

## **Meal Protein and Amino Acid Considerations: Crop Year 2018\***

While the current commodity market for meal is focused on Crude Protein level, the majority of end-users utilize soybean meal as a source of specific amino acids.

The primary use for soybean meal is as a supplemental source of essential amino acids, such as lysine, in poultry and swine feeds. While today's soybean market emphasizes protein quantity as described by crude protein level, the swine and poultry nutritionists who determine how the majority of meal is used are also concerned with protein quality. Protein quality is associated with the profile of specific essential amino acids in a protein and the extent to which these amino acids can be utilized by an animal. Soybean protein is considered to be relatively high in both quantity and quality.

### **Translating soybean composition into meal composition**

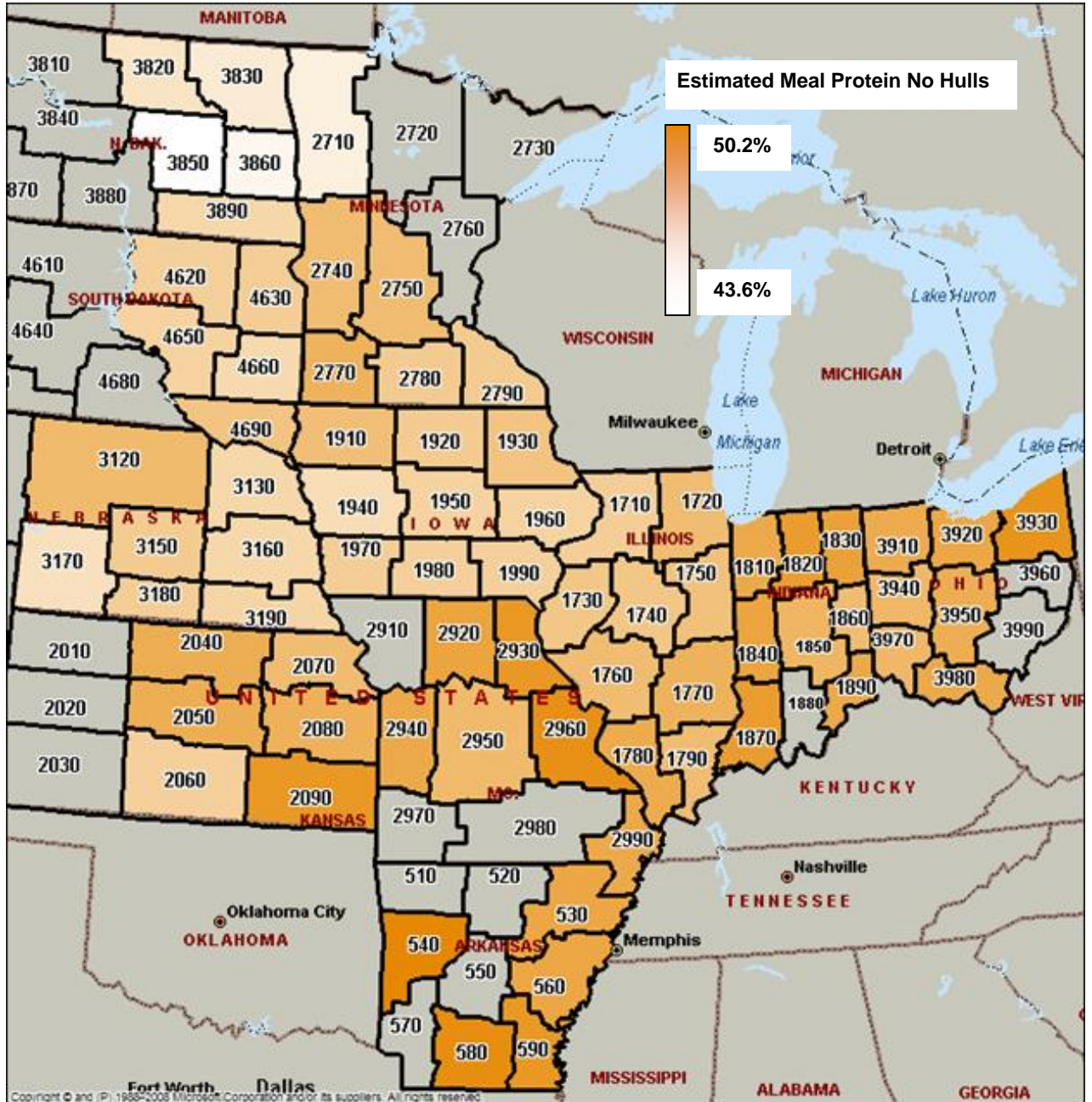
Swine and poultry nutritionists have little interest in soybean composition because they utilize soybean meal. Estimating meal composition from soybean composition is a challenge due to the multiple factors involved. When trying to better understand complex systems such as this, the development and use of models can be helpful.

