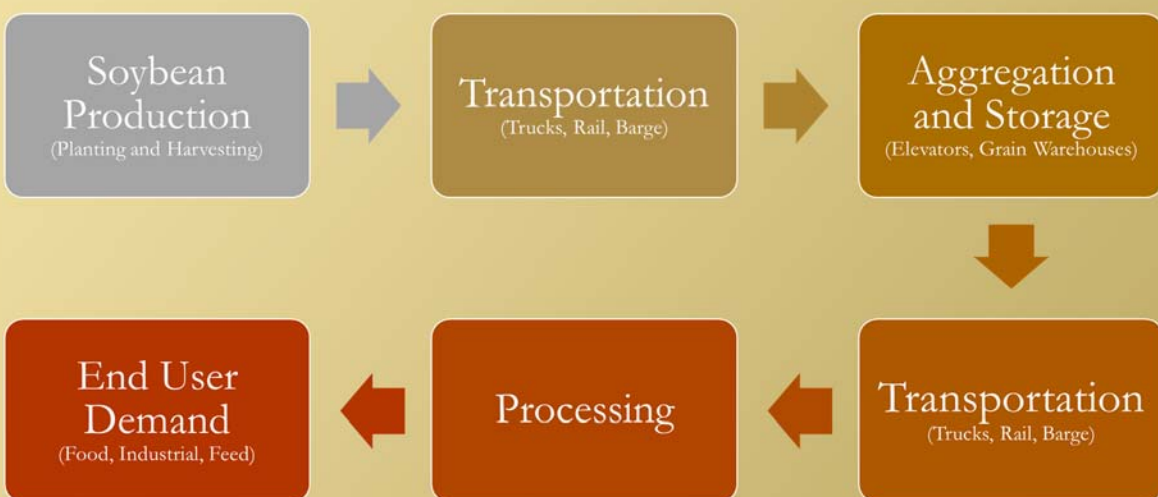
Missouri's Soybean Value Chain



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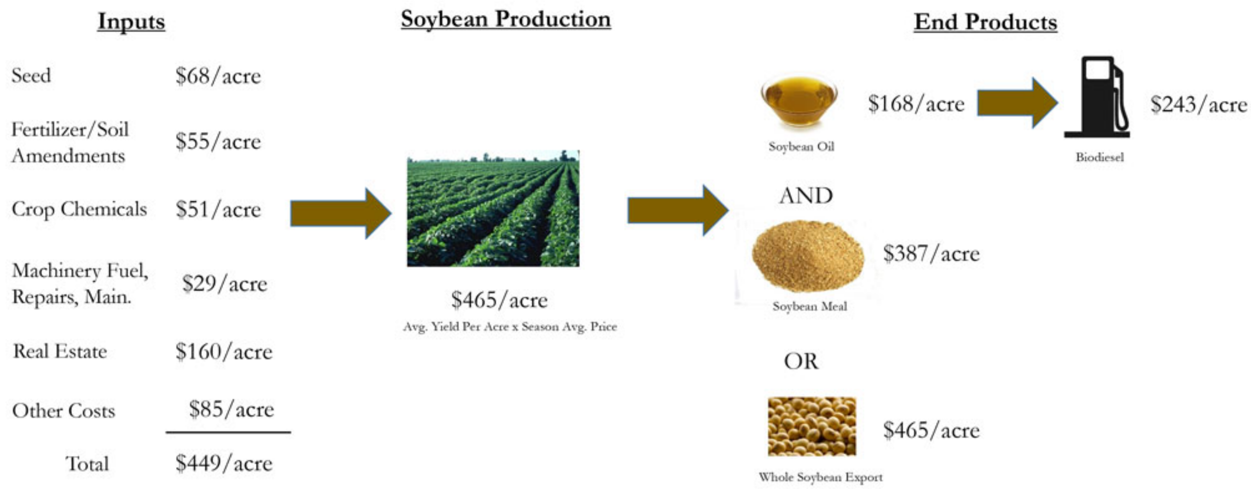
This "Missouri's Soybean Value Chain" report intends to assess Missouri's soybean value chain; summarize its current state and business environment; and identify strengths, weaknesses, opportunities and threats related to producing, transporting, processing and marketing Missouri soybeans. The first chapter describes opportunities that the Missouri soybean industry may consider. For example, the first chapter outlines opportunities including improving productive efficiency, optimizing soybean quality, pursuing biofuels markets and improving the transportation system.

The remaining report sections break down the analysis by value chain sector. In the second chapter, the report evaluates Missouri soybean supply trends by tracking acreage, yield and production trends. It also discusses soybean quality considerations, mentions traceability and explores the human resources involved in producing Missouri soybeans. The third chapter highlights transportation infrastructure by assessing grain storage and rail, barge and truck transportation resources. The fourth chapter explores the processing industry by providing a snapshot of the current-day industry and sharing opportunities to grow it. The fifth chapter reports the financial considerations associated with the Missouri soybean industry. It discusses soybean cash receipts and value of production data, and it also estimates the industry's economic contribution. During 2013, the soybean farming, soybean and other oilseed processing and biodiesel production industries in Missouri collectively employed nearly 25,000 people, generated more than $1.1 billion in labor income, added more than $2.9 billion in value and provided $494 million in tax revenues.

The following two images summarize the Missouri soybean value chain. The first graphic illustrates the costs incurred and value extracted from one acre of Missouri soybeans. The illustration reports that input expenses total $449 per acre on average when producing soybeans. The yield and price assumptions indicate that raising soybeans produces $465 in value per acre for soybean producers. Thus, they capture a $16 margin per acre. When marketing soybeans, the value chain may choose to process soybeans into meal and oil or it can export whole soybeans. If exporting whole soybeans, no additional value is created and the value creation remains $465 per acre. Processing soybeans into oil and meal would create $555 in value. If the value chain further processes the oil into biodiesel, then the oil's value would increase from $168 per acre for soybean oil to $243 per acre for biodiesel. Uses such as oil for human consumption, meal for livestock feed, whole beans into food or industrial products could be added to the graphic to indicate potential added value.

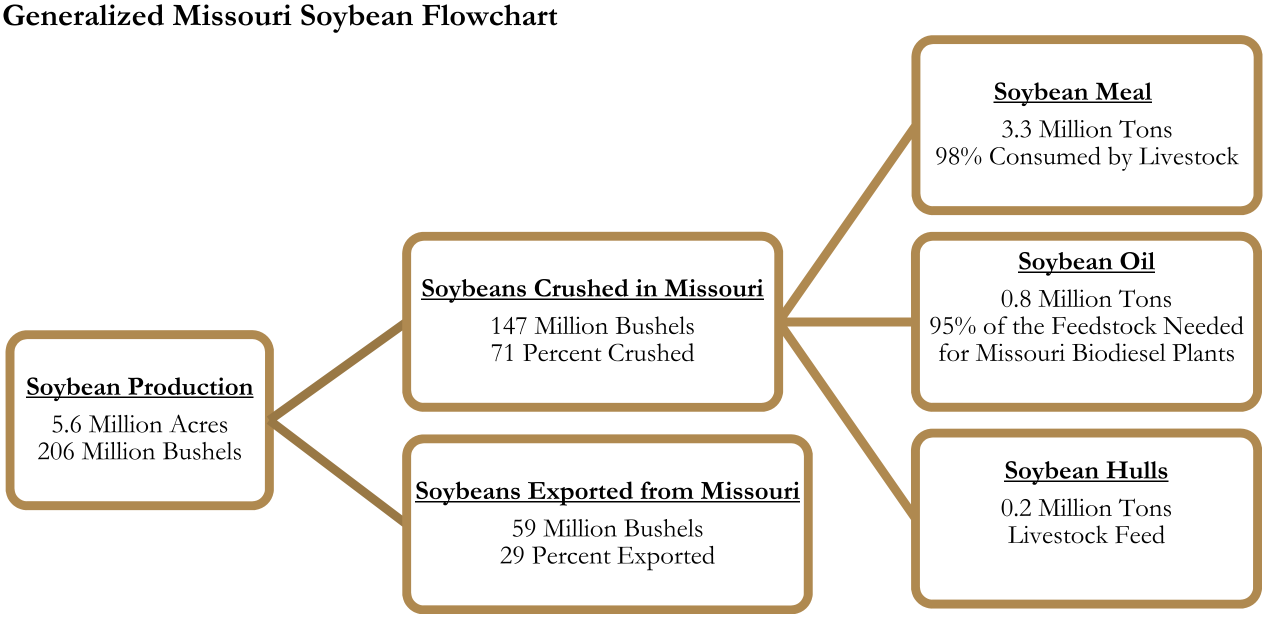
Missouri Soybean Value Chain, 2014, Dollar per Acre Equivalents



Source: University of Missouri

The following flowchart quantifies Missouri soybean supply and utilization. The visual describes that Missouri produces 5.6 million acres of soybeans. Of the Missouri-produced soybeans, in-state processors crush 71 percent of total production. Value chain stakeholders export the other 29 percent. From the soybeans crushed at Missouri facilities, processors produce meal, oil and hulls. Soybean meal and hulls predominantly have application in livestock feed rations. Soybean oil has food and industrial applications. Soybean product output from Missouri crushing facilities totals 3.3 million tons of soybean meal, 0.8 million tons of soybean oil and 0.2 million tons of soybean hulls.

Generalized Missouri Soybean Flowchart



Source: University of Missouri

Missouri's Soybean Value Chain

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1. Missouri Value Chain Opportunities

Missouri businesses may have several opportunities to participate in soybean value chain activities that affect their financial performance. The following opportunities are briefly explained. Some opportunities have examples of how other firms have pursued them. The value chain description that justifies these particular opportunities are presented in later chapters of this report.

1.1 Productive Efficiency

The core of a competitive business like agriculture is managing the unit cost of production. Maximizing yield is critical to achieve a low unit cost of production. Missouri currently ranks 16th among U.S. states for yield. During the past 10 years, yields have averaged 38.5 bushels per acre. Factors such as shallow soils and the prevalence of soybean cyst nematodes contribute to lower yields. Efforts to overcome inherent Missouri soybean production problems and enhance managerial efficiency are critical to improving Missouri value chain opportunities.

1.2 Quality

Early in the chain, input suppliers, farmers and elevators prioritize yield. For processors and end-users, however, the soybean's composition – protein and oil content – emerges as a top concern. Processors have identified from where high-quality soybeans originate. Local basis patterns may capture quality differences. To maintain marketing competitiveness, the early value chain stakeholders must manage to simultaneously optimize yield and quality. Desired quality characteristics may vary depending on the intended end use.

Efforts to communicate the importance of quality and reward high-quality soybean production would help foster quality. South Dakota and Illinois efforts to enhance soybean quality and communicate about it might provide good ideas for improving quality and attracting end-users who recognize that Missouri farmers are committed to delivering beans that meet their expectations.

1.3 Support Animal Agriculture

Animal feed is the No. 1 use of soybean meal. Protecting and growing this market is critical to Missouri soybean farmers' long-run interests. Several businesses and states have recognized the importance of animal agriculture and expended resources to promote it. A report commissioned by the Illinois Soybean Association challenged the industry to consider opportunities for processing more soybeans in the state and using the additional feed to raise animals within its borders. The University of Michigan recently reported that expanded animal production would be a necessary key to supporting added Michigan soybean processing capacity. In the 1950s, Perdue Farms constructed a soybean crushing facility and, consequently, gained a competitive advantage in its animal agriculture business.

To encourage aquaculture industry development in Indiana, the Indiana Soybean Alliance made several investments, including those for studies that illustrate soybean meal's potential as a fish meal replacement in fish diets. Identifying such developing meal markets and supporting them may create other opportunities for soybean processing ventures.

Support of animal agriculture includes helping maintain a legal environment that permits livestock production and processing. As more farmers recognize the value of manure as a soil amendment and fertilizer, the ties between crop and livestock farmers strengthen.

1.4 Biofuel Markets

Biodiesel adds value to the soybean supply chain because it is a processed product with potentially high-volume demand. Two major factors affect biodiesel demand. First, biodiesel is recognized as a cleaner-burning alternative to petroleum-based diesel, which can be mixed with petroleum-based diesel to create a fuel with different desirable characteristics. Second, federal and various state laws mandate or encourage its use as a fuel.

Two demand factors for diesel consumption influence how resources should be applied to increase soybean value. First, research into processing biodiesel to meet the demands of end-users is essential. Second, preserving federal mandates and recognizing the strengths and weaknesses of various state regulations that affect biodiesel demand are critical.

The importance of biodiesel as a soybean oil end use will be impacted, to some extent, by the quality and fit of soy oil as a food ingredient. If food processors transition from using soy oil in their products, then more soy oil will need to be processed into biodiesel. Alternatively, if varieties, such as high-oleic soybeans, and processing methods, such as interesterification, become prevalent, then soy oil for food consumption will continue to be a high-value soybean product application.

1.5 Traceable Supply Chains

Traceable supply chains are part of the infrastructure necessary for both rewarding quality and expanding value chain opportunities. Traceable supply chains involve coordinating growers, processors and end-users. Most traceable supply chains capitalize on meeting end-user demands without necessarily denigrating any other soybean uses.

Trait-enhanced soybeans are a factor motivating the need for traceable supply chains and processing. Such trait-enhanced products include high-oleic soybeans, omega-3 soybeans, low-phytate phosphorus soybeans and high-stearic soybeans. Within the high-oleic soybean value chain, farmers have an obligation to segregate high-oleic and commodity soybeans or risk losing their premiums. At the processing stage, processors must segregate high-oleic soybean oil from commodity oil or lose their advantage.

Other supply chain opportunities exist for sustainably raised, non-GMO, organic and other end products produced in a given manner. Within the soybean sector, food companies may integrate the supply chain by identifying varieties well-suited for a given application, such as soymilk, tofu or natto.

Traceable supply chains were attempted several decades ago with products such as high-oil corn and corn with highly available phosphorus. Neither succeeded. However, wheat has several differentiated varieties, and they successfully use identity preservation. Care needs to be exercised to develop supply chains that meet needs of end-users and encourage them to pay a premium.

1.6 Food-Grade Soybean Demand

Food processors use specialty soybeans to produce food products, including tofu, miso, soy sauce, natto, soymilk, tempeh, soy nuts and bean sprouts. Depending on the market opportunities for each product, soybean processors may consider adding food-grade processing to their business models in order to deliver these food-grade products to consumers. An Arkansas company successfully began growing and processing edamame with the result of increased profits for farmers and businesses through processing value gains and increased employment in the area.

Consumers are seeking high-protein foods. Demand for plant-based protein sources for human consumption are growing. Soybeans are only one plant-based protein source being developed and commercialized. Consumers also have interest in different processing methods for food. For example, despite the history of safely consuming soy products processed with hexane, some firms market mechanically extruded soybean products.

Two significant challenges accompany increasing soy-based food product demand. First, increasing human soy consumption should not come at the expense of diminishing meat's healthfulness. Diminishing meat consumption poses a greater threat to soybean value than soy-based food consumption growth poses an opportunity. Second, consumers interested in plant-based foods may also look to minimize exposure to chemically processed foods. The opportunity for chemical-free processing technologies must be understood on its affects throughout the value chain. For example, expeller pressed soybeans leave more oil in the meal which affects its use in animal feeds.

Emphasizing soybean product functional components may serve as an opportunity. Understanding and marketing the healthful aspects of plant sterols, vitamin E and isoflavones, for example, allows the soybean industry to gain entry into health and human food products without diminishing its traditional markets and processing activities.

1.7 Food-Grade Oil Demand

Historically, partial hydrogenation, which creates trans fats, was used to improve soybean oil's versatility in product applications. Between 2005 and fall 2013, at least 73 percent of processed food trans fat content had been voluntarily removed. This change has been estimated to have resulted in the loss of 8 million acres of demand for soybean oil. The U.S. Food and Drug Administration revoked the generally recognized as safe status for partially hydrogenated oil in June 2015, which may further erode demand for soy oil products.

At least two opportunities may counter this soybean oil demand change. First, interesterifying soybean oil would enable the food industry to still use soybean oil in challenging applications where partially hydrogenated oil fit particularly well. Processors may weigh this opportunity against other methods of finding suitable solid or semi-solid shortenings. Second, producers may increase identity-preserved high-oleic soybean production to meet end-user demands.

1.8 Truck Transportation

Currently, Missouri roads and bridges have a similar condition to roads and bridges in other soybean-producing states. Two bottlenecks are arising that would negatively impact Missouri soybean transportation. First, major roads such as I-70 are beyond their design capacity, and they experience increased delays due to congestion. These roads are critical for accessing river markets and processing facilities and efficiently transporting processed soybeans to users. Second, rural bridges constitute the majority of critical-condition bridges. Closing a rural bridge is estimated to create a 20- to 30-mile detour. The first leg of moving soybeans from field to market is deteriorating.

Missouri law allows trucks hauling crops to increase their hauling weights to 88,000 pounds gross weight during the harvest season on Missouri highways. A bill was introduced in Congress in 2015 that would allow states to increase weight restrictions for federal roads within their borders to 91,000 pounds if trucks have a sixth axle. This law would address inconsistencies that may exist between weight limits allowable on state and federal roads and improve transportation efficiencies.

Many Missouri farmers own and operate their own trucks for transporting grain. A recognized truck driver shortage may offer an opportunity for soybean farmers, particularly those not fully employed in agriculture, to supplement their incomes and maintain truck quality.

1.9 Rail Improvements

Private entities typically finance and maintain freight rail infrastructure. With private investment, firms willingly agree to make upgrade investments if they perceive those investments will improve their business positions later. Possible investments range from adding rail miles to retrofitting hopper cars into cars capable of hauling agricultural commodities.

Positive train control involves a set of advanced technologies that improve rail traffic safety. The mandate to implement positive train control by the end of 2015 will not likely be met. Such regulations may negatively impact soybean rail transportation.

1.10 Internal Waterways

Inland waterways transport essential crop inputs such as fertilizers and outputs such as corn and soybeans. Maintaining inland waterways as navigable channels requires maintaining a nine-foot depth. Locks and dams are critical for efficient barge transportation in northern Missouri. Most soybeans are exported from ports at or south of St. Louis. These ports are below the locks and not immediately impacted by improvements on locks north of St. Louis.

The Panama Canal's expansion, which should be completed in 2016, is expected to increase shipping of dry bulk cargo from the U.S. Gulf Coast to Northeast Asia. Rising grain bids by river terminals is expected to change basis patterns and pull more soybeans to barges on the Lower Mississippi River system, especially in winter months when barge traffic north of St. Louis may be frozen.

Waterway improvements need to be weighed relative to other transportation infrastructure improvements. The American Society of Civil Engineers suggests two ways to improve water transportation. First, it suggests identifying private companies to assist with the river's infrastructure improvements and maintenance. Through a public-private partnership, a public entity would enter into a contract with a private entity, which would have jurisdiction to offer a public service. Second, it suggests creating an "Essential Water Service" program modeled after the U.S. Department of Transportation's "Essential Air Service" program.

1.11 International Markets-Focused Processing

Raw soybean exports are important and need to be pursued. However, exporting soybean products processed in Missouri and then exported offers greater economic results. Processing within the state is derived from the competitive advantage of creating market-specific products. Some countries demand soybean meal but have little need for soy oil. Processing and selling the meal allows foreign buyers to obtain precisely what they need and enables Missouri to retain the processing benefits.

Processing soybeans and feeding them to livestock creates more local economic impact than exporting soybeans that foreign buyers process and use to feed animals. Keeping as much of the value chain in the state increases the value retained by the state. Processors may strategically locate their facilities in areas where they can serve international markets. For example, Virginia state government funding helped a private company secure resources to expand its soybean processing and export business. The grant assisted with financing infrastructure that enabled the company to market in additional nations.

1.12 New Demand Centers

Recent history has provided multiple examples of developing new soy product uses. Research efforts have discovered soybean ingredient uses for many products, including plastics, lubricants, coatings, printing inks and adhesives. Opportunities may exist to innovate within these categories or develop completely new industrial applications for soybean products. Product development offers continued opportunities to increase soybean demand and value.

1.13 Seed Processing

For soybean producers to grow a high-quality crop, seed is the first input to consider. Growing seed in Missouri for use in Missouri may affect the value chain. Essential to increasing seed value are identifying markets and adopting seed processing methods that promote seed quality, viability and traceability. Pioneer Hi-Bred's New Madrid County soybean production facility enables Pioneer to reach Missouri and other southern U.S. locations.

1.14 Storage

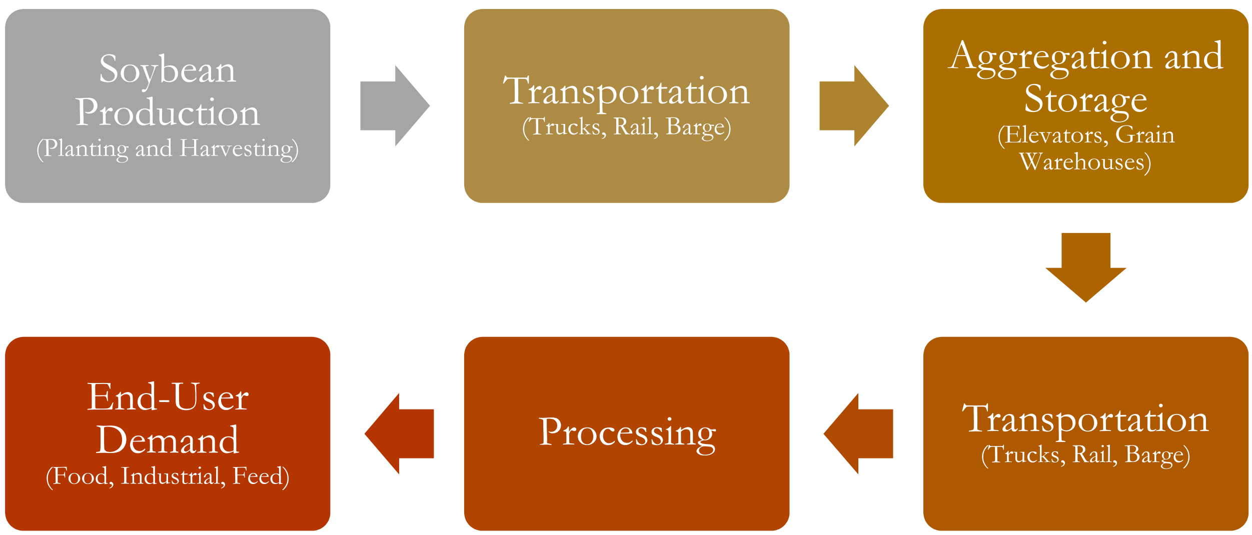
Storage infrastructure provides marketing flexibility to growers and processors. When storage is not available, financial losses can result if quality degrades. When storage is limited, losses can result from poor marketing decisions. Storage appears to be an issue only periodically and at isolated Missouri locations. Storage infrastructure investment needs to be maintained, but no immediate need for additional storage quantity is perceived. Growing demand for identity-preserved (IP) commodities and supply chain traceability may lead to demand for smaller, separate storage facilities near production locations.

2. Missouri Soybean Supply

2.1 Journey of a Missouri Soybean

Several stakeholders facilitate advancing soybeans through the Missouri soybean value chain. The journey starts as soybean producers plant and harvest soybean acreage, and it concludes when end-users have soybean-derived products available to use for food, industrial and feed applications. Exhibit 2.1.1 outlines principle stakeholders involved in the Missouri soybean value chain. After the production stage, firms transport soybeans using trucks, railcars and barges. Elevators and grain warehouses aggregate and store soybeans until buyers demand them. Then, transportation firms move soybeans from storage locations to processors, which crush and process the soybeans into products needed for food, industrial and feed uses. A soybean's journey is complete when end-users purchase and consume it as a food, industrial or feed product.

Exhibit 2.1.1 – Missouri Soybean Value Chain Journey



Source: University of Missouri

2.2 Missouri Soybean Industry Overview

Exhibit 2.2.1 details the top 20 U.S. states for soybean harvested acreage, yield and production during the 10-year period from 2005 to 2014. Missouri ranked fifth in total harvested acres. On average, it harvested 5,178,000 acres annually. Missouri's average yield of 38.5 bushels per acre caused it to rank 16th in average yield per acre. Because Missouri soybeans tend to yield more poorly, the state ranked seventh in bushels harvested but ranked fifth for harvested acres. Irrigation in states like Nebraska and deep soils in states like Iowa and Illinois give those states an advantage. For Missouri, it has opportunities to improve yields and possibly close the yield gap between it and other states. Productive efficiency needs continued emphasis among Missouri soybean producers.

