The True Cost of Cheap Feed — How High-PUFA Diets Impact Livestock Health

Analysis by Ashley Armstrong | January 07, 2025

STORY AT-A-GLANCE

- Modern livestock feed has shifted dramatically since WWII. It's now dominated by high-PUFA ingredients like corn, soybeans, and distillers grains (DDGS), which has fundamentally altered the nutritional composition of meat and dairy products
- DDGS, a byproduct of ethanol production, contains concentrated levels of both PUFAs and pesticide residues, with major producers like Tyson Foods incorporating hundreds of thousands of metric tons annually into their feed formulations
- The fat composition of pigs and chickens directly reflects their diet, with modern pork and chicken products containing significantly higher levels of PUFAs than their historical counterparts
- High-PUFA feeds cause documented gut health disruption in livestock, including dysbiosis, reduced nutrient absorption, and increased intestinal tissue damage. Animals fed high-PUFA diets show increased markers of systemic oxidative stress, with elevated levels of toxic byproducts like malondialdehyde (MDA) found in their plasma, liver, and brain tissue
- Research shows maternal diets high in oxidized linoleic acid can cause accelerated neurological damage in chicken offspring, including ataxia and encephalomalacia

Despite substantial evidence to the contrary, some still claim that polyunsaturated fatty acids (PUFAs) are beneficial and pose no long-term health risks with increased consumption.

In today's article, we'll explore the effects of higher PUFA diets on livestock health, offering a unique perspective. Understanding these impacts may lead you to question the potential consequences of our own rising PUFA intake on human health.

What Do Livestock Eat?

Over the past 70 years, we've seen significant changes not only in our diets — such as swapping butter for margarine — but also in the diets of the livestock we consume. And remember: you are what your food eats.

The diets of animals directly impact the nutritional quality of meat, dairy, and eggs, which in turn affects human health. So, what are livestock eating?

Primarily, high omega-6 PUFA diets derived from soybeans, corn, vegetable oil, and biofuel byproducts. Surprisingly, the majority of U.S. corn and soy production isn't consumed directly by humans.

After World War II, corn and soybeans became dominant row crops in the U.S., prized for their versatility in food, feed, and industrial uses. Acreage dedicated to these crops skyrocketed, replacing diversified cropping systems and displacing small grains and forages. Advances in hybrid seeds, fertilizers, pesticides, and irrigation boosted yields dramatically — corn, for instance, jumped from 30 bushels per acre in the 1940s to over 170 bushels per acre today.

However, this industrialized system has led to simplified monoculture rotations, often limited to corn and soybeans, reducing farm biodiversity and increasing reliance on chemical inputs to manage pests and maintain soil fertility. Federal subsidies and crop insurance programs further incentivize this model, favoring economic profitability for large agribusinesses over diversity and sustainability.

While this system produces cheap, PUFA-rich food in abundance, it comes at a cost: diminished food quality, declining environmental health, and negative impacts on livestock and human health. As one study notes:

> *"The benefits of using oxidized oils from rendering and recycling as an economic source of lipids and energy in animal feed always coexist with the concerns that diverse degradation products in these oxidized oils can negatively affect animal health and performance."*[1]

The question remains — what price are we really paying for cheap food?

Are Distiller Grains Good?

A new player has entered the livestock feed game, and it's far from ideal — Dried Distillers Grains with Solubles (DDGS).

The rise of the ethanol-as-fuel industry in the early 2000s introduced DDGS as a cheap and widely available feed ingredient, particularly high in polyunsaturated fatty acids (PUFAs). Produced as a byproduct of ethanol production, DDGS is a cost-effective option that has found its way into many livestock diets.

For every gallon of ethanol produced, approximately 2.6 kg of distillers grains are created.[2] In 2011 alone, the U.S. ethanol industry produced 35.7 million metric tons of distillers grains for livestock and poultry feed. This number has likely grown significantly since.

So how is DDGS made? Corn, the primary feedstock for ethanol production, undergoes fermentation to convert its starch into ethanol and carbon dioxide. The remaining components — protein, fiber, fat, and minerals — are concentrated, dried, and sold as DDGS.

