Market Potential for the Adoption of High-Oleic Soybeans in Michigan

Summary of Michigan Soybean Producer Perspectives

Sam Rickman, Shirel Ponnudurai, Jiayu Sun, Vincenzina Caputo, Adam Lock

FOOD CHOICE RESEARCH LAB

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Executive Summary

The soybean supply chain is an important aspect of the American agricultural sector, and is an important contributor to the U.S. economy. High-oleic soybeans (HOS), a seed variety innovation, are increasingly being discussed due to their positive impact on human health, livestock health, and food service equipment. Recent literature indicates a range of benefits of using HOS in livestock feed, including improved animal welfare, more nutritious meat products, and increased farmer profit potential. However, market growth of HOS has proven to be slow, limiting its availability for livestock farmers. This study investigates Michigan soybean farmers' perspectives on the primary barriers and opportunities of adoption. Producers expressed concern about the lack of crop trait availability, yield data, and supply chain outlets for HOS. While producers indicated a willingness to adopt HOS in the future, most feel that the current market premiums are not sufficient for widespread adoption. Producers identified that direct relationships between soybean and livestock producers is a supply chain innovation that could facilitate immediate market growth. For strategic advancement of HOS in the industry, producers identified the following three priorities: (i) evaluate and exploit the consumer market for HOS oil, (ii) develop competitive crop traits, and (iii) improve and generate reliable information about yield in local conditions.

Table of Contents

Meet the Team

Samuel Rickman

Shirel Ponnudurai

Jiayu Sun

Vincenzina Caputo

Adam Lock

The Food Choice Research Lab at Michigan State University, led by Dr. Vincenzina Caputo, focuses on the economic and behavioral dynamics of food choices. Using a cutting-edge, multidisciplinary approach that integrates economics, marketing, behavioral economics, and sensory science, the lab aims to understand both producer and consumer decision-making. The goal is to improve models that predict decision-making processes and behavioral responses to environmental changes.

The lab's research spans several areas: trends in consumption, the impact food environments on health and sustainability choices, consumer acceptance of new food technologies, the adoption of sustainable practices by producers, and policy evaluation. The team combines qualitative methods—such as focus groups and interviews—with quantitative approaches, leveraging diverse data sources, including economic experiments, scanner data, and big data. Using advanced tools like econometrics and machine learning, the lab generates actionable insights for a broad set of stakeholders, including food producers, consumers, retailers, food companies, and policymakers.

Through its work, the lab generates science-based, data-driven evidence that directly informs decision-making across the agrifood industry and public policy. Key collaborators include the Food Industry Association (FMI), commodity groups, and government agencies, ensuring that the research is grounded in real-world challenges and addresses the evolving needs of both industry and policy.

Market Background and Soybean Supply Chain

Topics:

- Soybean Value Chain
- Economic Impacts
- Introduction to High-Oleic Soybeans

The Soybean Sector in the United States

Soybeans are a very important crop in the U.S., with 92% of oilseed production coming from soybeans. There are over 300,000 U.S. farms growing soybeans, with 241,593 of those farms being individual or family-run. There is a disparity between the distribution of farm size and soybean production, with smaller farms (less than 250 acres) making up 67% of total farms but contributing less than 19% of annual soybean yield. Conversely, farms larger than 2,000 acres, representing less than 10% of all farms, produce over 42% of the annual crop (USDA NASS, 2017).

Market Insight

The flowchart below illustrates the U.S. soybean market supply and consumption in the 2022/23 marketing year (MY). Every year, most U.S. soybeans are domestically processed into separate products, while around 40% are exported whole. Figure 1 visualizes the path that US-grown soybeans take from production to consumption.

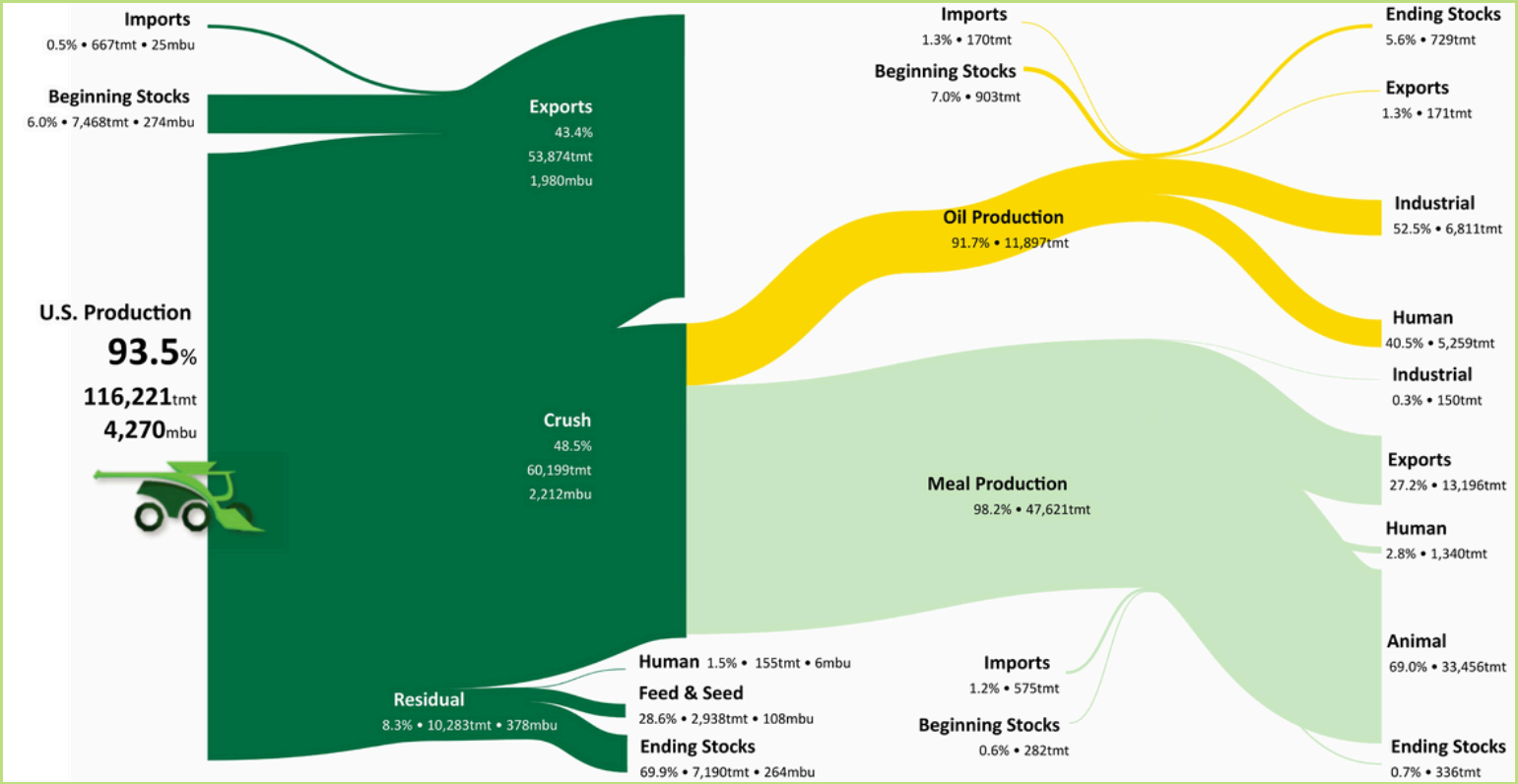


Figure 1: U.S. soybean market flow in MY 2022/23, Source: United Soybean Board, 2024

Soybeans have a significant effect on the United States economy, with the overall sector contributing ~0.6% of U.S. GDP. That was $27.72B USD in 2023, and $34.4B USD in 2022 (USDA ERS, 2023a). As shown in Figure 2, the soybean sector also accounts for the largest percentage of full-time jobs supported by the top ten U.S. agricultural exports. The U.S. soybean sector is a major contributor to the global soybean industry, having produced 113 million metric tons in 2023. Although Brazil surpassed the U.S. as the top producer in 2017, the U.S still accounts for 36% of all global soybean exports, and over 25% of the global soybean market. Domestically, soybeans rank as the second most produced crop behind corn and the third largest agricultural commodity behind corn and beef (USDA FAS, 2024).

