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SOURCES OF QUALITY VARIATION IN SOYBEAN MEALS

IZVORI VARIRANJA KAKVOĆE SOJINE SAČME

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SUMMARY

This presentation is not about the variability in the total mixed ration. It is about quality variation in soybean meals. Soybean meal quality does vary in the nutrient quantity and nutrient quality.

In conclusion, the three most important sources of variation in soybean meal are:

1) Soybeans and Climate

2) Processors and processing of soybeans primarily in the dehulling and cooking.

3) Testing and sampling.

Soybean meal is the most important source of proteins for animal and poultry feeding in the world. This primary role is unlikely to change because the poultry and aquaculture industries remain the dominant growth sectors in livestock agriculture. Today, poultry feed may contain anywhere from 10-30% soybean meal and swine rations can contain up to 15% soybean meal. Since soybean meal is such an important component of feeds, it is important that it be a source of consistent quality.

We are here to identify the sources of variation in the soybean meal that you purchase, determine its cause, and look at the steps a purchasing manager may do to reduce the costs of variation in feeds. These "variation" costs are typically reformulation costs, the cost of supplements to meet current program-feeding criteria, and reduced feeding efficiency.

From a total feed perspective, one could argue that the best way to reduce variation in available protein in feed is to use more soybean meal and use fewer or no substitute sources of protein such as meat and bone meal. Researchers often cite studies that indicate the coefficient variation (CV) for Crude Protein (CP) in soybean meal is significantly lower than other protein sources. The amino acid content of soybean meal is also far less variable than substitute proteins.

Another current benefit is that soybean and soybean-based products are at a 13-year low in price. Most other protein sources are at least as costly as soybean meal (on a protein unit to protein unit basis). Alternative protein sources require more adjustment on a batch to batch basis than soybean meal, and, most importantly, soymeal protein feed ingredient substitutes seldom produce any real evidence of improved feed and growth performance at a competitive cost.

SOURCES OF VARIATION:

Source one: soybeans and growing climate.

1.Soybean meal is made from different varieties of soybeans. Soybean varieties are generally bred

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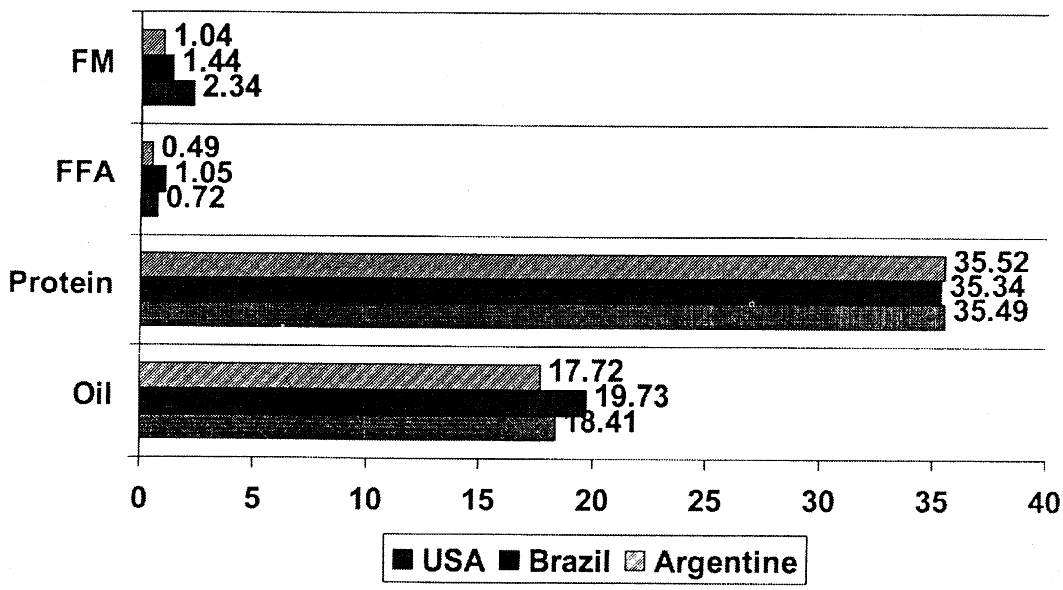
to produce more soybeans per acre (hectare). Yields, not necessarily component characteristics, have been of primary interest to a grower. With market prices low, farmers seek ways to lower costs and save money by planting soybeans stored in their bins. Soybeans account for about 15% of the grower's expense. "Bin run seeds" or seeds that US farmers recycle to save money account for 23-25% of US planting each year. An Illinois crop Improvement Association study indicates "bin run" soybeans cost farmers an average 2.73 bushels per acre (.18 mt/ha.) compared to certified seed. There is no research to indicate the effect "bin run" soybeans have on soybean meal quality. However, processed soybeans can come from a very diverse genetic pool even within small geographic areas due to the mixture of "bin run" and new certified seed varieties. The variety mix will have an influence on the protein and oil levels in the meal. Some varieties will be high in protein and low in oil and other varieties will be low in protein, low in oil, and so on.

