US SOY

High Oleic Soy in Dairy Rations

Frequently Asked Questions

For Dairy Nutritionists and Dairy Producers

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Purpose

The goal of this document is to bring awareness to key considerations when evaluating high oleic soy as an ingredient for dairy cow rations.

High oleic soybeans are a variety of soybean high in oleic acid, at least 70%. Conventional soybeans contain about 22-28% oleic acid. The fatty acid profile, specifically the high oleic acid content, makes high oleic soybeans a unique feed ingredient.

Heat-treated high oleic soy offers both fat and bypass protein, improving the energy density of the diet. However, the benefits of the bypass protein are dependent on the control and consistency of heat treatment.

There are many factors and considerations when evaluating heat-treated high oleic soy from growing to processing through feeding. High oleic soy has the opportunity to be a valuable feed ingredient included in dairy cow rations, and understanding how to successfully implement it is key.

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Feeding High Oleic Soybeans

Q1. I've heard HO soybeans increase milk fat? What kind of increase can I expect to see?

A1. The impact on milk income less feed costs ranged from 0.14 to 0.18 $/cow/day.[1] There are many ration factors that impact milk fat and the response will partly depend on what is replaced in the diet. Compared to conventional soybeans and other ingredients high in linoleic acid (18:2), high oleic soybeans have a reduced risk for milk fat depression.[2] This may result in increased milk fat or the opportunity to reduce the cost of supplemental fat compared to dry fat supplements. High oleic soybeans can increase the fat content of the ration, proving beneficial for both milk fat and energy-corrected milk (ECM) production.

Q2. Do high oleic soybeans increase energy-corrected milk (ECM)?

A2. When both milk yield and milk fat increases, ECM increases. In commercial diets balanced for bypass protein and fatty acids, practicing nutritionists generally expect to see a milk fat increase of about 0.10%. In turn, a Holstein producing 90 lbs of milk would have an additional 1.16 lbs of ECM per day.*

However, depending on the diet comparison, the response may be higher. In two high producing cow studies at Michigan State University (2024)[3,4], when roasted high oleic soybeans replaced conventional soybean meal and hulls, the average response was 8.2 lbs/d when compared to control diets without supplemental fat.

Q3. If I feed high oleic soybeans raw, what nutritional factors would I miss out on?

A3. Feeding heat-treated soybeans delivers both high quality protein and fatty acids to the cow. Raw soybeans have the same composition of fatty acids as heat-treated soybeans, yet deliver less metabolizable protein, which is key to higher production. Raw soybeans are more rumen available and have lower rumen undegradable protein (RUP). They also have higher levels of antinutritional factors (e.g., trypsin inhibitor), which may reduce protein digestion and absorption in the small intestine. Grinding has been shown to predispose soybeans to a shorter shelf life, especially when they are raw.

Q4. What is the minimum oleic acid content I should expect to see in high oleic soybeans?

A4. With today's varieties, oleic acid value typically ranges between 68%–80%. Testing for oleic acid in a commercial laboratory is recommended to verify successful segregation occurred from conventional soybeans while accounting for any geographical or genetic differences in total fat content. As genetics of high oleic soybeans continue to progress, the level of oleic fatty acid may also change. Certified commercial laboratories now offer fatty acid analysis by NIR analysis which reduces the cost and time required to obtain an accurate analysis, further encouraging that regular laboratory testing be done with oleic soybeans.

Q5. I'd like to try high oleic soybeans. How should I think about procuring them (grow myself, buy local, buy from a processor)?

A5. The recommendation is to feed properly heat-treated high oleic soybeans over raw soybeans due to the higher RUP value in the heated soybeans. Optimal heat-treatment of soybeans requires specific temperature and cooling in order to consistently produce a high-quality soybean product with consistent protein attributes. There are two main heat-treated high oleic soy feed ingredients – roasted soybeans and expeller meal. Regardless of the type of processing system, heating of the soybeans must be done with well-controlled heating and cooling. Available land base may determine whether high oleic soybeans are grown by the dairy or purchased. The logistics of planting, harvesting, and storage will often determine the feasibility of a dairy growing or buying from a processor concurrent with forage acreage requirements.

