008).

A major hurdle to using camelina meal as a livestock feed protein supplement is the FDA intake restriction for animal rations. Currently, the FDA restricts camelina meal to a maximum of 10% of the total dry matter in beef rations, due to high glucosinolates levels (EPA 2013). The intake restriction becomes a limiting factor in feedlot diets if camelina meal is the sole protein supplement. In bred cow diets, the intake restriction is limiting when forage quality falls below 6% crude protein, and camelina meal is the sole protein supplement (Neibergs et al.).

Figure 2 illustrates the camelina intake restriction for a 1200 lb cow in the first month of lactation with no access to pasture. Camelina meal is effective as a protein supplement when the crude protein of the hay fed falls below 10%. The percentage of camelina meal in the ration increases from 0% to 10% of dry matter intake as the forage protein content decreases from 10% crude protein to 6%. The intake limit becomes constraining when forage quality falls below 6% crude protein. At this level, camelina meal cannot be the sole protein supplement and still meet the animal's nutrient requirements.

## Least Cost Ration Formulation and Byproduct Meal Value Estimation

The method to determine the market value of canola and camelina meal is based on the least-cost ration formulation and the economic input substitution principle. In any production process, alternative combinations of inputs are combined to produce a given level of output. This economic concept is the input substitution principle. Livestock least-cost ration formulation is based on the input substitution principle. Different feedstuffs are combined to supply specific livestock ration nutrient requirements at the lowest cost. For example, if corn price increases relative to barley or wheat, a point will be reached where wheat and/or barley will be substituted for corn in a livestock ration.

**least cost ration formulation.** A method to design a livestock ration based on the economic theory that alternative combinations of inputs are combined to produce a given level of output, in this case meeting the animal's nutrient requirement ("input substitution principle").

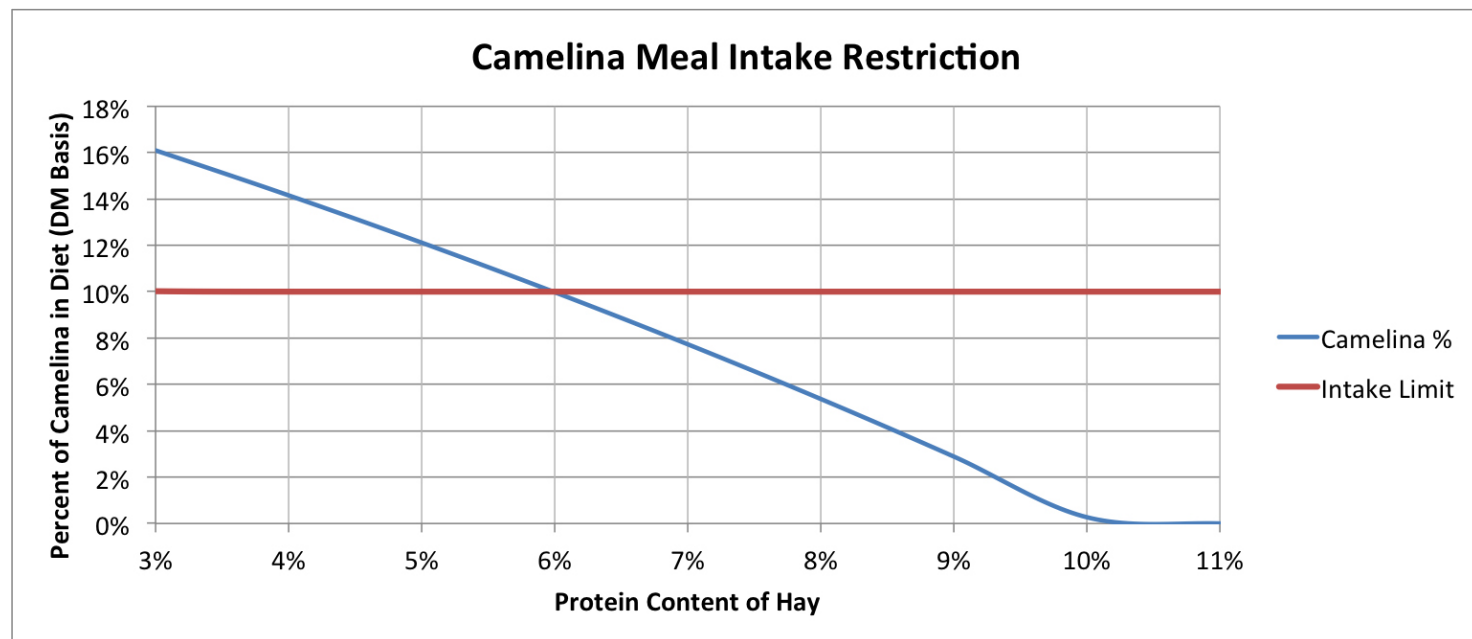


Figure 2. Supplementing with camelina meal for a 1,200 lb cow on hay.