It must always be understood that Models provide estimates that are based upon a defined set of assumptions. Any use of information from models must be tempered with this understanding. However, when critically viewed, information from models can be useful in the development of valuable insights toward the identification of issues that merit further exploration. The estimated meal protein and amino acid levels presented within the following pages are based on the use of models that utilized the compositional profile of individual soybean samples.

A downloadable Excel Table summarizing some F.I.P.S. District estimates for crude protein and 9 amino acids for both soybeans and meal, can be accessed using the following Link ([Click Here for NASS 2018 Soybean and Meal Crude Protein and Amino Acid data](#))

Soybean composition determines the maximum meal crude protein level that can be obtained when the soybean is crushed and meal is produced. At a given level of meal moisture, this occurs when hull and oil removal is maximized. The following data map presents the Average Theoretical Maximum Meal Crude Protein for F.I.P.S. Districts with reportable results. Each district is identified by a numeric code consisting of a combination of the respective state and district codes. As an example, district 1710 is District 10 in Illinois which has a state code of 17.

## Average Estimated Crude Protein in “No Added Hull” Meal at 12% Moisture



## Relationship between Meal Protein and Lysine

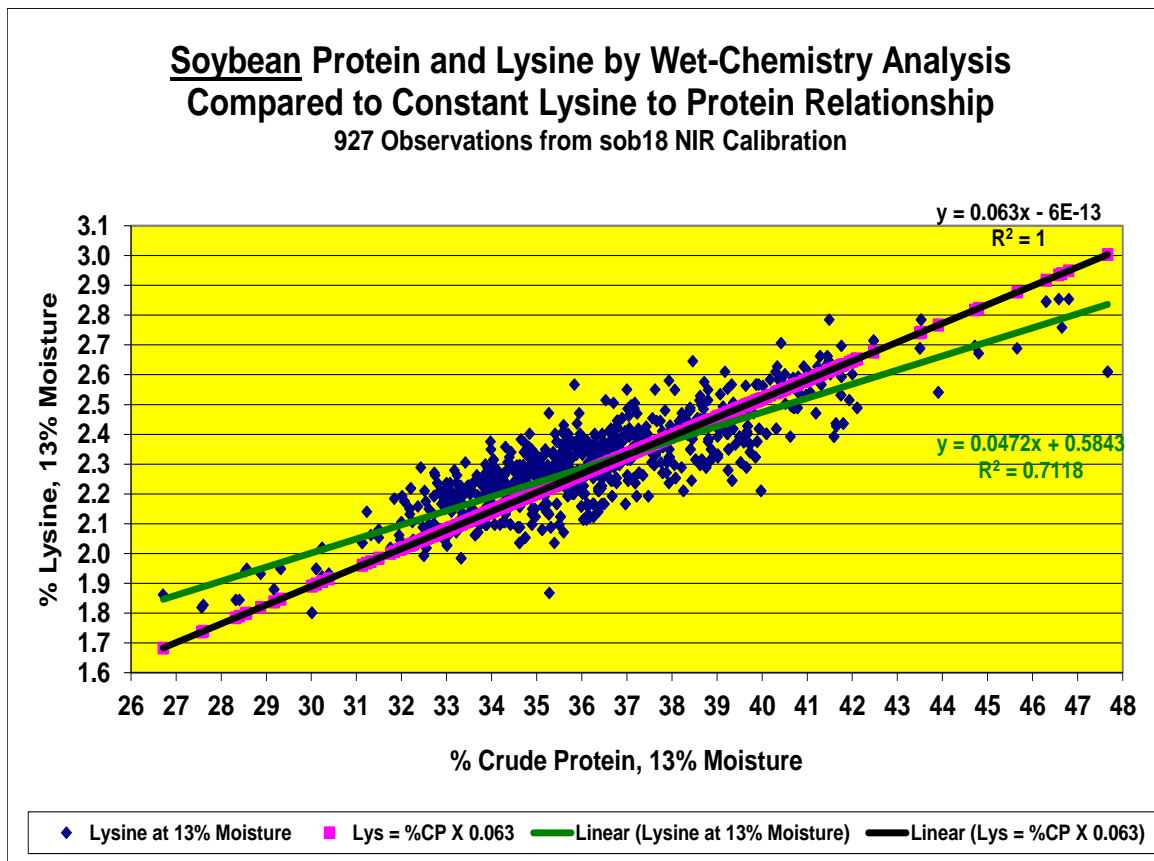
When formulating diets using conventional grains and proteins, achieving adequate levels of some nutrients represents more of a challenge than others. Such nutrients are often referred to as “Limiting”. When nutrient deficiencies occur, poorer animal health and/or productive performance may result. For

