IOWA SWINE DAY PRE-CONFERENCE SYMPOSIUM

SOYBEAN MEAL 360° — EXPANDING OUR HORIZONS THROUGH DISCOVERIES AND FIELD-PROVEN FEEDING STRATEGIES FOR IMPROVING PORK PRODUCTION

Presentation Abstracts

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US SOY

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U.S. soybean processing industry – the dynamics of change

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The United States is in the midst of the most dramatic expansion of soybean processing capacity in history. Reasons are: 1.) Significant processing margins allowing excellent returns to investment, 2.) an ever expanding need to provide the growing world with food, fuel and feed like no other commodity can, and finally, 3.) the realization that renewable biofuels can mitigate the effects of climate change, lower the carbon intensity of transportation and improve the sustainability of agriculture.

The most recent and impactful impetus for the expansion was precipitated by the California Renewable Diesel mandates and tax credit schemes that require huge amounts of biofuels to reduce petroleum usage. Current sustainability indexes and carbon intensity scores give a significant advantage to renewable vegetable oils and other fat feedstocks. The technology has proven that the older biodiesel process can be further amplified to provide a fuel that can be burned in diesel engines at a 100% rate with no impact or changes needed to the engines. The older 10% blend of biodiesel that consumed about 40% of the domestic production of soybean oil will need to increase to provide adequate supplies of the 100% "drop in" fuel with identical physical and chemical characteristics of petroleum diesel…Renewable Diesel.

The new technology has forced the marriage of soybean processors, the crushers that will provide the RBD (refined, bleached, deodorized) soybean oil with petroleum refiners for further refining of RBD soybean oil to produce a fuel that can be used with no engine modifications at a 100% rate. The new fuel can provide a cost effective, sustainable, lower carbon score, more environmentally friendly fuel for the heavy long-haul trucks, shipping vessels, railroad engines, heavy equipment and farm machinery. Other states (Oregon, Washington, New York, Minnesota) are in various stages of adopting the California standards, thus dramatically increasing the future demand for fats and oils.

Various fats and oils, with corresponding carbon intensity scores, can and are being utilized. Used cooking oil, canola oil, lard, tallow, yellow grease, corn oil, imported soybean oil, etc. can all be used to make renewable diesel. With soybeans being the dominant oil crop in the United States, US processors have jumped into significant and dramatic expansion of both existing and new plants. Over the past few years, the US has grown around 4.5 billion bushels of soybeans, with almost half of the exported annually, and the other half processed domestically into valuable animal feed and oil for human consumption and biodiesel. Farmers always plant what makes the most economic sense. Rotation between corn and soybeans has traditionally ruled the acreage wars. It is anticipated the future might see more soybean acres, slightly less soybeans exported, and a dramatic increase in domestic soybean processing capacity. Some plants have already been constructed and/or expanded. Many others are in various stages of construction or planning. The "announced" plants, if all come to fruition, would increase domestic crush and the available meal and oil by 27%. However, due to margin deterioration, disappointing EPA mandates and the realization that disposition of soybean meal will take some time, several plants have decided to slow or halt construction. Currently, a +20-24% increase in domestic crush feels more likely…still a huge increase.

In one sense, soybean oil demand for renewable diesel will be subsidizing the price of soybean meal as an additional 11 to 12 million metric tonnes of soybean meal will have to disappear, on top of the current production of 49 million metric tonnes. So, what is likely to happen:

1. Soybean meal price will come down relative to other proteins.
2. Soybean meal availability will increase as new capacity comes on line.
3. Soybean meal quality will improve due to new plants with new equipment.
4. Exports of soybean meal will have to increase, as well as domestic consumption.
5. Inclusion rates of soybean meal will likely increase due to price and new studies.
6. Poultry (broilers, layers and turkeys) are by far, the #1 consumer of US soybean meal with ~66% of production consumed domestically by birds. Growth in this industry is vital for the new soy plants to operate near capacity.
7. Relationships between processors and nutritionists (the two most valuable links of the soybean value chain) will have to increase in communication, openness and trust.