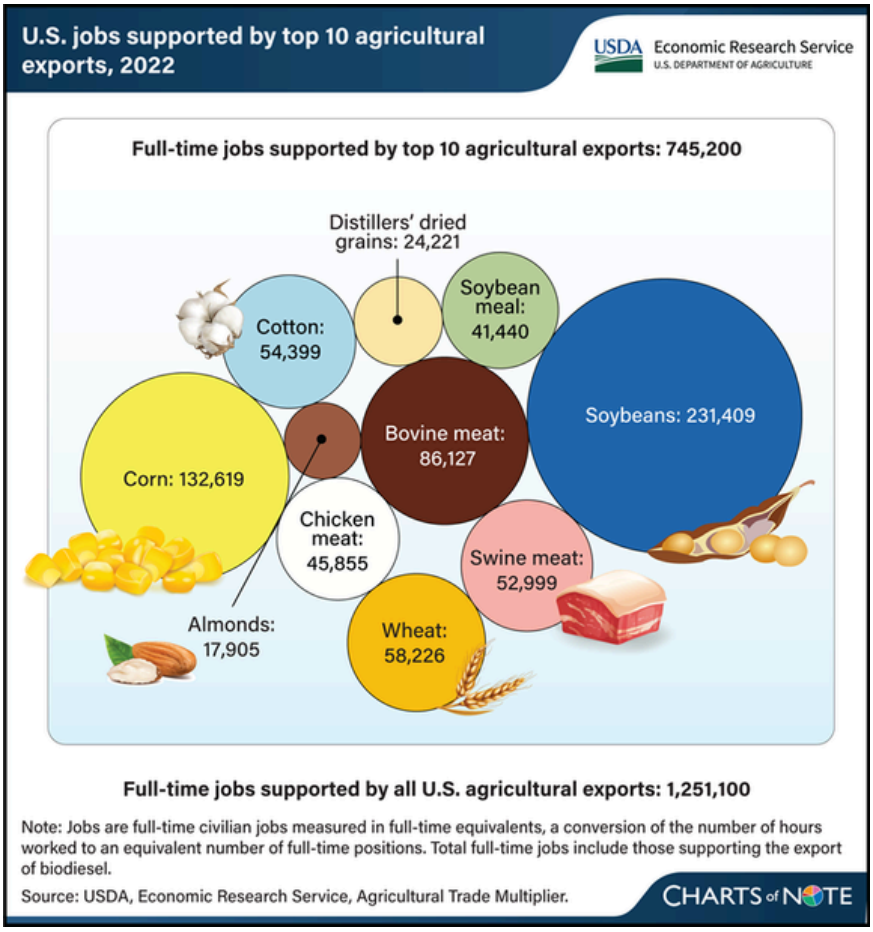


Figure 2: U.S. jobs supported by top 10 agricultural exports; Source: USDA ERS 2024

The Soybean Industry of Michigan

Michigan plays a significant role in U.S. soybean production, consistently ranking among the top 15 producing states. In 2022, Michigan harvested 105.28 million bushels from approximately 2.25 million acres, accounting for about 2.5% of the national total of 4.28 billion bushels harvested and 87.45 million acres (USDA NASS, 2024). With over 10,000 soybean farms spanning nearly 2 million acres, the state's annual soybean harvest contributes nearly $1 billion to Michigan's economy (The Michigan Ag Council, 2023). As seen in Figure 3, most of this production takes place in the southern half of the lower peninsula, which is consistent with the general agricultural geography of the state.

Notably, Michigan's soybean value chain has a broad economic impact, ranking among the largest in the U.S. With an average direct value of $1.329 billion and a total value of $2.641 billion from 2019-2022, the Michigan soybean supply chain contains all levels of production, including exports. The soybean sector accounts for approximately 0.5% of Michigan's total GDP, supports over 6,000 paid jobs, and pays $288 million in wages annually (NOPA 2023).

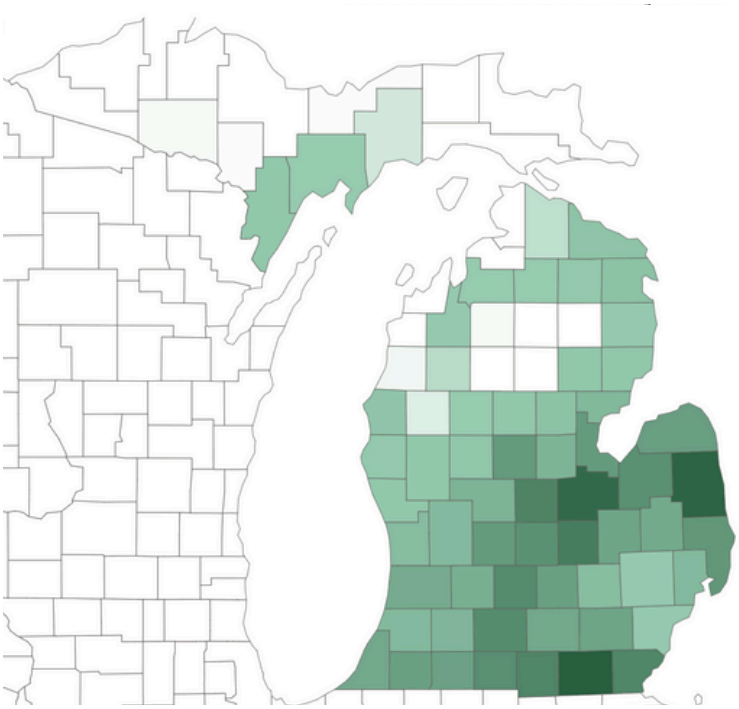


Figure 3: 2022 MI planted soybean acres by county, Source: United Soybean Board (2023a)

An Overview of the Soybean Supply Chain

A critical factor of large-scale production and high economic impact is the complexity of the soybean supply chain. Figure 4 provides a visual representation of the supply chain stages, which include inputs, agricultural production, processing, transportation/trade/distribution, manufacturing, and retail/consumption. In the following subsections, we describe each stage of the supply chain depicted in Figure 4.

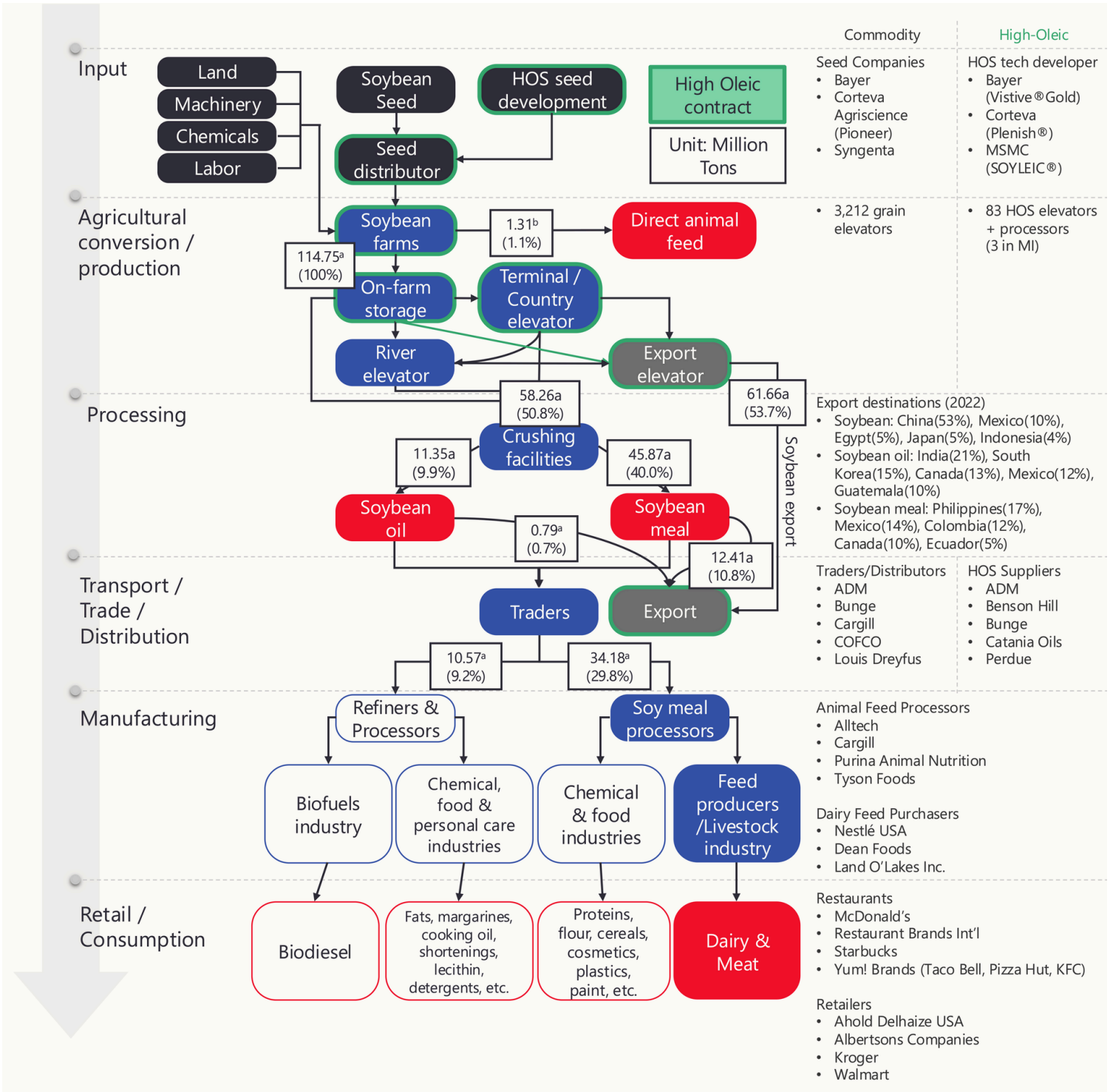


Figure 4: US Soybean Supply Chain; Sources: Engage the Chain (2022), Sanders & Tegeder (2023), U.S. SOY (2017), USDA FAS (2024)

1. Inputs

The main inputs in the soybean supply chain include land, machinery, storage, chemicals, labor, and seeds. There are over 2,500 varieties of soybeans, each selected for specific traits, making seed development an important part of this industry. Two companies dominate the U.S. market for soybean and corn seeds - Bayer and Corteva Agriscience, which together account for nearly 70% of total seed sales. Bayer alone oversees around 80 million acres of U.S. soybean production (Thomas, 2023; USDA ERS, 2023b). Farmers typically purchase seeds in the fall or winter for the following year, creating a lengthy period between seed purchase and harvest. According to a study conducted by the United States Soybean Export Council and illustrated in Figure 5, approximately 4.4 million (5%) of soybean acres were designated for non-GMO seeds. Looking further, around 1.9 (5%) million acres were allocated to non-GMO food-grade soybeans, and just under 2.1 million acres were allocated to non-GMO feed-grade soybeans (USSEC, 2022).