rapidly growing swine and poultry, the essential amino acid lysine represents an example of such a nutrient in corn-based diets.

Soybean meal is a good source of lysine. It has a high level of protein, the proportion of protein represented by lysine is relatively high as well and when meal is properly processed, the digestibility of lysine is relatively high.

The relationship between lysine and protein is described by the lysine to crude protein ratio (LCPR). In general, the higher the LCPR, the better when feeding rapidly growing non-ruminant animals.

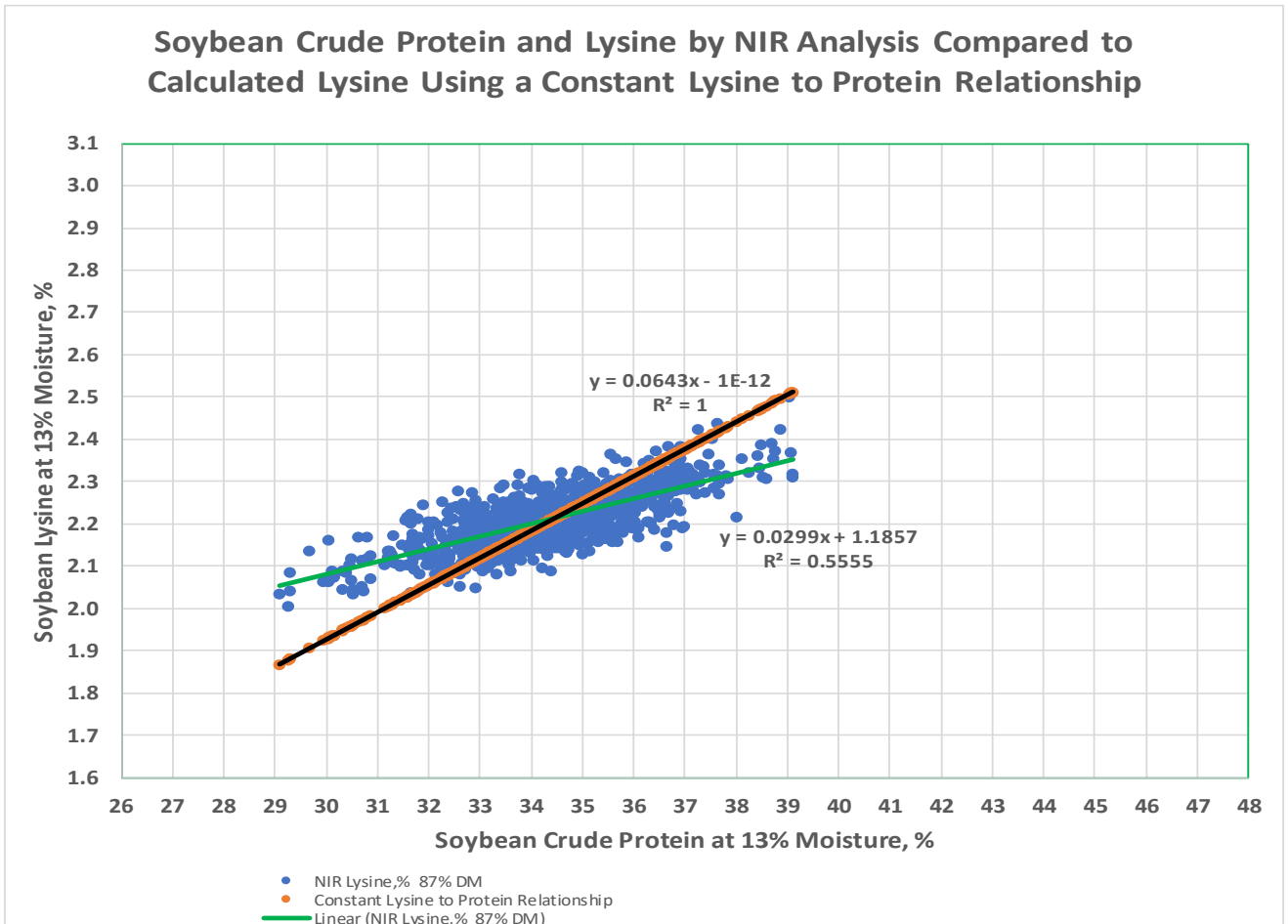
If the LCPR varied only slightly, then crude protein level would be a good indicator of lysine level. Unfortunately, the relationship between crude protein level and lysine level is not strong enough to enable swine and poultry nutritionists to use crude protein as a reliable indicator of lysine level. The chart below illustrates one aspect of this issue. It plots the relationship between soybean crude protein level and lysine level for a set of diverse soybeans that were analyzed by **wet-chemistry** (Note: This dataset includes exotic soybean samples which is the reason for the extended range in protein level.)