Since the starch is removed during ethanol production, the nonfermentable components like protein and fat are left in higher concentrations. This means DDGS contains significantly more fat and PUFAs than raw corn. However, these PUFAs are highly prone to lipid peroxidation, and research confirms that DDGS contains elevated levels of lipid oxidation products (LOPs) due to the heating process used for drying.[3]

Beyond lipid oxidation, DDGS often contains high levels of toxic agrochemicals. Most GMO corn used for ethanol is heavily treated with herbicides, insecticides, and fungicides such as glyphosate and atrazine. During ethanol production, these toxic residues become concentrated in the DDGS, as the starch is removed while other components, including pesticides, remain.

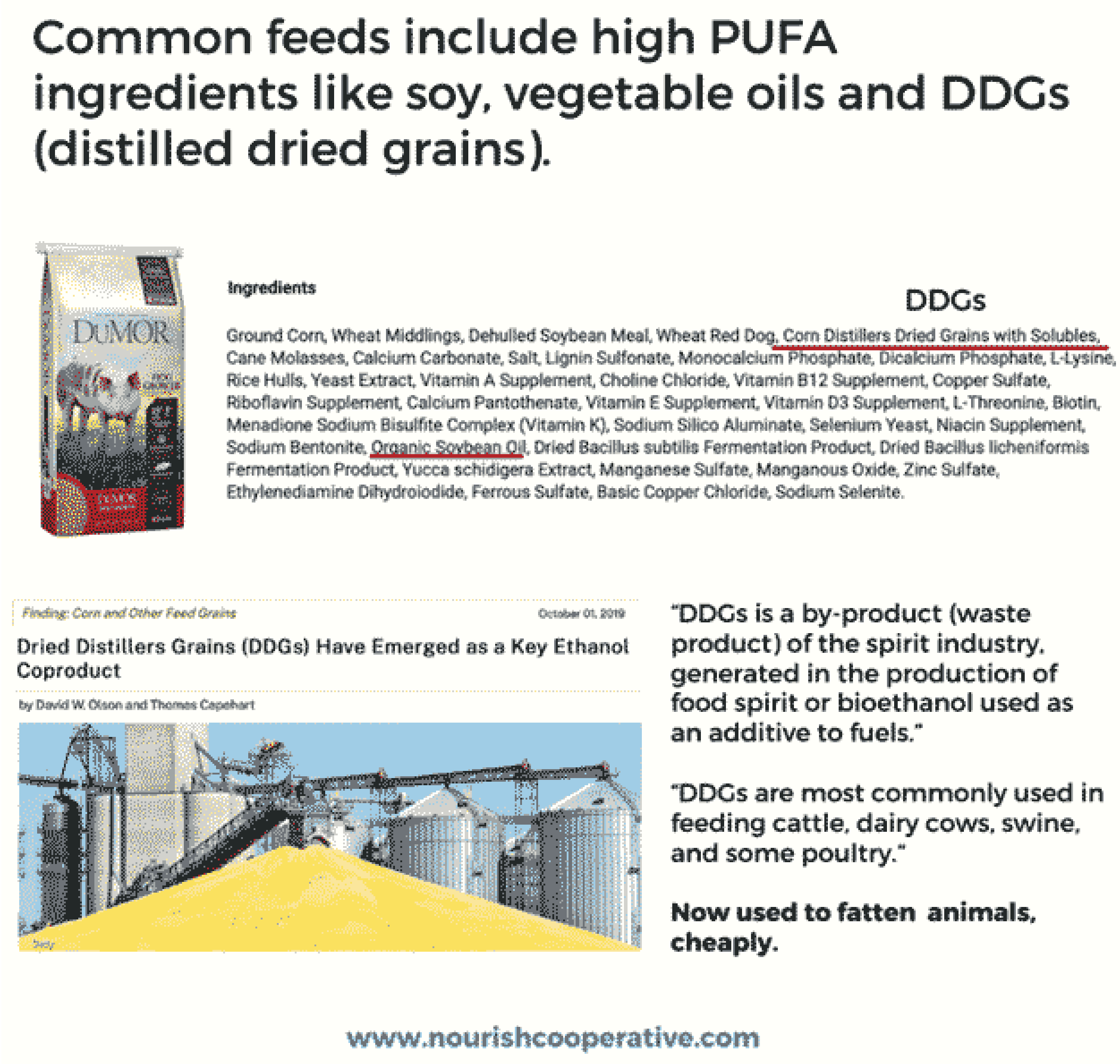
Studies show pesticide levels in DDGS can be significantly higher than in the original grain, posing risks to both livestock and environmental health. While exact feed formulations are proprietary information, DDGS is widely used in hog feed, meat chicken feed, egg layer feed and even to feed beef cattle.[4]