Q6. What should I be using for fatty acid values for a roasted high oleic feed ingredient?

A6. Typical fatty acid concentration and profile for high oleic soybeans are published and should be updated in ration-balancing models. The recommendation is to update any high oleic soy feed ingredient in your model to reflect your laboratory analysis results. Several laboratories provide both NIR and wet chemistry methods of testing both fatty acid concentration and fat profile in soybeans. This is recommended to better assess any effects of local growing conditions, agronomic practices or genetics on the fatty acid and protein content of the soybeans.

Q7. What is the RUP protein level I can expect from roasted high oleic soybeans?

A7. In the field, we've seen the RUP in roasted soybeans vary from about 40% to about 60%. A quality roasted soybean should have a consistent RUP, moisture, and protein content while having minimal heat-damaged protein. The quality of roasted soybeans is impacted by the heat treatment temperature, time in which the temperature is maintained, and the cooling process utilized. There can be considerable variability between roasting processors and even within the same processor depending on environmental conditions and variables.

Q8. What is the best way to determine the RUP and fatty acid profile of heated treated HO soybeans?

A8. Well established commercial laboratories in the U.S. are capable of testing heat-treated soybeans for both fatty acids and protein fractions. Accurately measuring protein fractions is more difficult than analyzing for the fatty acid content. These laboratories can also provide a database summary of what nutrient levels have been measured in other submitted samples illustrating both an average value and range. RUP level is best assessed by laboratory methods such as the Ross Assay. Protein dispersibility index (PDI), with a goal of 9–11, directionally indicates proper heat treatment in roasted soybeans. The Ross RUP and protein digestibility assay can also be applied to both high oleic roasted soybeans and expeller soybean meal.

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Q9. What is the best test to determine the quality of high oleic roasted soybeans?

A9. The quality of roasted soybeans is based on several parameters, including: moisture, crude protein, heat-damaged protein as determined by acid detergent insoluble nitrogen (ADIN), PDI, fatty acid content and profile, particle size, and the NDF which can be affected by hull removal or foreign material content. Preference should be given to processors who regularly test for these metrics and can provide a consistent product.

Q10. What is the optimum particle size for roasted high oleic soybeans?

A10. More research is needed to determine the specific optimal particle size of roasted soybeans. Michigan State University trials have targeted 750 microns. In the field, experience has seen good results cracking the soybean into quarters or even further cracked in eighths. More research needs to be done to understand a minimum micron size. One should be careful with smashing and grinding. If the soybean is overly processed, then the expanded surface area can reduce RUP due to higher ruminal digestion, thus reducing the RUP value gained through heating. If the soybean is only split or left whole, there will be excessive passage through the GI tract with overall lower digestion.

Q11. What are considerations when thinking about feeding rates of heat-treated high oleic soy products?

A11. There is no one-size-fits-all best feeding rate as it depends on contributions of other ingredients in the diet. Several factors and key questions should be considered when determining the optimum feeding rate.

1. What other feed ingredients are bringing fatty acids into the diet and can high oleic soy make for a better fatty acid profile?
2. How the ingredient compares in price and nutrient delivery compared to other fat sources and bypass protein sources (i.e., blood meal, corn gluten meal, etc.).
3. If bypass lysine is a limiting nutrient in the diet, then heated high oleic products may play a very positive role in formulation.
4. What other sources of soy protein (Soy 44 or Soy 48) are in the diet? If none, then heated high oleic products will bring in branched chain amino acids that may be beneficial.

Regarding roasted high oleic soybeans:

5. If the high oleic soybeans are homegrown, what is the opportunity cost to sell them versus feeding them from a profit standpoint?
6. High oleic soybean feeding rates commonly range from 3 lbs to 7 lbs as-fed in Holstein high-producing cow diets (DMI 62-65 lbs). Some producers are feeding as much as 10 to 12 lbs.

Regarding extruded/expelled high oleic soy:

7. What is the extent of high oleic acid being pulled out in the extruded/expelled process? It is common to see about 6%–8% fat in extruded/expelled products, which will impact the value from a fatty acid feeding standpoint.
8. Typical feeding rates of these heated high oleic soy products run 2 lbs to 5 lbs in Holstein high-producing cow diets.