The primary use of canola and camelina meal is as a livestock feed protein supplement, and given that the market for canola and camelina meal is not well defined, we can use the input substitution principle to value canola and camelina meal relative to a well-established protein supplement, such as soybean meal.

The following factors need to be considered when evaluating a protein supplement:

- availability,
- moisture content,
- handling,
- digestibility, and
- nutrient content.

The protein nutrient content has the greatest impact on feed value. Proteins from natural sources are equally digestible by beef animals (Shewmaker et al. 2013). The interchangeability of protein makes the protein content a useful measurement when valuing oilseed meals.

The input substitution method in this valuation uses four elements to calculate the value of alternative meals:

- price per ton of soybean meal,
- protein content of the soybean meal,
- protein content of the alternative meal supplement, and
- a cost adjustment for differences in handling and transportation costs.

The price per ton of soybean meal may be obtained from the USDA Agricultural Marketing Service (USDA – AMS) [Livestock & Grain Market News](#) page. Port of Portland soybean meal prices can be found by searching “custom reports” for “feedstuffs” on this website. There are two price series relative to protein content. The price series are “high” protein (48%) and “low” protein (44%) content meal.

Processing facilities often provide a guaranteed analysis of the meals they sell. The protein content in the analysis provides the needed protein information to evaluate the alternative protein supplement. If the meal comes from an on-farm pressing facility it is recommended that the meal be sampled and a feed nutrition test be conducted to determine nutrient content. Farm-processed byproduct meal nutrient values may change significantly depending on the efficiency of the farm’s oil extraction process.

**protein price equivalent (PPE).** A calculation that represents the maximum price a producer should be willing to pay for his product.

Once the price of soybean meal and the protein contents are known, the valuation process is completed in two steps:

1. Divide the protein content of the soybean meal by the content of the alternative supplement. This returns a conversion factor, which has no unit:

$$\frac{\text{Protein Content of Soybean Meal \%}}{\text{Protein Content of Canola Meal \%}} = \text{Conversion Factor}$$

2. Divide the price of the soybean meal by the conversion factor and make any cost adjustment for handling and transportation cost (HTC). The example below uses canola meal:

$$\frac{\text{Price of Soybean Meal \$ / Ton}}{\text{Conversion Factor}} \pm \text{HTC (\$/ton)} = \text{Protein Price Equivalent of Canola \$ / Ton}$$

This method returns the protein price equivalent (PPE), making a pound of protein from the alternative feedstuff (canola in this case) equal to a pound of protein from soybean meal. The calculated PPE represents the maximum price a producer should be willing to pay for the alternative given that the feedstuffs are available.

Table 3 contains the conversion factors for the meals used in this study based on the crude protein nutritional analysis content reported in Table 2.

Table 3. Protein conversion factors

Protein Conversion Factor	
Soybean meal/Soybean meal	1.00
Soybean meal/Farm-processed canola meal	1.95
Soybean meal/Camelina meal	1.41
Soybean meal/Commercial canola meal	1.30
Commercial canola meal/ Camelina meal	1.09
Commercial canola meal/Farm-processed canola meal	1.50

Figure 3 presents the input substitution curves for canola meal and camelina meal, respectively. These substitution curves are equivalent to isoquants in economic terms. Isoquants represent the combination of inputs that produce a fixed level of output. All points on the isoquant lines in Figure 3 provide 0.8 lb of protein. This represents the daily supplement of protein required for a small frame cow fed 7% protein hay. The isoquants are straight lines in this case because the crude protein nutrient analysis reported in Table 2 and conversion factors calculated in Table 3 are fixed parameters.

**isoquant.** An economic curve that represents the possible combinations of inputs that result in the production of a given level of output. Isoquants are used in the study of microeconomics to measure the influence of inputs on the level of production or output that can be achieved.