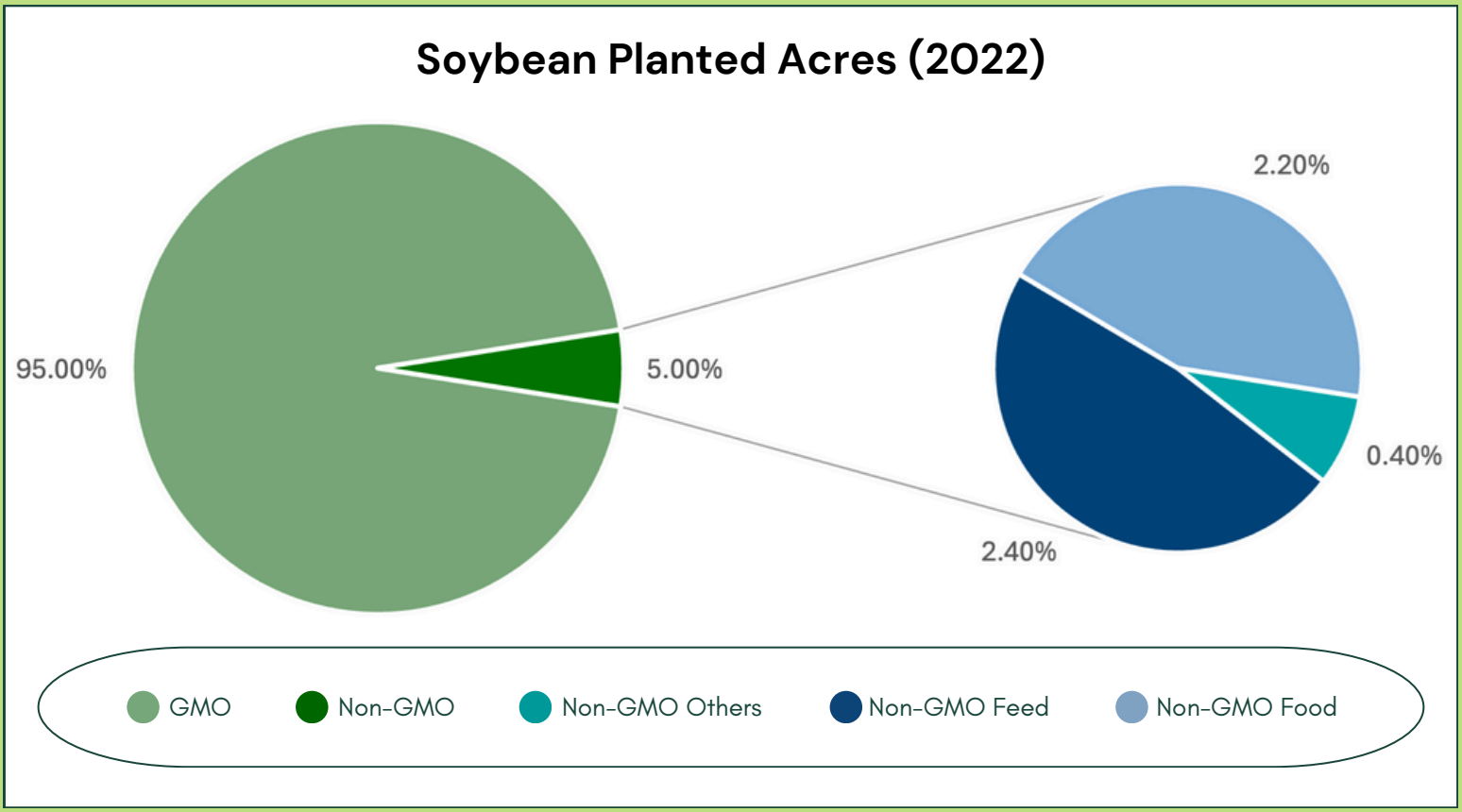


Figure 5: Shares of types of soybean seed planted in the U.S., Source: USSEC (2022)

Non-GMO are an example of identity-preserved (IP) soybeans. IP soybeans are distinguished by specific desirable traits, usually for advantages in human or animal consumption. The IP soybean supply chain needs to be segregated from the commodity chain to retain its desirable attributes, which mostly include high-oleic, non-GMO, organic, or food grade. IP beans can incur additional costs along the supply chain, such as regular cleaning of planting/harvesting equipment, additional storage, lower yields, and increased transportation distance. This requires a price premium to incentivize farmers to grow IP beans, creating a need for forward contracting with a buyer. With higher risk to producers involved with growing IP soybeans, the general market potential depends on whether additional revenue from premiums exceeds additional costs incurred by producers (Knudson, 2022b). Additional costs tend to vary from producer to producer, but a general summary of the market landscape for IP beans can be found in Figure 6.

2. Agricultural Conversion/Production

Farmers use planters to disperse seeds throughout their fields. Depending on the type of soybean, they may need to use machines to apply herbicides and pesticides a few times throughout the season. Once the crop has matured, farmers are free to harvest their crop. They do not necessarily need to harvest it immediately, and sometimes wait until late fall or winter to harvest depending on their own schedule. Then, they either put the grains in storage bins or bring the harvest directly to market from the field via truck. Having storage gives producers the advantage of being able to bring harvest to market at peak price times. Geographically, soybeans are mostly produced in the Midwest with Illinois and Iowa being the top producing states (see Figure 7). After soybeans are harvested, 15% are roasted or used as is for human or animal consumption, while 85% are stored and prepared for processing (USDA FAS, 2024).

Type	Price Premium (per bushel)	Properties	Market Dynamic	Producer Considerations
High-Oleic	≤$2.20	• Improved storage • Improved fry life • Better product texture • Less trans fats	• Increasing acreage planted • ~1.2 million acres planted	• ~76-103 bushel per acre avg. yield (data from seed companies) • Available in GMO, non-GMO seeds • Limited trait availability
Non-GMO	≤$2.00	• Excludes chemicals and substances utilized in GMO production	• Decreasing acreage planted • ~4.4 million acres planted	• ~$57 seed cost per acre, ~$108 chemical cost per acre • ~51 bushel per acre avg. yield • Relatively difficult to control weeds, pests
Organic	≤$7.00	• Excludes use of synthetic compounds	• Increasing acreage planted • ~165,000 acres planted	• ~$56 seed cost per acre • ~34 bushel per acre avg. yield • Relatively difficult to control weeds, pests • USDA grants available to subsidize production
Food Grade	≤$3.20	• High protein content • Improved color and texture • Lower water content	• Increasing acreage planted • ~1.9 million acres planted	• ~$57 seeds cost per acre • ~50 bushel per acre avg. yield • Relatively difficult to control weeds, pests
Conventional GMO	-	• Higher yields at lower costs • Herbicide/pesticide resistant	• 95% of soybean acreage planted	• ~$71 seeds cost per acre, ~$63 chemical cost per acre • ~53 bushel per acre avg. yield • Wide range of trait availability

Figure 6: Market landscape of IP and conventional soybeans; Sources: United Soybean Board (2022b), Knudson (2022b), United Soybean Board (2024a), USSEC (2022), University of Kentucky (2013), Hartman et. al. (2016), University of Minnesota (2020)

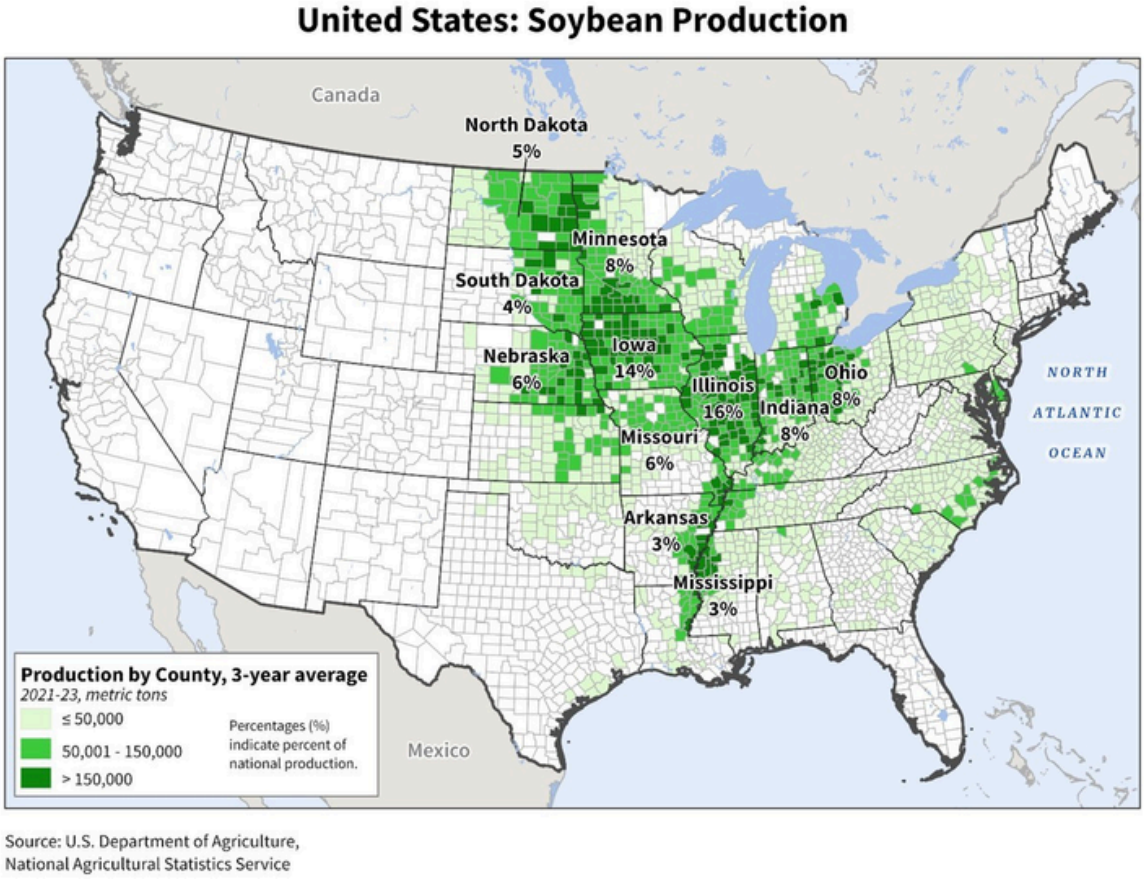


Figure 7: Soybean production by county; Source: USDA NASS (2024)

3. Processing

The general process of soybean processing is as follows: cleaning, crushing, softening, rolling, and extruding. Each of these steps serves an essential purpose in extracting the most possible oil from the beans (seedoilpress.com, 2023). A soybean's estimated processed value is derived from each co-product of a bushel of soybeans.