A visual review of the above chart indicates that a range of lysine levels can be present at a given level of protein. The chart includes a trend line for the plotted

data, indicated in green, with an  $R^2$  of 0.71. For perspective, the chart also plots what the relationship between crude protein and lysine would look like if the relationship between lysine and protein was constant at 0.063 (i.e. 6.3%) expressed as the proportion of crude protein represented by Lysine. These theoretical points are in pink with a black trend line.

NIR predictions from the 2018 sample set for the same relationship are presented below using the same axis scales as above. Since these are commercially grown samples, the observed range for both protein and lysine are reduced.



In both of the above charts, Lysine increases with Protein. However, a comparison of the two trend lines indicates that the observed change in Lysine level does not proportionally match that of protein. At higher protein levels, the observed Lysine level trends lower than the theoretical level while at lower protein levels, the observed Lysine trends higher than theoretical. Since the applied value of soybean meal relies, in part, on levels of lysine, the above relationship has important implications when meal is valued on the basis of crude protein content, as in the current commodity market. Since the meal from higher

protein soybeans is typically diluted with hulls to 48 protein, the above described relationship also has implications for the amino acid value of the resultant meal.

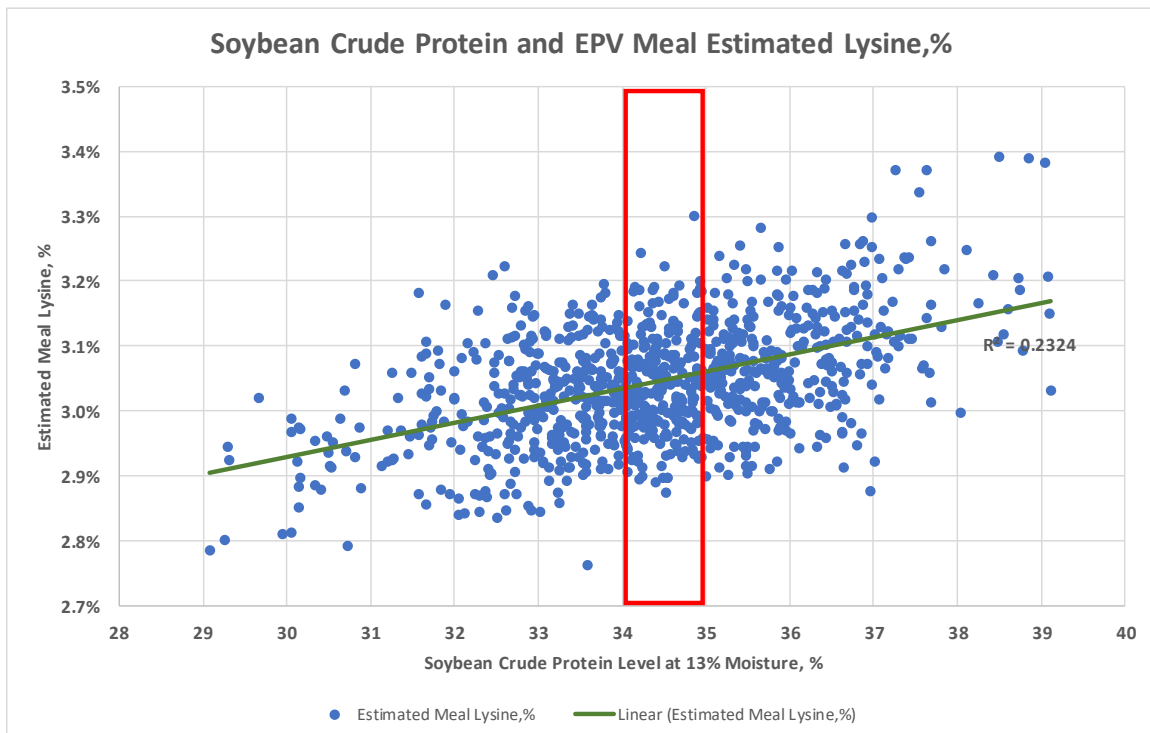
The “disconnect” between crude protein in meal and specific amino acids is further explored below.