**Price Estimation Testing.** For canola meal, the protein supplement input substitution-pricing model can be tested against USDA canola meal price reports (see Figure 4). Using the input substitution-pricing model, a predicted price for commercial canola meal (PPE) is estimated and then compared to the observed historical price (canola meal price). Soybean meal price is provided as a comparison. The soybean meal price is the base and is the highest price series in Figure 4. Canola meal PPE is expected to have a lower cost per ton in comparison to soybean meal because canola meal has lower protein content than soybean meal.

**Handling and Transportation Costs.** Figure 4 shows that canola meal PPE is consistently overvalued relative to reported canola meal price by \$39.11/ton on average. The overestimation represents the handling transportation cost (HTC) in the protein price equivalent equation. Shipping and labor costs increase when nutrient density and moisture content change.

Labor is an important consideration when analyzing supplementation. When making the decision on the quality of forage in the diet, a producer should look at the labor required to supplement low quality forages. A producer supplementing 100 lb of protein per day with soybean meal (assuming 51.6% protein soybean meal) would feed about 194 lb of meal per day. To feed the same amount of protein using canola meal (39.9%), 251 lb of meal would be required. In this case, changing protein sources from soybean meal to canola meal would result in a 29% increase in the volume of supplement fed every day. An increase in the volume of material fed may lead to an increase in the labor required.

Producers supplementing daily may prorate a week's supplement. Feeding 2-3 days/week reduces labor expense (Beatty et al. 1994). In contrast, feeding smaller portions more frequently reduces the potential for negative impacts on forage intake (Mathis 2003).

## Calculating Camelina Meal Price

The market for camelina meal is not developed. There is not a reported price series for camelina meal as there is for canola meal. Therefore, a predicted price comparison to reported market prices cannot be done. However, the protein price equivalent model can be calculated using the market price of soybean meal.