2. As an importer, it is important to compare Argentine, USA, & Brazilian soybean meals. As Graph 1 indicates, Brazilian soybeans are generally higher in oil than US soybeans. However, they are also higher in free fatty acids. The Brazilian oils are of poorer quality because the high FFAs mean higher refining costs and lower refining yields. In terms of crude protein, there is no significant statistical difference in the quantity of the "crude protein" in the soybeans between countries. Argentine and Brazilian soybean meal are generally exported on a pro- fat basis allowing for greater variability in both factors per shipment. Finally, the foreign material present is significantly higher for soybeans from the USA than from Argentina and Brazil. Most of the soybeans the USA exports are U.S. grade No. 2. This USDA grade allows the exporter up to 2 % foreign material in exports.

3. As Figures 16,17, and 18, from an "Asian Poultry Magazine" article By Johan Fickler (Appendix 1, Page 28) indicates large differences exist in the amino acid composition of feed

Graph 1. Comparison of U.S. Brazilian and Argentine Soybean Quality Factors
Grafikon 1. Usporedba američkih, brazilskih i argentinskih čimbenika kakvoće soje



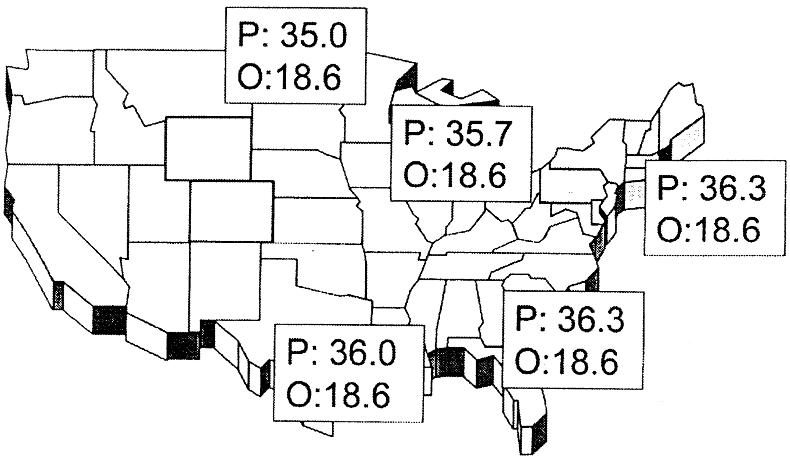
* 13% Moisture Basis
1996-98 Crop years
* Osnova vlage 13%
Urod godina 1996-98.

Sources: USDA/ARS, Tago (Portugal)
Japan Oilseed Processors Assn..
Izvori: USDA/ARS.Tago (Portugal)
Japansko udruž. prerađivača uljarica

ingredients from different regions. Soybean meal is no exception although the variation is in/other natural feed ingredients. For example, the Degussa study indicates that although Brazilian meal has high crude protein it has very low percentages of methionine and lysine in the crude protein. Soybean meal and US soybeans produced very consistent results not only in the US but in soybeans and soymeal exported to Mexico and Columbia as well.