8. Improved FCR (feed conversion ratio) via higher quality soybean meal can be realized by simple communication and value sharing. Every plant in the US can make better quality soybean meal today with no new equipment or manpower, but a nutritionist must value and compensate for opportunity loss and energy consumption.

This is the most exciting and dynamic time in the history of soybeans due to the expansions, increased usage of soybeans for food, fuel and feed, and due to the dire need to reduce global warming through more sustainable actions. Opportunities abound!

Key words: renewable diesel, soybean meal, soybean oil, soybean processing, soybean processing expansion

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Quantifying the value of increased soybean meal crude protein and energy in swine and poultry diets

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The soybean supply chain incentivizes upstream participants to maximize crop yield (volume), while downstream participants (nutritionists) make decisions based on crop quality characteristics such as amino acid concentration and energy content. These parameters tend to decline as soybean yield increases. Consequently, the value proposition for soybean meal (SBM) is not fully recognized in the market. Furthermore, on a global basis, SBM sales are based primarily on minimum crude protein (CP) content, which does not fully account for the true value of SBM to the end user. A recent study (Pope et al., 2023) presented a framework to quantify SBM value in swine and poultry diets using digestible amino acids and energy as the primary determinants of end-user value. SBM samples were analyzed for moisture, CP, and 11 amino acids (AA). These values were regressed to estimate 5 SBM CP concentrations (44.0, 45.0, 46.0, 47.0, and 48.0% CP) and the corresponding energy, and then used in a formulation exercise. Least cost diet formulation software calculated the cost of diets for swine and poultry for the 5 SBM CP concentrations. For each scenario, the only change allowed during the least cost optimization was the individual CP concentration of SBM. Relative SBM economic value ($/ton) was determined based on the changes in the nutritional properties of the SBM (amino acids and energy). To estimate the relative SBM value in the diet by CP concentration (44.0–48.0%, or total lysine 2.75–3.01%), differences in formula cost were applied to the SBM based on the amount used per ton. The results show that for each 1% increase in SBM CP concentration from 44.0 to 48.0%, the SBM value increased on average $9-14 per ton for swine and $11-18 per ton for poultry per ton of feed based on changes in ingredient prices from marketing years 2016/2017 through 2022/2023. This value represents the additional amount that swine and poultry end users could pay for a higher SBM concentration without increasing diet costs. This analysis can be used to understand the economic value of SBM based on intrinsic product and compositional characteristics.

Key words: amino acids, energy, poultry diets, soybean meal, soybean meal value, swine diets

Soybean meal net energy and productive energy are higher in commercial pork production systems

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The net energy (NE) of soybean meal (SBM) has been estimated in several experiments at the University of Illinois. In these experiments the NE of SBM was estimated to be between 83 and 100% of the NE in corn, which is greater than all current book values. These values were determined using indirect calorimetry or by using the slaughter procedure. It was also demonstrated that replacing soybean meal with corn and crystalline amino acids did not increase diet NE, which further indicates that the NE of SBM is close to that of corn. In a fat equivalence experiment, where the energy value of SBM was estimated based on the gain to feed ratio of pigs, the estimated NE was around 10% greater than in corn. However, there appears to be a difference in SBM NE values determined in academic facilities with strict environmental controls and those derived in commercial settings. Academic facilities lack pathogen and/or environmental stressors (type, density) that are encountered in commercial barns housing 1000 or more pigs per room. Therefore, a series of experiments (n = 5) conducted in commercial settings across multiple sites using a growth assay model indicates that the SBM NE value relative to corn (DM basis) ranges from 98 to 125%. In Exp. 1, 1900 pigs (36 to 66 kg BW) were used in a 28 d growth assay with 19 pigs/pen. The SBM NE value relative to corn was estimated to be 109% of corn (DM basis). In Exp. 2 and 3 a total of 800 pigs (Exp. 2, 47 to 67 kg BW; Exp. 3, 67 to 110 kg BW) were used in a 21 and 42 d growth assay, respectively. The SBM NE value relative to corn was estimated to be 98 and 101% corn (DM basis), respectively. A total of 2233 and 3796 pigs, initially 11 kg and 17.6 kg BW were used in Exp. 4 (21 d period) and 5 (22 d period), respectively. The NE value of SBM for Exp. 4 and 5 was estimated to be 105 and 125% of corn (DM basis), respectively. Interestingly, these higher NE estimates have been recently replicated by other production companies with commercial research facilities as well. We believe that this apparent conflict in NE estimates between environments is explainable by the health-promoting, non-nutritive molecules of SBM. Thus, from a commercial formulation standpoint, it is recommended that nutritionists utilize a SBM net energy value that is 100 to 110% of corn (DM basis).