Soybeans are stored on-farm or using a terminal elevator or country elevator as they are prepared to be shipped to a crushing facility (Soy Connection, 2023). If farmers have the facilities, they can crush soybeans themselves. Otherwise, farmers take their soybeans to the nearest crushing facility. Soybeans are then crushed to produce three resulting co-products: oil, meal, and hulls, although hulls make up a very small portion of the total value (United Soybean Board, 2018).

Once the co-products are separated, each can be used for individual purposes (NC Soy, n.d.). Soybean meal is mostly used for livestock feed, while the oil is used for consumer and industrial products. A small percentage of soybeans are roasted and ground for animal feed without the oil extruded. U.S. crush capacity is increasing due to the increased demand for soybean oil in the biofuel industry, therefore new processing plants are expected to start operating in the next few years (USSEC, 2024).

4. Transporting, Trade, Distribution

Soybeans are transported from the processor to a manufacturing facility. Soybean transport in the U.S. relies on rail, barge, and truck. Exported beans are primarily moved by rail and barge, with about 60% of exports passing through the Mississippi River Delta. Domestic transportation depends mainly on trucks and rail. Pacific Northwest ports handle most exports bound for Asian markets, as shown in Figure 8 (Denicoff et. al, 2014).

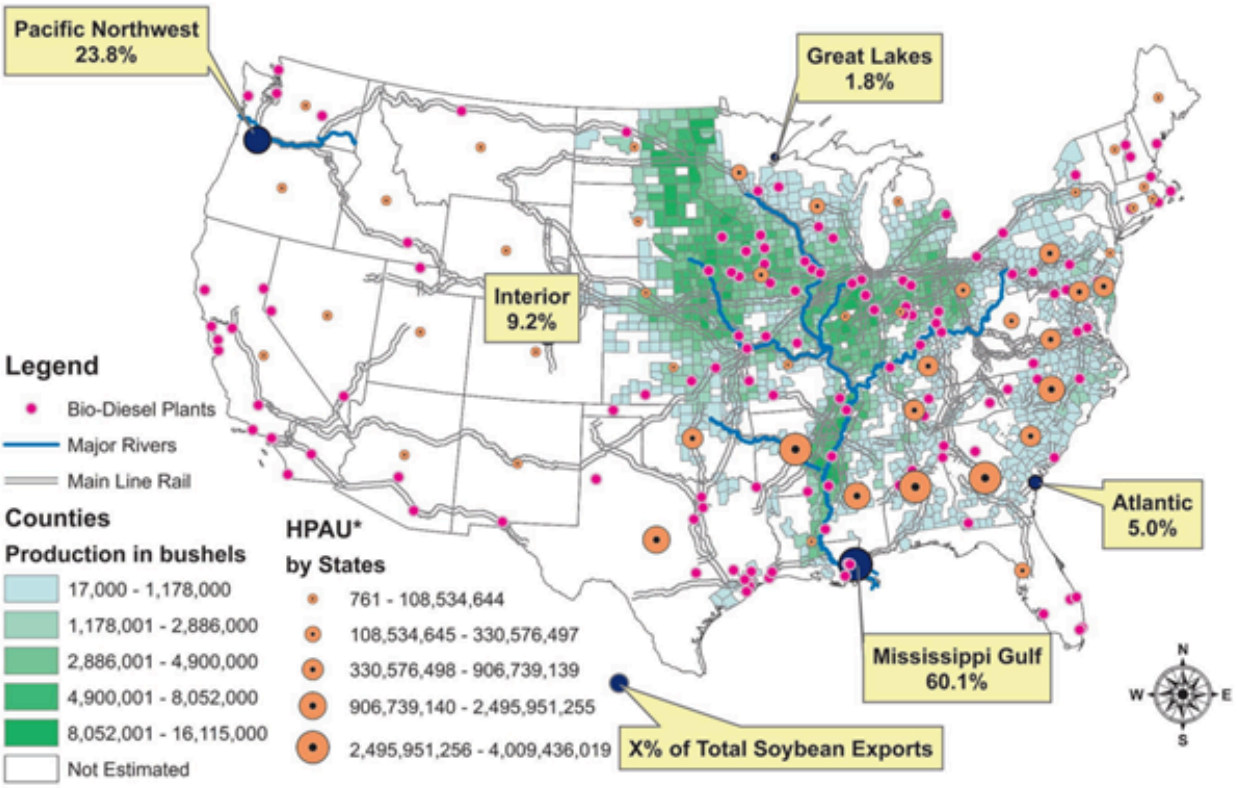
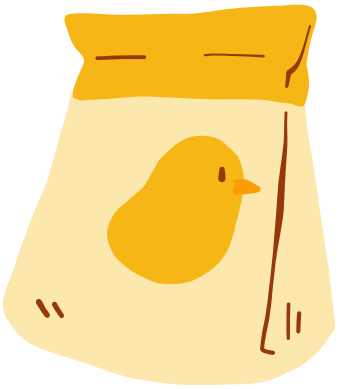


Figure 8: 2013 Soybean production by county, biodiesel plants, export port regions, and *High Protein Animal Units by State; Source: Denicoff et. al, (2014)

5. Manufacturing

There are two primary manufacturing procedures which prepare soybeans for end use. First, refiners and processors refine the oil into two products: cooking oil and biofuels/other inedible products. The second is meal processing, which prepares the byproduct meal into animal feed and vegetable-based products like protein supplements, flours, and cereals (Masagounder, 2016).



6. Retail/Consumption

In Marketing Year (MY) 2022/23, 95.8% of soybean meal was used as animal feed for poultry, swine, beef, and fish. Poultry was the largest consumer of soybean meal (57.9%), followed by swine (16.4%) and dairy cattle (14.2%) respectively. Figure 9 shows the breakdown of soybean meal consumption by category for marketing year 2022/23 (MY 22/23) (United Soybean Board, 2022b).

On the other hand, 46.9% of soybean oil produced in MY 22/23 was used in the biofuel industry. 29.9% was used for cooking oils, and 12.5% was used for baking and frying fats. Under 10% of soybean oil is used for other industrial purposes such as lubricants, paints, soaps, and plastics. Figure 10 shows the breakdown of soybean oil consumption by category (United Soybean Board, 2022c).

1.3% of oil, 27.2% of meal, and 43.3% of whole soybeans were exported in MY22/23. It is important to note that recent and projected trends of soybean oil consumption show that increasing amounts of meal are to be exported to countries in Asia and Europe. In MY23/24, soybean meal exports hit a record high, while soybean oil exports were much lower compared to previous years. This is partly due to increased crushing of soybeans to meet high soybean oil demand for renewable diesel, while the resulting surplus of meal is exported. Some potential areas of exploration are whether this excess supply of meal can alternatively be used to fuel growth in domestic animal farming by supplying more meal for increased animal meat production (United Soybean Board, 2024b).

