

Scientists study soybean production practices to improve protein quality.  
Dan Davidson

A team of researchers<sup>1</sup> across the Corn Belt are exploring how today's management practices influence oil, protein and amino acid composition in today's soybean crop and if there are practices growers can adopt that improve the compositional quality of the soybeans they sell. The team has completed two years of work in a three-year study.



**Introduction:** Soybean is the second most popular crop grown in the U.S. after corn with over 80 million acres being planted annually. Producers grow and market soybeans as a commodity, delivering directly to elevators or crushers. However, it's the oil and protein extracted from the seed that are the sellable end products and are feedstock for a range of products including animal and human protein, edible and industrial oils and a range of other commercial products.

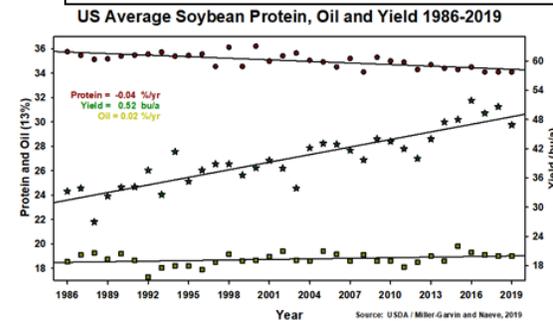
Unfortunately, crude protein levels have declined below the 36% standard as yields have increased while oil content remained relatively stable (Figure 1). Growers have more bushels to sell but crushers have less protein to market putting downward pressure on price. And when crude protein declines so does the quantity of essential amino acids, further reducing the nutritional value of soybean meal and compelling nutritionists to add synthetic amino acids and increasing ration costs.

We have long known that weather and genetics play a role in protein levels but don't know how management may impact protein and amino acid content. This research may identify potential management practices growers can adopt to sustain yield gains while improving or maintaining protein and amino acid levels in the seed; thus, increasing the market value of the soybeans they sell.

**Premise:** The purpose of this study is three-fold; use data from past field studies to evaluate the impact of cultural practices on protein, conduct field studies to identify best management practices that improve protein and essential amino acids, and conduct a survey to assess grower knowledge and attitude about seed quality and what practices could impact soybean seed composition at harvest.

**Results:** Management practices have a huge effect on soybean yield and when farmers adopt the best practices, and when weather cooperates, can break the 100-bushel ceiling. But we don't know how all these improved practices impact protein and amino acid composition in the seed. In bread wheat we know that timely applications of nitrogen and sulfur can improve seed protein content.<sup>2</sup>

Photo Courtesy of Peter Kovacs, South Dakota State University.

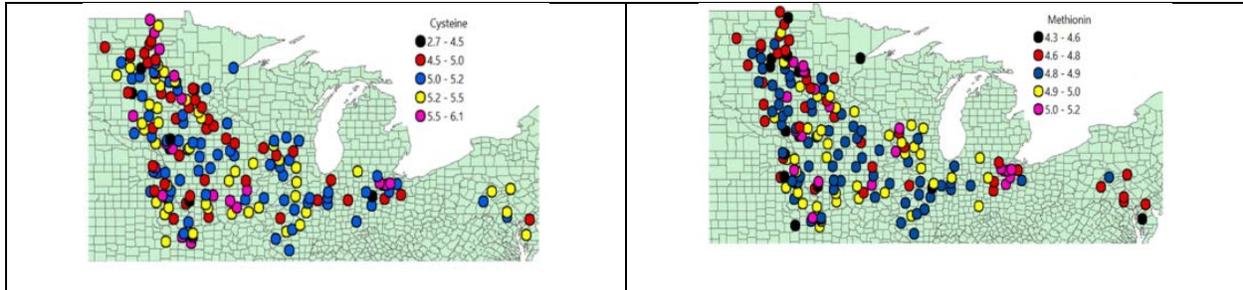


*Yield, oil and protein trends in the U.S.*

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<sup>2</sup> Practices to Increase Wheat Grain Protein. Montana State University Extension. <http://landresources.montana.edu/soilfertility/documents/PDF/pub/NWhtProtEB0206.pdf>.

It is well known that protein levels in U.S. soybeans decline as you travel from Eastern and Southeastern states to the western North Central states including the Dakotas and Minnesota. What wasn't known is how location impacts amino acid composition. The team's findings showed a similar trend with greater amino acid concentrations in southern than in northern latitudes (Figure 2).



2Spatial variation of essential amino acids cysteine and methionine in U.S. soybeans.

The main question being asked is if management practices influence protein levels. While environment remains the most dominant factor on protein from year to year, management can have an impact.

- Diverse crop rotations can improve protein levels.
- Effects of today's most popular practices including no-till, early planting, lower populations and narrower rows, seed treatment, foliar protection and foliar feeding on protein weren't evident.
- Application of small amounts of nitrogen (<50 lbs./A ) improved seed protein and amino acid composition.
- Maturity group selection didn't influence composition in the northern states but did in the southern states with longer MGs showing a decline in oil and an increase in protein.

One of the strategies that many growers practice is treating soybean seed with a rhizobia inoculant to improve nodulation (Figure 3) and nitrogen fixation and yield. However, it's was unknown if this practice can improve protein and amino acid quality. The team compared no inoculation, seed inoculation, seed and soil inoculation at V4 and seed and soil inoculation at R1 and found no effect. They concluded that in fields grown to soybeans previously and under ideal conditions with no stress there was no benefit from inoculation or co-inoculation on quality.



3Photo courtesy of Peter Kovacs, South Dakota State University

Additional finding will be reported as results are analyzed and published.

**Conclusions:** Improving the protein and oil quality has long been a mission of soybean checkoff to increase the value and price of soybeans growers sell. Growers can buy varieties that have greater protein levels. And one day they may be able to choose better management practices that can improve the quality of the seed they sell. "We still have a lot to learn about improving quality, but this is a great first step," said Dr. Ignacio Ciampitti, Farming Systems Professor in the Department of Agronomy at Kansas State University and Principal Investigator on this project. "Quality is the result of multiple factors. We need more knowledge to understand the complexity involved in choosing both the right variety and selecting the right management practices to optimize protein under current environmental conditions."

#### Links to published articles

Spatial Characterization of Soybean Yield and Quality (Amino Acids, Oil, and Protein) for United States. 2018.  
<https://www.nature.com/articles/s41598-018-32895-0>

Study builds on existing data to confirm strategic priorities. 2019.

<https://www.unitedsoybean.org/article/study-builds-on-existing-data-to-confirm-strategic-priorities>

Assessing Variation in US Soybean Seed Composition (Protein and Oil). 2019.

<https://www.frontiersin.org/articles/10.3389/fpls.2019.00298/full>

Spatial characterization of soybean yield and quality. 2019.

<https://www.bookstore.ksre.ksu.edu/pubs/MF3455.pdf>

Soybean yield, biological N<sub>2</sub> fixation and seed composition responses to additional inoculation in the United States. 2020. Accepted for publication in Scientific Reports.