DDGS is a cheap feed ingredient, often priced below $0.10 per pound. It provides protein and fiber, making it attractive for livestock feed formulations. As a result, it is widely used in feeds for hogs, meat chickens, egg-laying hens, and even beef cattle.

For example, Tyson Foods — the largest chicken producer in the U.S. — began incorporating DDGS into its poultry feed formulations in April 2004. By 2010, the company was using approximately 700,000 metric tons of DDGS annually across its feed mills. Imagine what that number looks like today in 2024!

While DDGS may be cost-effective, it comes with hidden costs. It delivers high levels of PUFAs and pesticides to livestock diets, which can impact animal health, meat quality, and the broader food system.

DDGS is a stark reminder that cheap inputs in industrial agriculture often carry long-term consequences for health and sustainability.

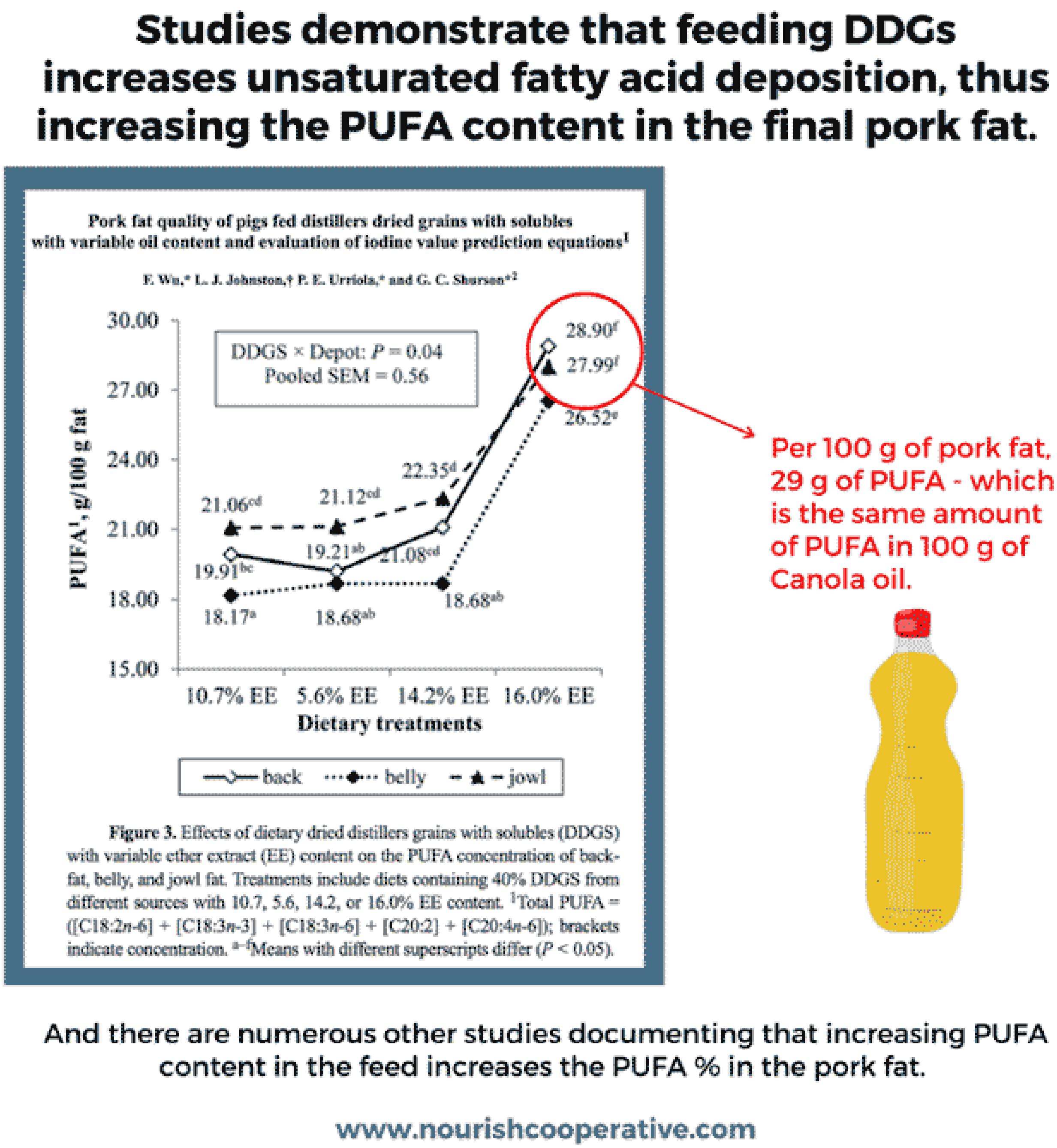


PUFA increase in Fat Tissues

As I've detailed in previous articles, pigs and chickens are quite literally a reflection of what they eat. Neither animals nor humans can produce polyunsaturated fatty acids (PUFAs) on their own, so the fat composition in their bodies reflects the fats they consume. This means the PUFA levels in pork and chicken are entirely determined by the diets provided to them.

Modern pork and chicken products now contain significantly higher levels of PUFAs compared to those from past generations. A key contributor to this shift is the inclusion of DDGS in livestock feed. DDGS, being high in PUFAs, directly impacts the fat composition of the animals. As DDGS levels in feed increase, the linoleic acid content in pork fat rises while the saturated fat content declines.[5]

The result? The nutritional profile of pork and chicken is now largely shaped by feed formulations — a critical point to consider when evaluating the health implications of consuming these products.