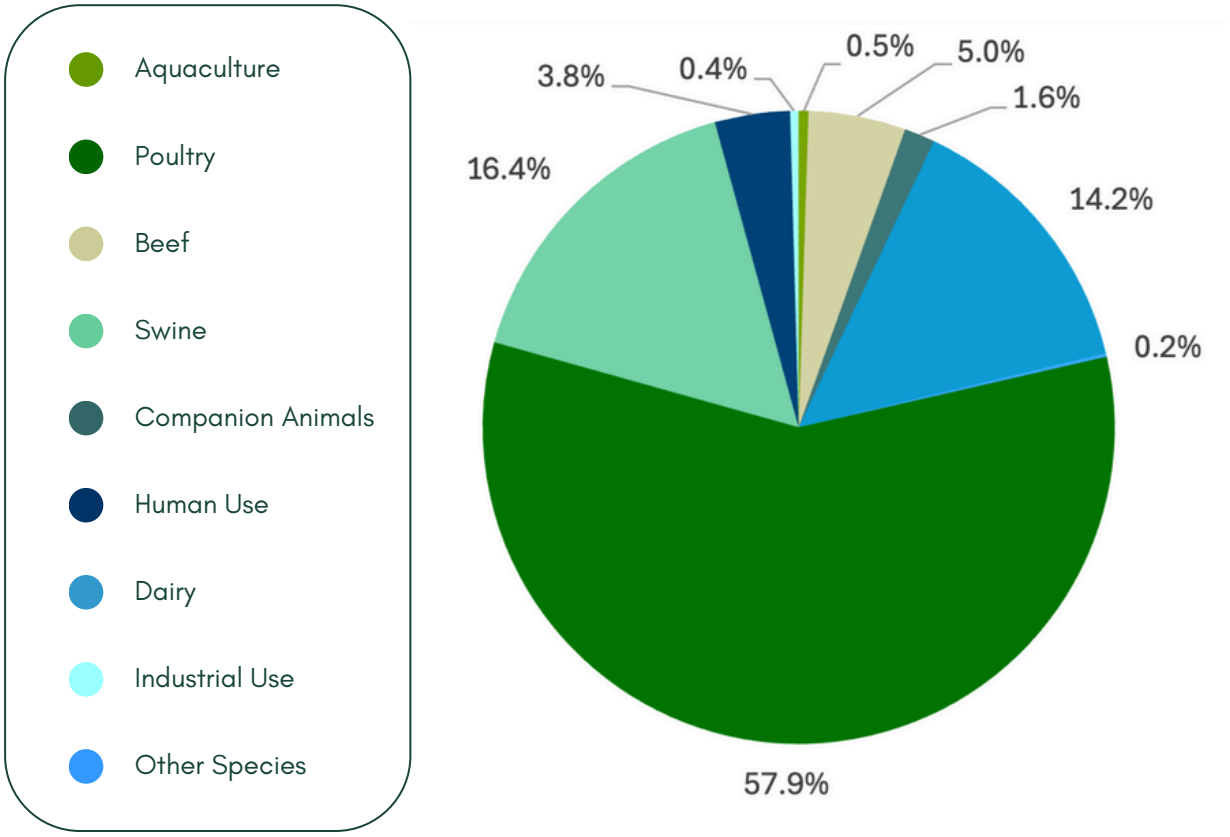


Figure 9: U.S. Soybean Meal Consumption, Source: United Soybean Board (2022b)

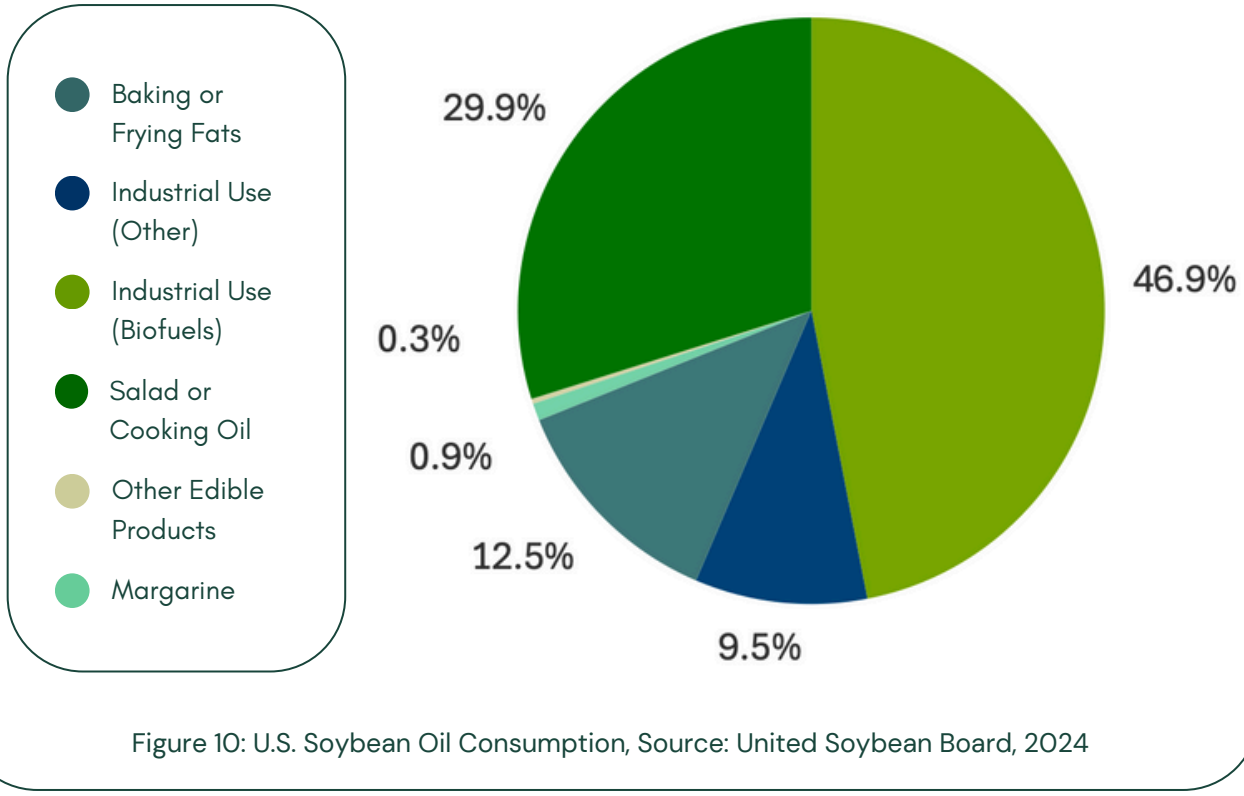


Figure 10: U.S. Soybean Oil Consumption, Source: United Soybean Board, 2024

Innovation in the Soybean Supply Chain: High-Oleic Soybeans

Soybean oil has been one of the most widely consumed oils since the early 2000s. However, its market share has declined due to concerns over the unhealthy trans fat content in partially hydrogenated soybean oil. In response, high-oleic soybeans have emerged as an innovative solution, offering lower levels of trans fats and thus creating potential for increased consumer demand (United Soybean Board, 2017).

HOS Overview

The introduction of high-oleic soybeans (HOS) represents a significant innovation, offering new opportunities for the industry. More specifically, HOS have higher oleic fatty acid content compared to the high linoleic fatty acid content of traditional soybean varieties. HOS currently occupies a small proportion of total soybean acres planted, but the United Soybean Board projects significant growth in the coming years (see Figure 11).

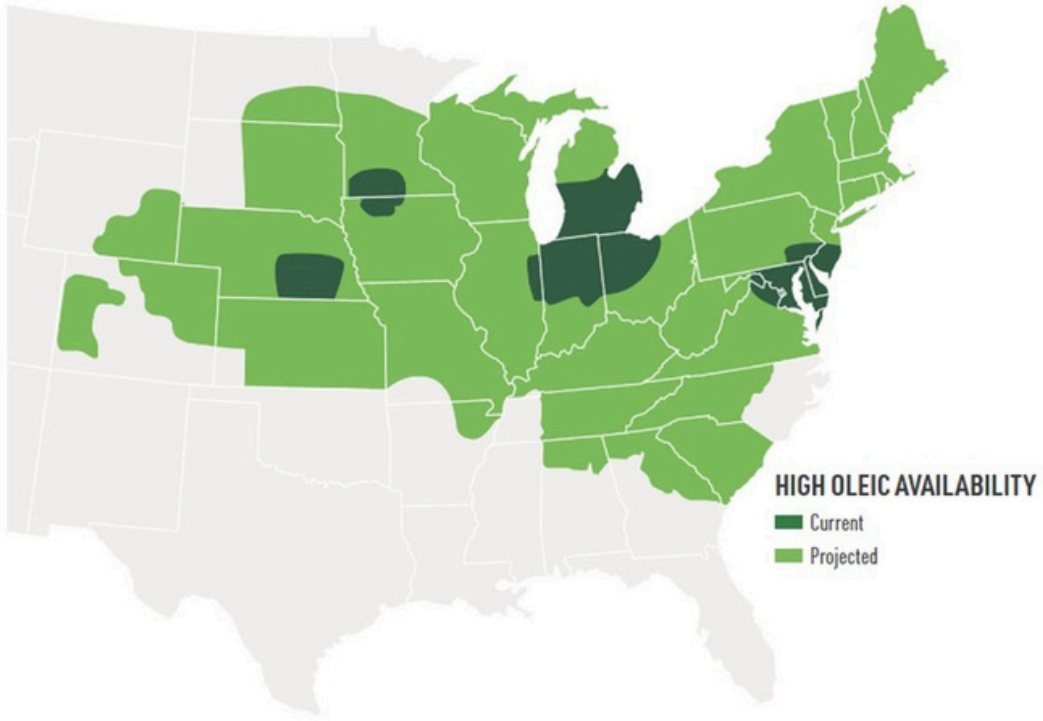


Figure 11: High Oleic Availability Projection; Source: United Soybean Board, 2024

This potential growth is driven by increasing demand, improved yields, and relative ease of switching over from traditional soybeans (Knowlton, 2022). According to recent Pioneer Corteva field trials (Jeschke, 2023), the yields of Pioneer's Plenish HOS are equal to and often greater than commodity beans. Plenish soybeans are emerging as the most popular HOS variety because they come Roundup-ready and can be more easily integrated into GM cash crop rotations. HOS are not yet available with Pioneer's most advanced trait technology, though Pioneer expects this technology within the next couple years.

Demand for HOS is rising, especially within the food industry where it is primarily used as fry oil (Knowlton, 2022). On top of improving oil performance in food service and manufacturing, HOS oil offers human health benefits (United Soybean Board, 2024a), and desirable traits in the livestock feed industry. Feeding high-oleic soybeans to livestock has shown nutritional benefits, including adding nutritional benefit to poultry and other meats (Ali et. al, 2024) and increasing milk and butterfat yield in dairy cows (Bales and Lock, 2024). Research by Nicholson et. al (2024) projected that switching to HOS could save dairy farmers up to 29 cents per cow, per day. This wave of literature has generated widespread interest in HOS as a feed option in the dairy industry. Livestock must be fed the whole soybean to fully realize the nutritional benefit of HOS. That diminishes the need for processing, but also is a slight diversion from the widely established traditional soybean supply chain.