Q12. How should I monitor cow performance while feeding high oleic soy?

A12. As with any diet change, several factors need to be monitored as closely as data on the farm will allow. Evaluate measurable changes in milk production, measurable changes in milk component values, changes in body condition score and reproduction. Individual cow daily milk weights along with herd daily milk and components will be key to monitor. Changes in milk fatty acid profiles greater than 16C may also be discernible in milk fat if dietary fat has been increased with high oleic soybeans. Consider how these metrics compare to any feed cost increases or decreases and thus daily income-over-feed cost.

Q13. What groups of animals on the dairy would most benefit from high oleic soy in the ration?

A13. The first consideration should be given to the highest producing groups on the farm. These are the groups that would deliver the most return relative to an increase in ECM. If the farm feeds one ration, high oleic soy can certainly be implemented across the herd.

Q14. What storage requirements are there for roasted high oleic soybeans?

A14. No special storage is needed other than segregation from conventional beans from harvesting through processing and use. On the farm, roasted high oleic soybeans should be kept dry, which could be in bin storage or flat storage in a commodity barn. As with any feed ingredient, the goal is to minimize shrink.

Roasting and Heating of High Oleic Soybeans

- **Q15. What does a typical roasting process look like that yields a consistent, quality roasted soybean?**

A15. High temperature air dryers and drum roasters are the most common and effective roasters. Both use hot air with the high temperature dryer moving soybeans with a conveyor over a perforated floor and the drum roaster utilizing a rotating drum with hot air. These processes prevent the soybeans from coming in contact with the flame. The goal is to heat the soybeans to 300˚F for about 2 minutes. The heated soybeans are then moved to a steeping bin and held there for 30 minutes to allow the heat to uniformly move throughout the soybeans. After roasting and steeping, the soybeans are cooled by moving air through them. These steps allow optimization of the heating process and prevention of overheating, which could damage the protein and reduce the digestibility of the roasted soybeans.

- **Q16. What testing should be done to ensure high oleic soybeans are properly heat-treated?**

A16. There are an array of analyses that can predict the effectiveness of the roasting and steeping process. These include protein dispersibility index (PDI), Ross rumen undegradable protein (RUP) test, acid detergent insoluble nitrogen (ADIN) test and urease activity test.

PDI Analysis: Protein Dispersibility Index is a measure of the percentage of protein soluble in water. A value of 9 to 11 indicates that the soybeans are optimally heated. A value greater than 11 indicates underheating and a value less than 9 indicates overheating. The downside of PDI is that sensitivity tends to decrease as the optimal heat treatment is approached.

Ross RUP Analysis: This test can estimate the percentage of RUP in the heat-treated soybeans, as well as the percentage of protein digestibility. Properly heated high oleic soybeans should have a Ross RUP of greater than or equal to 50% with an expected range of 40%–60%. The target for the digestibility of the RUP in heat-treated soybeans should be 85% or greater. Lower digestibility numbers could indicate overheating.

ADIN Analysis: This test measures the amount of nitrogen bound to the acid detergent fiber (ADF) fraction. Nitrogen (protein) bound to the ADF fraction has low digestibility. The goal is to minimize the ADIN as close to the 6.5% baseline as possible while still hitting PDI and RUP targets.

Urease Activity Analysis: Values of 0.05 to 0.25 indicate that enough heat has been added to lower the anti-nutritional effect of urease. It is not a good test to determine optimal heating.

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Q17. Is there an optimum time and temperature for heating the soybeans?

A17. The target soybean temperature during roasting for a hot air roasting process is 300˚F with a 2 minute transit time in the dryer or roaster. The transit time needed is affected by the temperature and moisture content of the raw soybeans.

Q18. Is there an optimum time for steeping the high oleic soybeans?

A18. The optimal steeping time to ensure uniform heat penetration throughout the soybean is 30 minutes followed by an immediate air cooling process to prevent overheating and decreased protein digestibility.

Q19. What does it cost to roast high oleic soybeans?

A19. Common high oleic soybean roasting fees are $35–$50 per ton plus a 10% shrink on the amount presented to the roaster. The shrink is related to dehydration that occurs in the heating process and to what degree soy hulls were removed during the processing.

