Increasing Soybean Meal Protein Level Reduces GHG Emissions and Improves Farm and Food Sector Sustainability Metrics

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INTRODUCTION

Soybean [Glycine max (L.) Merr.] is the most important oilseed crop in the United States. However, soybean protein content has been declining for decades, and a comprehensive ecosystem-based approach to address that decline does not exist. Furthermore, feed production comprises about 90 percent of greenhouse gas emissions from pig and poultry production, so improving soybean meal protein has significant farm revenue and emissions implications.

OBJECTIVES

Our goal was to develop a system model that characterizes and quantifies the link between improved soybean protein, improved corn demand, and reduced emissions. Research objectives:

i. Quantify and predict the feed value of improving soybean protein, and volume of soybeans required

ii. Quantify the effect of improved soybean meal protein on increasing feed corn demand

iii. Quantify the impact of increased soybean meal protein on emissions of swine and poultry operations.

PROCEDURES

1. We contracted with national and state soy checkoff groups starting about 5 years ago to work with seed companies and industry to reverse a 20-year slide in soybean protein, while protecting oil levels.
2. A special version of livestock ration formulation software was created to automatically calculate feed values of a large number of individual soybean samples.
3. Soybean protein and oil data from more than 50,000 soybean samples from replicated plots from 2013-2020 harvests were captured by University of Minnesota for the soybean checkoff and shared with our scientists and marketing teams.
4. We converted whole-soybean protein data into virtual soybean meal by mathematically extracting the oil to adjust nutrient levels to match soybean meal data, after the oil was extracted.
5. We then converted sample data into variety-level data.
6. Statisticians analyzed the data to establish feed values, oil levels, and also relative feed and oil value scores.

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PROCEDURES (continued)

7. We found a wide range of feed and oil values at the variety level and established predictive equations that accurately predict oil and protein levels.
8. We learned that soybean farmers are losing hundreds of millions in sales each year to DDGS and synthetic amino acids.
9. Syngenta, Ag Reliant, and National Pork Board collaborated with the checkoff on feed and oil improvement as a result of these findings. These are leading seed companies in the world, and NPB is a significant customer for soy and is globally recognized for farm and sustainability leadership.
10. Replacing confidential research with publicly available commercial data, we reconfirmed the obvious: increasing soybean quality produces an implied value that exceeds the loss of soybean meal volume.
11. After the soy checkoff program, nutritionist partners helped the marketing team see that corn demand automatically increases when soybean feed value increases, without biologically significant yield loss. Seeing the extra corn sales gives family farmers another reason to increase soybean feed quality.
12. We found Argonne Lab data that quantified emissions for feed ingredients and saw that 90 percent of pig and poultry emissions are from feed. In dairy, it's 26 percent. Dairy feed analysis is pending as of this poster submission deadline.
13. By applying our earlier findings to the Benavides findings at Argonne Laboratory, we found that pig and poultry carbon emissions intensity can decrease by more than 62 million tons, globally.
14. When soybean protein increases, fewer nitrates get into water.
15. Improving soybean protein has profound environmental benefits that are currently undervalued. The carbon alone is worth about $6 billion in potential value, at a time when 7 million tons of soil carbon are getting lots of press.
16. The findings enable an ecosystem strategy that can help farmers, food companies, oil companies, and consumers work to find common ground and more revenue while improving sustainability metrics at the same time.

CONCLUSIONS

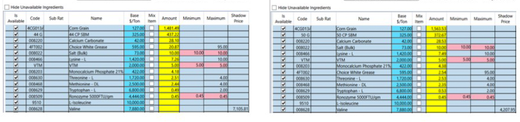
Our results show that when soybean meal protein increases from 44 percent to 50 percent, corn demand increases up to 13.8 percent, and lifecycle emissions decrease by up to 4.6 percent in pig diets and decrease by up to 4.5 percent in poultry diets, while improving implied soybean value by enough to offset the volume lost by improving protein. This also results in reduced nitrates and phosphorous into water.