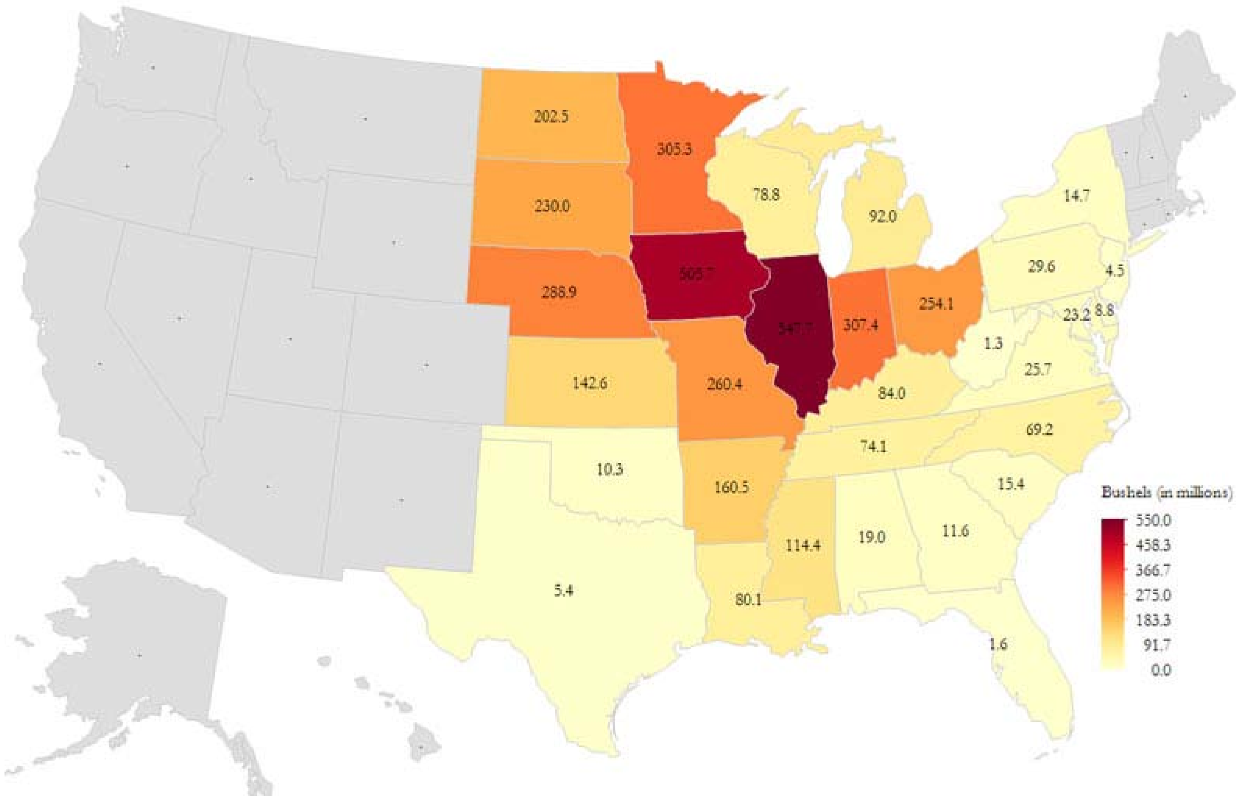
Exhibit 2.2.1 – U.S. Soybean Industry Overview by State, 10-Year Average, 2005 to 2014

Rank	State	Harvested Acres	State	Yield (bu/ac)	State	Production (bushels)
1	Iowa	9,527,000	Nebraska	50.8	Iowa	473,491,900
2	Illinois	9,240,000	Iowa	49.7	Illinois	442,596,000
3	Minnesota	6,967,000	Indiana	48.5	Minnesota	294,007,400
4	Indiana	5,314,000	Illinois	47.9	Indiana	257,463,300
5	Missouri	5,178,000	Ohio	46.7	Nebraska	244,805,200
6	Nebraska	4,819,000	New York	44.6	Ohio	212,018,000
7	Ohio	4,540,000	Pennsylvania	44.0	Missouri	199,094,100
8	South Dakota	4,181,000	Wisconsin	42.6	South Dakota	158,041,800
9	North Dakota	4,072,000	Minnesota	42.2	North Dakota	131,932,800
10	Kansas	3,477,000	Michigan	42.0	Arkansas	122,930,400
11	Arkansas	3,144,000	Louisiana	41.4	Kansas	118,218,000
12	Michigan	1,968,000	West Virginia	41.2	Michigan	82,656,000
13	Mississippi	1,859,000	Kentucky	40.8	Mississippi	74,638,850
14	Wisconsin	1,609,000	Mississippi	40.2	Wisconsin	68,543,400
15	North Carolina	1,529,000	Arkansas	39.1	Kentucky	58,180,800
16	Kentucky	1,426,000	Missouri	38.5	Tennessee	48,973,650
17	Tennessee	1,329,000	South Dakota	37.8	North Carolina	48,545,750
18	Louisiana	982,000	Maryland	37.3	Louisiana	40,654,800
19	Virginia	558,000	Tennessee	36.9	Pennsylvania	21,186,000
20	Pennsylvania	481,500	Delaware	35.6	Virginia	19,195,200

Source: USDA, National Agricultural Statistics Service

Exhibit 2.2.2 highlights soybean production data by state for 2014, which was a record year for Missouri soybean production. During 2014, Missouri soybean production totaled 260.4 million bushels. States with greater production than Missouri were Illinois, Iowa, Indiana, Minnesota and Nebraska.

Exhibit 2.2.2 – U.S. Soybean Production by State, 2014

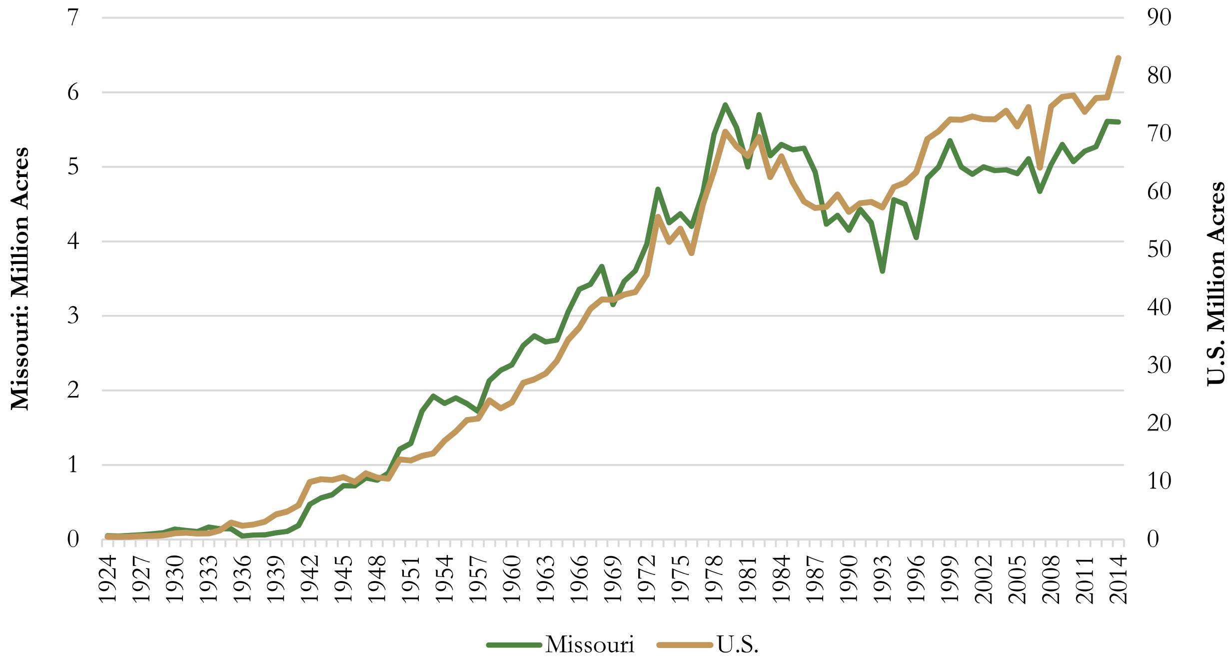


Source: USDA, National Agricultural Statistics Service

2.3 Missouri Soybean Production

Soybeans were initially planted in the early 20th century as a forage crop. Beginning in the 1940s, soybeans quickly transitioned from a forage crop to an oilseed crop. Within a decade, more than 95 percent of soybeans planted in Missouri were harvested as an oilseed crop. The transition to an oilseed crop was accompanied by a rapid rise in the number of acres planted to soybeans. Missouri production rose from 1 million acres in 1950 to 5.6 million acres in 2014. See Exhibit 2.3.1. Missouri's 5.6 million acres of soybean harvested acreage in 2014 accounted for 7 percent of the U.S. total soybean harvested acreage, which was 83 million acres.

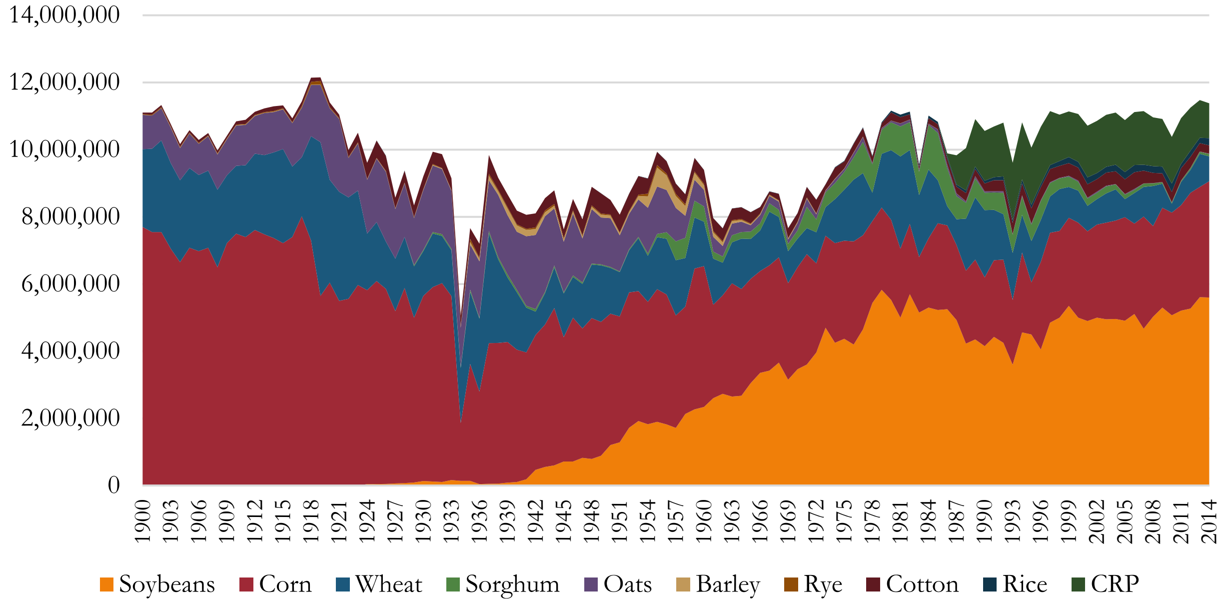
Exhibit 2.3.1 – Missouri and U.S. Soybean Acres Harvested, 1924 to 2014



Source: USDA, National Agricultural Statistics Service

Missouri soybean acreage growth triggered reductions in other row crop harvested acres and total acres farmed. See Exhibit 2.3.2. At the beginning of the 20th century, Missouri consistently harvested more than 10 million acres of row crops annually. During the first decade of the 21st century, Missouri consistently harvested 10 million acres of crops annually only when CRP was considered. Corn, wheat and small grain acres have decreased as soybean acres have increased. Conservation Reserve Program (CRP) acres accounted for more than 1 million acres of Missouri cropland in 2014.

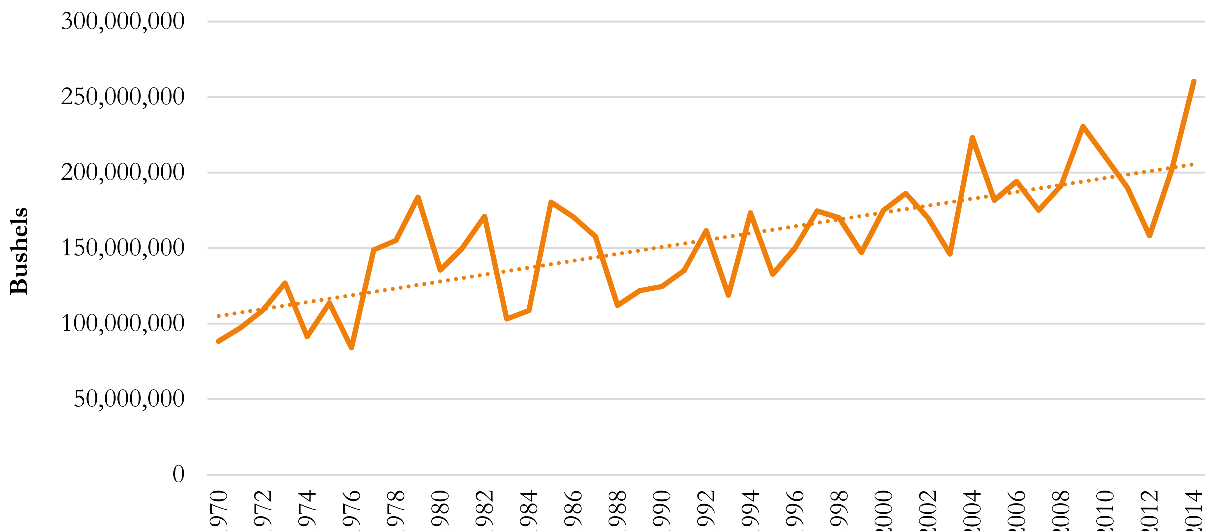
Exhibit 2.3.2 – Harvested Acres of Row Crops in Missouri, 1900 to 2014



Source: USDA, National Agricultural Statistics Service

Missouri soybean production has consistently risen due to both acreage growth and productivity improvements. Missouri soybean acreage peaked in 1979 – see Exhibit 2.3.1 – but total bushels produced continues to increase at an average annual rate of 2.3 million bushels. See Exhibit 2.3.3. Productivity per acre increased from 25 bushels per acre in 1970 to 45 bushels per acre in 2014. On average, yields improved by one-third of a bushel per year. If the current yield productivity rate continues, then Missouri annual soybean production can be expected to increase 25 percent to exceed an estimated 248 million bushels in 2025.

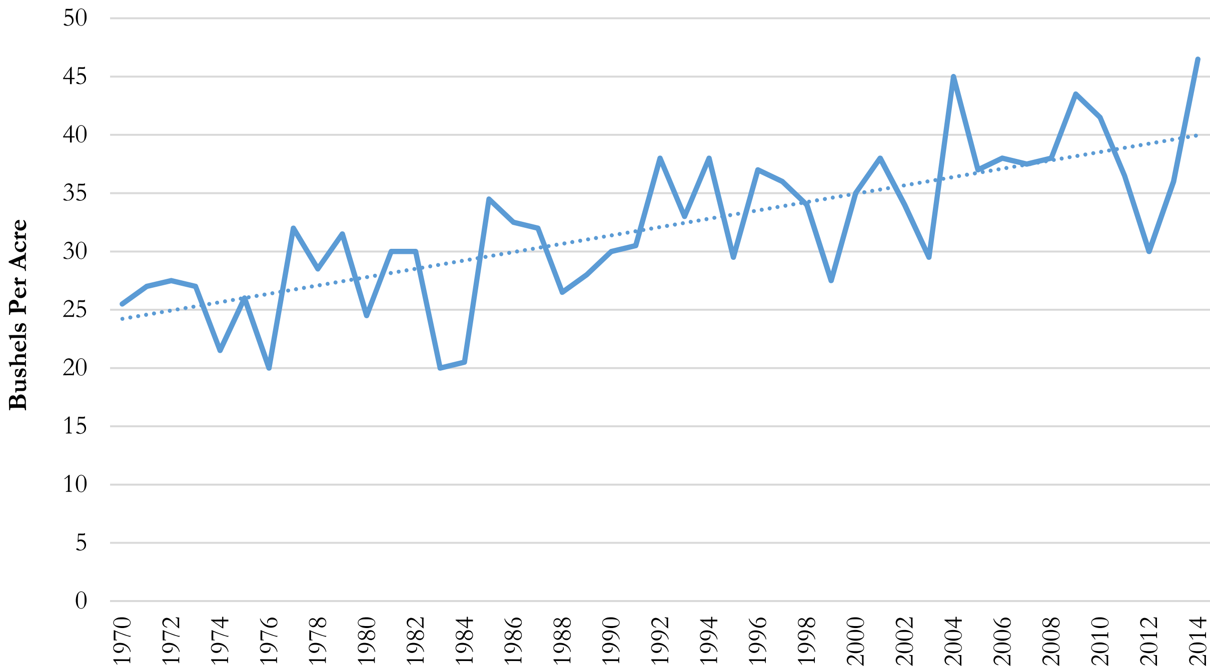
Exhibit 2.3.3 – Missouri Total Soybean Production, 1970 to 2014



Source: USDA, National Agricultural Statistics Service

Exhibit 2.3.4 tracks the trend in Missouri soybean yields from 1970 to 2014. The trend line indicates that Missouri soybean yields have improved over time. Note, however, that yields have year-to-year volatility as factors like weather and other production-related issues influence them.

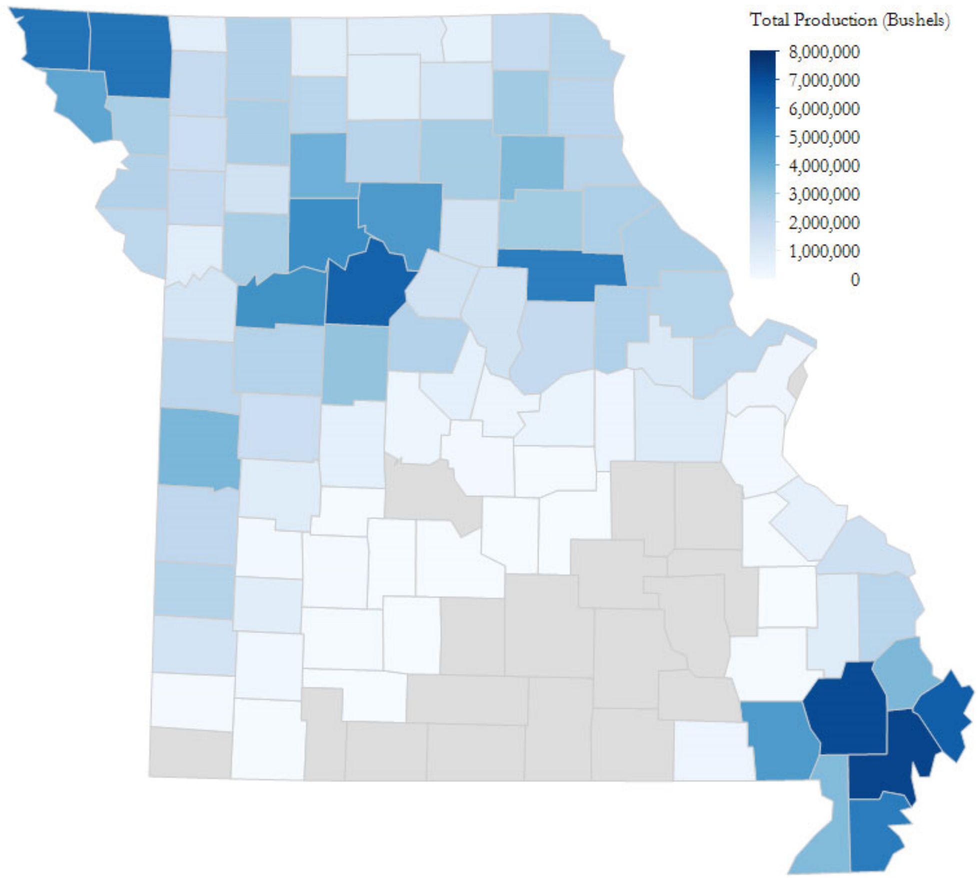
Exhibit 2.3.4 – Missouri Soybean Yield, Bushels per Acre, 1970 to 2014



Source: USDA, National Agricultural Statistics Service

Missouri soybean production exists throughout the state, but it predominates in the southeast counties and northern half of the state. See Exhibit 2.3.5 for a state map that highlights counties based on their average soybean production from 2005 to 2014. Counties shaded in dark blue produced more than counties shaded in light blue.

Exhibit 2.3.5 – Missouri Soybean Production, by County, 2005-to-2014 Average



Source: USDA, National Agricultural Statistics Service

Using an average of 2005-to-2014 values, Exhibit 2.3.6 lists the top 10 Missouri counties for total soybean production, acres harvested and yield per acre. Stoddard, Saline, Atchison and Nodaway counties were ranked in the top 10 for all three measures. New Madrid County ranked first for production and harvested acreage, but its average yield didn't rank in the top 10.

Exhibit 2.3.6 – Top 10 Missouri Counties for Soybean Production, Harvested Acreage and Yield, 2005-to-2014 Average

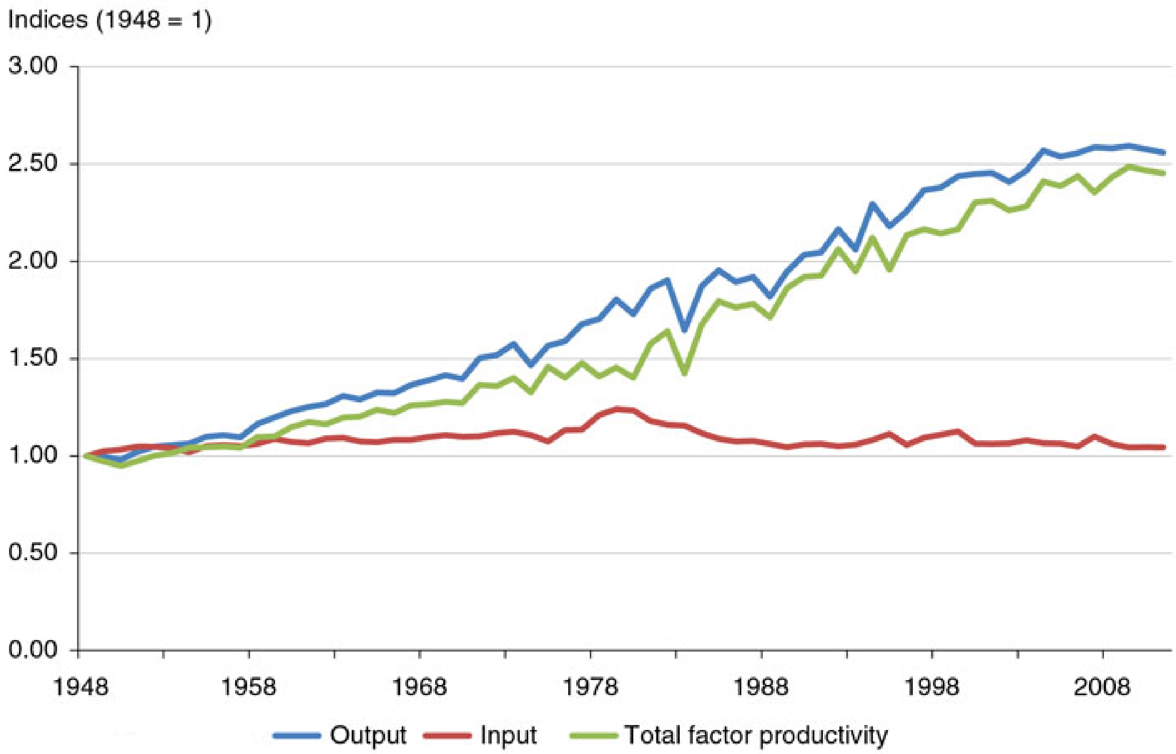
Ranking	Production	Acres	Yield
1	New Madrid	New Madrid	Atchison
2	Stoddard	Stoddard	Holt
3	Mississippi	Audrain	Saline
4	Saline	Mississippi	Lafayette
5	Atchison	Pemiscot	Nodaway
6	Nodaway	Saline	Buchanan
7	Pemiscot	Nodaway	St. Charles
8	Audrain	Carroll	Clinton
9	Carroll	Chariton	Stoddard
10	Lafayette	Atchison	Platte

Source: USDA, National Agricultural Statistics Service

2.4 Soybean Production Efficiency

Agricultural productivity growth in the U.S., generally, and Missouri, particularly, has occurred with very modest increases in input use. Total Factor Productivity, defined as output divided by inputs, in agriculture has doubled since 1970. See Exhibit 2.4.1. The quantity of inputs used, such as energy, equipment and fertilizer, has increased less than the quantity of soybeans produced.