What Are the Livestock Health Consequences of a Diet Higher in PUFAs?

Polyunsaturated fatty acids (PUFAs) are unstable molecules prone to oxidation when exposed to heat, light, reactive oxygen species (ROS), or heavy metals. This process, known as lipid peroxidation, induces metabolic oxidative stress and produces toxic byproducts such as malondialdehyde (MDA), thiobarbituric acid reactive substances (TBARS), and 4-hydroxynonenal (4-HNE), which serve as biomarkers for lipid peroxidation.

Lipid peroxidation can occur both during feed processing — resulting in livestock consuming oxidized fats — and within the animal's body during digestion. These oxidation byproducts have significant negative effects on health. So what do the studies say about higher PUFA diets for livestock?

1. **Gut health disruption —** In chickens, diets containing soy have been shown to cause dysbiosis and an overgrowth of pathogenic bacteria such as Campylobacter and Acinetobacter. Conversely, soy-free diets promote greater microbiome diversity.[6] Oxidized soybean oil consumption has also led to tissue damage in the small intestine for meat birds.[7]

   In hogs, the consumption of heat-treated soybean oil impaired small intestine growth, reduced nutrient absorption, and increased oxidative stress markers (e.g., MDA) while reducing total antioxidant capacity (T-AOC).[8,9]

   The gut disruption in hogs has been shown to disrupt gut health and reduce nutrient absorption in hogs:

   > *"Previous studies found that feeding oxidized lipids may negatively affect nutrient digestibility and utilization in animals due to localized oxidative damage to the intestinal epithelial cells.*
   >
   > *Ringseis et al. (2007) reported that feeding pigs oxidized sunflower oil, which contains high levels of linoleic acid similar to corn oil, increased*

TBARS in intestinal epithelial cells, which indicates an increased localized oxidative stress within the intestine.