4. Climate is an important factor in soybean quality. Soybean varieties can have a growth period that ranges/from 90-120 days depending on their latitude in the USA. Exported soybean meal is manufactured from soybeans grown from a wide geographic area under very different soil, and climactic conditions. For the past ten years, the United Soybean Board (USB) and Iowa State University have monitored soybean quality. Immediately after harvest, researchers sample different regions of the USA to give customers and processors an indication of the general quality of the crop and the variances from region to region. The data reveal a typical pattern of increasing protein in soybeans north to south. This "protein" pattern has been less pronounced in recent years. Graph 2 indicates the 10-year average "crude protein" and "oil yields". The oil content of the soybean from region to region is a steady 18.6% of the soybean. The crude protein content of the soybeans varies significantly from North to South by 1% or more. The protein content appears to vary by .3 % to .6% east to west. The average crude protein levels by region and for the country were below the ten-year average indicated in graph 2. It is not surprising that US soybean meal producers producing high protein soybean meal closer to 47.5% protein than to 48% minimum crude protein. If we compare the 1998 USB quality figures in with Graph 2, the crude protein is nearly a full percentage point above the ten-year average and the oil content is above the ten-year average. Again, US soybean meal was marketed at 48% minimum crude protein levels and customers were pleasantly surprised to receive soybean meal proteins from 48-48.5% regularly this year. The improved soybean quality is attributed to weather and the fact that Iowa did not have its first frost until October.

Graph 2. Oil and Protein Content: 1986-94 Soybean Crops
Grafikon 2. Sadržaj ulja i bjelančevina : Urodi soje 1986-94.



Basis 13% Moisture - Osnova vlage 13%
ASA Survey Results - Rezultati istraživanja ASA-e
Duplicated from American Soybean Association
Preneseno iz Američkog udruženja soje

5. To overcome regional, variety, and climatic conditions, processors like AGP are working with the State soybean associations and Agricultural Universities to develop varieties and growing programs that improve specific products. This crop improvement process involves field trials at Universities after which farmers and their cooperatives conduct meetings to review the trials and evaluate results. Cooperatives then offer a supply of the evaluated, desirable seed stock to their farmer members. These farmers located around a soy processing plant are encouraged to plant the specific varieties.

The better the soybean the better the soy product. The more quality advantages the processor will have in the market place. Soy processors must continue to be directly, involved in plant variety improvement so that regional differences in soybeans are reduced. This uniformity translates into better soybeans to be crushed, and better feed ingredients used in customer products.

Source two: soybean processors and processing

Soybean meal is subject to variations due to differences in processors and processing techniques. India has nearly 200 processing plants. Some Indian processing plants are over 50 years old and by today's standards, very inefficient. There are probably thirty first-rate plants in India. In many cases, these quality soybean processors have lost the ability to control their quality into international markets. Usually, international traders blend the various quality soybean meals from many of these plants at the Indian ports. This blending process lowers the overall quality and consistency of the exported soymeal due to the wide degree of processing quality from these plants. The trader does this because it increases the total quantity acceptable to the trader's market. Feeders and traders that consider the price the most important attribute of soybean meal drive demand for Indian soybean meal.

In contrast, five USA processing companies serve 85 percent of the American market. The other 15% is supplied by many other smaller plants with varying budgets. Many of the people in each of these companies have worked for two or three of these companies at some point in their career. The technology, equipment, and management of each of the plants are very similar. The consolidated nature of the U.S. industry and the tough, high level of domestic soymeal marketing are probably the major reasons for the U.S. quality level.