Predicting Soybean Protein (and Oil) Value

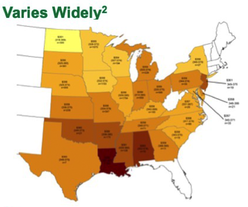
More Protein = Lower Feed Costs[1]

44 SBM Formula Cost – $191.20
SBM used/ton – 437.22 lbs
Corn used/ton – 1,481.49 lbs
Fat used/ton – 20.87 lbs

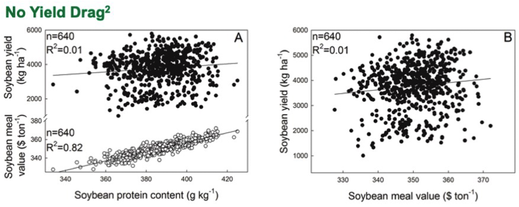
50 SBM Formula Cost – $180.72
SBM used/ton – 372.67 lbs
Corn used/ton – 1,563.53 lbs
Fat used/ton – 2.54 lbs



Soybean Value Varies Widely[2]



No Yield Drag[2]

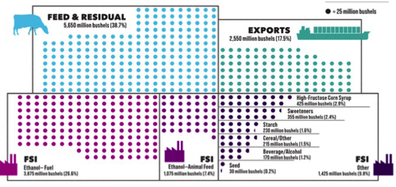


Corn Sales Go Up![1]

Higher-protein soybean meal increases corn demand up to:

5.2% in pork production

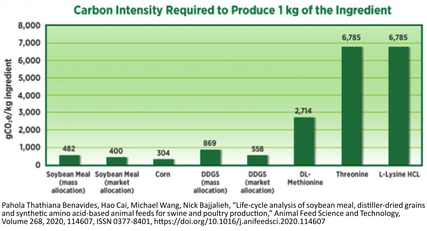
13.8% in broiler production



1. Preliminary soy volume and corn demand estimates based on public and commercial nutrition data. Source: Dr. Paul Mitchell, Dr. Bart Borg, Dr. Dean Boyd, Dr. Shawn Conley, John Osthus. Chart source: NCGA website.
2. Mourtzinis, S., Borg, B.S., Naeve, S.L., Osthus, J. and Conley, S.P. (2018), "Characterizing Soybean Meal Value Variation across the United States: A Swine Case Study." Agronomy Journal, 110: 2343-2349. https://doi.org/10.2134/agronj2017.11.0624

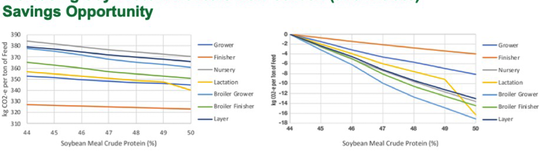
Natural Feed Emissions Lower Than Factory Feed

Natural Feed Naturally Reduces Emissions



Pahola Thathiana Benavides, Hao Cai, Michael Wang, Nick Bajjalieh, "Life-cycle analysis of soybean meal, distiller-dried grains with solubles, and synthetic amino acid-based animal feeds for swine and poultry production," Animal Feed Science and Technology, Volume 268, 2020, 114607, ISSN 0377-8401, https://doi.org/10.1016/j.anifeedsci.2020.114607

Increasing Soy Protein Reveals New Carbon (and Nitrate) Savings Opportunity



Compared to 44% CP, CO_2 - equivalent across phases:
- Up to 4.6% for swine diets
- Up to 4.5 % for poultry diets

Sources: Mourtzinis et al; Benavides et al; Dr. Paul Mitchell, Dr. Bart Borg, Dr. Dean Boyd, Dr. Shawn Conley, John Osthus; Public and commercial nutrition data.

SUMMARY

Our findings also indicate that as soybean protein content declined, crop farmers have lost billions of dollars in corn and soybean revenue since about 2000 to synthetic amino acids and corn distillers-dried grain with solubles (DDGS), and GHG emissions in feed have been gradually increasing. This research also supports increasing oil levels to increase oil value. These findings are significant to AOCS membership because they illustrate how GHG emissions can be reduced by improved soybean protein, thereby delivering on farmer goals of increasing feed value, and supporting food company goals of improving environmental sustainability.