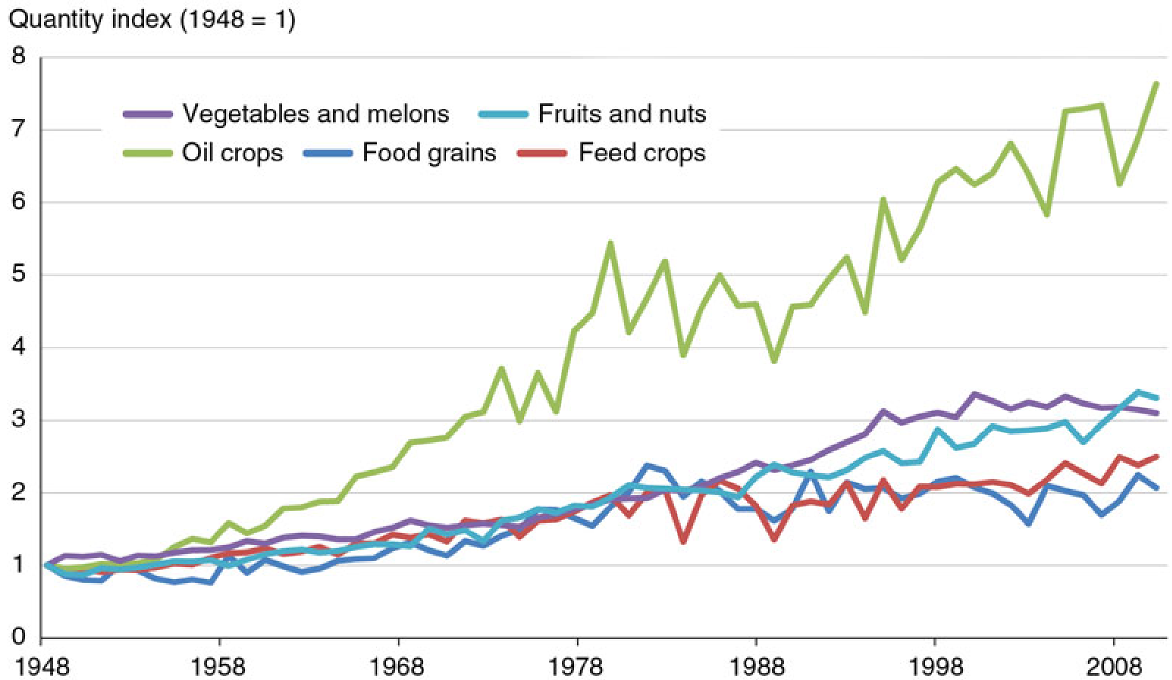
Exhibit 2.4.1 – Agricultural Productivity Growth, 1948 to 2011



Source: Wang et al. (2015)

Oilseeds – soybeans constitute 90 percent of U.S. oilseed production – are responsible for much of the productivity growth recorded in U.S. agriculture as oilseed output has increased faster than output for all other U.S. crops. See Exhibit 2.4.2.

Exhibit 2.4.2 – Oil Crop Output Relative to Other Agricultural Commodities, 1948 to 2011



Source: Wang et al. (2015)

One factor increasing productivity has been rapid biotech seed adoption. Just as Missouri farmers quickly switched from harvesting soybeans as a forage crop to harvesting them as an oilseed crop in the 1940s, they adopted herbicide-resistant soybeans within a decade of biotech seed being introduced. Currently, 90 percent of Missouri soybean acres are planted with biotech seed.

In the future, the willingness of Missouri farmers to adopt new technologies will enable them to improve their productivity and maintain their relevance. As traceable supply chains develop, adopting traits such as high-oleic soybeans will be possible.

Opportunities may exist to adopt seed processing methods that promote seed quality and viability and provide seed with desirable end-use traits. After seed production, drying, processing, storage and transportation processes influence seed quality. To optimize quality, seed processors maintain varietal integrity and minimize mechanical damage. During storage, maintaining the appropriate temperature and relative humidity levels are important (Henning et al. 2006). Facilities that can adopt such practices and maintain seed quality have potential as seed processors in Missouri.

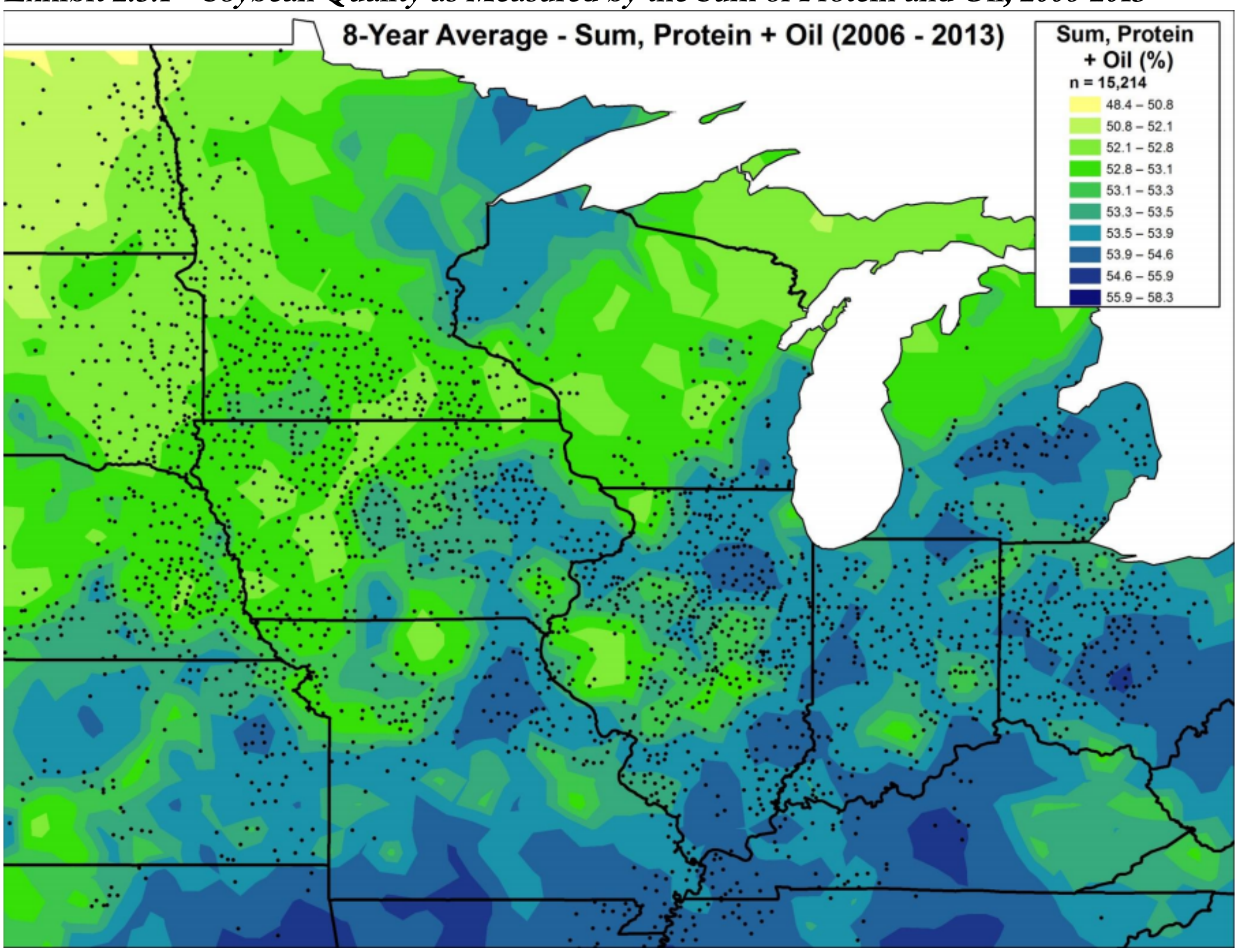
Missouri already has some experience with soybean seed processors. In September 2011, Pioneer Hi-Bred opened its New Madrid County, Mo., soybean seed production plant. The New Madrid County facility was Pioneer's first in Missouri and the company's largest facility in the world. The facility's location enabled Pioneer to reach southern U.S. locations (Campbell 2011).

2.5 Soybean Quality Concerns

Yield and production efficiency are critical factors that affect soybean production profitability, but delivering quality soybeans that meet end-user needs is equally important. In the past few decades, processors have noticed lagging soybean quality. With respect to soybean meal, for example, protein levels tended to range from 47.5 percent protein to 48.5 percent protein 20 years ago, according to a representative from the AGP processing facility in St. Joseph, Mo. Ten years later, they had dropped to 47 percent to 48 percent, and in 2015, typical soybean meal protein levels ranged from 46.5 percent to 47.5 percent. Although the AGP facility buys soybeans by the bushel today, its representative noted the potential future problem in this using this pricing model, especially as buyers increasingly emphasize quality (United Soybean Board 2015b).

The 2014 USSEC Soybean Quality Report indicates Missouri soybeans rank relatively well in total protein and oil content. See Exhibit 2.5.1.

Exhibit 2.5.1 – Soybean Quality as Measured by the Sum of Protein and Oil, 2006-2013



Source: U.S. Soybean Export Council (2014)

Computing the estimated processed value can suggest the value that a bushel of soybeans presents for a processor. For one raw bushel of soybeans, the estimated processed value conveys the bushel's total end-product value by adding value estimates for the meal, oil and hulls. As such, estimated processed value varies depending on a soybean variety's meal, oil and hull composition and market prices for each of the three products. To help producers understand the extent to which soybean quality varies in Illinois, the Illinois Soybean Association supports the Qualimap Tool Kit on its website. For each of the nine Illinois agricultural statistics districts, the Qualimap tool shares average, minimum and maximum protein and oil content, and it computes estimated processed value given the protein, oil and hull levels (Illinois Soybean Association). By selecting varieties that maximize the estimated processed value for a soybean processor, producers increase the interest that soybean processors may have in the soybeans that they grow.

To address quality and encourage producers to deliver high-quality soybeans that buyers would demand, the South Dakota Soybean Processors facility introduced the ValueTrak program. The program intends to share feedback about soybean quality with producers who market their soybeans to the South Dakota Soybean Processors plant. By providing such information, the South Dakota Soybean Processors may help to enhance quality of soybeans grown in the northern U.S., which has historically raised soybeans that contain less protein and oil than soybeans grown in southern growing areas. Additionally, to further incentivize producers to prioritize quality, the South Dakota Soybean Processors will pay quarterly cash premiums to producers based on the estimated processed value of soybeans that they supply to the facility. Producers who market soybeans that rank in the top 25 percent for estimated processed value during that quarter will receive premiums (South Dakota Soybean Processors). Other processors may consider similar incentive programs to motivate producers to emphasize quality when they make input decisions and grow soybeans.

During 2015, the Illinois Soybean Association launched the HY+Q initiative. The program, which emphasizes High Yield *Plus* Quality, highlights quality data collected from soybean producers and creates a dialogue to educate the industry about quality's importance and strides being taken to optimize quality. The HY+Q program will feature seed packaging seals that signify varieties that deliver both the high-yielding attribute and other quality traits demanded by end-users. Currently, the program indicates that several seals would be available that indicate quality attributes like protein, amino acids, energy and high oleic content (Illinois Soybean Association 2015).

2.6 Traceable Supply Chains

Traceable supply chains are part of the infrastructure necessary for rewarding quality and expanding trait-specific marketing opportunities. As consumer interest expands for sustainably raised, non-GMO, organic and other products produced in a specific manner, food processors have opportunities to develop a market position based on segregating such specialty products and operating a traceable supply chain. Within the soybean sector, SunOpta integrates the supply chain by identifying varieties well-suited for the particular application, such as soymilk, tofu, miso, soy sauce or natto. It coordinates with U.S. and Canadian growers to raise soybeans, such as non-GMO and organic varieties that fit customer needs. Through the process, SunOpta maintains a Traceability Identity Program to ensure that it can support a seed-to-table process (SunOpta).

In May 2015, the SunOpta food manufacturing facility in Hope, Minn., became the first U.S. facility to receive non-genetically modified organism designation through the USDA Process Verified

Program. Non-GMO and organic soybeans and corn undergo processing at the facility. To earn this designation, the facility adopted quality management protocol, which centered on food safety and transparency practices. Because of the verification, SunOpta may label products processed at the facility with the non-GMO/GE attribute (SunOpta 2015).

Sustainably grown is another attribute appealing to processors and consumers. The United Soybean Board reports that Unilever has a goal to source only sustainably raised soybeans, and it has set milestones for realizing that goal. By 2017, Unilever anticipates increasing its sustainably raised soybean supply to 1 million acres (United Soybean Board 2015d). To meet these demands, ADM procures sustainably raised soybeans from Iowa producers. By participating in the ADM/Unilever Soybean Sustainability Program, the producers earn an additional $0.10 per bushel as a premium. To participate, producers use guidelines from the U.S. Soybean Sustainability Assurance Protocol, which the United Soybean Board, American Soybean Association, U.S. Soybean Export Council and soybean checkoff developed, and they assess their operations using the Field-to-Market Calculator. After undergoing processing at the ADM facility in Des Moines, the oil is used as an ingredient in Hellmann's mayonnaise produced by Unilever (Farm Progress 2014). When purchasing the sustainably grown soybeans, Unilever uses a mass-balance approach (United Soybean Board 2015d). Processors in Missouri may have a similar opportunity if buyers commit to purchasing a reasonable quantity of sustainably grown soybeans.

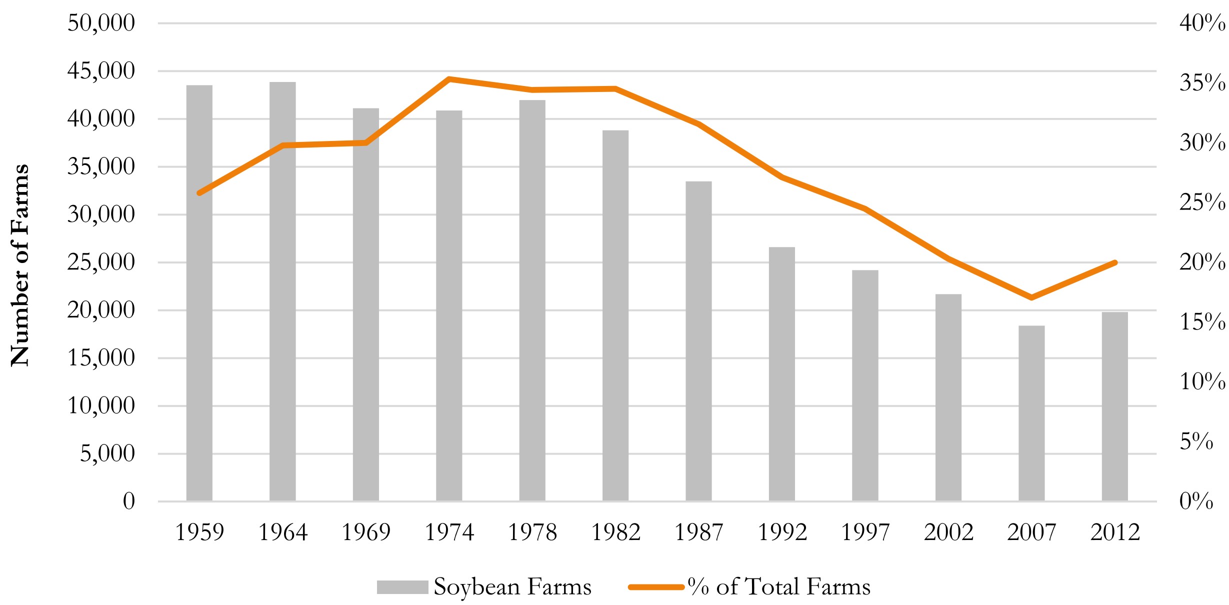
Within soybean value chains, new trait-enhanced soybeans represent another factor motivating the need for traceable supply chains and processing. Such trait-enhanced products include high-oleic soybeans, omega-3 soybeans, low-phytate phosphorus soybeans and high-stearic soybeans (United Soybean Board 2014c). High-oleic soybeans are already grown today in selected areas. When processed, they yield meal and oil, but the oil has different properties and market opportunities relative to commodity soybean oil. Within the high-oleic soybean value chain, farmers must segregate high-oleic and commodity soybeans. Otherwise, they risk losing their premiums (United Soybean Board 2014a). At the processing stage, the same need for segregation exists. If processors fail to segregate high-oleic soybean oil from commodity soybean oil, then the oil may lose its integrity and create less value for processors because buyers desire oil that would perform like high-oleic oil. As a result, a traceable supply chain that can capably segregate high-oleic soybeans and their derivatives presents an opportunity for processors.

A few processors have already entered into high-oleic processing. For example, in December 2014, Perdue Agribusiness, which has its headquarters located in Salisbury, Md., announced that it was building new storage tanks specifically to grow its capacity as a high-oleic soybean processor. By creating more storage space dedicated to high-oleic soybean oil, the company anticipated that it would improve its ability to efficiently supply the trait-enhanced oil (United Soybean Board 2014b).

2.7 Missouri Soybean Farmer Profile

Human resources are the most valuable factor in any production process. People drive the efficiencies and accomplishments noted in the previous sections. Although the number of acres planted to soybeans has increased since the 1950s, the number of operations planting soybeans has decreased from almost 45,000 farms in 1959 to 20,000 farms in 2012. See Exhibit 2.7.1. The percentage of Missouri farms growing soybeans decreased from a high of 35 percent in 1974 to 20 percent in 2012. Such specialization has occurred in all major Missouri agricultural enterprises. During the past 50 years, many farms that previously used a diversification strategy and produced both crops and livestock became more specialized and chose to either grow crops or raise livestock.

Exhibit 2.7.1 – Number of Missouri Soybean Farms and Percentage of Total Farms



Source: USDA National Agricultural Statistics Service, Census of Agriculture

Soybean farm size is not uniform throughout Missouri. See Exhibit 2.7.2. Forty-eight percent of Missouri farms that grew soybeans in 2012 recorded farm size that didn't exceed 100 acres. This subset of Missouri soybean farms raised only 7 percent of the state's total soybean production. On the other extreme, 1 percent of soybean farms produced 13 percent of all Missouri soybeans in 2012. Farms that exceeded 1,000 acres tended to have slightly greater productivity per acre as seen by comparing the percent of acres grown to the percent of production produced.

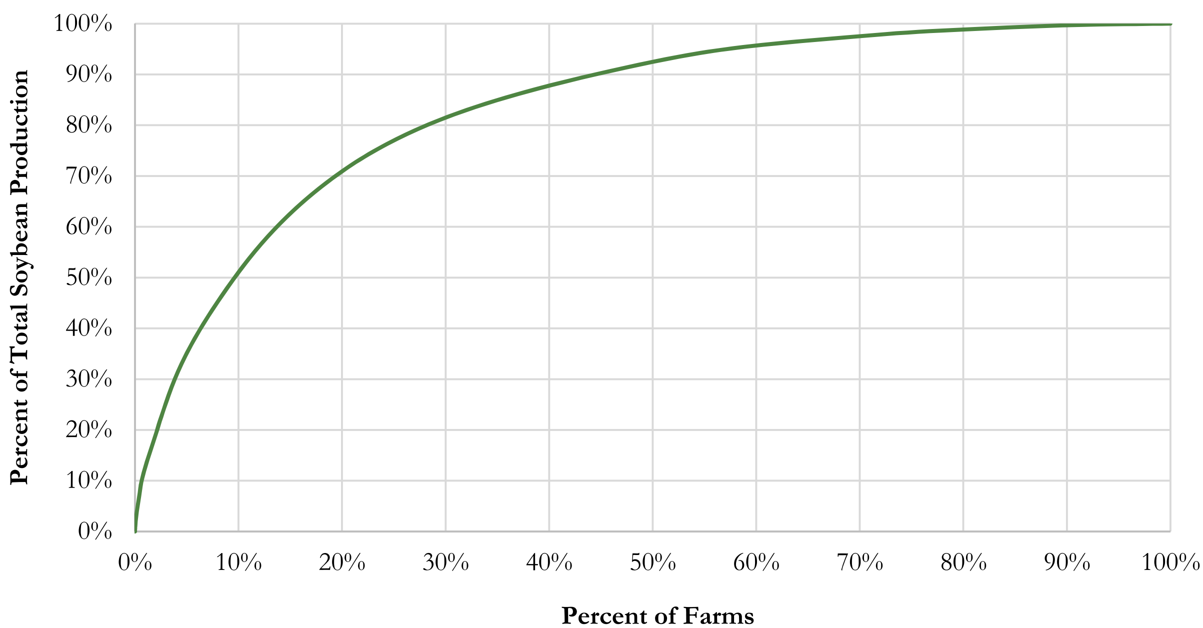
Exhibit 2.7.2 – Missouri Farms with Soybeans, Acreage and Bushels Produced, 2012

Farm Size	Number of Soybean Farms	% of Total Farms	Number of Acres	% of Total Acres	Bushels Produced	% of Total Bu. Prod.
1 to 99 Acres	9,607	48%	409,142	8%	10,260,250	7%
100 to 249 Acres	4,386	22%	690,610	13%	17,966,918	12%
250 to 499 Acres	2,736	14%	955,984	18%	25,686,971	17%
500 to 999 Acres	1,960	10%	1,347,746	26%	38,575,025	26%
1000 to 1,999 Acres	923	5%	1,211,474	23%	36,769,537	25%
2,000 or more Acres	211	1%	635,319	12%	19,567,837	13%
Total	**19,823**	**100%**	**5,250,275**	**100%**	**148,826,538**	**100%**

Source: USDA, National Agricultural Statistics Service, Census of Agriculture

Exhibit 2.7.3 graphically illustrates the fraction of Missouri soybean production grown by a given percent of Missouri soybean farms. To interpret the graph, select a percent of total soybean production, follow the horizontal line until it intersects the graph line, and then follow a vertical line down to the horizontal axis to discover the percent of farms providing that specific share of Missouri soybean production. As an example, 70 percent of Missouri soybean production originated from 20 percent of Missouri soybean farms in 2012. On the other hand, 50 percent of Missouri soybean production originated from 10 percent of Missouri soybean farms.

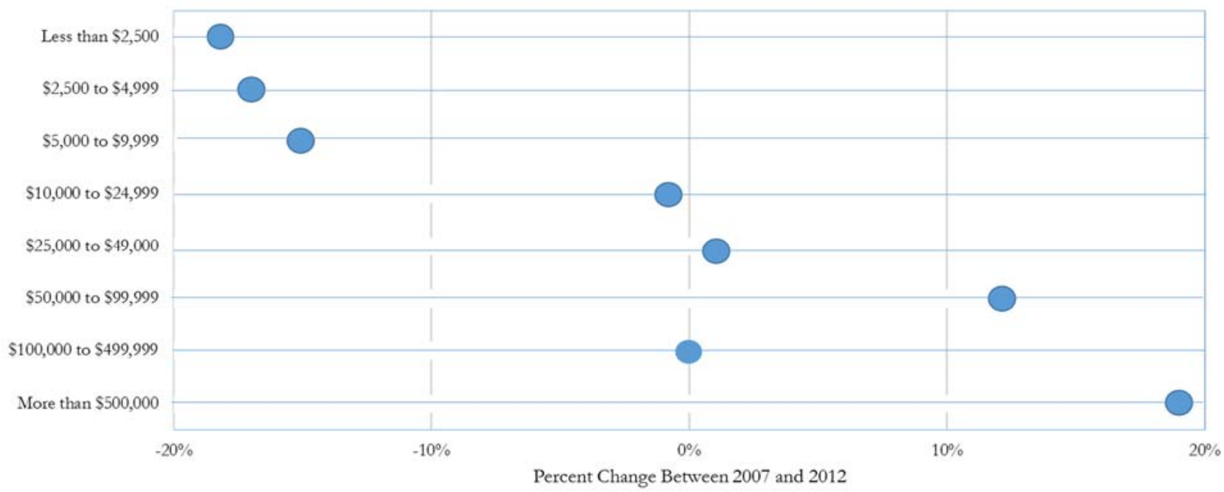
Exhibit 2.7.3 – Missouri Farms with Soybeans, Acreage and Bushels Produced, 2012



Source: USDA, National Agricultural Statistics Service, Census of Agriculture

Exhibit 2.7.4 illustrates changes in Missouri farm (not exclusively soybean farms) size based on farm value of sales. Between 2007 and 2012, the number of farms with sales that exceeded $25,000 increased, but the number of farms recording less than $25,000 in sales decreased. These data indicate that Missouri farms are growing larger as they become more efficient.