Q20. Why do some people expel and extrude rather than simply roast?

A20. Adding the extruding and expelling steps to the roasting and steeping steps for high oleic soybeans results in a significantly higher and more consistent RUP value for the high oleic meal compared to just roasting and steeping the soybeans. Extruding the roasted soybeans prior to expelling ruptures the fat cell and promotes more effective fat removal during the expelling process. Both steps add heat and increase the RUP while further improving digestibility. RUP values for high oleic meals are 65% or higher with 85% or higher RUP digestibility compared to 40%–60% RUP and variable RUP digestibility for high oleic roasted soybeans. Additionally, about two-thirds of the soybean oil is removed in the expelling process, creating a more cost-effective protein source during times of high soybean oil prices compared to high oleic roasted soybeans. Other dietary factors affecting ration economics such as total ration fat and total ration RUP costs also need to be considered when deciding between high oleic roasted soybeans and high oleic expeller meal.

Growing High Oleic Soybeans

Q21. What can a soybean grower expect in yield?

A21. With over 10 years of commercial high oleic soybean production experience, research data indicates that current high oleic soybean seed products provide farmers with yields comparable to other high-yielding commodity soybean seed varieties.

Q22. What agronomic considerations should a soybean grower be aware of?

A22. High oleic seed varieties are not currently converted to E3 series genetics and are in a closed loop system, likely to stay in place through 2027. E3 technology in soybeans makes them tolerant to three key herbicides: glyphosate, glufosinate and 2,4-D. Because they do not currently contain the E3 series genetics, managing weed pressure is a consideration. Glyphosate-resistant water hemp is the main weed population concerning potential high oleic soybean growers. Without the E3 herbicides, water hemp populations can be reduced by starting with a clean seed bed, and utilizing a pre-emergence residual herbicide program. If timing and weather conditions allow for it, planting a thick cover crop such as cereal rye can suppress annual weeds and offer other benefits to the seed bed.

Q23. How does selling high oleic soybeans work?

A23. High oleic soybean processors contract with the seed company to obtain planting material, then the seed company or processor contracts directly with a farmer. This farmer receives an agreement from the processor, who pays the bushel premium to the farmer upon receipt.

Q24. How does a soybean grower obtain high oleic soybean seed?

A24. High oleic soybeans are in the market introduction phase. For this reason, soybean processors do not have large uncommitted supplies of high oleic soybeans to meet spot market demand. The contracting system helps to ensure that high oleic soybean production volumes meet the demand from customers. High oleic contracting also helps coordinate the actions by all participants in the supply chain. The critical functions include seed supply availability from seed companies, production of commercial soybeans by the farmer, soybean storage and transport, and processing or exporting of soybeans. In some cases, supplier companies may be involved in one or more steps in the supply chain. As an example, some seed companies are further vertically integrated into contracting with growers, crushing/refining, and exporting.

There are generally two options.

1. Processor contracts with the seed company to obtain planting material then contracts directly with a farmer who receives an agreed-upon premium per bushel as well the amount of seed and when it will be provided.
2. Direct-to-farm utilizes a contract tied to a seed company.

Q25. What harvest considerations should a grower be aware of?

A25. Harvest considerations are determined by the delivery contract; some processors allow delivery anytime, while others run crush campaigns calling for the grain when needed only. Generally, farmers are compensated with higher premiums when delivery options are needed.

Q26. What drives the premium for high oleic soybeans?

A26. The premium for high oleic soybeans and oil is driven by several factors:

- Willingness to pay for premium products by end-users, such as dairies.
- Supply/demand of competitive oilseeds and other fats and oils.
- Possible higher transportation costs for farmers to deliver the high oleic soybeans to identity preservation elevators or high oleic processors that may be a greater distance than their usual delivery location.
- Identity preservation (confirmation of high oleic at delivery with rapid fatty acid testing, segregation throughout processing)
- Agronomic considerations such as required herbicide programs

Ideally, high oleic soybeans provide a win-win situation in which the soybean farmer receives a premium yet that premium does not exceed the value added for the end-user.

Q27. How should a dairy producer think about valuing the high oleic soy feed ingredient if they are growing it themselves?