Key words: energy, growth, pig

Soybean meal functional compounds – the science behind observations of improved pig health and viability

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This presentation aims to provide an overview of soy functional bioactive compounds and their potential effects on pig health and physiology. A functional bioactive compound is a naturally derived, dietary compound that is regularly consumed and impacts a particular physiological process. Functional bioactive compounds are not considered nutrients, as their lack does not correlate with any specific deficiency. Soybean meal has a rich profile of functional bioactive compounds. including polyphenols and terpenoids, bioactive peptides, dietary fibers and oligosaccharides, and functional lipids. Four categories of compounds represent approximately 70% of the functional bioactive compounds found in soybeans that have recognized effects in human nutrition and are most prevalent in soybean meal: 1) polyphenols and terpenoids including phenolic acids, isoflavones, saponins; 2) bioactive peptides, usually generated by designed, incomplete digestion; 3) dietary fiber and oligosaccharides; and 4) functional lipids, including phytosterols and phospholipids. These compounds can act alone, or synergistically with the gut microbiome to create metabolites, that have many biochemical and physiological functions that transcend traditional nutritional roles. We will discuss proposed mechanisms of soy's functional bioactive compounds inferred from various sectors, including human nutrition and medicine, cell culture experiments and disease challenge models.

Key words: functional bioactive compounds, pig, soybean meal, soybeans

Soybean meal displacement impact on pig growth

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Soybean meal (SBM) is an excellent protein source for pigs because of its well-balanced amino acid profile and its competitive cost compared to other protein sources. In addition, SBM contains a significant amount of health-promoting compounds, such as isoflavones, saponins, and phenolic antioxidants that can modulate immune responses and improve growth performance of pigs exposed to viral disease challenges. With the availability of distillers' dried grains with solubles (DDGS) and cost-effective crystalline amino acids, the levels of dietary SBM have been driven to very low levels, especially in late finishing diets, largely eliminating the growth- and potential health-promoting benefits that SBM may provide. We showed in growing pigs (38.5 to 73.2 kg, 512 pigs) that pigs fed DDGS (25%) had a 1.12 kg lower body weight at the end of the study, whereas replacing SBM with 0.60% of lysine·HCl (plus other crystalline amino acids) reduced final body weight by 2.59 kg. Supplementation of crystalline amino acids decreased final body weight, growth rate and feed intake linearly when DDGS were not included in the diet, whereas the response was quadratic in DDGS diets. Feed:gain was 3.2% higher for pigs fed diets with DDGS compared to control-fed pigs, consuming 0.08 kg more feed per kg of gain. Feeding diets with supplemental crystalline amino acids (0.60% supplemental lysine·HCl) resulted in a 4.2% higher feed:gain or 0.10 kg more feed-per-kg of gain. In finishing pigs (83.1 to 124.7 kg; 480 pigs), inclusion of DDGS reduced average daily gain and tended to decrease daily feed intake without affecting feed efficiency. Supplemental crystalline amino acids linearly decreased average daily gain and worsened feed efficiency. Pigs fed DDGS to displace SBM were 1.22 kg lighter at marketing with a feed efficiency that was similar between the two groups. Inclusion of 0.60% lysine·HCl while balancing other essential amino acids decreased final market weight by 2.74 kg and increased feed:gain by 5.0% which was equivalent to 0.16 kg of extra feed-per-kg of gain. In both studies, replacement of SBM was carefully balanced through formulation of diets that met or exceeded requirements for standardized ileal digestible lysine, methionine plus cystine, threonine, tryptophan, valine and isoleucine and were equal in net energy content. Comparing the highest to the lowest inclusion level of SBM showed that displacement of SBM from 31% to 6% in growing pig diets compromised gain by 3.2 kg and F:G ratio by 0.17 units. In finishing pigs, displacement of SBM from 21% to 0% compromised gain by 3.6 kg and F:G ratio by 0.18 units. Minimum SBM specifications throughout the growth cycle of finishing pigs may be established to maximize profitability, especially in a fixed-time scenario.