HOS Market Landscape in Michigan

Michigan HOS producers must navigate the IP supply chain to obtain a premium, the local levels of which are between $.50 and $1.50 per bushel (Michigan Soybean Committee, n.d.). There are only three processors in Michigan currently offering high-oleic soybean premium contracts: Battle Creek Farm Bureau, Quality Roasting, and Zeeland Farm Services (United Soybean Board, 2024a). Michigan farmers have access to 15 varieties of HOS, which range from 1.9 to 4.8 maturity (Michigan Soybean Committee, n.d.). The Michigan dairy and livestock market is interested in HOS, but there is an apparent need to understand producer perspective on opportunities and barriers to adoption.

Data Generation and Summary

Description:

- Semi-structured interviews
- 12 farmers on 8 soybean farms
- Analysis and Discussion

Questions and Procedures

Following Caputo et al. (2023), interview analysis was organized into six main themes. Each interview began with a brief presentation outlining the research objectives. The themes are: (i) producer profiles and current operations, (ii) current soybean types and knowledge of HOS, (iii) factors influencing producer decisions on seed selection, (iv) barriers and challenges for HOS production, (v) supply chain adjustments for wider adoption, and (vi) industry opportunities for higher impact. These themes were identified through analysis of producer responses to interview questions developed through a literature review and discussions with stakeholders. A pilot session was conducted with a Michigan soybean farmer, along with consultations with representatives from U.S. Soy, the Michigan Soybean Association, the University of Wisconsin, and the Michigan State University research team to finalize the questions and procedures. The list of questions used in the interviews can be viewed in the appendix. Table 1 presents our thematic areas and related core questions. Probing questions were also used during the interviews to explore covered issues more thoroughly.

Results

To analyze the data, we followed Caputo et. al, 2023 by recording and transcribing interviews and observing trends in how the producers answered our questions. If there were responses common to more than one interviewee, we recorded the similarities and synthesized them in the following report.

Thematic Areas	Relevant Questions
Producer Profiles and Operations	• Provide a brief overview of your current production setup. • What type(s) of crops do you grow?
Current Soybean Types and Knowledge of HOS	• Are you familiar with High-Oleic Soybeans? • Are you aware of any other soybean types? • Do you currently grow HOS? • Would you be willing to grow HOS in the future?
Factors Influencing Producer Decisions on Seed Selection	• What factors go into deciding what types of soybeans (or other crops) you grow each year? • Are you planning to convert more of your operations to HOS production? • What would motivate you to switch to HOS? • What conditions are ideal for the adoption of new seed technologies?
Barriers and Challenges for HOS Production	• What do you perceive as the biggest challenges to growing HOS utilization in the industry as a whole? • Talk about the learning curve associated with the transition to HOS production. • List three limiting factors related to HOS production. • Has/would a switch to HOS affected your consumer base? • Are there any additional quality or productivity concerns that you have about HOS compared to other varieties?
Supply Chain Adjustments for Wider Adaption	• How is the HOS supply chain different than the non-HOS supply chain? • What drives these differences? • Do you ever change your interactions in the supply chain?
Industry Opportunities for Higher Impact	• Could you please list three opportunities related to HOS production? • What must policymakers, processors, and consumers understand about a transition from traditional soybean to HOS production? • How does your company assess consumer demand and measure a product's success?

Table 1: Thematic areas and associated questions for interviews with soybean producers

Producer Profiles and Operations

Table 2 reports the general profiles of the eight soybean farms that participated in the individual interviews. To ensure producer anonymity, names, individual production level, employment, etc. have not been included in this report. The farms ranged in size from 1,100 acres to 8,000 acres, with the average being about 2,700 acres. On average, these farms grow approximately 1,000 acres of soybeans, with an average annual production being approximately 47,000 bushels. Most producers sell their soybeans to local elevators, with some working directly with larger processors or local livestock producers. Besides soybeans, commonly grown crops include corn, winter wheat, and dry beans.

Current Soybean Types and Knowledge of HOS

All participants are aware of HOS and expressed a willingness to grow it in the future. Currently most farms grow commodity soybeans or non-GMO varieties, while only one currently grows HOS (see Table 2). One farmer grew HOS in the past but stopped their production due to low profits compared with non-GMO. Despite low adoption rates, producers discussed promising market potential for HOS, with many indicating that they've noticed an increase in demand from potential buyers in recent years. Some interviewees mentioned conversations they've had in which local livestock producers approached them asking about their familiarity with HOS. Farmer 7 said, "*One dairy actually approached me and asked if I grow these beans, but I already purchased my seed for the year so I said no. I am open to that type of relationship in the future if they reach me on time.*" In fact, that type of request led Farmer 2 to adopt HOS on their farm.

"One dairy actually approached me and asked if I grow these beans, but I already purchased my seed for the year so I said no. I am open to that type of relationship in the future if they reach me on time."

Farm	Male/ Female	Farm Size	Supply Chain Outlet	Grow soybeans under contract?	Grow HOS?	Soybean Types
1	F	<2,700 Acres	Local Elevator, Larger Processor	Yes	No	Commodity, Non-GMO
2	M	>2,700 Acres	Larger Processor, Local Dairy	No	Yes	Commodity, HOS
3	M	<2,700 Acres	Larger Processor	Yes	No	Non-GMO
4	M	>2,700 Acres	Local Elevator, Larger Processor	No	No	Commodity
5	M	>2,700 Acres	Larger Processor	Yes	No	Non-GMO
6	M	<2,700 Acres	Local Elevator	Yes	No	Commodity
7	M	<2,700 Acres	Local Elevator	Yes	No	Commodity, Non-GMO
8	F	<2,700 Acres	Local Elevator	No	No	Commodity

Table 2: Producer Profiles

Factors Influencing Producer Decisions on Seed Selection

We observed a clear trend, visualized in Figure 12, in the responses of farmers when they were asked what factors affect their decision of what types of soybeans to grow in the following season. Producers feel comfortable doing what they have done in the

past, if it works well. Changing from their status quo is usually caused by perceived increased profit potential. Comparable or greater yield potential and available premiums have piqued interest in HOS for producers, but they expressed caution due to potentially high associated costs. Factors like on-farm infrastructure adjustments or transportation costs to supply outlets can erode profit margins gained from HOS premiums. One producer said they bring their harvest directly from their fields to their local elevator because they do not have on-farm grain storage, which incentivizes them to grow what that elevator demands. Finally, producers mentioned that the market price of soybean vs. other commodities play a role in their seed choice. In 2024, the market price of corn has been lower relative to soybeans, leading some producers to use a higher percentage of their acreage for soybeans.

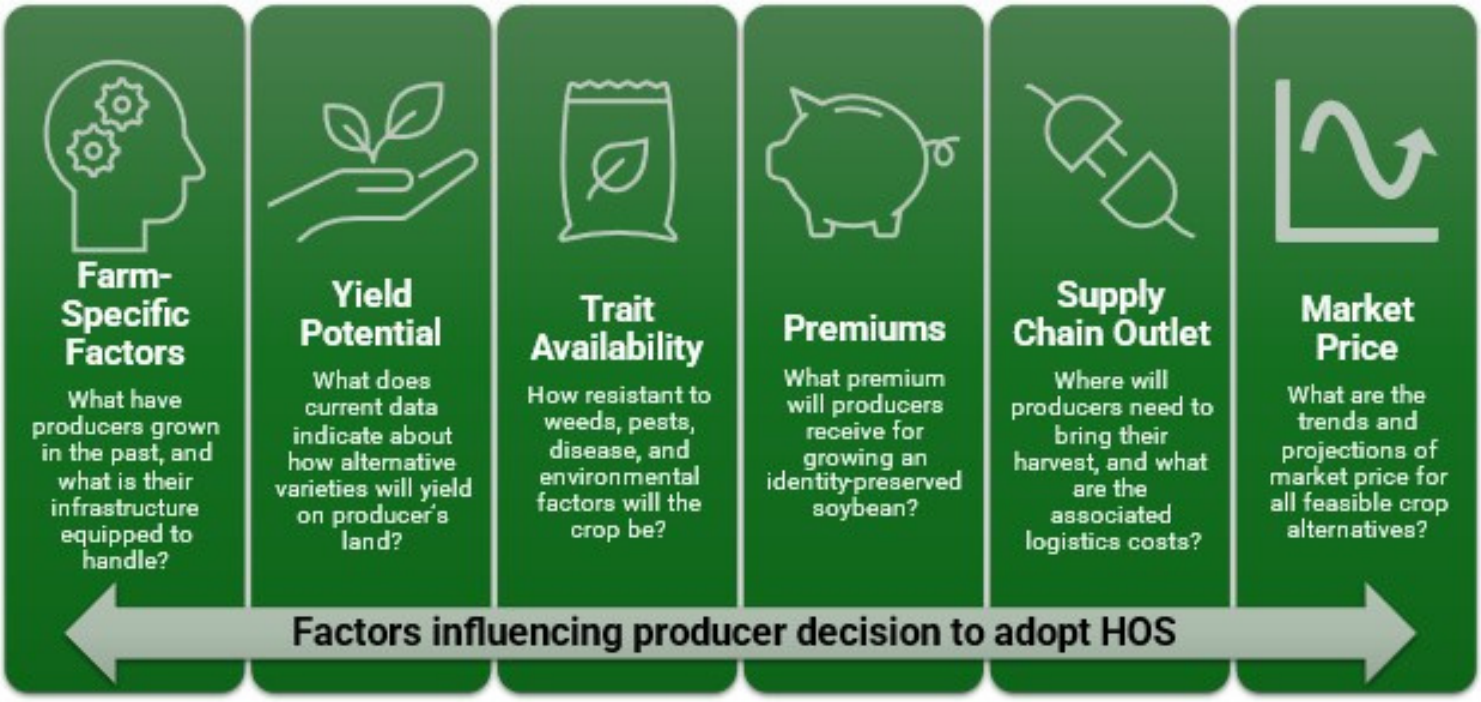


Figure 12: Main factors as indicated by producers while considering variety choice

Barriers and Challenges for HOS Production

"*...there needs to be more information available about yield. I have not seen that yet with these high-oleic beans.*" said one producer. This was the one unanimously acknowledged challenge of HOS adoption by producers. Some spoke about personal data they've accumulated over the years on how seed varieties will fare in their soil. Others mentioned publicly available field trial research from trustworthy sources. They all indicated that it is difficult to find local yield data for HOS, thus creating concerns about the accuracy of yield projections. Current literature indicates that

most yield information on high-oleic soybeans come from further south or on the East Coast (U.S. Soy, 2022), or from the seed companies themselves, which can be perceived by producers as unreliable for their situation. Lack of trait availability contributes to farmers' yield concern. One producer said "*The biggest challenge to HOS utilization across the industry is the trait package currently available. I am concerned about weeds and would like to see more traits available*." Producers fear that a lack of traits may create issues with weeds, pests, and disease, eroding their profit potential.

