Dairy benefits from high-oleic soybeans

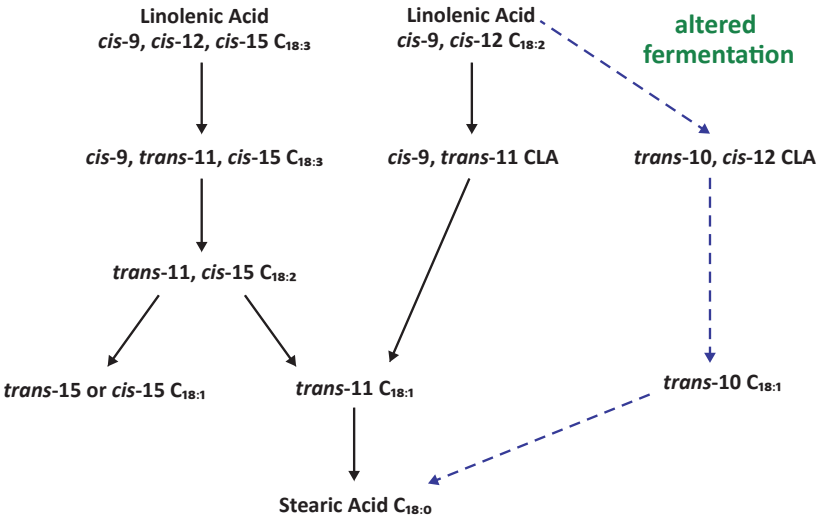
Laura Cassiday

In the early 2000s, high-oleic soybeans were developed for the human food market in response to growing health concerns about trans fats and partially hydrogenated oils. Unlike conventional soybeans, which contain about 23 percent oleic acid (*cis-9* C18:1) and 54 percent linoleic acid (C18:2), high-oleic soybeans have around 76 percent oleic acid and 7 percent linoleic acid. Rich in the same heart-healthy fatty acids found in olive oil, high-oleic soybean oil also offers superior heat stability and a longer fry life compared to conventional soybean oil.

- **High-oleic soybeans provide a rich source of oleic acid, improve milk components, reduce feed costs, and are increasingly being adopted in dairy diets.**
- **They can be fed at higher levels than conventional soybeans with less risk of milk fat depression, sometimes boosting milk fat percentage.**
- **Despite higher seed costs, they can increase profitability through higher milk fat output and reduced reliance on purchased feed.**
- **Roasting the soybeans alters their chemistry, enhancing protein availability and milk yields.**

While high-oleic soybean oil has not yet dominated the food industry (mainly due to price competition from canola and palm oils), the specialized soybeans are growing increasingly popular in the dairy industry. First introduced to dairy cow diets in 2017, high-oleic soybeans have recently surged in popularity as a "home-grown" fat source that farms can produce and use on-site. In September 2025, about half of all high-oleic soybean acres were grown for dairy feed, versus only about 5 percent in 2020.

"What is exciting is that high-oleic soybeans offer a rare win-win—improved milk components and reduced feed costs, while also supporting local crop production," says Adam Lock, professor of dairy nutrition at Michigan State University. Because farmers are paid for their milk based on pounds of fat and protein, an increase in either component can boost their profits, especially if home-grown feed can replace all or some purchased feed.



Biohydrogenation pathways during normal and altered ruminal fermentation.
Source: From Thomas Overton

During dairy processing, fat is skimmed off milk and used to make butter, cheese, and other cream-based products, as well as added back to fluid milk in various amounts to yield whole and low-fat milk. Since 2016, an increased demand for butter has made the price of milk fat surpass that of protein. Importantly, studies have shown that dairy cows fed high-oleic soybeans can produce more milk and more milk fat than cows fed conventional soybeans (https://doi.org/10.3168/jds.2024-25092).

WHAT HAPPENS IN THE RUMEN?

High-oleic soybeans can boost milk fat yield because of interactions between fatty acids and microbes in a cow's rumen—the stomach chamber where plant material is fermented and broken down before further digestion in other chambers. Unsaturated fatty acids are toxic to some rumen microbes. Hence, microbial enzymes hydrogenate them to form saturated fatty acids. These saturated fatty acids, along with any unsaturated fatty acids that escape biohydrogenation, are absorbed for use in the cow's small intestine.