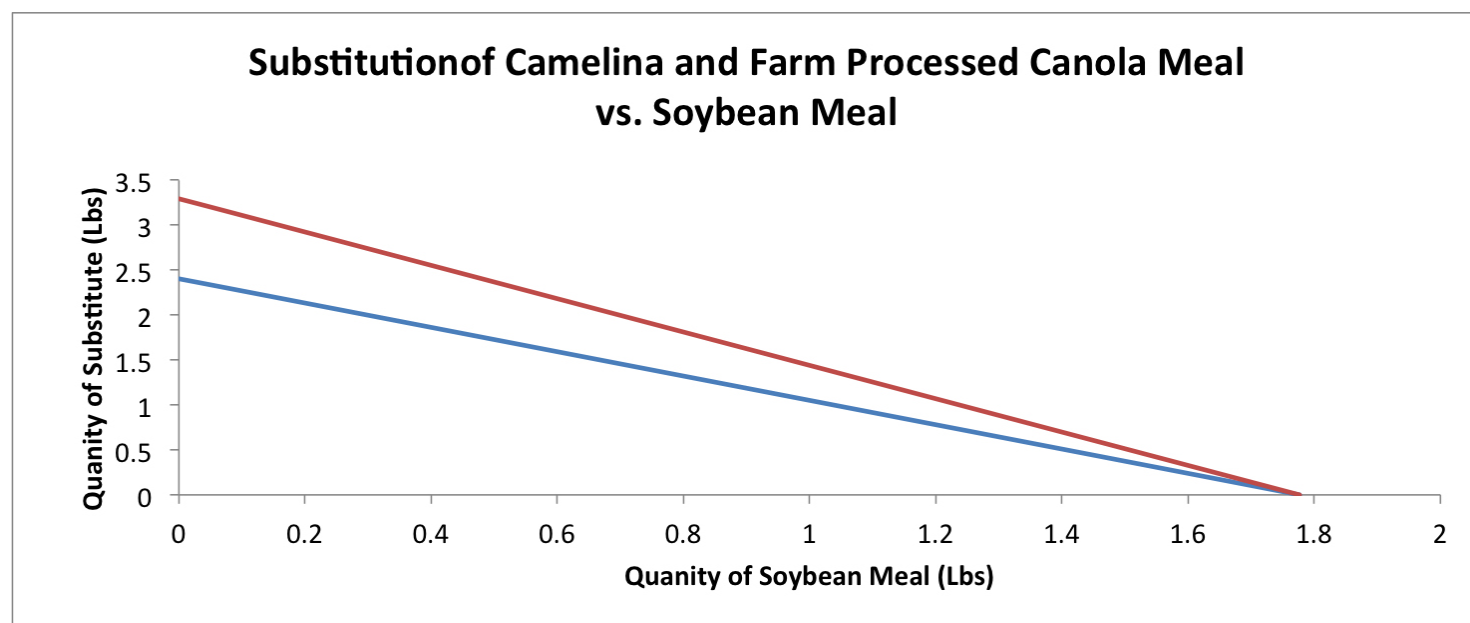


Figure 3. Substitution of canola and camelina meal for soybean meal.

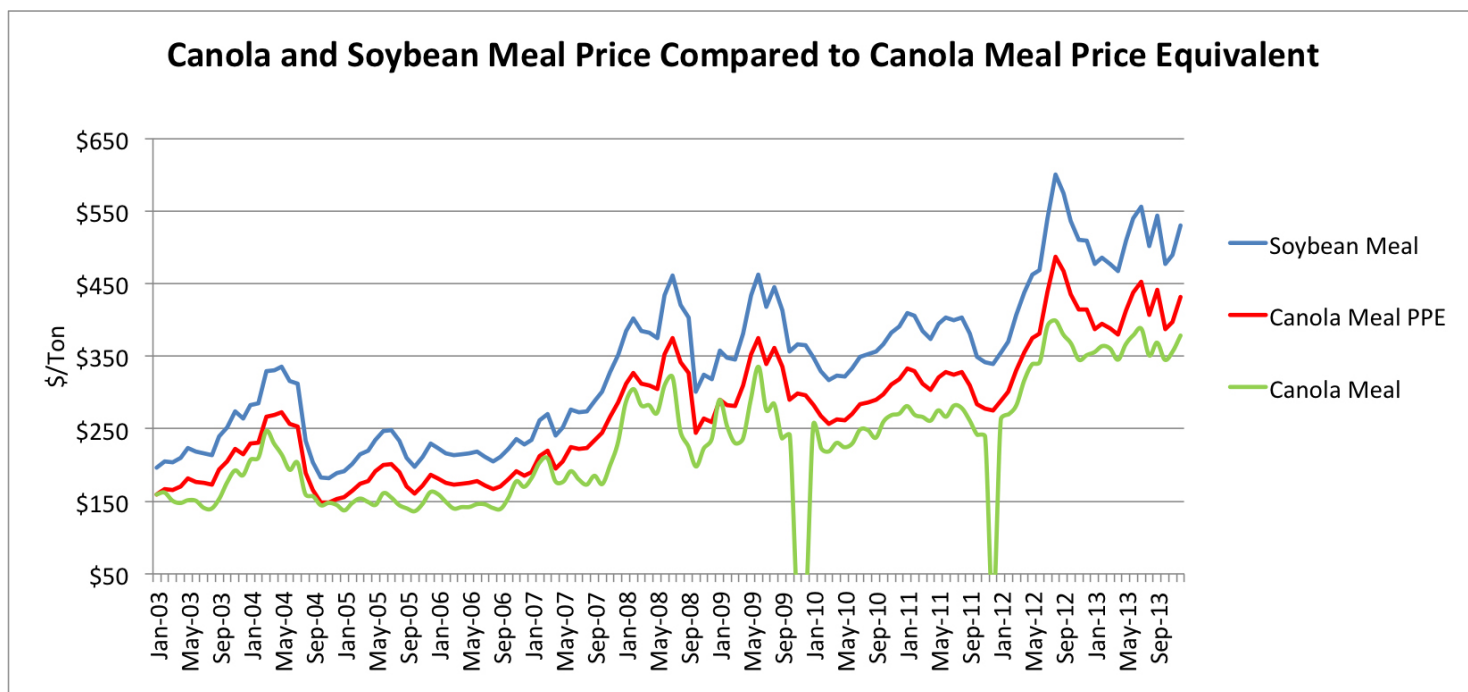


Figure 4. Canola and soybean meal price compared to canola meal protein price equivalent.