## Estimates of Amino Acid Levels in Meal

As previously mentioned, end-users of meal are interested in meal composition, not soybean composition. To estimate meal composition from soybean composition, a model was used. (Note: Please see comments regarding the use of model and their results within the “Methods and Acknowledgements” page.)

The following chart plots the crude protein level of each **soybean** sample on the horizontal axis against its **estimated level of lysine in meal** based on its compositional profile. For this illustration, hulls were used to standardize down meal crude protein when it exceeded 48% protein subject to not exceeding the Crude Fiber maximum.

Based on a visual examination of the chart the relationship between Soybean-Protein level and estimated Meal-Lysine is weak. The  $R^2$  of 0.23 supports what the eyes are able to discern. (Note: The range for  $R^2$  is zero to 1. The closer  $R^2$  is to 1, the stronger the relationship between two criteria).



The soybean protein threshold for producing 48 percent protein soybean meal ranges from approximately 34 percent to 35 percent protein, depending upon oil level. (The level of oil is an important consideration since the more oil per bushel, the fewer pounds of meal that can be produced. Therefore, at the same level of protein, soybeans with higher oil levels will produce meal with higher protein levels since the same pounds of protein per bushel are being averaged over fewer pounds of meal. Some high oil samples below this protein range may still make 48 percent protein meal and not all samples within this threshold-range will produce 48 percent meal.) This threshold is outlined by the “red-box” in the above chart.

The average lysine level for the samples within the “red-box” is 3.04 percent with a standard deviation of 0.08. Lysine levels within the “red-box” range from a low of 2.87 percent to a high of 3.30 percent. This level of variation in lysine for High Pro meal has significant implications for the use of meal in poultry and swine feeds.

### **Protein/Amino Acid Considerations:**

Protein and amino acid characteristics are described in terms of Quantity and Quality. Both are important considerations in determining the applied value of supplemental protein sources.

Protein/Amino Acid Quantity is the proportion of the total product represented by each amino acid at a stated moisture level.

Protein Quality is a function of the extent to which the amino acid profile of a given protein provides those Essential Amino Acids that tend to be limiting to animal health and performance in a given application. Protein Quality is described in terms of the proportion of the protein represented by specific amino acids. The extent to which each amino acid is digested is an additional consideration.

Having a protein source that is high in both Quantity and Quality is most desirable.