Under normal conditions, rumen microbes convert linoleic acid to stearic acid (C18:0). But when the rumen's pH is low due to factors like improper diet or overcrowding, or excessive linoleic acid is present, the biohydrogenation pathway becomes altered, and the microbes convert linoleic acid to *trans-10, cis-12* conjugated linoleic acid (CLA). When absorbed in the small intestine, this compound has a potent inhibitory effect on milk fat production, directly downregulating genes involved in lipogenesis in the mammary gland.

To avoid this milk fat depression, farmers must limit the feeding of conventional soybeans, and they often avoid them altogether in favor of alternate fat and protein sources. Soybean meal—in which most oil, including linoleic acid, has been extracted for human consumption—is more widely used as dairy cow feed than whole soybeans in most regions.

On the other hand, oleic acid is 2-3 times less likely than linoleic acid to be converted to *trans-10, cis-12* CLA in the rumen, says Kevin Harvatine, professor of nutritional physiology at Penn State University in University Park, Pennsylvania. "We have to limit feeding of normal soybeans because of worries about milk fat depression," said Harvatine. "Whereas with high-oleic soybeans, we can feed two to three times more."

Because farmers can feed more high-oleic soybeans as a source of fat, protein, and energy, they can often reduce or eliminate other fat and protein sources, such as calcium salts or soybean meal.

FAT EFFECTS

In addition to having a reduced risk of milk fat depression, oleic acid has other beneficial effects on dairy production. Oleic acid can act as an emulsifier, increasing its (and other fatty acids') absorption by the cow's small intestine. The fatty acid has also been shown to stimulate adipose tissue lipogenesis, mitochondrial activity, and milk fat synthesis (https://doi.org/10.3168/jds.2024-25092).

Research indicates that, in some cases, feeding high-oleic soybeans can have beneficial effects on milk fat yield. In one study, the milk fat percentage rose from 3.73 percent to 4.06 percent for cows fed ground high-oleic soybeans in place of soybean meal. In another, milk fat percentage increased from 3.09 percent to 3.50 percent in cows fed ground high-oleic soybeans compared with ground conventional beans (https://doi.org/10.3168/jds.2018-14498).

But farmers should not necessarily expect an increase in milk fat, says Thomas Overton, professor of dairy nutrition and management at Cornell University in Ithaca, New York. "Whether milk fat percentage or yield goes up varies with what the cow's normal diet is," he said. "If the cow already has normal milk fat levels, they may not necessarily see a milk fat response with high-oleic soybeans."

That is because the fat in milk comes from two sources: fatty acids the cow makes herself in the mammary gland, and fatty acids that come from the diet and body fat reserves. If the cow is already getting enough fat in her diet, any extra fat from high-oleic soybeans will cause her to cut back on making her own fat in the mammary gland—so the overall fat percentage in the milk will remain the same.

But even if farmers do not see a milk fat boost, high-oleic beans can still have beneficial effects, Harvatine says. "Because the cow does not have to use all those nutrients to

make fat, she has them available for all sorts of uses," he said. "So, my guess is in those cases, you would see better reproduction, better immune function, better health outcomes, but we have a hard time measuring those things."

On the other hand, if the cow's diet is deficient in fat, the dietary oleic acid will complement the cow's own fatty acid production, increasing milk fat yield by up to 65 grams per cow per day (https://doi.org/10.3168/jds.2023-23738).

Higher fat yields can have a big impact on a farmer's bottom line. In an economic analysis, researchers found that, even with the increased cost of purchasing high-oleic versus conventional beans, higher fat yields from the specialty soybeans have the potential to increase milk income less feed costs (MILFC) by 27 cents per cow per day. That translates to an increase in farm profitability of $33,000 per year for a dairy feeding 500 milking cows and $130,000 for a farm feeding 2,000 cows.