A27. High oleic soybean growers who are planning to feed the soybeans to their dairy cattle should seek to understand their actual cost of production for the crop and its opportunity cost. At a minimum, the high oleic soybeans should be valued at the cost of production. Alternatively, the opportunity cost is the value at which the high oleic soybeans could be sold plus the cost of storage for the amount of time that it will take to feed the soybeans minus the cost of transport to an alternative buyer. In order to realize the maximum feeding value for dairy cattle, high oleic soybeans must be properly roasted or processed into an expeller meal. Processing costs can be between $25 and $45 per short ton depending on the system, with shrink due to processing and moisture loss adding approximately 10%–13% more to the value of the product. A producer could alternatively value high oleic soybeans at the market value of the protein and fat sources they replace in the ration. Lastly, the value of observed or expected increases in milk fat or ECM should be considered.

Checkoff Compliance

Q28: When a soybean grower is selling high oleic soybeans directly to a dairy farmer, what is the process to stay in compliance with the soybean checkoff?

A28. The soybean checkoff is assessed at the rate of one-half of 1 percent (0.5) of the net market price of soybeans sold by the soybean producer to the first purchaser. In this case, the first purchaser is a dairy farmer.

Q29. What are the guidelines around when and how the soybean checkoff should be paid?

A29. Checkoff remittance payments are made to each Qualified State Soybean Board on a monthly or quarterly basis. Check with your state soybean board for exact details on how and when remittance payments should be made. The Soybean Promotion, Research, and Consumer Information Program (SPARC) form can be obtained from your Qualified State Soybean Board's website. This form must be mailed with payment. Some states facilitate an online payment option. If a first purchaser fails to remit assessments by designated due dates, they will be subject to a 2% late fee compounded monthly.

Q30. If I'm a dairy farmer buying high oleic soybeans, do I have a responsibility to participate in the soybean checkoff?

The federal Soybean Promotion, Research, and Consumer Information Act requires the assessment to be collected by the first purchaser and remitted to the Qualified State Soybean Board, who in turn remits half of this assessment to the national United Soybean Board.

Q31. If I'm a soybean grower selling high oleic soybeans to another private party, do I have a responsibility to participate in the soybean checkoff?

A31. Yes. The responsibility of complying with the federal Soybean Promotion, Research, and Consumer Information Act lies with the first purchaser and soybean grower. Each first purchaser must collect from the soybean grower, and each soybean grower must pay the assessment to the first purchaser.

To learn more about the Soybean Promotion, Research, and Consumer Information Act, visit https://www.ams.usda.gov/rules-regulations/research-promotion/soybean.

[1] Nicholson, Charles F., et al. "Economic Analysis of High-Oleic Soybeans in Dairy Rations." Journal of Dairy Science, June 2024.
[2] Weld, K.A. and Armentano, L.E. "Feeding high oleic acid soybeans in place of conventional soybeans increases milk fat concentration." Journal of Dairy Science, Volume 101, Issue 11, 9768 - 9776.
[3] Bales, A.M., and A.L. Lock. "Effects of Increasing Dietary Inclusion of High Oleic Acid Soybeans on Milk Production of High-Producing Dairy Cows." Journal of Dairy Science, Oct. 2024.
[4] A.M. Bales, A.L. Lock. Effects of raw and roasted high oleic soybeans on milk production of high-producing dairy cows. Journal of Dairy Science, Volume 107, Issue 12, 2024
[*] Equation used: (.327 x lbs milk) + (12.95 x lbs fat) + 7.65 x lbs protein). Example: 90 lbs of milk at 4.3% fat and 3.3% protein = (90 x .327 = 29.43) + (.043 x 90 = 3.87 x 12.95 = 50.12) + (.033 x 90 = 2.97 x 7.65 = 22.72). 29.43 + 50.12 + 22.72 = 102.27 lbs ECM. Assume a 0.1 increase in percent fat (.043 -> .044) then (.044 x 90 = 3.96 x 12.95 = 51.28) – the only change is lbs of fat (3.87 -> 3.96). 29.43 + 51.28 + 22.72 = 103.43 ECM thus increased ECM by 1.16 lbs.

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