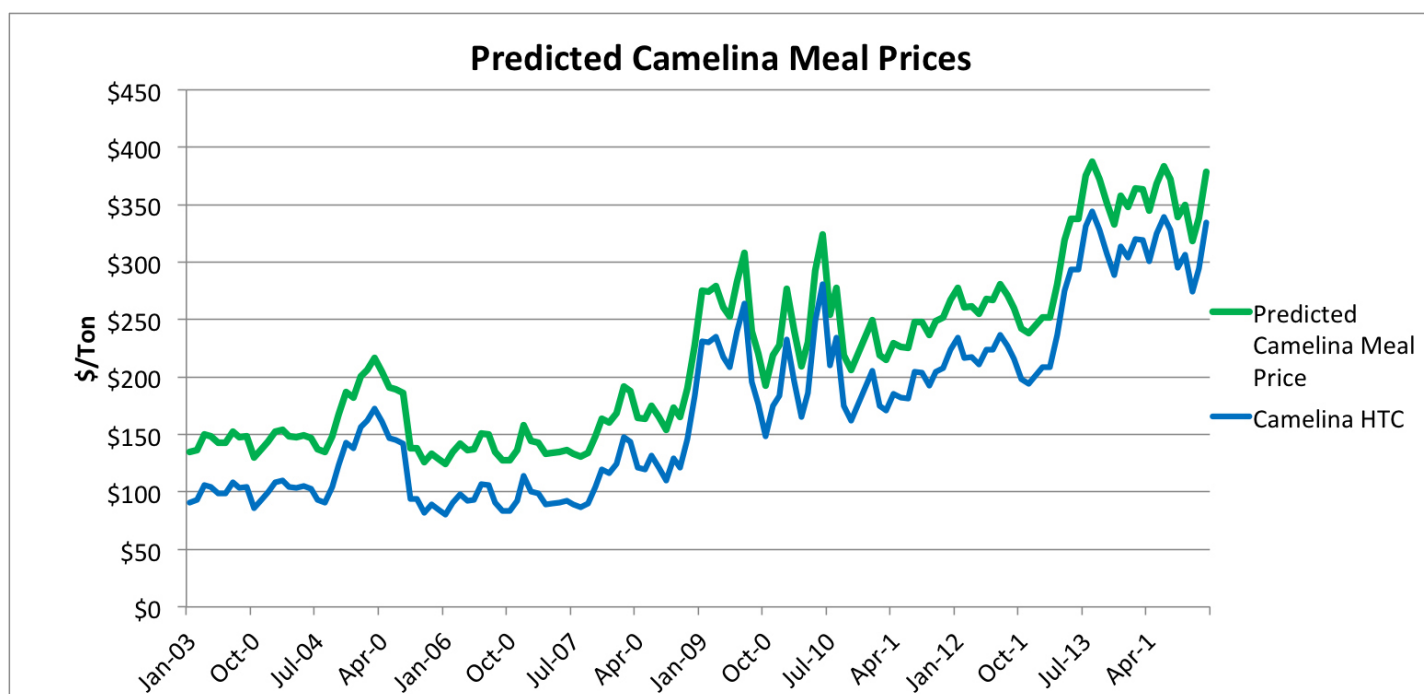


Figure 5. Predicted camelina meal prices.

The results of this analysis from 2003 to 2013 are presented in Figure 5. The green line is the protein price equivalent estimate of camelina meal. The handling and transportation cost (HTC) adjustment can only be estimated. As previously noted, the data provided for canola indicates that its HTC was on average \$39.11/ton (see Figure 4). Camelina meal has slightly lower protein content than canola meal, so transportation costs on a protein basis will be slightly higher. In addition, there is likely a market discount for the 10% dry matter maximum intake restriction. The market price estimate of camelina meal using a HTC estimate of \$44/ton is provided as the blue line in Figure 5.

## Conclusions

Biodiesel production and crop rotation benefits have increased interest in producing canola and camelina. In biodiesel production, a by-product meal is produced that has value as a protein supplement in beef rations. Protein supplementation is often required in beef cow winter rations that use low quality, low protein content hay, and for rations for growing cattle such as heifer replacements and backgrounded calves.

The market for canola and camelina meal is thin, meaning there is a small volume marketed, which increases the volatility in market prices. This paper presents a method to value canola and camelina meal relative to soybean meal that has a widely reported market price. If canola and camelina meals are priced according to their protein content and adjusted for shipping and moisture content these meals can be substituted for soybean meal to supplement low protein forages in livestock rations.

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