Even in the U.S., there are differences between plants. Plants located on the coast or on the periphery of livestock growing areas mainly crush primarily for export. My overseas customers have commented to me concerning the difference in grind from these plants that sell for export and those plants that also sell for domestic consumption. South American meal is predominantly produced for export. The plant owner in South America must balance the needs of the international trader for inexpensive soymeal with his quality considerations. The industry is heavily reliant on exports of products for its economic survival. In the past, plant management may have quality as a priority, but transportation and marketing considerations have controlled the South American soy business. In the past three years, much of the South American soy processing business has changed hands. Many of the same processors in North America control most of the soy processing capacity in South America. There should be a convergence in quality between soymeal price and quality between South and North American industries. Good margins the past five years have brought intense building and expansion and over capacity in both South and North American industries. This expansion in capacity has put great pressure on crush margins. Processors have tried to niche market quality and technology directly to end-users by offering branded or "trademark" high protein and dairy by-pass soybean meals to counter depressed margins. This new soymeal is a result of individual company research and development and usually involves maintaining an identity preserved supply channel to the final user in the market.

In the processing itself, dehulling and differences in heat processing can explain variations in soymeal quality.

1) Dehulled soybean is the standard US soybean meal. Dehulling ensures that valuable soybean meal nutrients such as amino acids and energy are not diluted with undigestible fiber. Furthermore, the removal of hulls before toasting ensures that binding to fiber components does not render valuable amino acids dormant. Not all fibers are equal in a total mixed feed ration. Fiber in the energy converter is like using a low octane gasoline in an engine. It will run the engine but not efficiently.

2) The effectiveness of heat processing is critical to the digestibility of soybean meal. Under cooking leaves residual anti-nutrients that reduce digestibility such as anti-trypsin (protease inhibitors), allergenic proteins, lipoxygenase, urease, and lectins. Over processing reduces the digestibility of lysine and other important nutrients. It is important to the purchaser to buy properly cooked soybean meal. There are four cost-effective tests available to determine whether soybean meal is cooked properly.

a) **Protein Solubility Test (KOH)**: In this test 1.5 grams of soybean meal are ground to pass through a 60 mesh and then stirred in 75 ml of 0.2% KOH solution for 25 minutes. The material is then centrifuged at 2700 rpm for 15 minutes with a portion of the liquid decanted for Kjeldahl analysis. Protein solubility is calculated as a percentage of the original soybean meal. The ideal KOH range is 73-86%. The KOH test is a good index for determining over processing of soybean meal but it is not a very sensitive test for determining under cooking of soybean meal.

b) **The Urease Test** involves the conversion of urea to ammonia with the measurement of the rise in the pH of the solution. The assay is based on the pH increase from ammonia released from urea by residual urease enzyme in soybean meal. The rise in pH determines the activity of the urease enzyme present in the soybean meal and this indirectly indicate whether trypsin inhibitor is present as both of these proteins are denatured and deactivated during heating. The optimum pH is considered to be between 0.05 to 0.25. The urease test is only good for detecting undercooked meal. Meals with no urease activity may still have excellent nutritive value.

c) **The PDI and NSI** are two procedures for determining solubility or dispersion in water. Both are similar and measure the amount of protein extracted from the soybean meal by water. The PDI grinds the meal in a blender at 8500 rpm for 10 minutes with water. The NSI grinds the meal and then stirs it with water. In both cases, the protein is determined between the original sample and a sample of water that has been centrifuged. This is a sensitive test which differentiates between good soybean meals as well as whether soymeal has been overcooked or undercooked. The ideal ranges for the PDI and NSI are in the 36 - 66 ranges with the NSI about 1% lower.

The particle size of the soybean meal is only important if the soybean meal is not reground or pelleted in the finished feed product. However, grinding and screening during soybean processing does save money at the feed mill. Grinding if necessary can add $1.00 to $1.50 to the price of a ton of soybean meal.