> *...there needs to be more information available about yield. I have not seen that yet with these high-oleic beans.*

Farmers must acquire a contract from a processor to grow HOS if they hope to obtain a premium, and there are very few processors in Michigan who currently administer such contracts. In fact, Michigan premiums for HOS are relatively low when compared to premiums for non-GMO or food grade soybeans, and other IP beans have more supply chain outlets (Knudson, 2022; OEFFA, 2014). This was a contributing factor in one producer's decision to "unadopt" high-oleic soybeans. They said, "*Premiums vs. fuel price are a regular concern when making these decisions, we found that it was no longer worth it with HOS*." This producer cultivated HOS for a few years, but ultimately adopted non-GMO beans instead. They even transport their non-GMO harvest to the same processor where they brought HOS, illustrating the incentive of greater premiums of non-GMO beans.

Other cited challenges have to do with meeting rigorous standards of the IP supply chain, leading to increased labor and transport costs. Farmers must first meticulously clean out planting/harvesting equipment, storage bins, and trucks to ensure they do not lose their premium from cross-contamination between HOS and commodity soybeans. Then, they must dedicate storage bins to HOS or bring harvests directly from the field to the market. A producer noted "*I would be concerned about the higher cleaning costs needed to prevent cross-contamination between my commodity beans and high-oleic beans*." This leads some producers to adopt an "all or nothing" stance on adoption of HOS. "*If I were to go to HOS, my goal would be to switch my entire farm over eventually. On my farm, I try to keep what type of beans I grow the same. I don't want to worry about keeping different specialty beans separate, so I keep my farm uniform*," said a producer. Producers are concerned that they may devote all that time, labor, and money to meet IP standards, and one mistake could cause the loss of their premium. One producer went as far as to say, "*It'd be like learning a completely new crop*." These sentiments were unanimous among producers who cultivate GMO soybeans, but less of a concern with others who already grow IP beans.

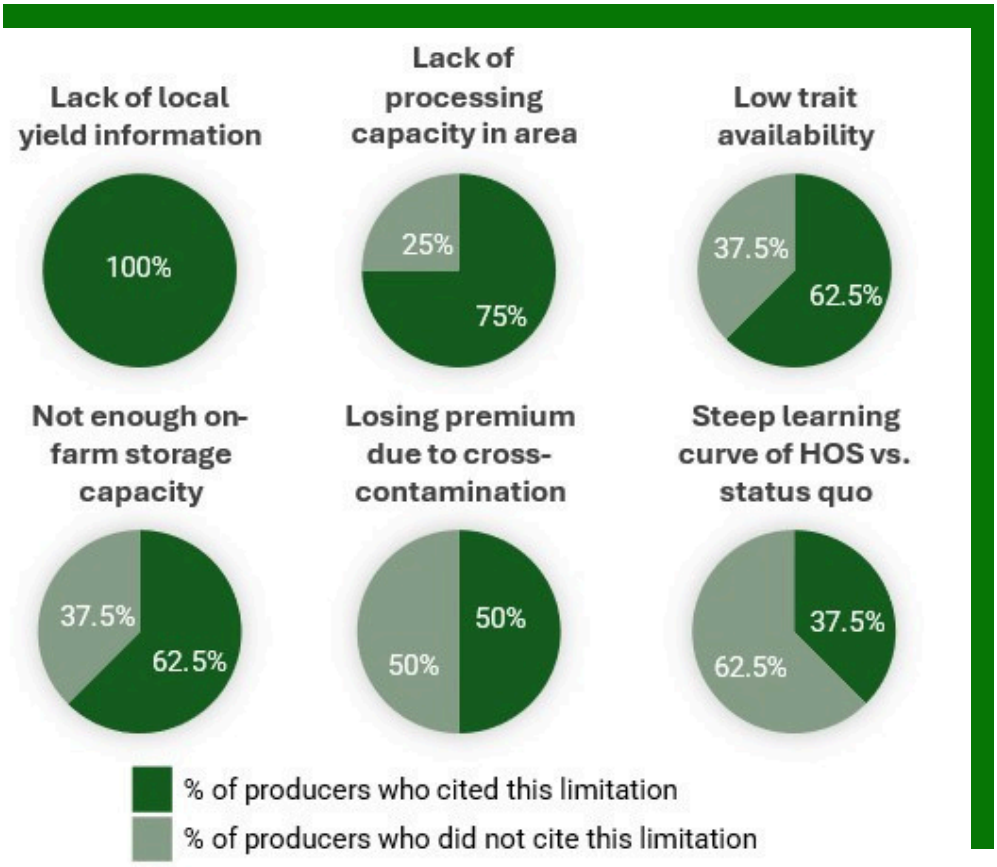


Figure 13: Main concerns of Michigan producers around production of HOS. Note: these trends were organically observed across interviews; we did not explicitly prompt them to talk about specific limitations.

Supply Chain Issues and Adjustments for Wider Adoption

The current soybean supply chain is relatively robust for conventional, non-GMO, and food grade varieties, but requires adjustment to increase HOS adoption among farmers. As shown in Figure 14 , only 3 of Michigan's 223 licensed soybean processors have HOS programs, which creates deterrents for producers. First, the number of outlets significantly limit the number of contracts available for Michigan soybean farmers to obtain premiums for HOS. Second, it causes high transaction and logistic costs to bring their harvest to market. As illustrated in Figure 14, the average producer would need to drive considerably further to obtain a premium for HOS, compared to commodity outlets or other IP outlets. An obvious solution is to increase the number of drop points for HOS. However, we observed in an interview with a HOS processor that the volume of contracts they administer to HOS producers is contingent on their own advanced agreements with retailers and food service. Their opinion is that demand for high-oleic soy oil is highly elastic, as most consumers are not aware of the nutritional benefits and thus unwilling to pay

premium rates. For that reason, most of their sales go to the food service industry where businesses are more interested in other beneficial properties of high-oleic soy oil, including longer shelf life and less damage to infrastructure. These factors may contribute to slow market growth and limited supply chain outlets.