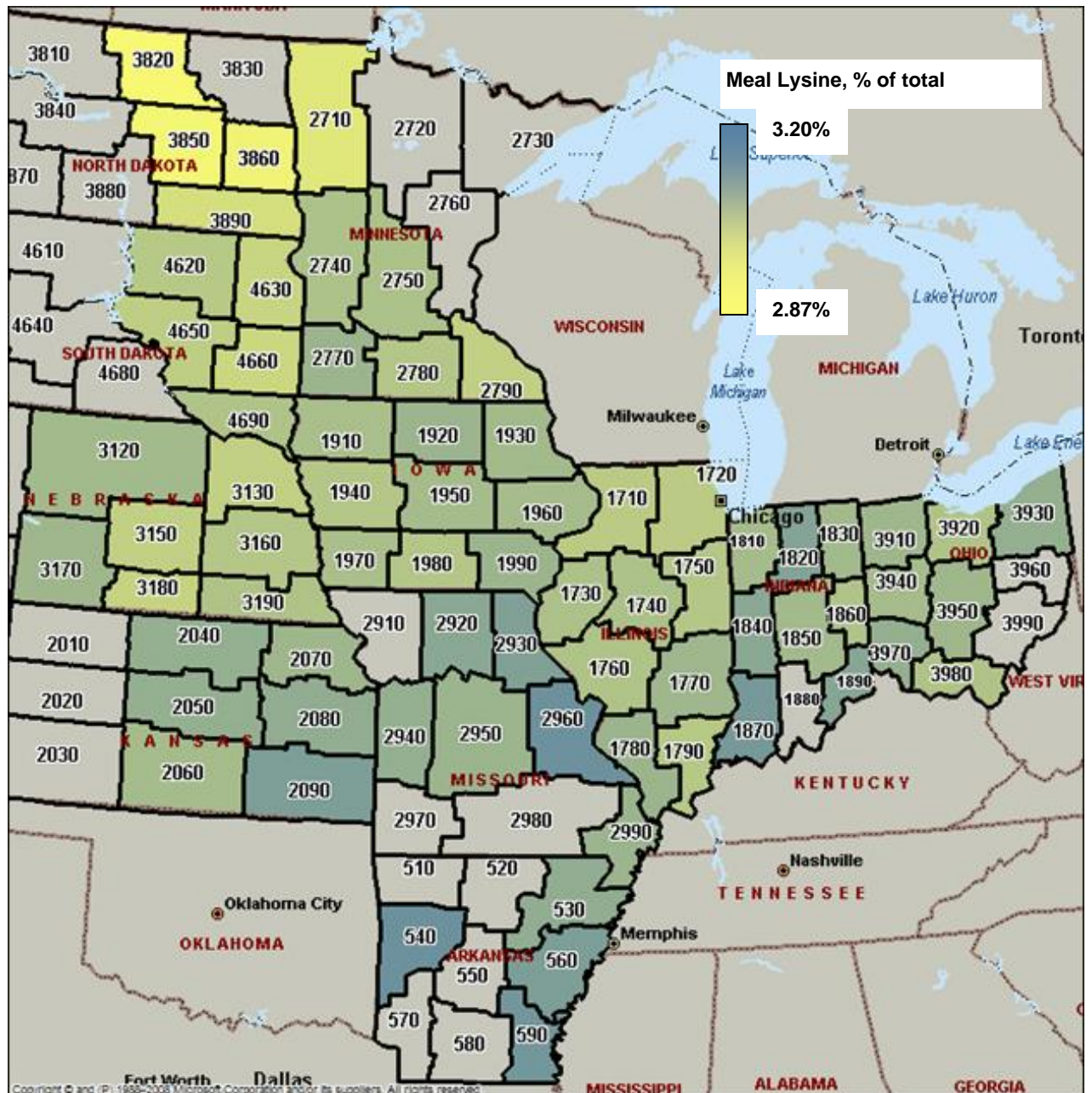
Both Protein/Amino Acid Quantity and Protein Quality are typically expressed in percentage (%) units. Therefore, when discussing/considering Amino Acid characteristics, the specific descriptor involved must be made clear.

As seen in the above Lysine illustrations, the relationship between Lysine and Crude protein is not consistent. This is true not only for a given level of protein but also across different protein levels with a trend toward a lower Lysine to protein ratio as protein levels increase. These points have some interesting

implications for the valuing and use of soybean meal in the current commodity market structure which focuses on meal crude protein. This is further explored below:

The following data map presents district average values for the estimated level of lysine in Commodity-Type Meal and should be compared to the map that immediately follows it which displays the average ratio of Lysine to Crude Protein for each district. For both criteria, a higher number is better.