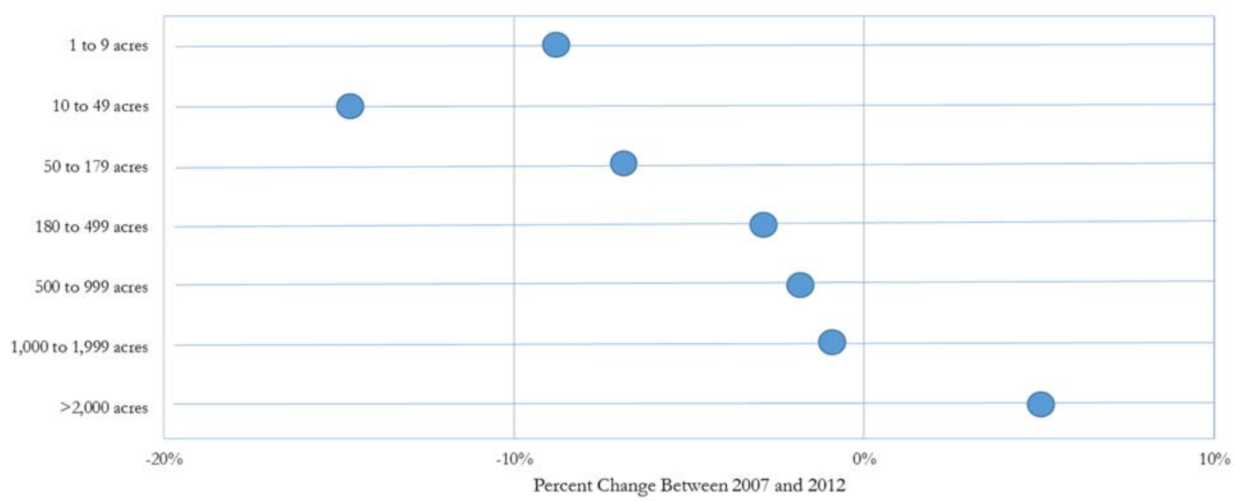
Exhibit 2.7.4 – Percent Change in Number of Missouri Farms Measured by Value of Sales, 2007 to 2012



Source: USDA, National Agricultural Statistics Service, Census of Agriculture

Exhibit 2.7.5 evaluates the change in number of Missouri farms based on their acreage. The only farm size classification that grew in number of farms from 2007 to 2012 was the category with farm operations that had more than 2,000 acres. Between 2007 and 2012, the number of farms with less than 180 acres decreased most compared with the other acreage size categories tracked by the USDA National Agricultural Statistics Service.

Exhibit 2.7.5 – Percent Change in Missouri Farm Size by Acres, 2007 to 2012



Source: USDA, National Agricultural Statistics Service, Census of Agriculture

The USDA Tenure, Ownership and Transition of Agricultural Land (TOTAL) survey provides insights into Missouri land management changes. Exhibit 2.7.6 indicates that 21 percent of Missouri land was owner operated during 2012. Conversely, agricultural producers rented 68 percent of Missouri land from landowners using various business structures. Most non-farming landowners own properties as individuals, or they own properties through partnerships. Landowners organized as a trust are most commonly estates retained by heirs as farms.

Exhibit 2.7.6 – Landowner Business Structure in Missouri, 2012

	Acres		Number	
Business Structure	**Quantity**	**Percent**	**Quantity**	**Percent**
Owner Operator	2,176,606	21%	14,609	20%
Landlord Business Organization	6,995,916	68%	48,114	66%
Rented from Individual	3,276,137	32%	24,363	34%
Rented from Partnership	1,423,861	14%	11,225	15%
Rented from Trust	1,752,566	17%	10,857	15%
Rented from Corporation	543,352	5%	1,669	2%
Total	10,272,053	100%	72,477	100%

Source: USDA, National Agricultural Statistics Service, Tenure, Ownership and Transition of Agricultural Land (TOTAL)

The TOTAL database also provides insights about landowner disposal plans. Exhibit 2.7.7 reports that 13,529 Missouri landowners plan to transfer ownership of 2.6 million acres of agricultural land within the next five years; the transfer may occur through a sale, gift or trust. Assuming that the 13,529 landowners do transfer land, this could mean that more than 2.6 million acres of agricultural land – 10 percent of the total in Missouri – will change hands by 2017. The survey data also suggest that some land will be transferred via will upon the current landowner's death. Such transfers may further increase possible acreage transferred within the next five years. Using a will, more than 8,000 Missouri landowners plan on transferring land ownership for nearly 1.85 million acres.

Exhibit 2.7.7 – Landowner Disposal Plans in Missouri, 2012

Landowner Disposal Plans	Acres	Count
Via Will	1,848,789	8,368
Within 5 years, via sale, gift or trust	2,660,298	13,529

Source: USDA, National Agricultural Statistics Service, Tenure, Ownership and Transition of Agricultural Land (TOTAL)

The 2012 Census of Agriculture reports that Missouri principal farm operator age averaged 58.3 years during 2012. Exhibit 2.7.8 presents principal operator age data by category. In 2012, the greatest number of Missouri principal farm operators were 55- to 64-year-olds. Note that only 636 principal farm operators reported being younger than 25 compared with 13,102 being 75 year old or more.

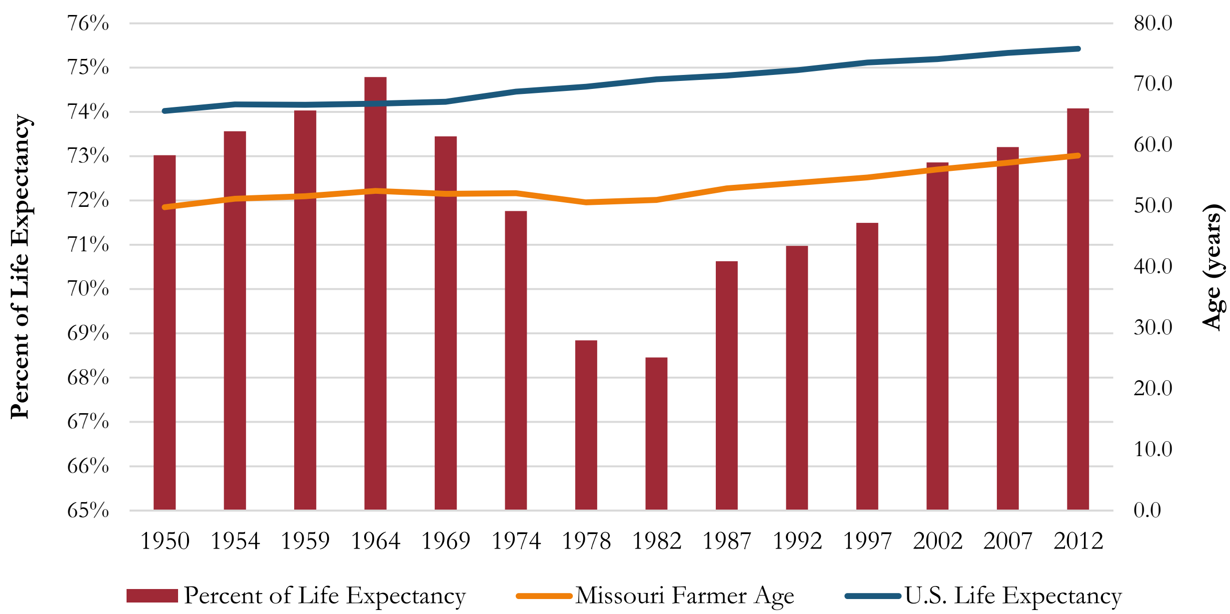
Exhibit 2.7.8 – Age of Principal Operator in Missouri, 2012

Age	Number
<25	636
25 - 34	5,594
35 - 44	10,182
45 - 54	22,064
55 - 64	27,041
65 - 74	20,552
≥75	13,102
Average Age	58.3

Source: USDA, National Agricultural Statistics Service, Census of Agriculture

The Social Security Actuarial Life Table reports that a 58-year-old male is expected to live 23 more years; a 58-year-old female will live an estimated 26 more years. Assuming a farmer's life expectancy is the same as that for an average citizen, the average farmer has already reached 75 percent of his or her life expectancy. Exhibit 2.7.9 illustrates that the percentage of the average farmer's life expectancy peaked in 1964, declined until 1982 and has steadily climbed since that time.

Exhibit 2.7.9 – Missouri Farmer Life Expectancy, 2012



Source: USDA, National Agricultural Statistics Service, Census of Agriculture

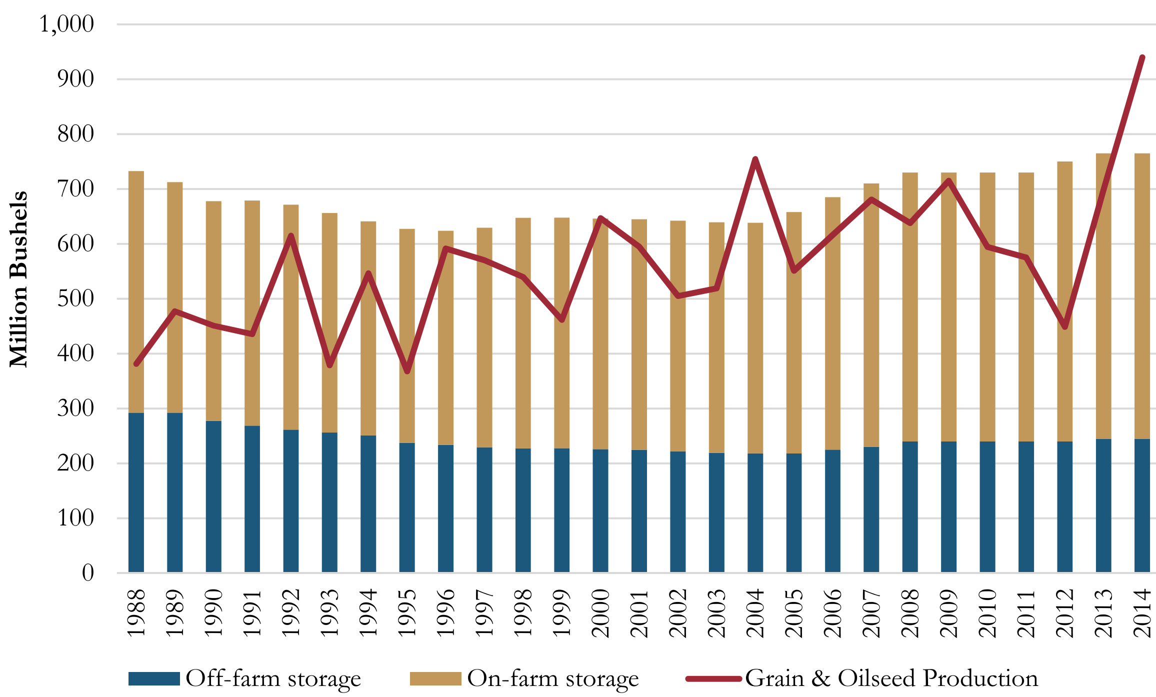
3. Missouri Soybean Distribution

3.1 Grain Storage

On a per bushel basis, soybeans are the most valuable row crop in Missouri. Soybean value is about 2.5 times the value of corn and 1.7 times the value of wheat. Corn will usually be stored in substandard storage before soybeans. However, soybeans are often stored long into the next year, and maintaining quality is critical. On-farm and commercial storage is a key for the value chain.

Exhibit 3.1.1 shares the quantity of Missouri on-farm and commercial, off-farm storage capacity. Commercial storage shrunk by 47 million bushels, or 19 percent, from 1988 to 2014, but on-farm storage increased by 80 million bushels. To handle total crop production, Missouri would require storage space that totals 765 million bushels. From 1988 to 2014, all grain and oilseed production exceeded the combined on-farm and off-farm storage capacity in three different years. When storage is unavailable, financial losses can result as quality degrades. Storage appears to be an issue only periodically and at isolated Missouri locations. Storage infrastructure investments need to continue, but Missouri has no immediate perceived need for additional storage.

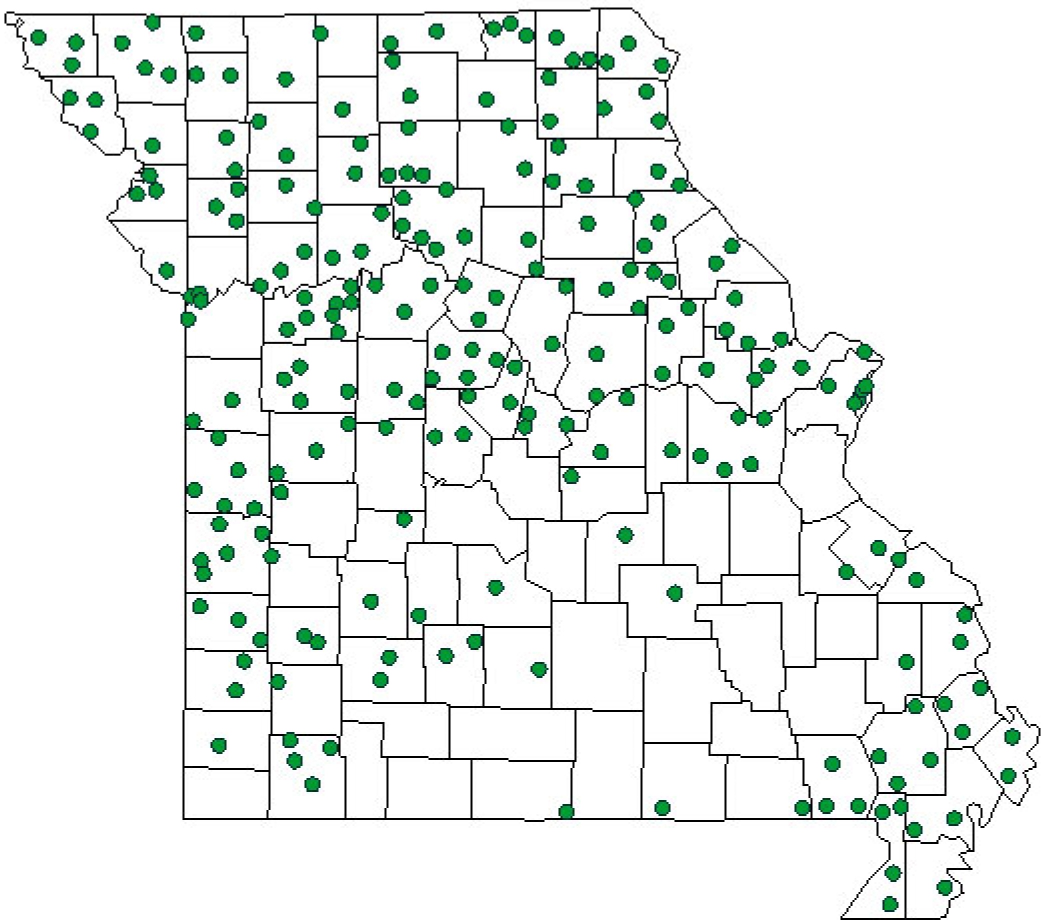
Exhibit 3.1.1 – Missouri On-Farm and Off-Farm Storage Capacity, 1988 to 2014



Source: USDA, National Agricultural Statistics Service

Grain dealers and warehouses represent key market channels in grain movement. A grain dealer is an entity that buys, receives or exchanges grain from a producer. Grain dealers may be also classified as warehouses if they store grain, and they will have either a Missouri or federal license. Many rules related to bonding, auditing, net worth and so forth have been established to protect grain farmers and prevent these businesses from failing financially. Exhibit 3.1.2 pinpoints Missouri commercial grain dealer locations. Facilities tend to locate in key Missouri soybean-producing regions.

Exhibit 3.1.2 – Missouri Grain Dealers, All Classes

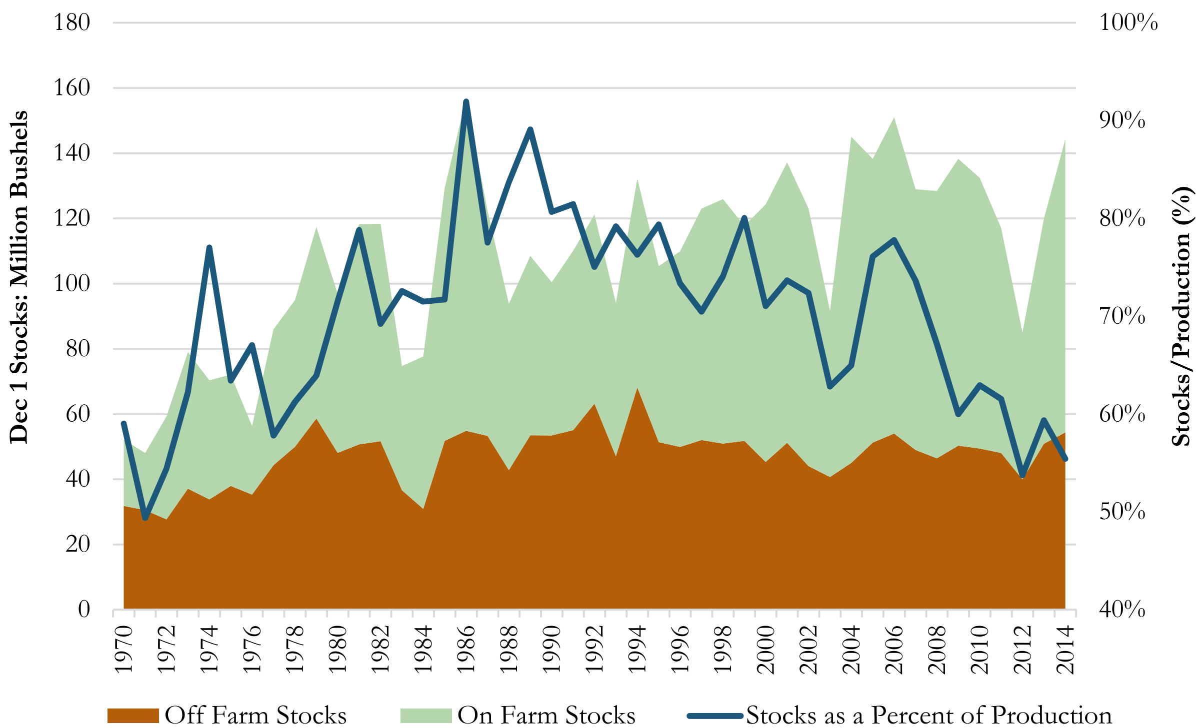


Source: Missouri Department of Agriculture (2015)

Exhibit 3.1.3 tracks Dec. 1 soybean stocks by year. Generally, commercial stocks are steadier than on-farm stocks. Commercial firms attempt to maintain a ready soybean supply to meet their needs. In Missouri, commercial soybean stocks tend to be about 50 million bushels, or 25 percent of annual production. On-farm stocks are held by producers and used as a marketing tool. When prices rise, on-farm stocks as a percent of production decrease. Total stocks/production fluctuated from a high of 92 percent in 1986 to a low of 49 percent in 1971. Stocks as a percent of production have decreased in the past decade due to favorable yields and prices. It appears that Missouri farmers have sufficient storage to maintain adequate stocks and leverage pricing opportunities.

By storing soybeans after harvest, producers anticipate earning higher prices than they would receive at harvest. Between 2010 and 2014, Missouri soybean prices tended to reach their highest levels in July, and prices tended to be lowest in October. As a percentage of the five-year average soybean price, Missouri soybean prices in July averaged 106.7 percent of the average, and the October soybean prices in Missouri averaged 92.6 percent of the five-year average price (USDA National Agricultural Statistics Service).

Exhibit 3.1.3 - Missouri Soybean Stocks, Dec. 1, 1970 to Dec. 1, 2014



Source: USDA, National Agricultural Statistics Service

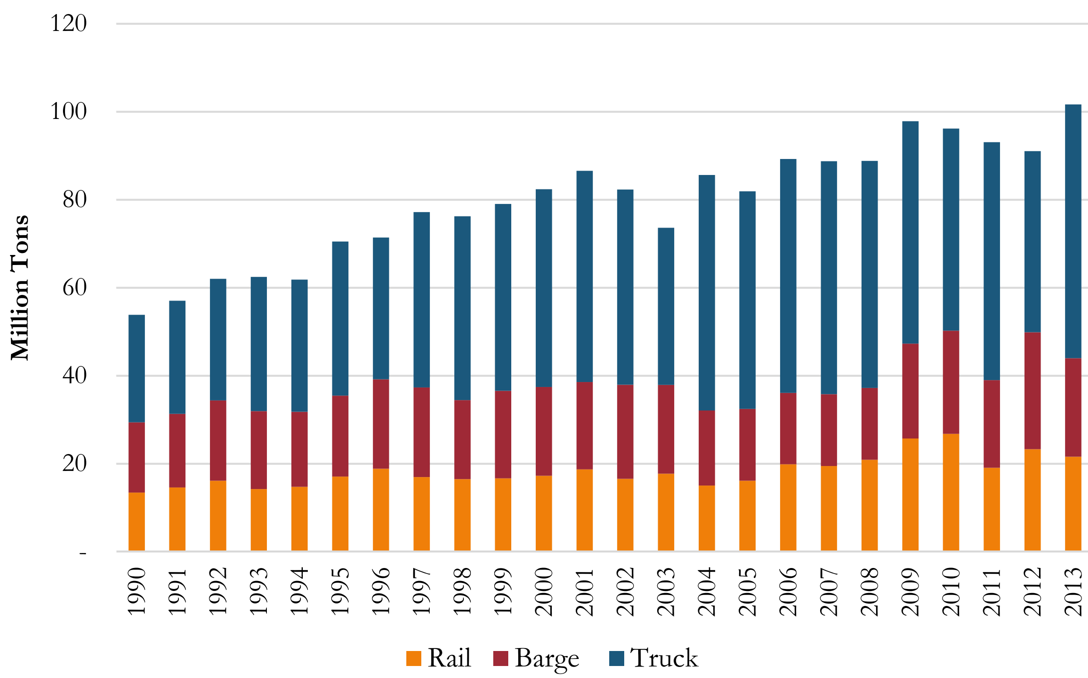
Demand growth for identity-preserved (IP) commodities and supply chain traceability will create demand for smaller, separate storage facilities located near production supplies. Quality control, freedom from cross-contamination and the potential to load totes or shipping containers nearby will be important for these facilities.

3.2 U.S. Soybean Transportation Modes

Transportation and infrastructure system health influences the ability for soybean producers and other value chain stakeholders to access markets and fulfill orders. In many ways, the U.S. infrastructure network differentiates U.S. commodities, including soybeans, from products available from other international suppliers. The U.S. has this competitive advantage because of its efficient transportation system that enables cost-effective shipping. As an example, transportation expenses for a soybean customer in Shanghai, China, that buys one tonne of soybeans would be 21.68 percent of the customer's costs if purchasing soybeans from Davenport, Iowa; 21.36 percent if purchasing from Sioux Falls, S.D.; and 25.13 percent if purchasing from Mato Grosso, Brazil (Reidy 2015). Aging or congested infrastructure may delay critical value chain functions and motivate the need to enhance such infrastructure resources or risk losing competitiveness.

Soybeans and soybean products are transported by truck, rail and ship to reach their end destinations. Most soybeans are often transported using multiple modes, and an efficient transportation system exists in the U.S. To transport all soybeans in 2013, 57 percent travelled by truck, and the remainder used rail and barge transportation. See Exhibit 3.2.1. Rail use and barge use have varied little from year to year. Total soybean shipments have continued to increase since 1990. During a 23-year period, shipments increased from more than 50 million tons to just more than 100 million tons.