Source three: sampling and testing

Sampling and testing is our first impression about the quality of a certain shipment of soybean meal. We determine or "prove" the quality of soybean meal by testing for certain attributes such as crude protein, moisture, fiber, and urease activity. These tests help us determine with some degree of accuracy the soybean meal contribution to the total mixed ration. In practice, the degree of accuracy of these tests depends on how they are performed, where they are performed, who performs them, and their role in the economic activity. There is error or chance in sampling and error or chance in testing. This idea of testing for quality appears to be a source of great debate between buyers and sellers. If these tests, no matter what method, are performed by competent people, fresh chemicals, and properly calibrated equipment they should produce the same results. In practice, they never are. In light of this reality, each test method has what is called a permitted analytical variance. This means that although the test may yield two different results, there is a tolerance that should be applied to account for known error in the test. The permitted analytical variance for 48% soybean meal can be described as:

1. Expected Value * AV%/100= AV
2. Calculate Range (EV-AV to EV+AV)

Where EV = Expected or guaranteed minimum value.
AV% = Analytical Variation percentages.
AV = Analytical Variation

48 X {(20/48 +2)/100}= 1.157

48 - 1.157= 46.84

48 + 1.157= 49.15

The above analytical variance indicates that despite the best efforts of a tester, there could be a variance in the result that spans 2.31 percentage points of "crude protein". The reliance on only one factor to determine soymeal quality could lead to significantly erroneous conclusions about the quality of a soybean meal. Crude protein, for example, is the measure of nitrogen with results expressed as protein assuming that all protein contains 16% nitrogen. The purchaser should conduct his tests for feed composition using the tests available and look at the soybean meal's fiber content, moisture content, color, texture, and smell.

They should also recognize that testing more than once will it produce variation from the first test in soybean meal.

Another usual source of variation in soybean meal is the sampling method used to determine soybean meal quality. The sampling error of an estimate is the error caused by the selection of a sample instead of conducting a census of the population (i.e. testing everything). Sampling error is reduced by selecting a large sample and by using efficient sample design and estimation strategies such as stratification. Sampling assumes that the samples taken are used to determine the quality of soybean meal. In fact, samples are usually sampled to obtain the 500-mg required for each Kjeldahl analysis. For example, in a 15000 metric ton shipment using an automatic sampler at the NOPA required rate, a surveyor would get 140 - 180 kilograms of samples in 10 sublets of 14-18 kg. From these 10 sublets, the tester will cut each sublot down into two 2-kilogram samples for use in two composite samples. The two composite samples will weigh about 20 kilograms each. One sample is kept for further analysis, reference, or other requirements and the other sample is used for testing. On the 20 kilograms used for testing, the Kjeldahl analysis is run three times. Each test requires 500 milligrams of soymeal.

The total quantity tested from the 15000 metric tons is 1.5 kilograms. This amount is equal to one ten thousandth of the product loaded and eight thousandths of the product sampled. Of course more samples could be taken and more soymeal could be tested but, generally, buyers are unwilling to bear the cost of intensive sampling and testing. The idea is to present the buyer with the best representation of the product being shipped. It is important for the purchaser to know that the sampling error between one cargo sample and another cargo sample is likely to be huge. For this reason, the best sample is still one taken by an automatic sampler and analyzed by an independent laboratory at origin. Once a sample is loaded into a ship and "vibrated" for five or six thousand miles, probed in a non-uniformed manner, one cannot expect to have developed the same composite sample as the origin.

I have attached a copy of the NOPA and GAFTA sampling methods. Neither sampling method produces a more accurate or representative sample than the other does, and both methods have the same potential to be grossly unrepresentative of the actual cargo.

The results of the sampling and testing affect the way a buyer uses soybean meal. Inaccurate testing of crude protein and fiber can result in waste (poor feed efficiency) and disputes. Mixing of soymeal from different plants or different qualities during storage and handling before export shipment can introduce undesirable variations in soymeal. In general, transportation itself does not effect the consistency of quality in soybean meals unless it is subjected to bad weather.

SAŽETAK

U ovom se izlaganju ne radi o varijabilnosti u ukupnom miješanom obroku. Radi se o variranju kakvoće sojine sačme. Kakvoća sojine sačme razlikuje se u količini i kakvoća hranjivih sastojaka.

U zaključku, tri najvažnija izvora variranja sojine sačme su:

1. Soja i klima
2. Prerađivači i prerađivanje zrna soje ponajprije ljuštenjem i kuhanjem
3. Testiranje i uzorkovanje.