**F.I.P.S. District Averages for Commodity-Type Meal: Estimated Lysine as a Percent of Total**







The districts chosen and some of their respective average values are presented in the following tables.

District	State	Soybean, 13% Moisture		Estimated EPV Meal		Lysine/Protein	EPV, \$/bu.
		Protein, %	Oil, %	Protein, %	Lysine, %	Ratio, %	
3850	North Dakota	32.6	18.3	43.9%	2.90%	6.61	\$ 9.19
2060	Kansas	33.6	19.8	46.3%	3.05%	6.58	\$ 10.02
2050	Kansas	35.5	18.8	48.1%	3.07%	6.39	\$ 10.35
580	Arkansas	36.0	20.2	49.8%	3.20%	6.43	\$ 10.55

The next table presents estimates for the composition of meal. These will be compared using some least cost feed formulation scenarios in which values will be compared to those for District 2050 which is highlighted in yellow.

District Averages for Estimated EPV SBM Characteristics, % of Total										
District	Protein	Lysine	Threonine	Methionine	Cysteine	Arginine	Isoleucine	Leucine	Trptophan	Valine
3850	43.9%	2.90%	1.67%	0.58%	0.65%	3.19%	2.08%	3.36%	0.46%	2.17%
2060	46.3%	3.05%	1.75%	0.60%	0.69%	3.42%	2.25%	3.55%	0.49%	2.35%
2050	48.1%	3.07%	1.72%	0.61%	0.70%	3.59%	2.32%	3.56%	0.51%	2.38%
580	49.8%	3.20%	1.81%	0.62%	0.70%	3.70%	2.39%	3.71%	0.55%	2.46%

The relationship between levels of amino acids and protein is not consistent. For comparison, the following table presents the average ratio of each amino acid to the crude protein for each of the 4 districts.

Average Ratio of Amino Acid to Crude Protein, % of Protein									
District	Lys/Pro	Thr/Pro	Met/Pro	Cys/Pro	Arg/Pro	Isl/Pro	Leu/Pro	Trp/Pro	Val/Pro
3850	6.61	3.80	1.34	1.47	7.27	4.75	7.67	1.04	4.95
2060	6.58	3.77	1.29	1.49	7.39	4.86	7.65	1.06	5.06
2050	6.39	3.58	1.27	1.45	7.47	4.83	7.42	1.06	4.95
580	6.43	3.64	1.25	1.41	7.43	4.79	7.46	1.10	4.94

Estimated meal amino acid values were utilized in least cost feed formulation scenarios to explore meal value implications associated with such differences. The only difference attributed to the different soybean meals was their amino acid characteristics. The same price was used for each meal variant so that differences in feed ingredient cost would be reflective of the respective SBM amino acid characteristics.

“Composite” diets, intended to reflect relative nutrient needs for an entire production cycle were utilized. Diets were formulated on a digestible amino acid basis with the same individual amino acid digestibility coefficients being applied for each meal variant. In addition to corn and soybean meal, Distillers Dried

Grains with Solubles (DDGS) and Meat and Bone Meal was offered. While these latter ingredients were offered in each scenario, if its use did not enable the lowest cost it was not included in the least-cost formulated diet.

To also illustrate that the meal value-proposition depends upon the specific application, a diet intended to represent a Swine application and another for Broilers were used

Price assumptions for ingredients pertinent to this discussion are presented in the following table. (Note: The prices used here are intended to approximate those for Summer 2019. Ingredient prices are subject to constant change and may vary considerably from the time that this and similar illustrations were developed and subsequently viewed at a later time. In addition, specific prices may vary depending on location and the specific companies involved. Therefore, the following values represent “snapshot” estimates for the fixed set of assumptions upon which they are based. The intent of this exercise is to illustrate that observed compositional differences have applied value implications when other factors are held constant.)

<b>Partial List of Ingredients and Prices Pertinent to Illustration</b>		
<b>Ingredient</b>	<b>Unit</b>	<b>\$/Unit</b>
All Soybean Meal	ton	\$325.00
Corn	Bu.	\$4.25
DDGS	ton	\$120.00
Meat and Bone Meal	ton	\$310.00
L-Lysine HCl	lb	\$0.81
L-Threonine	lb	\$0.92
DL-Methionine	lb	\$1.50
L-Tryptophan	lb	\$5.00
L-Valine	lb	\$3.94
Animal Fat	lb	\$0.26

Estimates of meal value differences based on observed amino acid differences are presented in the following table. District 2050 was used as the basis for comparison. Therefore, its values in the following table that reports gross value differences relative to District 2050 is zero since it represents the baseline value. District 2050 is again highlighted with a yellow background in the following table.