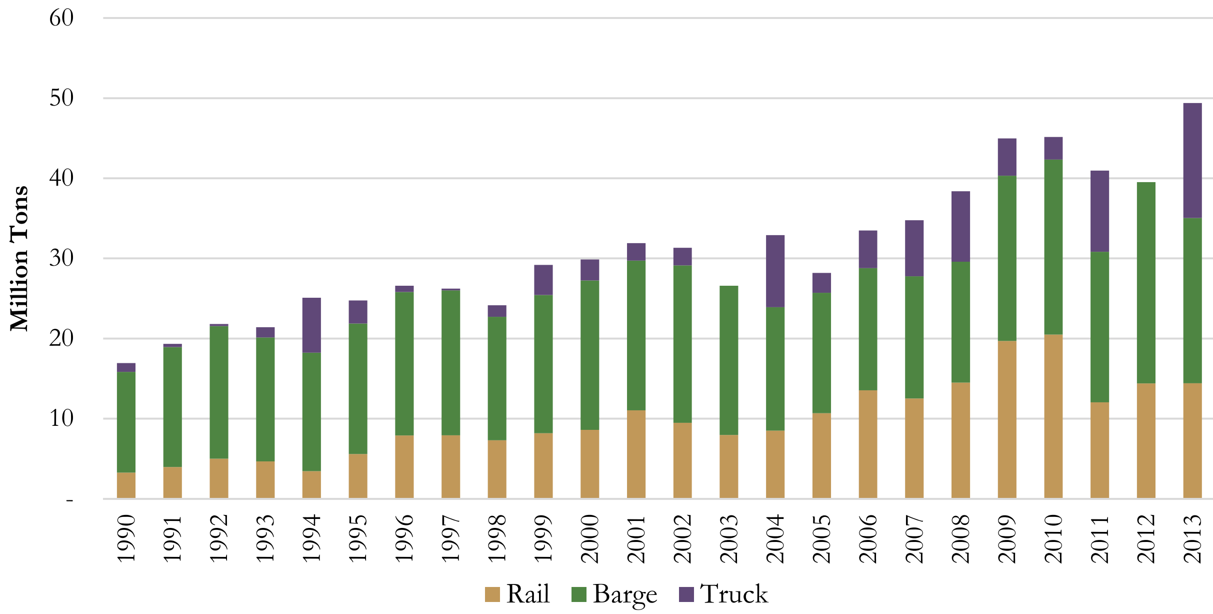
Exhibit 3.2.1 – U.S. Soybean Total Shipments (Export and Domestic) by Mode



Source: USDA, Agricultural Marketing Service

For soybeans being exported, barges represent a highly used as a transportation mode. In recent years, rail has represented an important soybean export transportation mode, and very little soybean volume destined for export markets has moved by truck. See Exhibit 3.2.2. Rail had a 30 percent share in 2013. In some years, truck transportation plays little to no role in moving soybean exports as the value chain almost completely uses just barges and railcars. During the past 23 years, soybean exports increased from about 17 million tons to nearly 50 million tons.

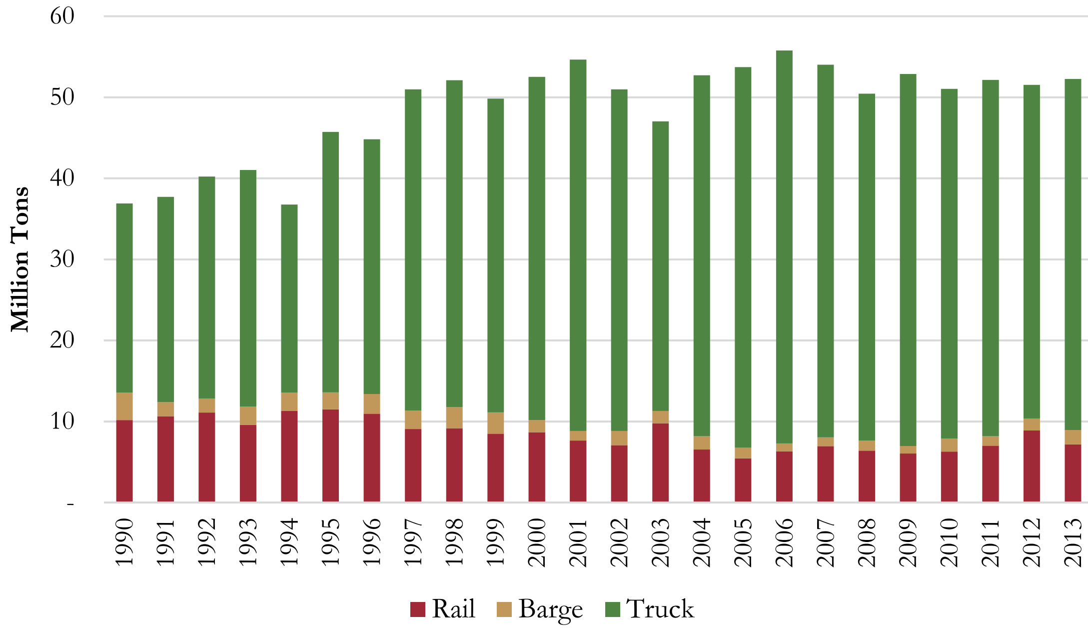
Exhibit 3.2.2 – U.S. Soybean Export Shipments by Mode



Source: USDA Agricultural Marketing Service

For domestic soybean shipments, a vast majority of transportation is achieved by truck. See Exhibit 3.2.3. On average, rail constitutes about 20 percent of the transportation modes used, and barge use is at best 10 percent in some years. In 23 years, the soybean volume transported domestically increased from about 37 million tons to more than 50 million tons. Domestic soybean transportation has been holding fairly steady year to year since 1997.

Exhibit 3.2.3 – U.S. Soybean Domestic Shipments by Mode



Source: USDA Agricultural Marketing Service

3.3 Missouri Rail Transportation

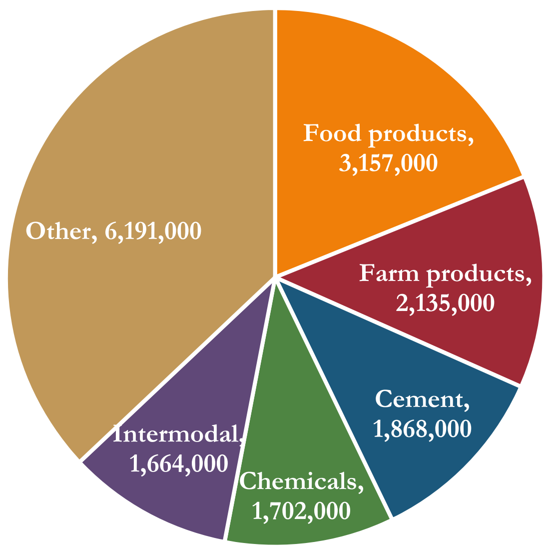
As a grain transportation mode, rail can accommodate larger quantities and use less fuel than transporting grain over long distances by truck. Missouri has 3,957 miles of freight railroad lines – the 10th highest number of rail miles in the U.S. – that are operated by 17 railroads (Association of American Railroads, 2014). Exhibit 3.3.1 maps Missouri rail lines. Class I railroads represent the large carriers; operating revenues determine railroad classifications. Regional and local railroads typically engage in line-haul service. Of the six Class I freight railroads in Missouri, their ranks by miles operated in Missouri during 2012 were BNSF Railway Company, 1,711 miles; Union Pacific Railroad Co., 1,482 miles; Norfolk Southern Corp., 409 miles; Kansas City Southern Railway Co., 396 miles; Soo Line Railroad Co. (CP), 143 miles; and CSX Transportation, 13 miles.

Exhibit 3.3.1 – Missouri Rail Freight Carriers

Source: Missouri Department of Transportation (2015)

During 2012, Missouri railroads originated 16.7 million tons – 403,500 carloads – of commodities. Exhibit 3.3.2 categorizes rail traffic by major commodity group, and it reports the tonnage hauled. The three largest categories hauled in 2012 were food products, 3,157,000 tons; farm products, 2,135,000 tons; and cement, 1,868,000 tons. According to the Association of American Railroads, of the farm products that originated in Missouri, more than 60 percent of the rail tonnage was corn, and soybeans and wheat represented the remainder. The food products category includes items such as soybean meal, canned food, animal feed, flour, corn syrup and distillers grains.

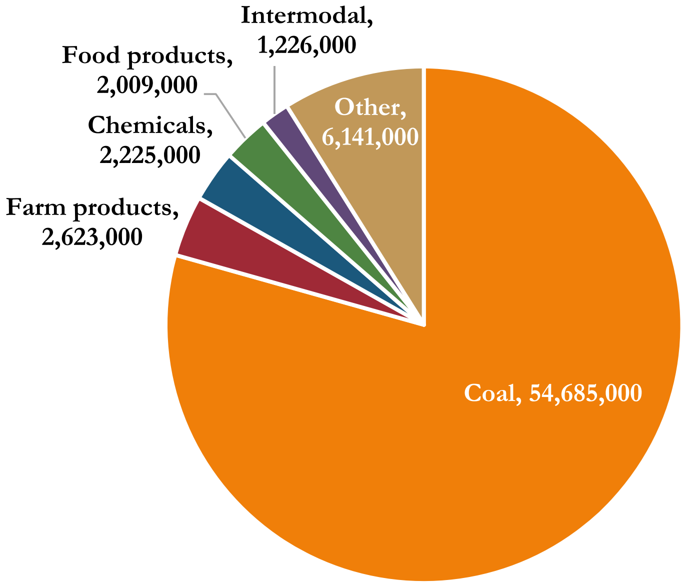
Exhibit 3.3.2 – Missouri Rail Traffic, Tons Originated from Missouri, 2012



Source: Association of American Railroads (2014)

During 2012, rail traffic terminated 68.9 million tons – 820,800 carloads – of commodities within Missouri. Exhibit 3.3.3 shares these rail traffic data by major commodity group and tonnage hauled. By weight, coal was the most significant commodity hauled into Missouri. It represented 79 percent of the total, and coal shipments weighed 54,685,000 tons. Missouri's electricity power plants primarily consume coal. Farm products represented a distant second at 2,623,000 tons.

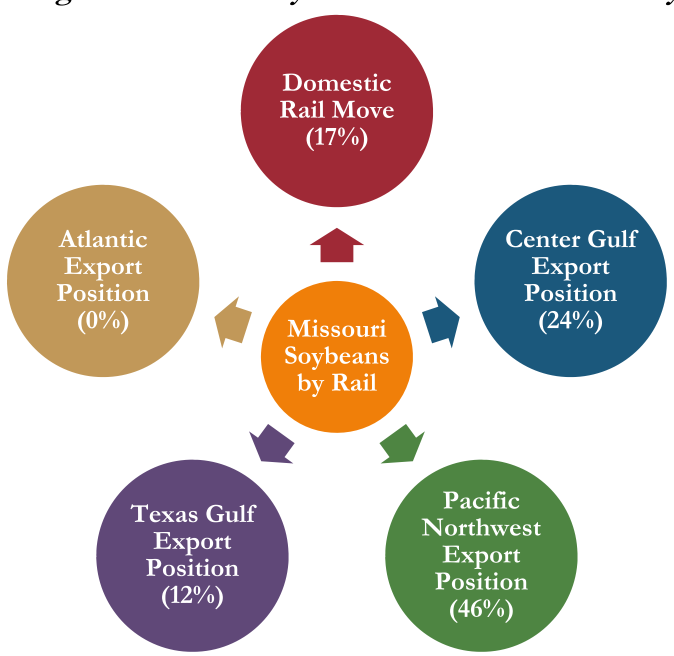
Exhibit 3.3.3 – Missouri Rail Traffic, Tons Terminated in Missouri, 2012



Source: Association of American Railroads (2014)

For soybean rail movements, Missouri moves a significant amount – 46 percent of its soybean rail traffic – to Pacific Northwest export positions. Exhibit 3.3.4 reports rail positions for Missouri soybeans. Soybean rail movements from Missouri also represent the Center Gulf and Texas Gulf export positions for 24 percent and 12 percent, respectively, of all rail positions.

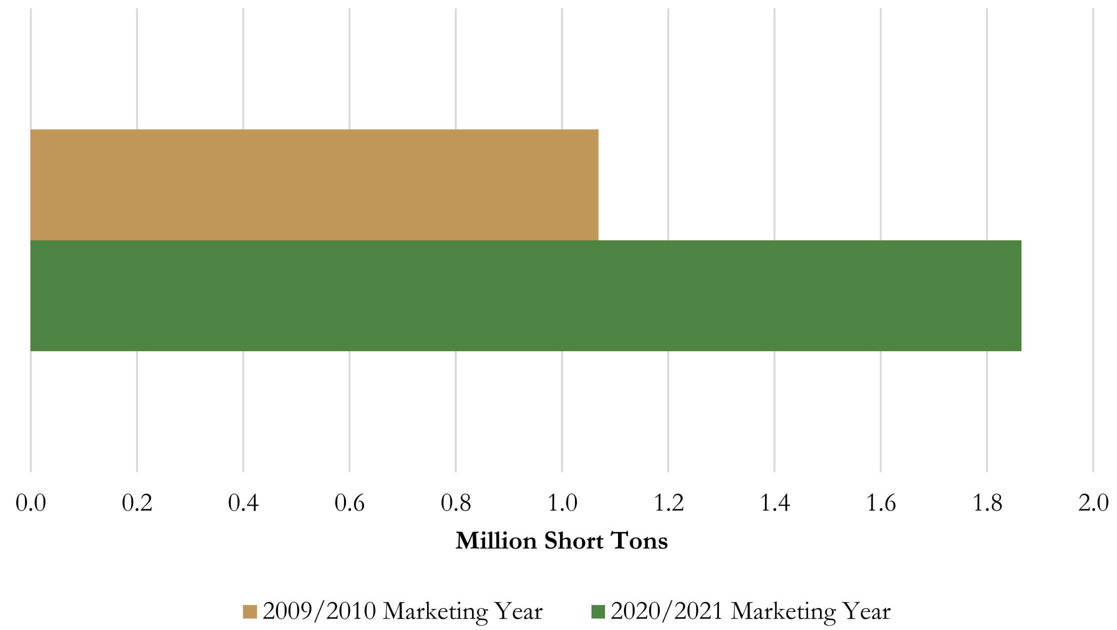
Exhibit 3.3.4 – Percentage of Missouri Soybeans Moved to Position by Rail, Missouri



Source: Informa Economics (2012)

Informa Economics (2012) expects Missouri rail movements to increase in the future. See Exhibit 3.3.5. By the 2020/2021 marketing year, the firm estimates that Missouri soybean railroad movements will increase to 1.87 million tons.

Exhibit 3.3.5 – Missouri Soybean Rail Movement Volumes, Short Tons



Source: Informa Economics (2012)

Exhibit 3.3.6 presents soybean rail transportation costs for the three major railroads operating in Missouri. Note that these data are for the entire U.S., and they vary by railroad. Across all U.S. freight railroads, the cost of moving soybeans by rail has typically totaled near $25 per ton during the past three years.

Exhibit 3.3.6 – U.S. Rail Gross Freight Revenue, Per Car and Per Ton, 2012 to 2014

Company	Product	2012		2013		2014	
		Per Car	Per Ton	Per Car	Per Ton	Per Car	Per Ton
Burlington Northern Santa Fe (BNSF)	Field Crops	$3,308	$38.28	$3,224	$39.10	$3,639	$43.77
	Soybeans	$4,765	$47.49	$5,060	$50.34	$5,340	$51.48
Norfolk and Southern Combined Railway Subsidiaries (NS)	Field Crops	$2,155	$21.74	$2,165	$21.72	$2,234	$22.38
	Soybeans	$1,685	$16.48	$1,979	$19.97	$1,901	$18.75
Union Pacific (UP)	Field Crops	$3,600	$35.25	$3,745	$36.52	$4,001	$38.98
	Soybeans	$2,806	$26.97	$3,345	$32.15	$3,779	$36.68
All Companies	**Field Crops**	**$2,527**	**$25.83**	**$2,525**	**$25.99**	**$2,734**	**$28.12**
All Companies	**Soybeans**	**$2,329**	**$22.75**	**$2,630**	**$25.71**	**$2,827**	**$27.44**

Source: Surface Transportation Board

Because most rail transports are long hauls, understanding the national railroad system helps to use it effectively in soybean transportation. Commonly, private entities finance and maintain freight rail infrastructure. Using revenues that they earn by shipping goods, the railroads have funding available to not only operate the railroad but also ensure that it stays in good condition and improve its functionality. For example, when a railroad identifies the need for more capacity, it may use private funding to make the necessary improvements (American Society of Civil Engineers 2015).

For the 2013 harvest, railroads experienced bottlenecks and delays. In that year, crop production reached high levels, and winter weather influenced shipments. Crude oil also emerged as a commodity that would compete with grains and oilseeds for space in rail transportation schedules. The rail industry transported 400,000 carloads of crude oil during 2013. This was a stark increase compared with the 11,000 carloads transported by rail during 2009. Areas influenced most by delays have been those that rely heavily on freight rail and have fewer alternatives (Reidy 2015).

In many cases, railroads recognized the problem and acted to prevent such bottlenecks from clogging the transportation system in the future. Based on data from Informa Economics, Class I railroads invested $21 billion in 2014 to upgrade their systems. At the time, the associated construction delays may have created some shipping challenges. Presently, however, the system benefits from the improvements (Jorgensen 2015). This rail example indicates that privatizing transportation and infrastructure resources may present an opportunity in some scenarios. With private investment, firms may willingly agree to make upgrade investments if they perceive those investments to improve their business positions later.

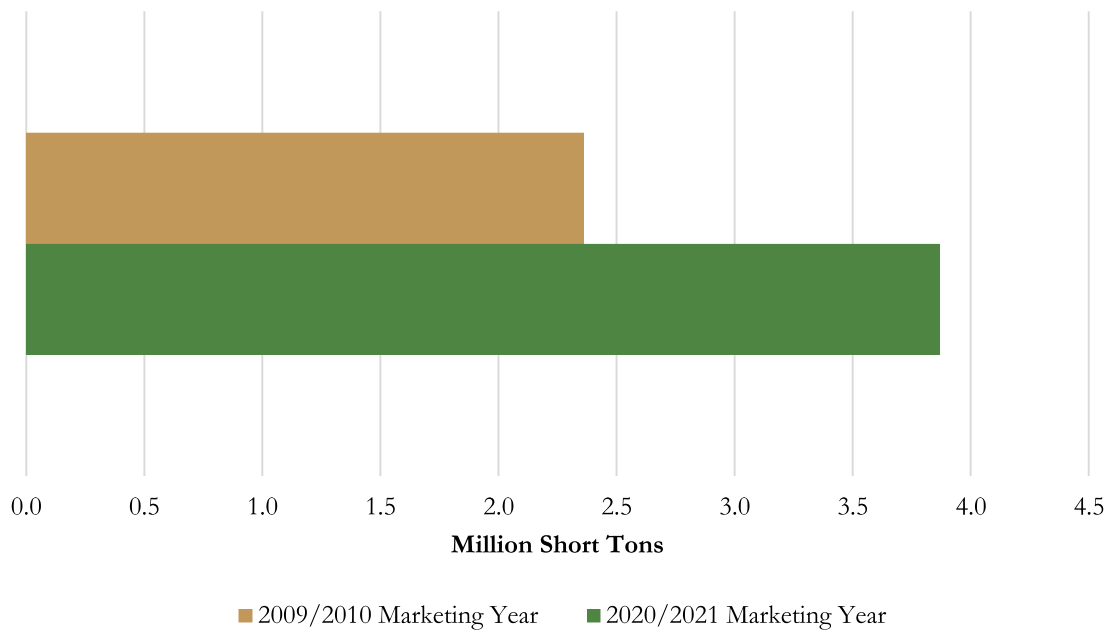
Within the grain transportation sector, firms may have an opportunity to retrofit old rail cars to handle grain. Based on insights from Informa, coal shipments made using open railcars have decreased. By repurposing these open railcars and adding covers to them, the cars have new application to haul grain. BNSF has already recognized this as an opportunity. Today's Farmer magazine reported in September 2015 that BNSF had plans to add an estimated 900 covered-hopper grain cars to its inventory during 2015 (Jorgensen 2015).

One recent development that may impact rail soybean transport is the Congressional mandate to implement Positive Train Control by Dec. 31, 2015. Railroad companies have already expressed doubt that they will meet the mandate and will have no choice but to stop traffic on sections not yet completed (Association of American Railroads, 2015). This traffic disruption would impact delivery of inputs, such as fertilizers, and outputs, such as soybeans.

3.4 Missouri Water Transportation

Missouri also has the ability to transport soybeans by water. Missouri typically moves most of its soybean exports to the Center Gulf. According to Informa Economics (2012), 96 percent of Missouri's barges move to the Center Gulf. Only 4 percent are considered domestic barge moves. Informa Economics also expects Missouri barge movements to increase in the future. See Exhibit 3.4.1. By the 2020/2021 marketing year, the firm estimates that Missouri soybean barge movements will reach 3.89 million tons.

Exhibit 3.4.1 – Missouri Soybean Barge Movement Volumes, Short Tons



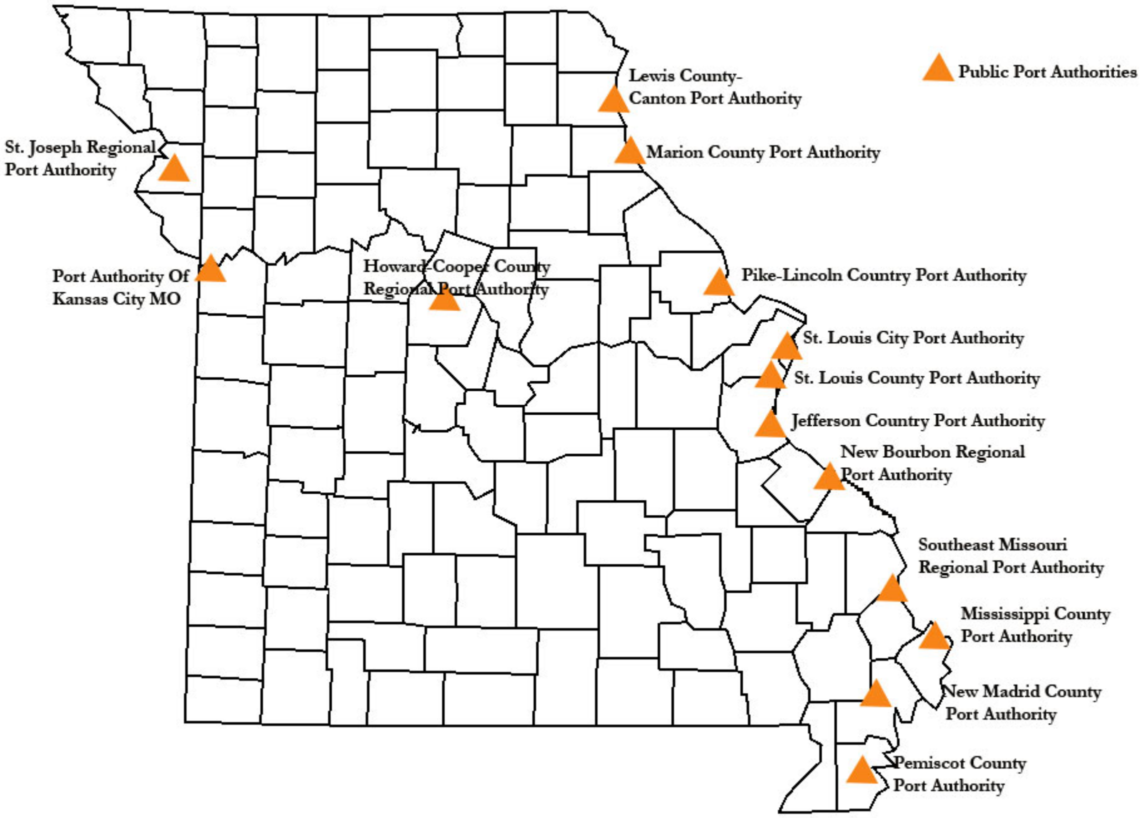
Source: Informa Economics (2012)

The American Society of Civil Engineers reports that Missouri ranked 10th for miles of inland waterways relative to other U.S. states, according to its 2013 report. The state had more 1,000 miles of such waterways. To be recognized as a navigable channel, inland waterways require a nine-foot depth. For the Missouri River, the American Society of Civil Engineers in its 2013 Report Card for Missouri's Infrastructure report suggests that private companies be identified to assist with river infrastructure improvements and maintenance. Another option to encourage funding support involves creating an "Essential Water Service" program modeled after the U.S. Department of Transportation's "Essential Air Service" program. With this approach, a waterway would set a freight movement minimum. If the waterway meets the goal, then the Coast Guard and U.S. Army Corps of Engineers would support the waterway (American Society of Civil Engineers 2015).

Missouri has 1,588 high-hazard dams. If a high-hazard dam were to fail, then the failure would potentially lead to significant loss of life and property (American Society of Civil Engineers 2015).