TO ROAST OR NOT TO ROAST

One action dairy farmers can take to maximize the benefits of high-oleic soybeans is roasting the beans, which involves heating them to an internal temperature of about 300 °F and keeping them there for 30 minutes, followed by cooling and grinding. Lock's research has shown that compared to raw high-oleic soybeans, roasted beans increased average milk production per cow from 42.2 kg/day to 45.9 kg/day, fat yield from 1.71 to 1.83 kg/day, and protein yield from 1.37 to 1.47 kg/day, while not significantly changing milk fat percentage.

Roasting soybeans increases the amount of rumen-undigestible protein—protein that escapes the rumen to reach the small intestine, where it can be absorbed by the cow. In contrast, rumen-digestible protein is easily broken down by microbes in the rumen for their own use, rather than the cow's. About 60-70 percent of the protein the cow consumes is degraded by microbes in the rumen, making it unavailable for the cow to use for milk production or general health.

Roasting makes dietary protein resistant to microbial enzymes by causing the proteins to denature, aggregate, become less soluble, or bind with sugar molecules. As a result, the proteins make it to the small intestine, where acidic conditions and bovine enzymes like trypsin and chymotrypsin break them down for absorption.

In addition, roasting denatures a trypsin inhibitor that can interfere with protein digestion in the small intestine, and it decreases the activity of urease, an enzyme that produces ammonia from urea-containing feeds. It also may allow more lysine, an amino acid that has been implicated in milk production, to reach the small intestine. Further, roasting decreases rancidity and enhances palatability of the high-oleic beans.

But most farmers are not currently set up to roast their own beans, which would require an investment in equipment, time, labor, and possibly, separate storage facilities. Lock estimates that roasting carries a cost of $35-50 per ton. However, "Our data would say, on a reasonable-sized farm, you could repay the cost of roasting high-oleic soybeans pretty quickly," he says. For farmers that do not want to invest in their own equipment, local mills or "mobile roasters" could be options.

Milk effects of raw and roasted high-oleic soybeans.
Source: Bales and Lock, *J Dairy Sci*, 107, 10869, 2024.

Variable	CONVENTIONAL	RAW HOSB	RST HOSB
Milk (kg/d)	42.3	42.2	45.9
Fat (kg/d)	1.56	1.71	1.83
Protein (kg/d)	1.4	1.37	1.47
Fat (%)	3.73	4.06	4.03

CONVENTIONAL – regular soybean meal.
RAW HOSB – raw, ground high-oleic soybeans in place of soybean meal.
RST HOSB – roasted, ground high-oleic soybeans in place of soybean meal.

HOME-GROWN FAT

Even if farmers do not see gains in milk production or fat yield, high-oleic soybeans have the potential to reduce feed costs, especially if they can be grown on-farm. In this way, dairy farms with sufficient land can grow their own protein and fat supplements, reducing the cost of purchased feed.

"If a herd already has normal milk fat levels, they may not see a milk fat response," said Overton. "But if the economics pencil out based on the ability to save some feed costs, then absolutely look at feeding them, and if you get a milk fat response, that is just a bonus."

Harvatine notes that Pennsylvania dairy farmers were early adopters of high-oleic soybeans because they were already growing, roasting, and feeding conventional soybeans. So, they just had to swap out acreage of regular soybeans with the high-oleic variety.

However, some dairy farmers have every available acre planted with forage, so they must purchase their high-oleic beans, perhaps contracting with a nearby farmer. "For each producer, it is a very different economic decision," Harvatine said.

Some farmers assume they can cut costs by swapping high-oleic beans for expensive, palm-oil-based fat supplements. But Lock does not think that is a good idea because palmitic acid (C16:0, found in palm oil) and oleic acid have unique properties. His research has shown that the two fatty acids have additive effects on milk production. "My recommendation is that high-oleic soybeans can replace the majority of supplemental fat sources in the diet, but you should keep some or all of the palmitic acid," Lock said.

It is no surprise that dairy farmers in regions with robust soybean industries are leaning into high-oleic varieties—not just for their nutritional value, but for the opportunity to integrate a locally grown feed. "Things that are new in the cow feeding world do not come along very often," said Overton. "This is new, and everybody is interested in it. People get experience with high-oleic soybeans on farms, and they figure out over time how best to fit them into feeding programs."

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