Using differences, relative to District 2050, in ingredient costs for the respective formulations and attributing those differences to the soybean meal utilized,

relative value differences for the different meal amino acid profiles were calculated on a per ton of Soybean Meal basis. From these relative meal values, differences in bushel value were also calculated.

### “Snapshot” Differences Relative to Meal Estimates for District 2050

<b>Estimated Meal Gross Value Differences Relative to District 2050</b>					
		<b>Swine Illustration</b>		<b>Broiler Illustration</b>	
<b>District</b>	<b>Meal Crude Protein</b>	<b>Meal \$/Ton</b>	<b>Soybeans \$/Bu.</b>	<b>Meal \$/Ton</b>	<b>Soybeans \$/Bu.</b>
3850	43.9%	(14.37)	(0.32)	(24.24)	(0.53)
2060	46.3%	(2.54)	(0.06)	(6.49)	(0.14)
<b>2050</b>	<b>48.1%</b>	<b>Basis for Comparison</b>			
580	49.8%	9.69	0.21	10.88	0.24

### Further Discussion and Perspective

When formulating feeds, nutritionists must associate each ingredient that they intend to consider for use with a nutrient description. When the level of a given nutrient is consistent and/or known for an ingredient, assigning a value can be rather straight forward.

When the level of a nutrient is known to vary and actual values cannot be determined prior to use, the nutritionist must attribute a value to the ingredient. If the actual value is less than the attributed value, this difference represents a risk in that underfeeding a nutrient may have a negative impact on animal health and/or performance. Poorer animal performance can be far more costly than the cost of compensating for potential lower nutrient levels through appropriate ingredient changes. An approach for managing this risk is to attribute lower than average nutrient values to an ingredient when the actual value is not known.

If the actual value is greater than the attributed value, and this difference is not recognized and utilized, a lost opportunity results when the nutrient is over-consumed by an animal. Using lysine as an example, if the actual value of lysine in the meal is greater than the attributed value, then more than the required level of lysine will be consumed by the animal. Apart from serving as an expensive source of energy, excessive lysine in the diet is of little value to the animal and thus represents a waste of this resource. In addition, when excess Lysine and/or

other amino acids are broken down within the animal's body, the nitrogen in these compounds ends up being excreted into the environment.

If the actual level of lysine in the meal is lower than the attributed value, the level of lysine in the formulated feed will be lower than what the nutritionist has determined to be optimal and animal performance can suffer.

The levels of lysine and other amino acids attributed to meal is a factor in the determination of its applied value. When the attributed value is lower than the actual value, soybean meal is both underutilized and undervalued. This lost value extends to what an end user is willing and able to pay for meal, which further extends to what a processor is able to pay for soybeans. The cumulative effect of the poultry and swine production industries consistently underutilizing and undervaluing soybean meal is potentially huge and ultimately, to a large extent, is borne by the farmer if this "cost" is passed down the value-chain. To the extent that such a "risk-discount" exists, it is essentially "invisible" to the market.

A disconnect exists between the current market which focuses on protein quantity and the needs of the largest meal end-user segment which also must consider protein quality. There is a cost associated with this disconnect. Better information and its use could offset the risk and associated cost-of-not-knowing by allowing for a more effective and efficient utilization of the nutrients within a given lot of soybean meal.

A similar situation may exist for other nutrients provided by soybean meal. If so, then a market that values composition in addition to weight would not only allow for a truer pricing of meal based on its applied value, but also a more efficient utilization of this important resource. Pricing based on actual applied value would contribute to the competitiveness of soybean meal due to its more effective use. Pricing based on compositional characteristics and their applied value would also encourage product improvement. A more efficient utilization of the nutrients provided by soybean meal would also contribute to the sustainability of soybean production in terms of both its economic vitality as well as its environmental footprint.

***\*Disclaimer:***

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