A 2011 study conducted by Hanson Professional Services on the Missouri Department of Transportation's behalf found that the Missouri River had 79 ports. Of those, 29 actively operated. Thirty were classified as inactive, and 20 were unknown facilities. The report noted that if investment were available, then most of these facilities could be renovated and at least be equipped to work with dry shipments, including those for grain and fertilizer, with minimal investment required (American Society of Civil Engineers 2015). Exhibit 3.4.2 identifies Missouri port authorities located on the Missouri and Mississippi rivers. Port authorities typically operate public terminals that offer services such as barge-rail-truck transfers, loading and storage.

Exhibit 3.4.2 – Missouri Port Authorities



Source: Missouri Department of Transportation (2015)

Exhibit 3.4.3 shows locks that operate on the Mississippi River and may assist Missouri soybean transportation. Old locks, such as some situated along the Mississippi River, may not easily accommodate the size of barges used today. In the 2013 Report Card for Missouri's Infrastructure, the American Society of Civil Engineers described that lock No. 20 to lock No. 25 measured just 600 feet in length; locks No. 20 to No. 27 are located in Missouri. As such, barges passing through these short locks would need to be separated to make it through the lock, but splitting a barge takes time and may create safety issues. The Water Resources Development Act of 2007 authorized lock No. 20, No. 21 and No. 22 to be lengthened, but it didn't guarantee the funding. Instead, it mandated annual appropriations. The 1,200-foot lock length for which the act provided permission would better manage the larger barges typically used to transport goods today (American Society of Civil Engineers 2015). For shorter locks that continue to operate, investment in them would improve the efficiency of barge traffic.

Exhibit 3.4.3 – Mississippi Locks and Dams Serving Missouri

Source: Northeast-Midwest Institute's Mississippi River Basin Blog (2014)

Constructing one lock would cost an estimated $376 million. In comparison, rehabilitating one would cost an estimated $40 million. As a result, nine rehabilitation projects could be funded at the same cost to build one new lock. As a result, upgrading critically damaged or failing locks and dams would preserve an important transportation resource (Reidy 2015). By upgrading locks and dams, soybean producers would have expanded transportation options available to them. According to a September 2015 story from Today's Farmer, upgrading locks and dams along the Mississippi River north of St. Louis would be beneficial (Jorgensen 2015). With a high-functioning inland waterways system, shippers can realize fuel efficiency benefits compared with using truck or rail transportation. Additionally, barge use may displace railcars and trucks from the transportation system and decrease congestion in those modes (American Society of Civil Engineers 2015).

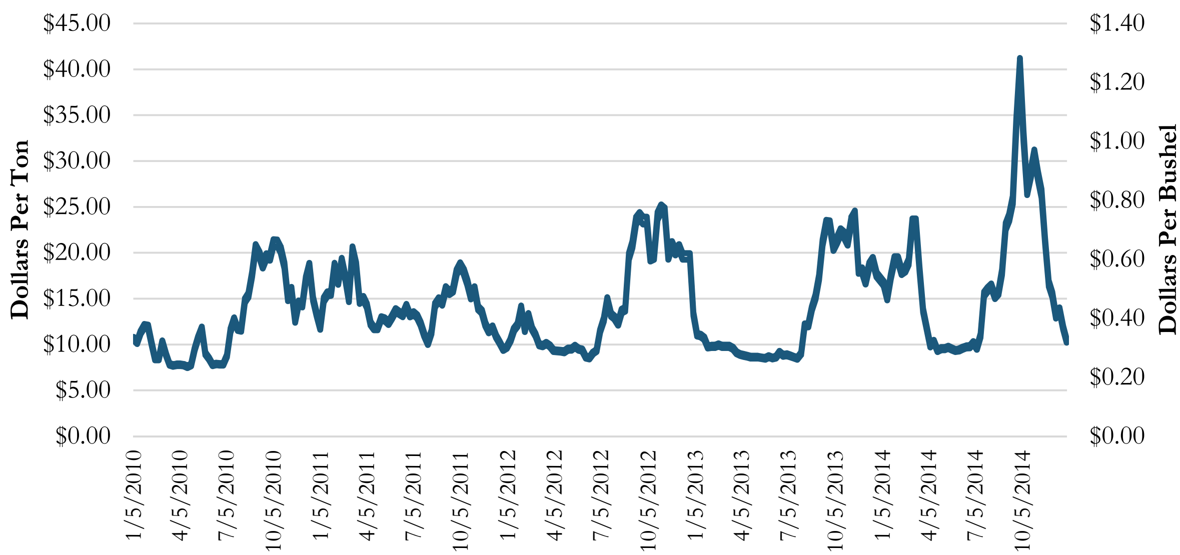
To fund inland waterway enhancements, establishing public-private partnerships is one option. Through such a partnership, otherwise called a P3, a public entity would enter into a contract with a private entity, which would have jurisdiction to offer a public service. For inland waterways, a partnership could involve the public U.S. Army Corps of Engineers establishing a contractual agreement with a private entity. The agreement would stipulate that the federal government continues to own the given lock and dam infrastructure, but the private entity would assume a role to fund, operate, maintain, rehabilitate and/or replace locks and dams. To ensure that the private entity complies with the necessary provisions, the U.S. Army Corps of Engineers would have inspection, monitoring and enforcement duties. Plus, it would manage non-navigational inland waterway activities including flood control. For a public-private model to work, Congress would need to permit navigational asset long-term leases between the U.S. Army Corps of Engineers and non-federal entities, and Congress would need to enable lessees to collect sufficient revenue. Additionally, private sector equity investors would require a sufficient return, and private sector debt investors would require an adequate debt service coverage ratio (The Horinko Group 2013).

Like for rail, Informa recommends retrofitting open coal barges to handle grain. Already, many barges have undergone the conversion that makes them well-suited for hauling grain. However, adding covers to more barges that formerly transported coal could expand grain and oilseed transportation options (Jorgensen 2015).

Expanding the Panama Canal, which should be complete in 2016, is expected to increase shipping of dry bulk cargos from the U.S. Gulf Coast to Northeast Asia. Switching from the current Panamax vessels to Small Cape and some Capesize vessels for canal-bound vessels is expected to decrease ocean shipping costs from the U.S. Gulf Coast to major Asian ports. Lower shipping costs will divert significant export grain tonnage from west coast rail to Mississippi River barges (U.S. Department of Transportation, Maritime Administration 2013). Rising grain bids by river terminals are expected to change basis patterns and pull more soybeans to barges on the Lower Mississippi River system, especially in winter months when barge traffic north of St. Louis may be frozen.

Exhibit 3.4.4 reports the cost of barge shipments to the Gulf Louisiana from St. Louis during the past five years. Fall 2014 had the highest costs in recent history; costs reached $1.24 per bushel, or $41.23 per ton, on Sept. 30, 2014. Soybean production seasonality is reflected in this data point as prices increase typically around harvest.

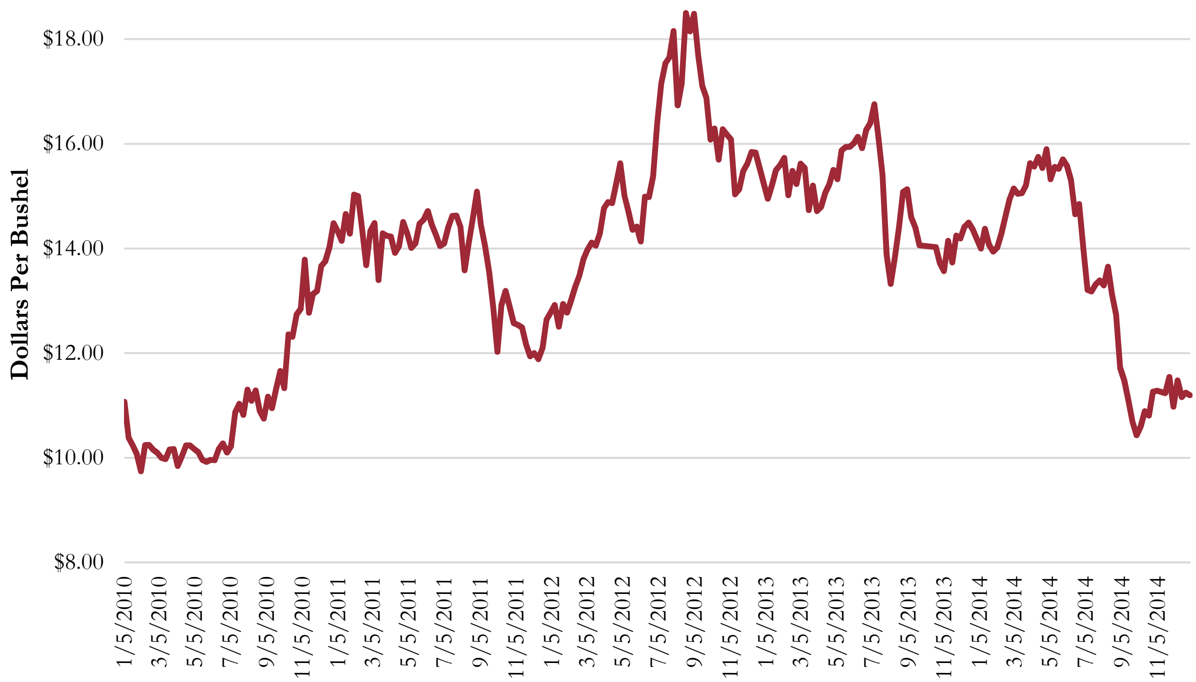
Exhibit 3.4.4 – St. Louis Spot Barge Rates, Dollars per Ton and per Soybean Bushel



Source: USDA, Agricultural Marketing Service

Exhibit 3.4.5 shares 30-day bids for soybeans delivered to the Gulf Louisiana Port in dollars per bushel. During the observed period, bids reached their highest level during 2012. Toward the end of 2014, soybean export grain bids had decreased to nearly the same levels recorded in 2010.

Exhibit 3.4.5 – Soybean Export Grain Bids at Gulf Louisiana Port



Source: Livestock Marketing Information Center

3.5 Missouri Truck Transportation

Trucking is the first leg of soybean transport from the field to storage and market. Efficient trucks and road infrastructure are essential for profitable and competitive Missouri soybean production. The American Society of Civil Engineers released its Report Card for America's Infrastructure for 2013. Exhibit 3.5.1 shows the grades for infrastructure that affect soybean transportation for the U.S., Missouri and key soybean states surrounding Missouri. Missouri is not significantly different from the U.S., Illinois and Iowa. Missouri roads received a slightly better grade than those in the U.S., Illinois and Iowa, but it fell between the two states and below the national average for bridges.

Exhibit 3.5.1 – Road and Bridge Conditions in the U.S., Missouri, Illinois and Iowa*

Infrastructure Category	U.S. grade	Missouri grade	Illinois grade	Iowa grade
Roads	D	C	D+	C-
Bridges	C+	C-	C+	D+

* Grading system: A= excellent, B = good, C = mediocre, D= poor and F = failing
Source: American Society of Civil Engineers (2015)

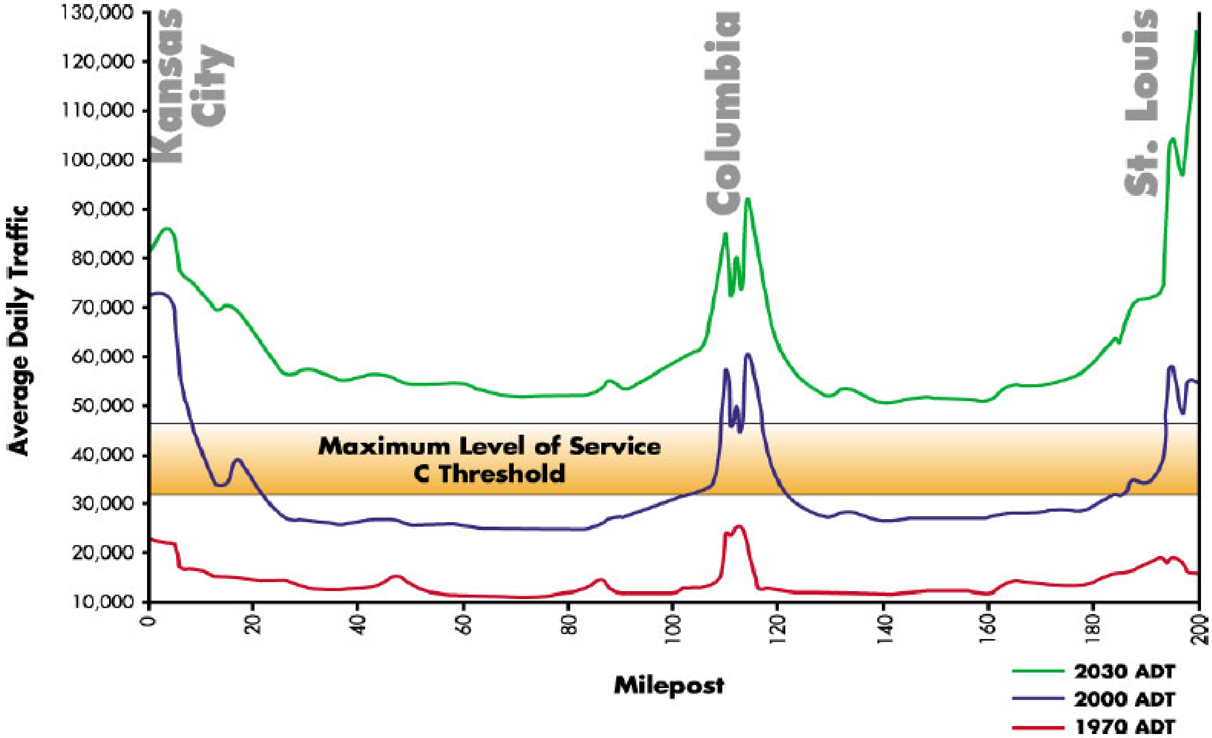
Missouri ranks seventh for having the largest highway system, but generally, it has a low fuel tax rate. In Missouri, federal funding provides the most support for Missouri roads. Federal funds plus the state fuel tax collectively contribute nearly 70 percent of transportation revenue (American Society of Civil Engineers 2015). Options to increase funds available for transportation system improvement include raising fuel tax rates, increasing other revenue sources or adding revenue streams.

To enable governments to modernize and improve transportation networks, the Soy Transportation Coalition suggests raising more funds through an elevated federal fuel tax rate, which hasn't been reassessed since 1993. In September 2015, Today's Farmer reported that the federal tax totaled $0.184 per gallon for gas and $0.244 per gallon for diesel at the time. For the federal fuel tax to have greater potential to fund infrastructure improvements, the Soy Transportation Coalition supports efforts to apply an inflation index to the federal fuel tax (Jorgensen 2015). At the state level, Missouri hasn't changed its fuel tax since 1992 (American Society of Civil Engineers 2015). Supporting a similar effort to index the state tax to inflation may better position Missouri to maintain and enhance its widespread roads system.

Encouraging local control may be another option to improve Missouri roads. In the 2013 Report Card for Missouri's Infrastructure, the American Society of Civil Engineers suggested that arranging city or county ownership of road infrastructure may be an option to maintain those roads (American Society of Civil Engineers 2015). If local municipalities increase their responsibility for roads, then they'll still need access to resources to use when maintaining those roads.

Interstate 70 is a critical truck artery across Missouri. Soybean trucks travel east to St. Louis to deliver grain to elevators on the Mississippi River and west to soybean crush plants in Kansas City. I-70 was designed and constructed to handle 12,000 to 18,000 vehicles per day. As of 2012, portions near St. Louis, Kansas City and Columbia were carrying more than 30,000 vehicles per day (Missouri Department of Transportation 2012). Accident closures in these areas commonly back truck traffic for miles and may delay trucks for hours. Tax increases, toll roads or renewing Missouri River barge traffic have been suggested to alleviate truck congestion. Exhibit 3.5.2 details the past and projected average daily traffic pattern across I-70 and the maximum level of service threshold.

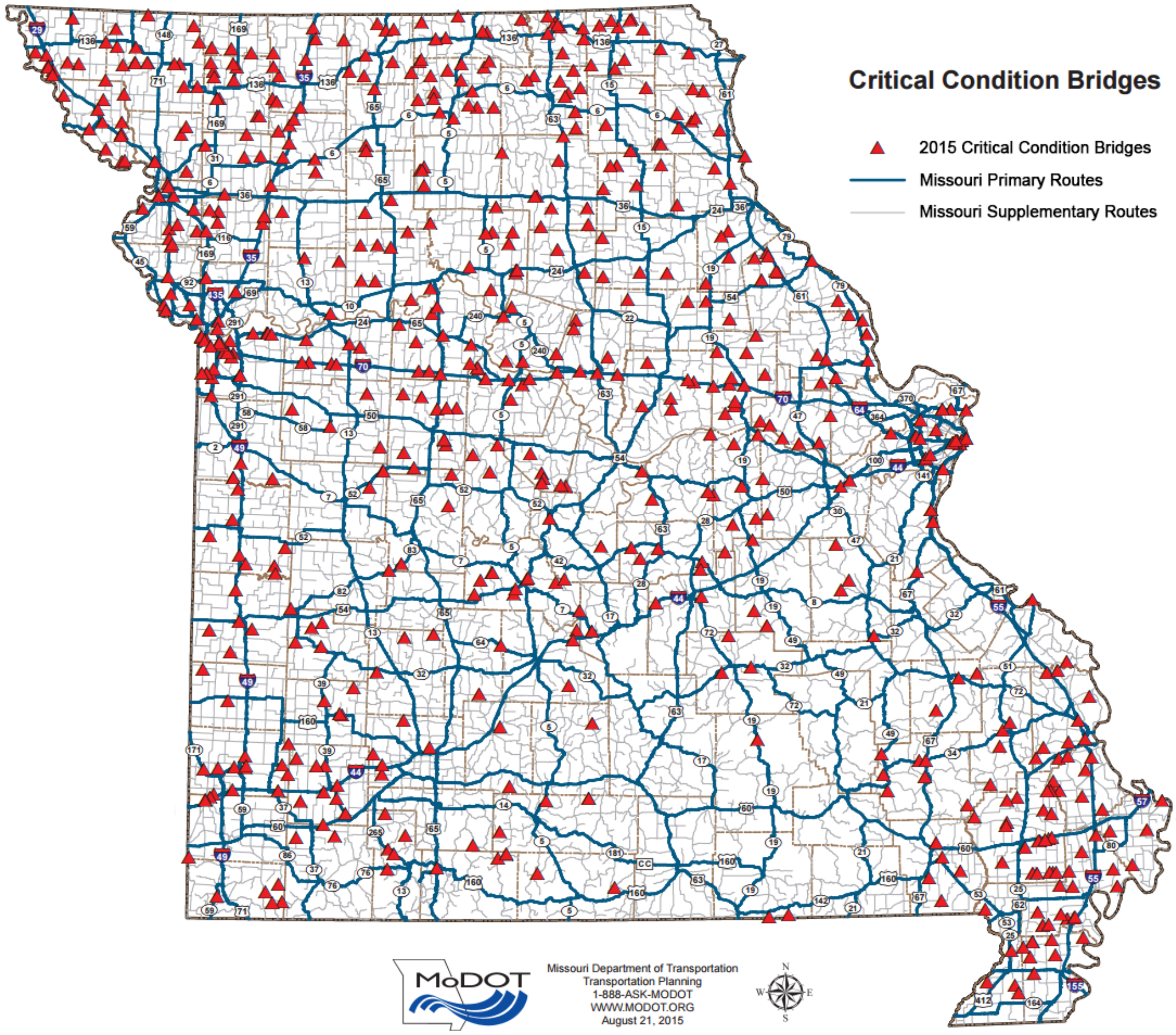
Exhibit 3.5.2 – Average Daily Traffic for Interstate 70, Past and Projected



Source: Missouri Department of Transportation (2012)

The Missouri Department of Transportation is responsible for 10,400 bridges in the state. In 2015, the department reported that the state had 641 bridges considered to be in critical condition; this was an increase from 591 in 2014. See Exhibit 3.5.3. Of the 641 bridges in critical condition, 509 are on supplementary roads – usually, these are lettered paved roads such as Rt. E. – and 72 are on primary roads – usually, these are numbered state highways such as MO 42. These smaller roads are critical for efficiently transporting soybeans from the field to storage facilities and first markets. Missouri Department of Transportation estimates that the detour length, if a bridge is closed, to be 30.2 miles for bridges on supplementary roads and 21.1 miles for bridges on primary roads. Such deteriorating infrastructure could impose serious costs for farmers transporting soybeans.

Exhibit 3.5.3 – Map of Missouri Bridges in Critical Condition



Source: Missouri Department of Transportation

In August 2015, a new Missouri law that increased truck weight limits became effective. Traditionally, most trucks navigating Missouri highways had 80,000-pound weight limits. Given the new law, however, trucks hauling crops may increase their hauling weights on Missouri highways by 10 percent during the harvest season (Thorsen 2015).

At the federal level, a recently introduced bill would provide states with the authority to adjust weight restrictions for federal roads within their borders. According to the National Grain and Feed Association, the Safe, Flexible, and Efficient Trucking Act would enable states to increase interstate highway weight limits to 91,000 pounds if trucks have a sixth axle; this would be an increase from the current 80,000-pound limit. In many states, the federal weight limit has lagged the weight parameters permitted on state roads. Thus, the new bill, introduced in September 2015, would address inconsistencies that may exist between weight limits allowable on state and federal roads (Gonzalez

2015). If Missouri had the flexibility to make weight maximums equivalent for state and federal roads, then that consistency may help to improve transportation efficiency in the state.

Many Missouri farmers own and operate their own trucks for transporting their products to market. Some use these trucks throughout the year to haul material for others. The American Trucking Associations published estimates in October 2015 that found the truck driver shortage in 2014 totaled about 38,000 drivers and that indicated the shortage would grow to 47,500 drivers in 2015 (Costello and Suarez 2015). This shortage may offer an opportunity for soybean farmers, particularly those not fully employed in agriculture, to supplement their incomes and maintain truck quality.

4. Missouri Soybean Demand

Whole soybeans have many uses. The whole bean, full-fat flour and roasted soybeans, which are all whole bean products, have food, feed and industrial applications. However, when processed, soybean product applications further diversify.

4.1 Soybean Processing Technology and Products

The soybean processing industry involves crushing soybeans into various products such as meal, oil and hulls. Oil can be used in a variety of applications. Food applications include margarine, salad dressing and snack foods, and industrial applications include biodiesel, candles and paints. Meal and hulls have feed value in livestock rations. Typically, processing one bushel of soybeans will produce 11.3 pounds of crude soybean oil and 45 pounds of soybean meal (Soyatech, LLC 2013). Hulls would represent a relatively minor component of the soybean processing volume.

Each fraction – meal, oil and hulls – has unique properties and potential uses. Exhibit 4.1.1 illustrates possible soybean product applications by fraction. Depending on the processing methods applied, soy protein can be formatted into meal, flour, protein concentrates, protein isolates or other ingredients used by the nutraceuticals sector. Meal itself generally would have animal feed applications. It could have uses in cattle, swine, poultry and fish feeds and pet foods. After further processing, the soy flour, protein concentrate and protein isolate products would have improved functionality for food and industrial uses. Food processors may use such ingredients in bakery products, beers and ales, meat analogs, breakfast cereals, baby foods, candies and sausage casings. From an industrial perspective, soy flour, concentrates and isolates could have application in adhesives, particle board, insecticides, antibiotics, water-based paints, plastics, textiles and other products. Soy protein-derived ingredients with nutraceutical properties are isoflavones, saponins, phytic acid and protease inhibitors (Center for Crops Utilization Research 2009).

The industry classifies soy protein products given their protein content on a dry weight basis that excludes added vitamins, minerals, amino acids and food additives. Soy flour must contain at least 50 percent protein but less than 65 percent protein. Protein content of soy protein concentrates must range from 65 percent protein to less than 90 percent protein. Soy protein isolate products must contain at least 90 percent protein. Crude fiber content also varies by product on a dry weight basis. The crude fiber levels must not exceed 5 percent for soy flour, 6 percent for soy protein concentrate and 0.5 percent for soy protein isolate. For all three, they should contain no more than 10 percent moisture, and the standard limits ash on a dry weight basis to 8 percent (Soyatech, LLC 2004).