Additionally, Dibner et al. (1996) observed increased intestinal epithelial cell turnover and decreased lymphocyte proliferation in follicles of the lamina propia in broilers fed oxidized poultry fat, indicating that nutrient absorption and digestion may be compromised due to the impairment of intestinal cells."[10]

2. **Metabolic dysfunction —** High-PUFA feeds lead to more efficient fat gain in livestock with fewer calories due to the metabolic and hormonal effects of PUFAs. Here is a quote from Dr. Ray Peat:

   "Linoleic and linolenic acids, the 'essential fatty acids,' and other polyunsaturated fatty acids, which are now fed to pigs to fatten them, in the form of corn and soy beans, cause the animals' fat to be chemically equivalent to vegetable oil. In the late 1940s, chemical toxins were used to suppress the thyroid function of pigs, to make them get fatter while consuming less food.

   When that was found to be carcinogenic, it was then found that corn and soy beans had the same antithyroid effect, causing the animals to be fattened at low cost. The animals' fat becomes chemically similar to the fats in their food, causing it to be equally toxic, and equally fattening."

   Increased oxidation can interfere with important metabolic functions in livestock.[11]

3. **Endogenous antioxidant system impairment —** The body's natural antioxidant systems, such as glutathione peroxidase (GSH-Px) and superoxide dismutase (SOD), play crucial roles in detoxifying ROS.

   With a high PUFA intake and higher levels of PUFA oxidation, higher levels of toxic byproducts such as malondialdehyde (MDA) and 4-hydroxynonenal (4-HNE) can be produced. These compounds place a heavy burden on the body's endogenous antioxidant system, which is responsible for neutralizing ROS and protecting cells from oxidative damage.

> *"The enzyme activity (of the natural antioxidant system) was influenced by the degree of unsaturation of the diet."*[12]

In one study, the chicken's natural antioxidant system was downregulated as DDGS was added to the diet, indicated by lower levels of T-SOD, T-AOC, and GSH-Px in tissues.

Table 5. Biochemical indices in breast muscle and liver of male broilers[1]

	Breast fillet			Liver		
Item	T-AOC, U/mg of protein	T-SOD, U/mg of protein	GSH-Px, AU	T-AOC, U/mg of protein	T-SOD, U/mg of protein	GSH-Px, AU
Treatment						
0% DDGS	1.85	207.78^{a}	25.80	27.47	172.96^{a}	60.56^{a}
5% DDGS	2.06	143.42^{b}	25.38	21.92	136.89^{bc}	49.66^{b}
10% DDGS	2.00	129.57^{b}	22.56	20.52	108.45^{d}	36.63^{c}
15% DDGS	1.75	137.92^{b}	19.64	19.86	144.47^{b}	53.45^{ab}
20% DDGS	1.88	138.30^{b}	19.54	18.32	111.95^{d}	44.81^{bc}
25% DDGS	2.20	140.67^{b}	18.81	18.24	114.16^{cd}	34.95^{c}
SEM	0.25	7.93	2.88	0.45	14.26	4.70
P-value	0.9809	0.0244	0.7627	0.1116	<0.0001	0.0003

[a–c]Means within a column without a common superscript differ significantly ($P < 0.05$).

[1]Values are means of 8 birds per treatment. T-AOC = total antioxidative status and capacity; T-SOD = total superoxide dismutase; GSH-Px = glutathione peroxidase; AU = arbitrary units; DDGS = distillers dried grains with solubles.

Table from: The Journal of Applied Poultry Research, September 2012, 21(3):603-611 — as DDGS was added to the diet, T-SOD and GSH-Px activity is lower.

4. **Brain damage —** High-PUFA diets, especially linoleic acid, more than double the omega-6 fatty acid content in the chicken brain. These unstable fats oxidize, increasing levels of aldehydes like MDA in the plasma, liver, and brain.[13]

   Maternal diets high in oxidized linoleic acid (and low in vitamin E) caused accelerated neurological damage (e.g., ataxia, encephalomalacia) in chick offspring.[14] Lowering maternal dietary linoleic acid or supplementing it with vitamin E was protective. Studies found these effects were due to oxidized linoleic acid metabolites (OXLAMs), which can disrupt brain microvasculature and blood coagulation.