Key words: crystalline amino acids, growth, pig, soybean meal, soybean meal displacement

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Strategic use of soybean meal to prevent carcass weight dip during summer

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The persistent reduction in carcass weight during summer months poses a substantial challenge for the swine industry, limiting its profitability potential. This phenomenon often aligns with peak market hog prices, with July and August being the most financially consequential. We attribute this decrease in carcass weight of 6 to 12 lbs. to the compounding effect of exposing pigs to heat stress conditions and the displacement of soybean meal with feed intake-reducing ingredients such as corn DDGS, corn germ, and wheat midds. Our research has highlighted the pivotal role of soybean meal in enhancing pig performance and defined an optimal dose of soybean meal by dietary phase (Boyd and Rosero, 2022). To mitigate the carcass weight dip phenomenon, we developed a nutritional program that excluded feed intake-reducing ingredients and contained high levels of soybean meal to maximize feed intake and growth performance of growing pigs to be sold during summer months. Compared to the typical high-energy diet program (added fat and including corn DDGS) used until the summer of 2019, this soybean meal-based diet program implemented across the Hanor system reduced feed cost by approximately $4 per pig (reference ingredient prices from 2020-2023; Pope et al., 2024) and improved carcass weight by an average of 5.5 lbs. during May to August 2022. Considering the 2022 hog market prices, the soybean meal-based diet program generated an additional $14 per pig revenue compared to the previous high-energy diet program. The practical application of our proposed nutritional strategy, utilizing high soybean meal levels and excluded feed intake-reducing ingredients, offers profound financial benefits for producers aiming to maximize profitability.

Key words: growing pigs, heat stress, soybean meal, summer carcass dip, summer months

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What does all this mean for swine diet formulations?

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During the past 3 to 4 years the general public have been made aware of data, previously held privately, that allow us to have a much better understanding, or cause us to explore through research, the additional benefits of using soybean meal in swine diets. Improved understanding of actual nutrient content and the impact of soy functional bioactive compounds forces the formulator/nutritionist to take into account aspects outside of the normal considerations of ingredient price and minimum/maximum use of the particular ingredient. Information indicating soybean meal net energy content may be much greater than previously understood, along with the positive health and growth enhancing influence of soy functional bioactive compounds causes the need to take the dietary program decision process to a new level by assuring that pig performance differences are included in ingredient and final diet choice. In some cases, it may be beneficial to establish minimum soybean use levels in the formula, which may drive the formula cost higher. These differences in performance may become evident in improved mortality, average daily gain, and feed conversion, all of which will have an economic impact on the cost of production of a given pig or group of pigs. This information must be joined with ingredient and live hog prices at a given time, or forecast into the future, to model the performance differences and settle on a cost of production rather than an invoice price of a given ton of feed. If the added step of financial modeling of pig performance, market price, mortality etc. is included, the optimum cost of producing the pig may be through use of the diet with greater cost. An easy example to consider is the possible elimination or reduction of the summer weight dip. The summer months are many times the most profitable months considering live hog price. However, in some production systems, maintaining target weight through the heat of the summer is difficult so there is lost opportunity to sell weight at a time that live hog prices may be higher. Use of a diet with minimum soybean meal constraints and maximum crystalline amino acid and distillers dried grains and solubles constraints will likely be more expensive than a more traditional formula with less control points. However, through financial modeling, in which the cost of producing the pigs is described, the more expensive option may in fact be the dietary program of choice for the greatest profit to the producer.

Key words: cost of production, diet formulation, functional bioactive compounds, growth, pig

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