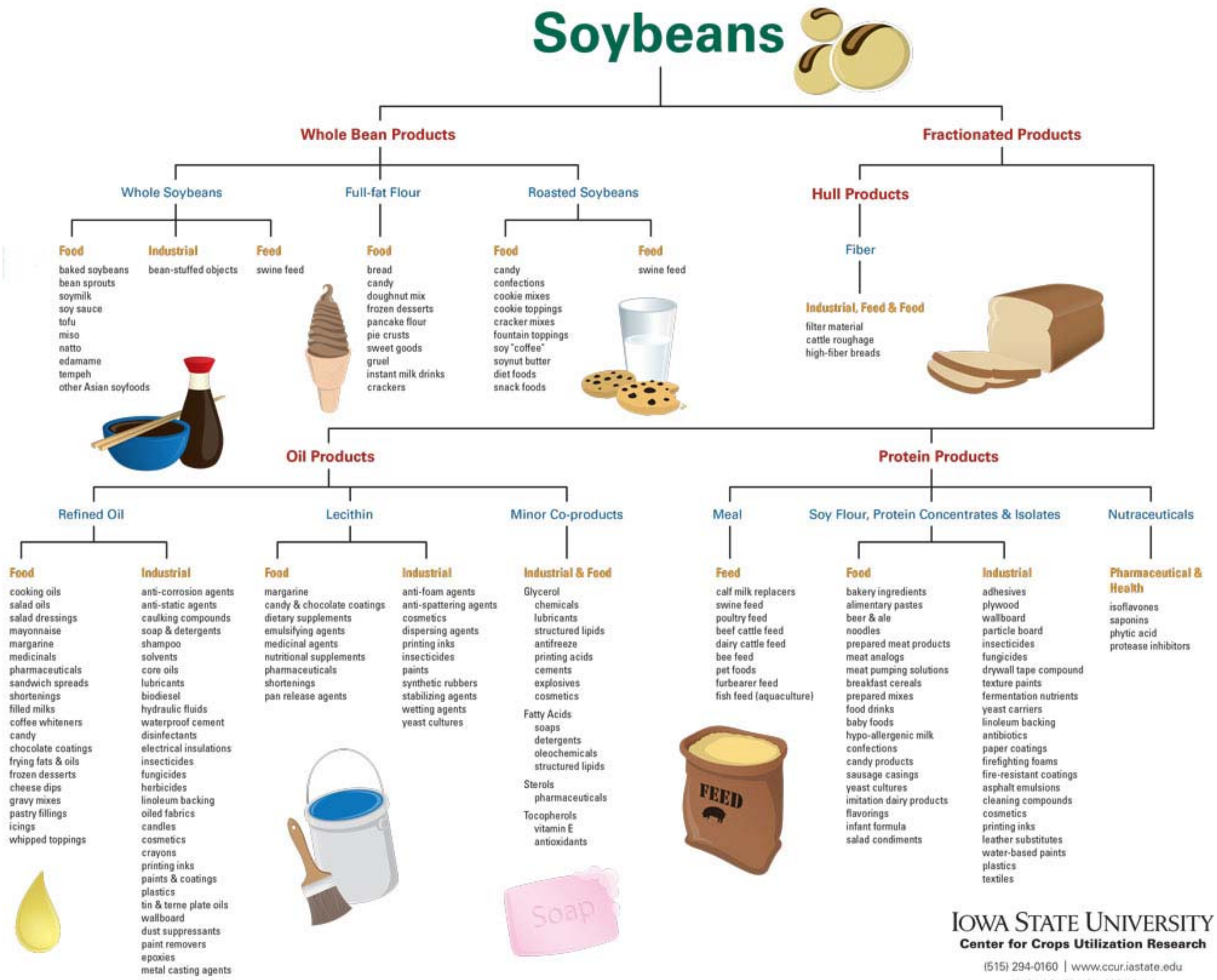
Crude oil separated from soybeans can undergo further processing into refined soybean oil, lecithin, glycerol, fatty acids, sterols and tocopherols. Refined oil would have food and industrial applications. The food industry could use refined soybean oil in products such as cooking oils, salad dressings, margarines, shortenings, coffee whiteners, chocolate coatings, frying oils and icings. Within the industrial sector, refined soybean oil has varied possible applications, including use as a component in anti-corrosion agents, soaps and detergents, shampoos, solvents, biodiesel, hydraulic fluids, plastics, paints and coatings and epoxies (Center for Crops Utilization Research 2009).

The Codex Alimentarius dictates international standards for named vegetable oils including soybean oil and several others. The standard provides satisfactory ranges for the five major fatty acids that constitute soybean oil. According to the standard, soybean oil contains 8 percent to 13.5 percent palmitic acid, 2 percent to 5.4 percent stearic acid, 17 percent to 30 percent oleic acid, 48 percent to 59 percent linoleic acid and 4.5 percent to 11 percent alpha-linolenic acid (Codex Alimentarius 2015b). For some time, the U.S. has proposed to develop an international standard for high-oleic soybean oil. During 2015, however, the high-oleic soybean oil standard discussion was tabled until high-oleic soybean oil trade expands. At that time, the U.S. would likely resubmit the standard's proposal (Codex Alimentarius 2015a). Already, the Codex lists standards for high-oleic safflower oil, high-oleic sunflower oil and mid-oleic sunflower oil (Codex Alimentarius 2015b).

After oil has been removed from soy protein, adding water and using centrifugation or steam precipitation can detach lecithin from the oil. As an emulsifier and stabilizer, soy-derived lecithin tends to be popular in food products (United Soybean Board). In food, consumers may find lecithin in margarines, dietary supplements, pharmaceuticals, shortenings and pan release agents. Industrially, soy lecithin has several potential applications, including cosmetics, printing inks, synthetic rubbers and yeast cultures. The glycerol, fatty acid, sterol and tocopherol components have industrial and food uses (Center for Crops Utilization Research 2009). For example, phytosterols are reported to keep the intestines from absorbing cholesterol, and in some cases, they're added to foods and beverages (Higdon, Drake and Jones 2008). Tocopherols found in soybean oil not only provide vitamin E that supports human health, but they also act as antioxidants that can protect oil (Soyatech, LLCa).

As a type of fiber, soybean hulls may have application as cattle feed, an ingredient in high-fiber bread and a component of some industrial products (Center for Crops Utilization Research 2009).

Exhibit 4.1.1 – Products Derived from Soybean Processing



Source: Center for Crops Utilization Research (2009)

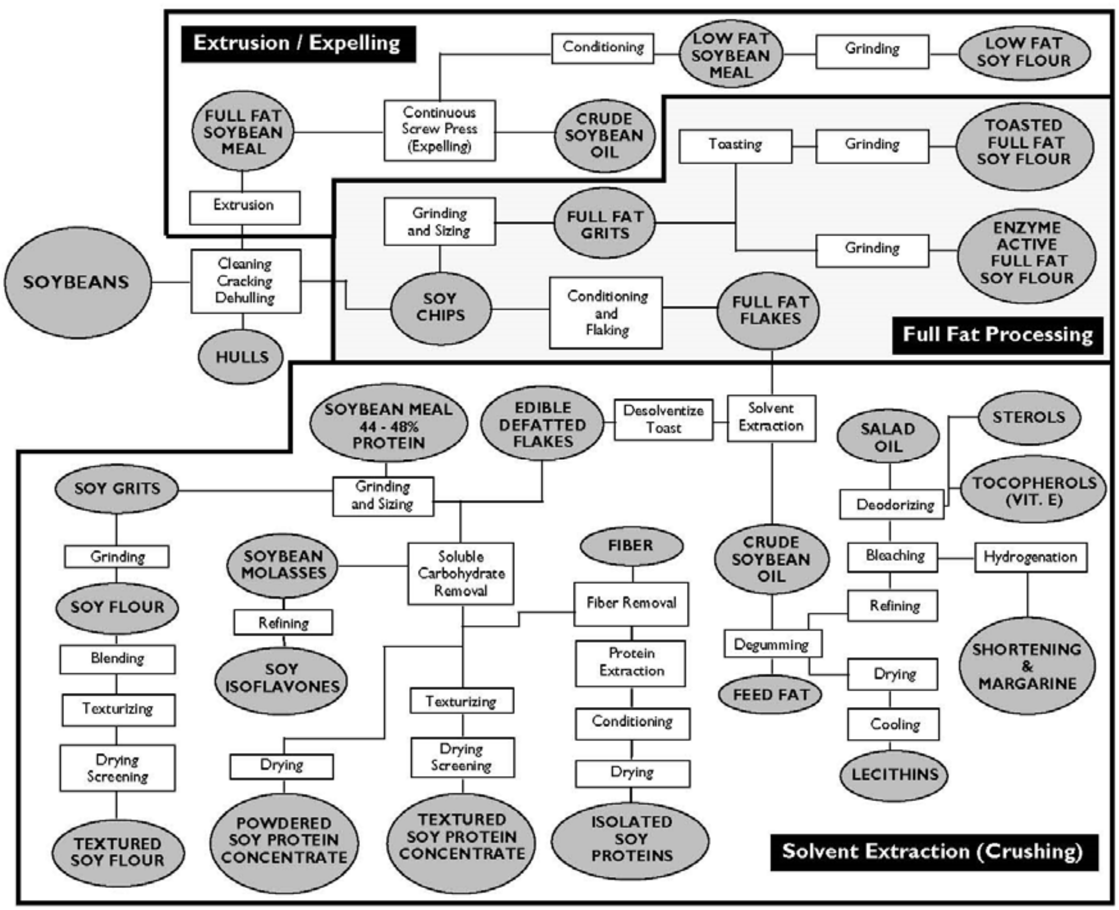
Products yielded from soybean processing somewhat vary depending on the type of processing used. Generally, processing facilities can use one of three approaches: extrusion/expelling, full-fat processing and solvent extraction. Exhibit 4.1.2 illustrates the variation among the three processes. The extrusion/expelling process relies on mechanical force. After dehulling soybeans, processors would use extrusion to produce full-fat soybean meal, which is later processed with a continuous screw press to yield crude soybean oil and low-fat soybean meal (Soyatech, LLC 2013).

In a full-fat processing model, the oil fraction doesn't get separated from the meal. Instead, dehulled soy chips can be ground into grits – and ultimately, flour – or processed into flakes. The flakes and flour would have all fat retained and act as high-energy products (Soyatech, LLC 2013).

Solvent extraction, the third processing option, would begin with full-fat flakes. After applying a solvent solution, the crude soybean oil and soybean protein would separate. Toasting the protein components would remove residual solvent and produce edible defatted flakes. Like previously explained, the crude soybean oil could undergo further processing into various derivatives, such as feed fat, lecithin, salad oil, sterols and tocopherols. With respect to the protein component, it could be processed into soybean meal, soy grits, soy flour, soy protein concentrates, soy protein isolates, isoflavones, textured proteins and other products (Soyatech, LLC 2013). The textured soy products can originate from several processes. To make a textured product, processors may use a spun fiber method, extrusion or steam texturing. With the spun fiber approach, it requires isolated soy protein as the initial ingredient. Soy flour, protein concentrates or protein isolates may be used for extrusion or steam texturing methods. The texturization process creates a physical structure that is similar to meat. As such, texturized soy protein primarily has application as a meat extender. However, other potential uses include meat analogs, imitation bacon bits and pasta products (Berk 1992).

Within a chemical process, hexane commonly serves as the compound that essentially "washes" and releases oil from soybean flakes. According to a paper published by the Soyfoods Association of North America, hexane extraction first debuted during the 1930s, and consuming residual hexane doesn't present risk or danger to consumer health given the exposure level. A processor removes volatile hexane through elevating the temperature via steam. When exposed to heat under high vacuums, residual hexane tends to volatilize (Swanson).

Exhibit 4.1.2 – Soybean Processing Options



Source: Soyatech, LLC (2013)

Despite some industry stakeholders explaining hexane's safety, some processors have chosen to use hexane-free processes as an opportunity to differentiate their businesses. For example, Indianola, Iowa-based Harvest Innovations uses hexane-free methods when processing non-GMO and organic soybeans. On its website, the company promotes several products, such as grits, flour, powder, flakes, shaped cereal pieces, dehulled soybeans and expeller-pressed soybean oil. The processing methods for all products exclude chemical use. These products have wide-ranging applications, which include soymilk, infant formula, dairy analogs and meat analogs. Harvest Innovations lists that it will also introduce hexane-free soy isolates (Harvest Innovations 2013). Using a hexane-free process or identifying a natural solvent may create a processing opportunity.

Soybean products include several components that have functional benefits. When separated from soybean meal or oil, these components may be inserted into food products to make them more healthful. Such components include plant sterols, vitamin E and isoflavones. ADM promotes having offered all three of these ingredients. It sources its CardioAid® plant sterols and Novatol™ vitamin E from soybean oil, and NovaSoy® isoflavones originate from food-grade soybean flakes (ADM 2010). Within the Novatol brand, ADM features several types of naturally sourced vitamin E products. ADM promotes that the naturally sourced version is superior to synthetic vitamin E because the body retains the natural form better. ADM vitamin E products, including those within the Novatol brand, may have application in capsules and tablets (ADM 2015b). ADM offers Novasoy isoflavones in concentrations that range from 20 percent to 70 percent. The company claims to be one of the largest global isoflavone producers. More than 125 supplement brands use Novasoy isoflavones as an ingredient (ADM 2015a).

ADM promotes that plant sterols essentially compete with cholesterol for absorption, and as a result, the body would absorb less cholesterol if an individual consumes plant sterols. The FDA has approved a cholesterol health claim for plant sterols. That claim suggests that consuming at least two 0.4-gram servings of plant sterols per day and maintaining a diet low in saturated fat and cholesterol may cause heart disease risk to decline. The CardioAid® plant sterols from ADM may be added to several different product categories, including margarines, salad dressings, yogurt, beverages, mayonnaise, dairy analogs and meat alternatives (ADM 2015a).

Bunge is another processor with experience in the plant sterol business. In 2004, Bunge created a phytosterols-related alliance with Procter & Gamble and Peter Cremer North America. Through the alliance, Bunge would supply deodorizer distillate from its oilseed processing business; the deodorizer distillate contains the phytosterols. Bunge processes several oilseeds, including soybeans, rapeseed and sunflower. Peter Cremer North America would oversee manufacturing activities, and Procter & Gamble's food ingredients division would market the phytosterol products to use in food and pharmaceutical applications (Bunge Limited 2004).

Historically, partial hydrogenation was a popular further processing method used to improve soybean oil's versatility in product applications and allow it to compete with fat alternatives such as butter and lard. By essentially adding saturation to oil, partial hydrogenation converts liquid oil into a product with more solid characteristics. Research has linked trans fats to having a negative effect on cholesterol levels. As such, effective Jan. 1, 2006, the U.S. Food and Drug Administration mandated that products containing more than 0.5 grams of trans fat per serving have their trans fat content listed on product labels (Soyatech, LLCb). To avoid listing the trans fat content, many food manufacturers reformulated their products. Between 2005 and fall 2013, the Grocery Manufacturers Association reports that at least 73 percent of processed food trans fat content had been voluntarily removed. In many cases, the reformulation came at the soybean industry's expense. The American Soybean Association estimated that the industry lost 8 million acres of demand for soybean oil (Bloomberg 2013). More recently, the U.S. Food and Drug Administration revoked the generally recognized as safe status for partially hydrogenated oil in June 2015, and it announced that all partially hydrogenated oil must be removed from food products by June 2018, unless a firm can prove the ingredient's safety (Edney and Giammona 2015). For food manufacturers that still rely on partially hydrogenated soybean oil as an ingredient, they will need alternatives in order to adhere to the new Food and Drug Administration mandate.

Interesterifying soybean oil is one option that may enable continued use of soybean oil in challenging applications where partially hydrogenated oil fits particularly well. Facilitated by a chemical or enzymatic process, interesterification alters the fatty acid arrangement found in triglycerides. Through this process, interesterification doesn't create trans fats; however, the resulting interesterified oil can fit into many product applications that have used partially hydrogenated oil. For example, interestified oil may be used to produce solid and semi-solid shortenings. For several decades, chemical interesterification has been a viable processing option. In the late 1990s, enzymatic interesterification processes were developed (SoyConnection).

Processors with the capability to blend oils may also respond to the market for trans fat-free oil. Firms that blend oil may, for example, start with a fully hydrogenated soybean oil. As the name implies, this oil would have been completely hydrogenated to create a highly saturated fat that lacks trans fat. Using the fully hydrogenated soybean oil as a base, blenders may add liquid oil to create the desired physical characteristics. Generally, a blend that uses fully hydrogenated soybean oil would fit well in bakery products (SoyConnection).

Processing facilities that develop new industrial applications for soybean oil and soybean meal represent another opportunity for soybean processors. Since it formed in 2001, the United Soybean Board has considered opportunities for soybean products as industrial ingredients. Research efforts have suggested soybean ingredient potential in many types of products, including plastics, lubricants, coatings, printing inks and adhesives (United Soybean Board 2015c). Opportunities may exist to innovate within these categories or develop completely new industrial applications for soybean oil. CHS is one processor that has innovated in the industrial category. Its oilseed processing division, which annually refines more than one billion pounds of soybean oil, developed PlastiSoy epoxidized soybean oil. Produced by oxidizing unsaturated soybean oil with a high iodine value and an organic acid, PlastiSoy has several possible applications such as a secondary heat and light stabilizer in PVC; acid scavenger in soy-based inks, agricultural chemicals and insecticides; pigment dispersion agent; and lubricating and cutting oil (CHS, Inc. 2010).

Food processors may use soybean ingredients in many product formulations, which creates an opportunity for processors dedicated to food-grade processing. The edamame industry in Arkansas provides an example. In 2012, American Vegetable Soybean and Edamame Inc. opened a processing facility in Mulberry, Ark. At the time, most domestically consumed edamame originated from Asia, and the company wanted to provide a U.S.-produced alternative. American Vegetable Soybean and

Edamame Inc. operated as a division of its JYC International parent company, which imports edamame from abroad and distributes the Arkansas-grown edamame. The company chose Arkansas because it had an environment that fits edamame's needs, and it also received local and state support and assistance from the University of Arkansas (Magsam 2012).

At least during its first year operating, American Vegetable Soybean and Edamame Inc. supplied edamame seed to growers, and it harvested the edamame for growers. In that year, more than a dozen producers grew edamame on about 1,000 acres, and the plant itself employed about 40 people who processed and packaged edamame (Magsam 2012). By 2015, the processing facility had grown to employ 80 people, but during harvest, the company's employment increases to an estimated 150 people. Product processed at the facility supplies international markets, and within the U.S., Sam's Club, Costco, Whole Foods and Kroger outlets carry the product (Lovett 2015).

Processors may use specialty soybeans to produce other food products. Those include tofu, miso, soy sauce, natto, soymilk, tempeh, soy nuts and bean sprouts (Grabau and Herbek 2013). Depending on the market opportunities for each product, processors may consider adding food-grade processing to their business model in order to deliver these food-grade products to consumers.

Among consumers, protein as a macronutrient has positioned itself in the spotlight, and increasingly, consumers are entertaining plant-based protein sources as an alternative to animal-based sources. In 2015, one estimate suggests that the global protein market's value would total $24.5 billion. The estimate also projected that annual growth would be strongest for plant-based protein ingredients. Several factors have contributed to the interest in plant protein. Those include the expense associated with animal-derived protein, intentions to reduce animal-derived protein intake, interest in clean eating and ingredient sustainability. Despite the plant-based protein market's growth, several niche protein ingredients are being developed and commercialized to compete with soy-based proteins. For example, plant-based protein ingredients receiving attention include pea protein, microalgae, canola protein and cricket flour (Bizzozero 2014).

4.2 Missouri Soybean Processing Facilities

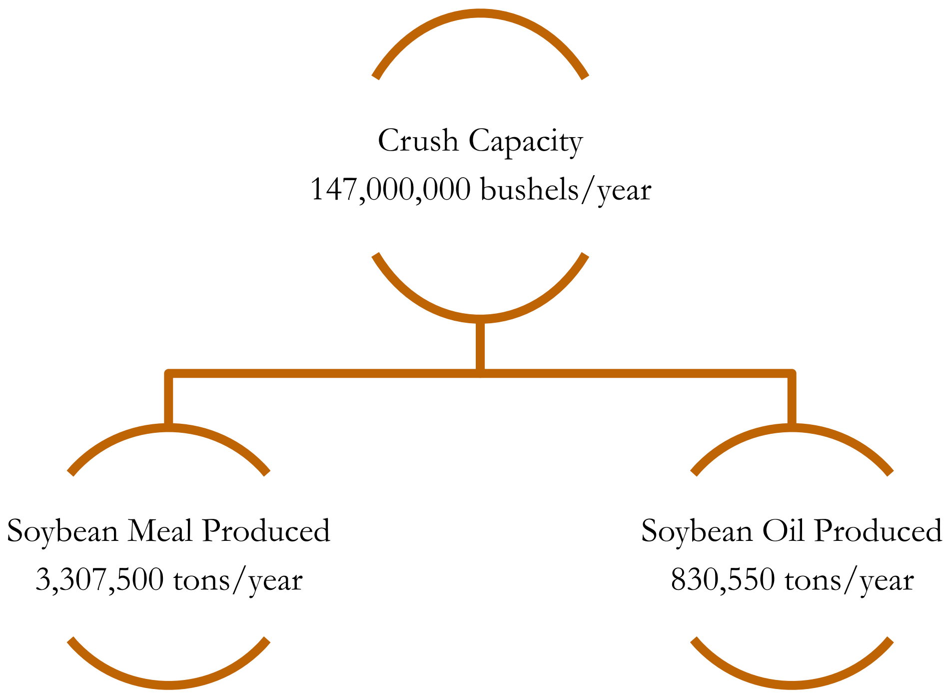
Missouri has a vibrant soybean processing industry. Four major soybean crushing facilities operate within the state. Exhibit 4.2.1 lists these facilities and their locations. Three facilities operate in western Missouri, and one operates in eastern Missouri. In addition to these facilities buying Missouri soybeans and supplying processed products to Missouri buyers, two Illinois facilities – one in Quincy and one in Cairo – also serve eastern Missouri, and one Kansas facility in Emporia serves western Missouri.

Exhibit 4.2.1 – Missouri Major Soybean Crushing Facilities

Facility	Location
Ag Processing, Inc.	St. Joseph
Cargill	Kansas City
ADM	Deerfield
ADM	Mexico

In total, the Missouri soybean crushing facilities have the annual capacity to process 147 million bushels. See Exhibit 4.2.2. How much supply does Missouri have for these plants? Soybean production in Missouri from 2005 to 2014 has averaged 199 million bushels. The remainder of Missouri soybeans not utilized for Missouri crush are exported as whole soybeans to other countries or sent to other states to be crushed. Assuming that a soybean bushel yields 11.3 pounds of oil and 45 pounds of soybean meal, the Missouri soybean crushing industry has the capacity to produce more than 3.3 million tons of soybean meal and more than 830,000 tons of soybean oil each year.

Exhibit 4.2.2 – Estimated Missouri Soybean Crush Capacity and Co-Products, 2015



Source: Based on University of Missouri and Soyatech, LLC estimates

The USDA recently resumed its reporting of the U.S. soybean crushing industry (Exhibit 4.2.3). Although the data set is limited to a four-month period, it gives perspective about the U.S. crush industry and soybean meal markets. Based on the four months of data, the report suggests that the U.S. will crush about 55 million tons of soybeans annually. Along with the information presented in Exhibit 4.2.2, it would suggest that Missouri processes 4.4 million tons a year, which would be an 8.8 percent share of the U.S. soybean crush. Iowa and Illinois would be considered large soybean crushers. Based on the August 2015 regional crush estimation, their market shares would total 21 percent and 14 percent, respectively. Additionally, approximately 98 percent of U.S. soybean meal is used as animal feed. Only a small amount has application in edible protein products.