"These studies provide direct evidence that OXLAMs induce ataxia and mortality due to encephalomalacia in chickens ... the neurotoxic effects of OXLAMs may be caused by blood coagulation and disturbances in the brain's microvasculature."

5. **Systemic oxidative damage —** Oxidized fats in the diet increase oxidative stress markers throughout the body:

    - Chickens fed sunflower oil had elevated plasma and liver MDA levels.[15]
    - Laying hens consuming oxidized vegetable oil experienced increased MDA in plasma and liver,[16] increased rates of liver DNA damage,[17] and follicle apoptosis.[18]
    - Chickens fed oxidized vegetable oils increased TBARS in the plasma while reducing antioxidant levels, including vitamin E, across various tissues.[19]

    "The previous results could indicate that inclusion of thermally oxidized lipids, independently of the origin, in swine diets has a detrimental effect on the metabolic oxidative status of the animals measured by oxidative damage and specific endogenous antioxidants.

    In addition, vitamin E concentration in plasma or serum seems to decrease consistently in animals fed peroxidized lipids and could be considered a good indicator of metabolic oxidative status in pigs."

    High levels of antioxidants like vitamin E are added to livestock feed to reduce PUFA oxidation, but these antioxidants can be depleted during digestion, allowing further oxidation along the digestive tract.

Raw soy beans contain antinutrients that can interfere with digestion, nutrient absorption and metabolism — like trypsin inhibitors, lectins, phytic acid, saponins, and goitrogens. It is well known in the industry to not feed raw soy beans as this can lead to problems. So, soy beans are commonly roasted to lower these antinutrients. But the heat treatment used to neutralize the antinutrients in raw soybeans can also oxidize the unstable PUFAs they contain.

This oxidation process can produce harmful byproducts like toxic aldehydes such as MDA and 4-HNE, which negatively impact the health of chickens and reduce the nutritional quality of the feed.

PUFA oxidation in feed is why high levels of antioxidants like vitamin E are included in feed in relatively high amounts, to minimize the oxidation. But those PUFAs can get further oxidized when digested along the chicken digestive tract after vitamin E stores are used up.

The metabolic stress caused by high-PUFA diets has undeniable negative effects on livestock health,[20] raising concerns about the broader implications for human health. If these issues are well-documented in livestock, it's worth questioning the impact of similar dietary patterns on humans. Are we overlooking the real cost of high-PUFA diets for both animals and people?

Conclusion

There is substantial evidence pointing to the health consequences of a system built around livestock feed ingredients that are high in PUFAs. This article only scratches the surface of the research available. Yet, the conventional system persists because it is profitable. Agribusinesses control the seeds used to produce these feed ingredients and the toxic chemicals required to grow the crops, creating a self-sustaining and lucrative cycle.

The takeaway? A food industry centered on PUFAs has significant repercussions for both human and livestock health. It's time to question the cost of prioritizing profitability over quality and long-term health.

Corn and soy will undoubtedly remain part of livestock feed, and to some extent, that's acceptable. However, the key lies in being mindful of total PUFA intake — it's not a case of "the more, the merrier." The heavy reliance on vitamin E supplementation in livestock feed highlights how these high-PUFA diets require added antioxidants to mitigate the oxidative stress they create.

By using cheap byproducts from other industries and subsidized crops like corn and soy, the price of conventional food remains low — but at the expense of quality.

If low-PUFA chicken or pork is not accessible, prioritize meat from ruminant animals, such as beef or lamb. These animals naturally have lower PUFA levels in their fat, making them a better choice for minimizing PUFA intake and promoting better health.

About the Author

Ashley Armstrong is passionate about helping others restore metabolic health and in creating an alternative food system low in PUFAs. Armstrong is the co-founder of **Angel Acres Egg Club**, which specializes in low-PUFA (polyunsaturated fat) eggs that are shipped to all 50 states, and **Nourish Cooperative**, which ships low-PUFA chicken, low-PUFA pork, beef, cheese, A2 dairy and traditional sourdough to all 50 states.

Dr. Mercola and Ashley **discussed the importance of low-PUFA eggs in a previous interview**, embedded below for your convenience.

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