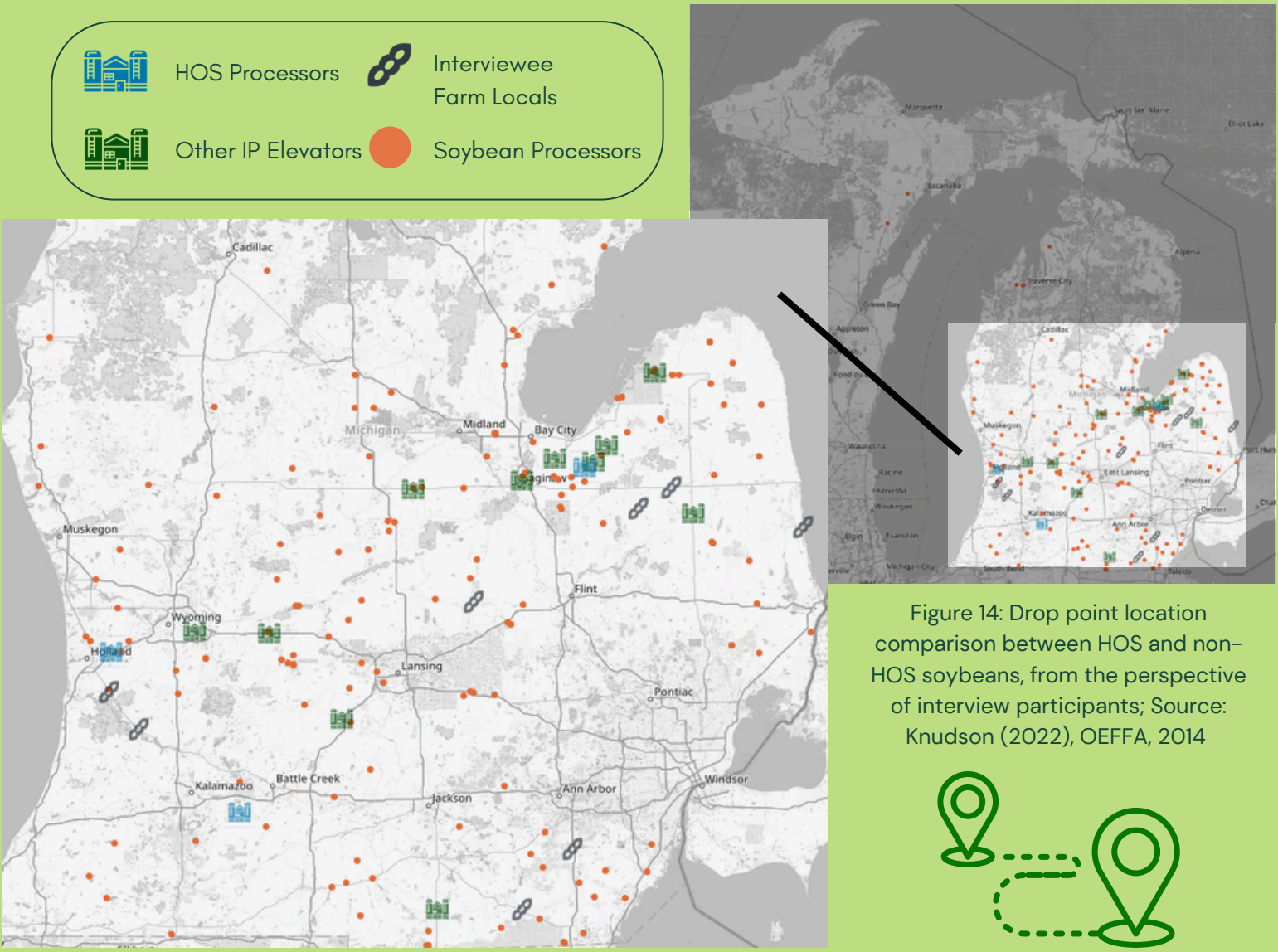


Figure 14: Drop point location comparison between HOS and non-HOS soybeans, from the perspective of interview participants; Source: Knudson (2022), OEFFA, 2014

A simple adjustment to the supply chain would be to promote and facilitate relationships between cash croppers and livestock producers, bypassing the need to bring harvest to processors. It is often difficult for livestock farmers to acquire HOS feed at a profitable price from processors or feed mills, despite increasing demand. Facilitating these relationships can give soybean producers an opportunity to obtain a premium for HOS while minimizing incurred supply chain costs, both for livestock and soybean producers. This has proven to be a profitable strategy for both soybean and livestock farmers, as observed in our interview with farmer 2, as well as our

interviews with dairy farmers. Producers feel that there is a sustainability side to this as well, as all nodes of the supply chain would be geographically concentrated. A potential drawback to this strategy from the industry perspective is the loss of checkoff funds from farmer transactions with processors.

Industry Opportunities for Higher Impact

There are three opportunities that would lead to higher impact of HOS on the industry: (i) evaluate and exploit consumer-side market potential for HOS oil, (ii) further crop trait development and marketing, and (iii) increased localized information about yield potential. Producers themselves are aware of the growing literature on the nutritional benefit of HOS, both for humans and livestock. However, they expressed doubt that consumers are aware of these positive properties. It is unclear what consumer willingness to pay is for HOS oil, which is a gap in the literature. Second, producers are deterred by the lack of crop traits.

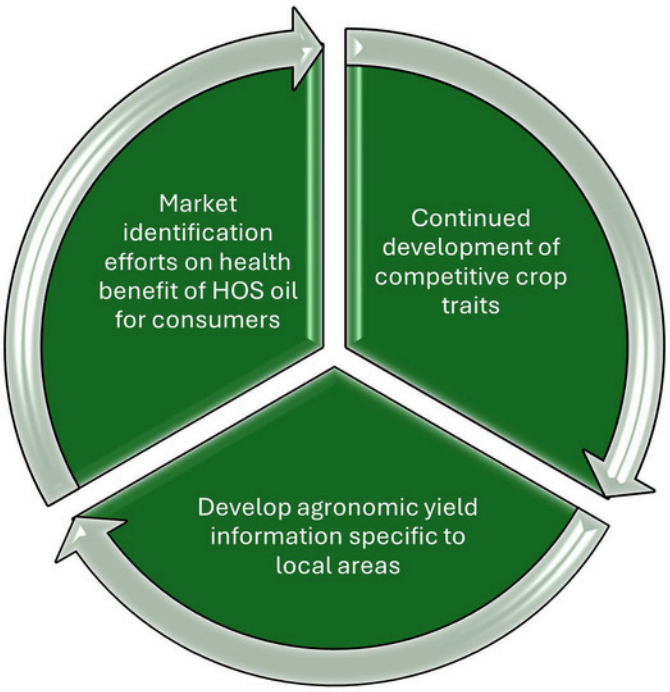


Figure 15: Potential industry priorities identified by producers

One producer said, “I don’t even think there needs to be a premium [for HOS] if the trait package is comparable with commodity soybeans.” Pioneer aims to have HOS with their Enlist E3 trait package available by 2025, which could incentivize farmer adoption. Further technological innovation, along with expanded yield data development, would help offset current perceived needs for premiums to outweigh increased logistics costs. If producers believe that HOS yield exceeds commodity soybean yield, many will not even need a premium to feel comfortable adopting as there will be less pressure from the IP supply chain. Yield per acre differences between varieties are a large contributing factor to profit margins for soybean producers, and the (though limited) data on HOS projects higher yield per acre.

Summary and Final Remarks

An array of benefits created by the unique nutritional properties of high-oleic soybeans mark a significant development in the value chain, increasing demand for HOS products in the food service, livestock, and retail industries. However, this seemingly superior product has shown slow market growth, confounding industry stakeholders. Our interviews with Michigan soybean growers shed light on the slow market growth of HOS and identify opportunities for increased industry adoption.

Producers unanimously indicated that they are willing to adopt HOS in the future or expand their current use. On-farm infrastructure requirements for HOS are like that of other types of soybeans, with the main difference in farmer operations being labor and time spent ensuring harvests meet the relatively strict standards of the IP supply chain. However, producers are deterred by the lack of available crop traits. Cultivation of specialty soybeans with lower trait availability (i.e. HOS, non-GMO, food-grade, and organic) requires market premiums sufficient to offset additional costs incurred along the IP supply chain. Many producers feel that market premiums for HOS are too low to offset these costs, a problem quantifiable through comparing higher premiums of other specialty soybeans to those of HOS. Profitability limitations are exacerbated when considering the additional transaction costs posed by the lack of Michigan supply chain outlets for HOS. For producers, those factors could be nullified if HOS yield per acre is comparable or greater, which some seed companies project to be true. However, producers perceive there is a lack of reliable local information to make accurate projections about HOS yield on their own farms.

The most immediately attainable supply chain adjustment is to bypass the processing and manufacturing nodes of the supply chain by facilitating relationships directly between livestock and soybean producers. This strategy could provide livestock producers with a reliable supply of HOS and soybean growers with premiums, while minimizing incurred costs of the HOS supply chain. In fact, our interviews indicate both livestock and soybean producers have experienced increased profits through this type of relationship. Soybean producers feel that other avenues for industry growth include marketing the nutritional benefit of HOS oil to retail customers, furthering trait development, and improving yield information available to farmers.

Appendix

Soybean Interview Questions

The interview with soybean farmers includes 5 sections, as described below.

1. Can you please provide a brief overview of your current production setup? For example, your:
    a. Annual production
    b. Planting acres
    c. Variety and types of crops
    d. Number of employees
2. What factors go into deciding what varieties of soybeans (or other crops) you grow each year?
    a. How often do you adjust?
3. Are you familiar with High-Oleic Soybeans?
    a. If so, what information do you know about them?
    b. Are there any stories (what is being said) in your community about growing HOS?
4. Do you currently grow HOS?
    a. If so:
        i. What percentage of your production is from HOS usage?
        ii. When did you first convert to (partial) HOS production?
        iii. What motivated this transition?
        iv. What advice would you give to producers who are just starting to make the transition to HOS?
    b. If not:
        i. What are some of the obstacles for switching?
            1. Lower availability of seeds?
            2. Varieties not suitable for local climate and soil conditions?
            3. More challenging supply chain?
5. Are you planning to convert more of your operations to HOS production?
    a. What would motivate you to switch to HOS?
6. Are there any additional quality or productivity concerns that you have about HOS compared to other varieties?
7. Could you talk about the learning curve associated with the transition to HOS production?
8. Could you please list three limiting factors related to HOS production?
9. Could you please list three opportunities related to HOS production?
10. What type(s) of seed varieties do you use?
    a. Why? What are the pros and cons?
    b. Related to this, what are the market opportunities you see with the varieties you are currently using?
11. Are you aware of any other seed varieties?
    a. What are the market opportunities do you see with these other varieties?
12. What conditions are ideal for the adoption of new seed technologies?
13. Who are your buyers?
14. Are your buyers aware of the market transition towards HOS?
15. What are their attitudes towards this shift?
16. Has/would a switch to HOS affected your consumer base?
17. What percentage of your soybeans do you sell under contracts, and how long have you had these relationships with your buyers?
18. Is it difficult to finance the new purchase of materials necessary for HOS?
    a. Are there any significant barriers to capital?
19. How would you describe the soybean supply chain?
    a. With who do you interact the most (least)?
    b. What is your role in the supply chain?
20. How is the HOS supply chain different than the non-HOS supply chain?
21. Do you ever change your interactions in the supply chain?
22. What do you perceive as the biggest challenges to growing HOS utilization in the industry?
23. How does your company assess consumer demand and measure a product's success?
24. What must policymakers, processors, and consumers understand about a transition from traditional soybean to HOS production?
25. Is there anything else that we should know about:
    a. Your production process?
    b. Soybean production in general?
26. Do you have any questions or final comments?
27. Do you have any additional contacts within your industry that we can reach out to for this study?

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Contact: vcaputo@msu.edu