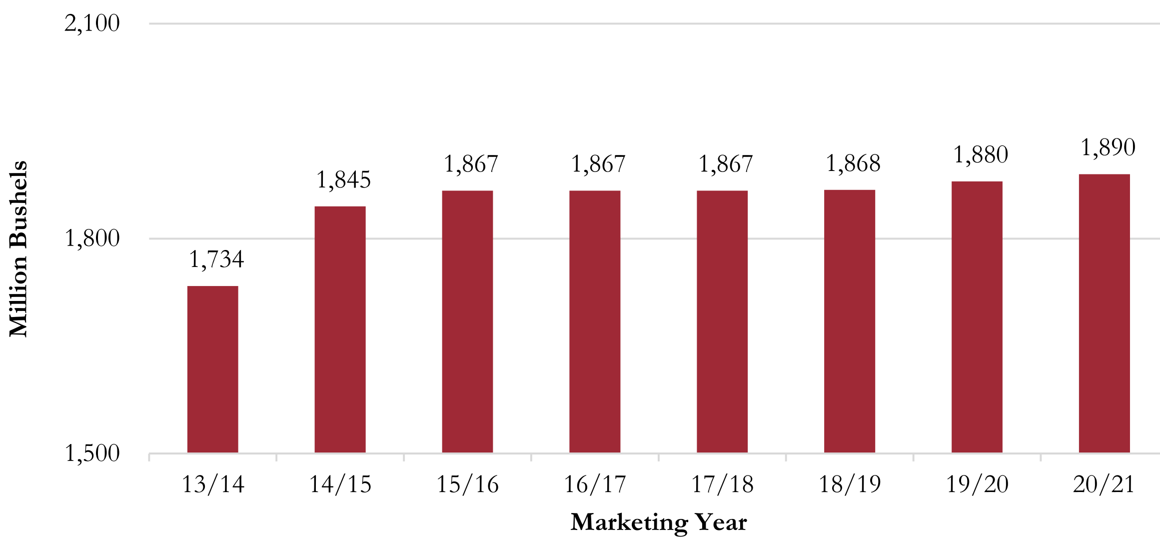
Exhibit 4.2.3 – U.S. Soybean Crushing Industry, May 2015 to August 2015

Item	May 2015	June 2015	July 2015	August 2015
Soybeans crushed (tons)	4,682,322	4,549,979	4,680,103	4,382,895
Crude oil produced (1,000 pounds)	1,754,179	1,708,286	1,708,286	1,643,322
Cake and meal produced (tons)	3,472,958	3,380,130	3,380,130	3,187,881
For animal feed (tons)	3,432,522	3,332,573	3,332,573	3,106,490
For edible protein products (tons)	40,406	47,557	47,557	81,391
Millfeed produced (tons)	235,330	226,653	226,653	297,000

Source: USDA, National Agricultural Statistics Service

Projections about the domestic crush of U.S. soybeans are displayed in Exhibit 4.2.4. Although these projections indicate a significant domestic crush increase from the 2013/2014 to 2014/2015 marketing years, the later projections estimate that domestically used soybeans for crush will maintain a fairly stable level. These data suggest that the annual U.S. domestic use for crush will range between 1.8 billion bushels and 1.9 billion bushels.

Exhibit 4.2.4 – U.S. Soybean Supply, Domestic Use for Crush, Million Bushels



Source: Integrated Policy Group, Division of Applied Social Sciences, University of Missouri (2015)

Exhibit 4.2.5 assesses the overall Missouri soybean and other oilseed processing industry. Existing soybean crush facilities should be included in this exhibit, and other types of oilseed processing businesses may also be reflected in the data. For example, the table may also include data points from facilities that process soy flour and bakery goods. Certain biodiesel plants may also be reflected. In the most recent year available, the soybean and other oilseed processing sector employed 441 people and included 14 establishments. In 2013, this sector provided $2.319 billion in industry sales that directly contributed to the Missouri economy.

Exhibit 4.2.5 – Missouri Soybean and Other Oilseed Processing Sector (NAICS 311224)

Item	2011	2012	2013	2014
Employment	417	443	449	441
Establishments	19	18	17	14
Industry sales (millions)	$739.2	$884.6	$2,318.9	N/A

Source: U.S. Bureau of Labor Statistics, Quarterly Census of Employment and Wages; IMPLAN

4.3 Impact of Processing Facilities on Soybean Prices

Soybean processing facilities create demand for soybeans, and as a result, a processing facility's presence can influence prices. The Michigan Department of Agriculture and Rural Development's Strategic Growth Initiative recently funded a study that evaluated whether Michigan could support another soybean processing facility. The study concluded that a 5- to 10-cent local price increase per bushel would be a conservative price bump associated with a soybean processing facility. A summary of the study describes that a 20- to 30-cent price increase for Michigan soybeans would be more likely. In Ohio and Indiana, prices tend to be about 30 cents higher than those in Michigan. The study's summary attributes the better Ohio and Indiana prices to those states being located near major markets and having several large soybean processors (Knudson 2015).

To understand the influence that biodiesel has had on soybean prices, a December 2010 study from Centrec Consulting Group, LLC created a model to project industry dynamics if biodiesel production hadn't increased between 2005 and 2009 and had, instead, maintained levels recorded during the 2004 marketing year. The study's authors concluded that prices for all U.S. soybeans would have dropped by $0.13 per bushel to $0.16 per bushel by the end of the observed period (Centrec Consulting Group 2010).

In 2009, the Board of Governors of the Federal Reserve System published a paper that evaluated the effects of biodiesel production on soybean prices. Data cited in the paper illustrate that U.S. biodiesel production growth corresponded with strengthening soybean prices. The authors evaluated data from the two-year period that preceded June 2008, and they found that U.S. biofuels production growth increased soybean prices by more than 15 percentage points, which was nearly 10 percent of the soybean price increase (Baier et al. 2009).

The Centrec Consulting Group study explained that changes in soybean product prices depend on changes in the estimated processed value (EPV) for soybeans. Per bushel, EPV communicates the combined value of soybean meal, soybean oil and soybean hulls. Soybean prices and the EPV tend to follow similar patterns. Because EPV considers multiple products – meal, oil and hulls – the dynamics that influence it can be interesting. When demand changes occur, certain dynamics influence whether the EPV changes. For example, suppose that soybean oil prices increase because soybean oil demand grows, but soybean meal demand doesn't fluctuate. The higher oil prices will trigger processors to crush more soybeans and increase the soybean meal supply. Consequently, soybean meal prices drop. In this scenario, soybean oil prices strengthen, but soybean meal prices weaken. This causes EPV to not change to the extent that may have been expected. The study cautioned about such co-product economic effects (Centrec Consulting Group 2010).

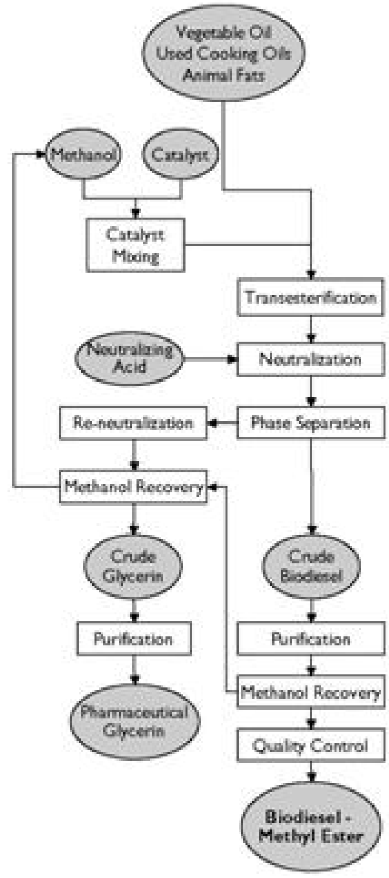
Expanding the soybean crush because of rising demand for one co-product may present some advantages for customers who buy the co-products that experience depressed prices. The dynamics associated with biodiesel production provide an example. To fulfill the need for more biodiesel, crushers must process more soybeans. When they do that, they produce more soybean meal, which poultry and livestock producers use a feed ration component. Because animal agriculture absorbs most soybean meal, providing soybean meal to this segment at a competitive price preserves the market. During the five years preceding 2015, soybean meal prices declined at least $21 per ton because of biodiesel production. On a statewide basis, Missouri poultry producers saved $11.9 million in 2013 by incurring less expense for soybean meal. For Missouri hog producers, their savings totaled $7.2 million, and dairy and beef producers in the state saved $1.8 million (United Soybean Board 2015a).

4.4 Biodiesel Industry

To convert soybean oil into biodiesel, the oil requires further processing. Exhibit 4.4.1 outlines the process for using transesterification in biodiesel production. By blending oil with a catalyst, the transesterification process can begin. After neutralization and phase separation, crude biodiesel results. Purifying the crude biodiesel, recovering methanol from it and monitoring the product for quality ultimately lead to methyl ester biodiesel production (Soyatech, LLC 2013).

The recovered methanol can yield crude glycerin, and if it's purified, the glycerin may have pharmaceutical applications (Soyatech, LLC 2013). When producing biodiesel, the process typically generates 10 pounds of crude glycerol, or glycerin, for every 100 pounds of biodiesel. At large-scale biodiesel plants, they typically have the scale for refining glycerol into a product that has food, pharmaceutical and cosmetics applications. Because the purification process tends to be too expensive for small-scale biodiesel facilities, they may sell the crude glycerol that they produce to large refineries. As the biodiesel industry has grown, however, more crude glycerol has become available, and prices have felt pressure. As a result, the industry has considered alternative crude glycerol uses and disposal options, including combustion, composting, animal feed, thermo-chemical conversions and biological conversions (Wen 2012).

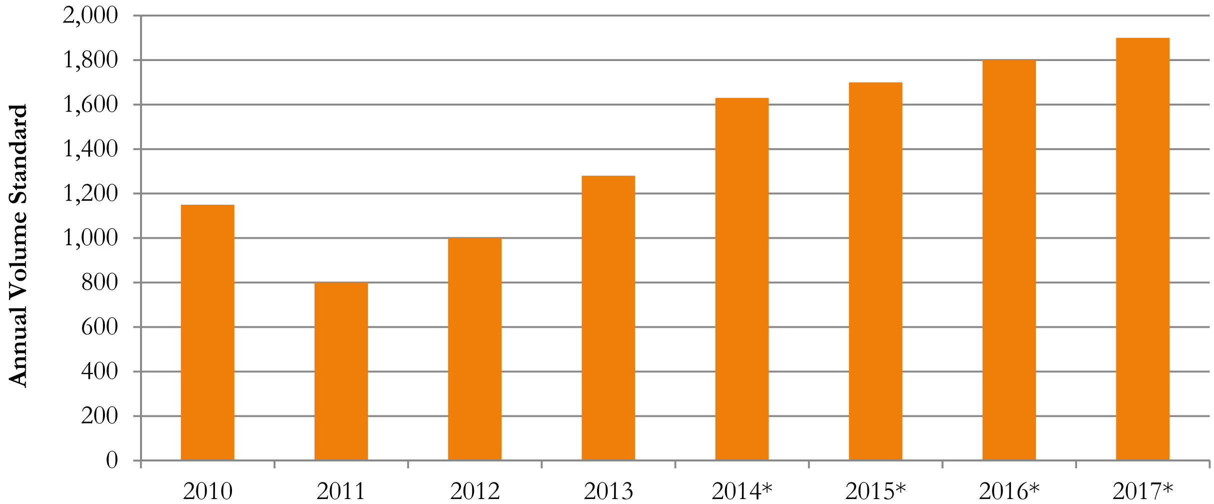
Exhibit 4.4.1 – Biodiesel Processing Using Transesterification*



* Note: The graphic illustrates basic steps used to produce biodiesel. The actual processes used will vary by facility.
Source: Soyatech, LLC (2013)

At the federal level, the Clean Air Act gives the U.S. Environmental Protection Agency the jurisdiction to set renewable fuel standard levels for several renewable fuel categories. Biomass-based diesel uses feedstocks such as soybean oil, canola oil, waste oil and animal fats, and the category sets its lifecycle greenhouse gas reduction requirement to at least 50 percent. Exhibit 4.4.2 presents the annual biomass-based diesel volume standards set by the Environmental Protection Agency. For 2015, the proposed standard is 1.7 billion gallons, and by 2017, the EPA's proposal grows to 1.9 billion gallons (U.S. Environmental Protection Agency 2015).

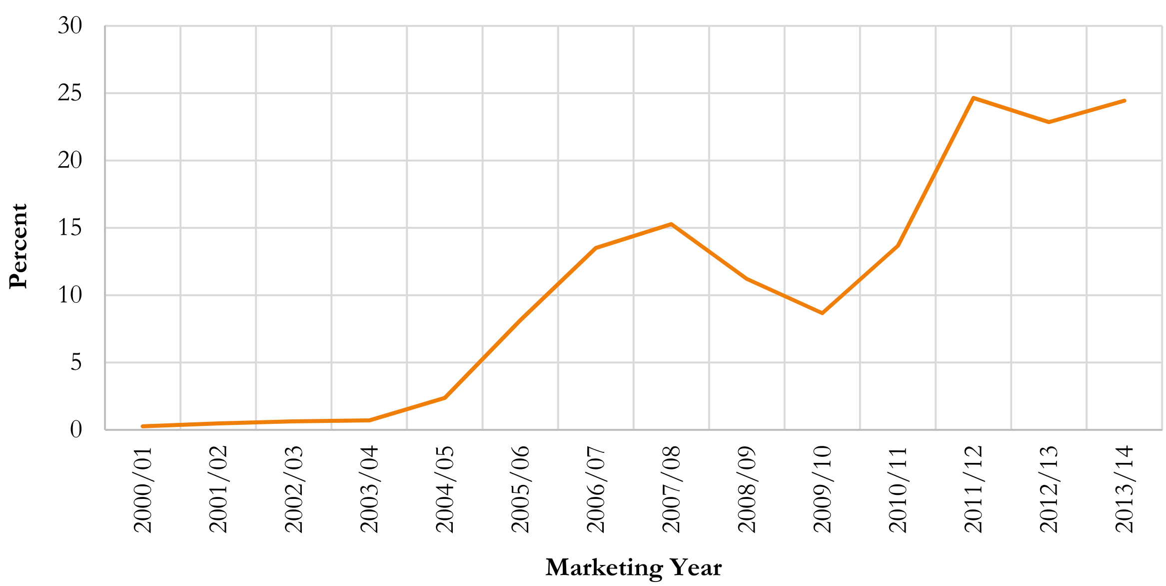
Exhibit 4.4.2 – U.S. Biomass-Based Diesel Volume Standards



* Projected
Source: U.S. Environmental Protection Agency (2015)

To produce biodiesel, soybean oil represents an important feedstock option. Exhibit 4.4.3 illustrates the progression in U.S. soybean oil used to produce biodiesel as a share of the total U.S. soybean oil supply. The chart indicates that using soybean oil to produce biodiesel started to accelerate during the 2004/2005 marketing year, and despite some volatility, the share of U.S. soybean oil used to produce biodiesel has maintained an upward trend. In 2013/2014, nearly 25 percent of the U.S. soybean oil supply was directed to biodiesel production.

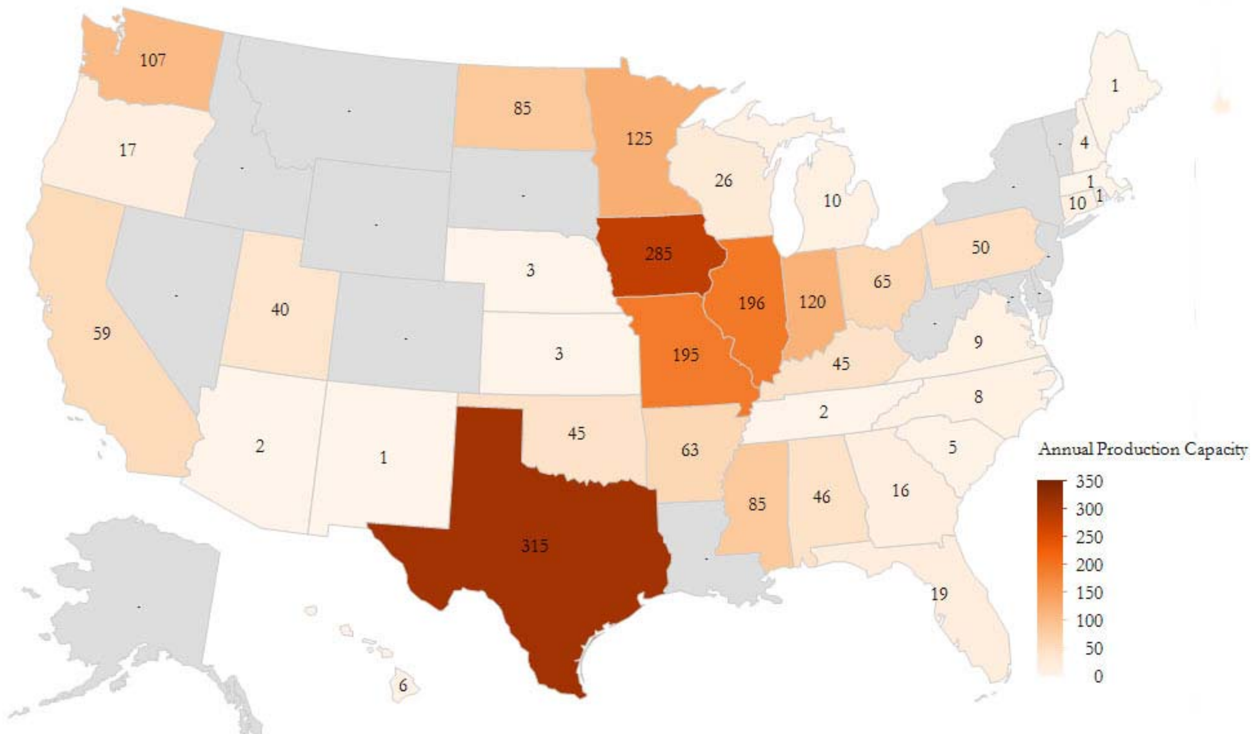
Exhibit 4.4.3 – Share of U.S. Soybean Oil Supply Used for Biodiesel Production



Source: USDA, Economic Research Service

The U.S. biodiesel industry includes 95 plants that had 2.1 billion gallons per year of operable capacity in July 2015, according to the U.S. Energy Information Administration. Missouri ranked fourth in the U.S. for biodiesel production capacity; nine Missouri plants had annual capacity values that totaled 195 million gallons in July 2015. Texas was the largest biodiesel producer; its nine plants' capacity totaled 315 million gallons per year. Iowa, 285 million gallons per year, and Illinois, 196 million gallons per year, followed Texas as leading states with biodiesel production capacity.

Exhibit 4.4.4 – Biodiesel Production Capacity by State, Million Gallons per Year, July 2015



Source: U.S. Energy Information Administration, Monthly Biodiesel Production Report (2015)

As of fall 2015, Exhibit 4.4.5 lists Missouri's biodiesel plants by facility name, location, feedstock and capacity. Of Missouri's estimated current capacity, 88 percent of the capacity is devoted exclusively to processing soy oil into biodiesel. Recent updates to Missouri's industry would include Deerfield Energy increasing its capacity to 50 million gallons per year; previously, its maximum production level was 30 million gallons per year. Also, Blue Sun St. Joe Refining LLC in St. Joseph, which has a 30 million-gallon annual capacity, is currently undergoing bankruptcy proceedings. Thus, the list doesn't reflect its presence in the Missouri biodiesel industry, but its status could change in the future. Current estimated capacity for the Missouri industry is 211 million gallons per year.

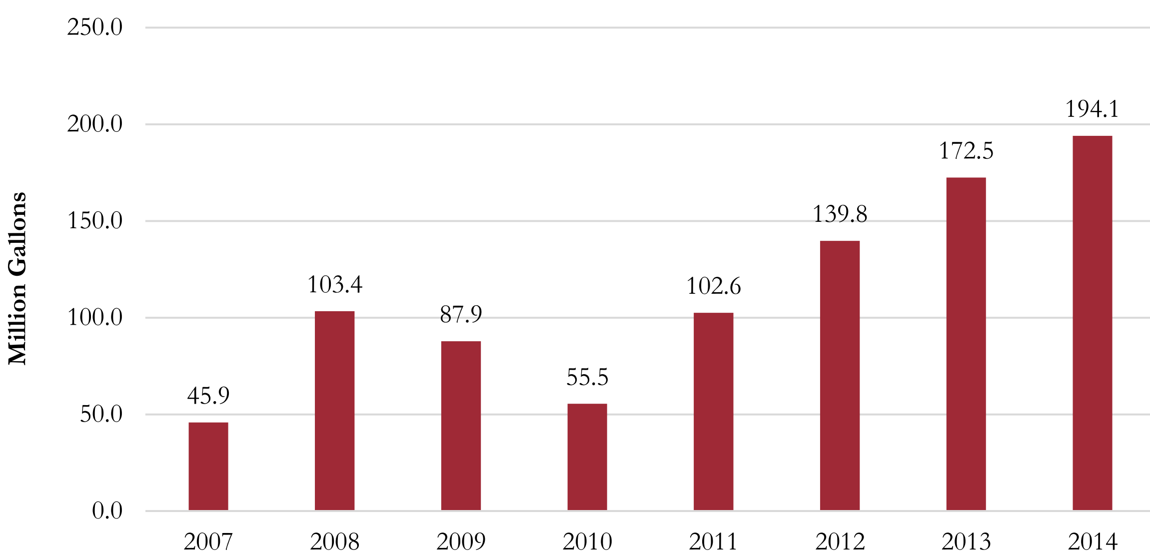
Exhibit 4.4.5 – Missouri Biodiesel Plants, Locations, Feedstock and Capacity

Facility	Location	Feedstock	Capacity (MGY)
Ag Processing, Inc.	St. Joseph	Soy oil	30
Deerfield Energy, LLC	Deerfield	Soy oil	50
Global Fuels, LLC	Dexter	Animal fats and soy oil	5
ME Bio Energy, LLC	Lilbourn	Multifeedstock	5
Mid-America Biofuels	Mexico	Soy oil	50
Natural Biodiesel Plant, LLC	Hayti	Multifeedstock	5
Paseo-Cargill Energy, LLC	Kansas City	Soy oil	56
Lakeview Energy LLC	Moberly	Multifeedstock	10
		Total	**211**

Source: Biodiesel Magazine (2015) and Missouri Soybean Association

By calendar year, Exhibit 4.4.6 reports Missouri biodiesel plant actual production data. During the past five years, significant growth has occurred, and production reached 194.1 million gallons in 2014. Note that production has increased every year since 2010. Of the years reported, 2007 had the lowest production when the Missouri facilities produced just 45.9 million gallons.

Exhibit 4.4.6 – Missouri Biodiesel Plant Production



Source: Missouri Department of Agriculture and National Biodiesel Board

As mentioned earlier, the U.S. created a national renewable fuel standard that dictates annual renewable fuel production expectations. In addition to the federal standard, several states have made other efforts to regulate biodiesel or renewable diesel use. Exhibit 4.4.7 summarizes actions taken by several states: Minnesota, Louisiana, Massachusetts, Oregon, Pennsylvania and Washington. The Minnesota policy originally intended to begin a biodiesel mandate during May 2012; however, its implementation decision was delayed to September 2013. From April to September, the standard requires that diesel sold in Minnesota must contain at least 10 percent biodiesel. On May 1, 2018, the mandate dictates that the biodiesel mandate will increase to 20 percent. During the off-season, Minnesota-sold diesel fuel will need to be at least 5 percent biodiesel.

The Pennsylvania regulation sets biodiesel blend levels based on state biodiesel production. For example, within one year after Pennsylvania generates 40 million gallons of biodiesel, diesel must contain at least 2 percent biodiesel. The policy sets production targets for 5 percent and 10 percent blend requirements, and when Pennsylvania biodiesel production reaches 400 million gallons, the blend mandate will increase to 20 percent within one year.

Exhibit 4.4.7 – Selected State Regulations Impacting Biodiesel or Renewable Diesel Use

State	Summary of Law/Regulation
Minnesota	"In September 2013, the commissioners of the Minnesota Department of Agriculture, Department of Commerce, and Pollution Control Agency determined that all conditions had been satisfied to implement a 10% biodiesel (B10) mandate, originally set to begin May 1, 2012. During the months of April through September, diesel fuel sold in the state must be at least B10, increasing to 20% biodiesel (B20) on May 1, 2018. Diesel fuel sold during the remainder of the year must contain at least 5% biodiesel (B5)."
Louisiana	"Within six months following the point at which monthly production of biodiesel produced in the state equals or exceeds a minimum annualized production volume of 10 million gallons, at least 2% of the total diesel sold by volume in the state must be biodiesel produced from domestically grown feedstock."
Massachusetts	"Pursuant to state law, all diesel motor vehicle fuel and all other liquid fuel used to operate motor vehicle diesel engines in Massachusetts must contain at least 2% renewable diesel fuel by July 1, 2010; 3% renewable diesel fuel by July 1, 2011; 4% renewable diesel fuel by July 1, 2012; and 5% renewable diesel fuel by July 1, 2013."
Oregon	"All diesel fuel sold in the state must be blended with at least 5% biodiesel (B5). For the purpose of this mandate, biodiesel is defined as a motor vehicle fuel derived from vegetable oil, animal fat, or other non-petroleum resources, that is designated as B100 and complies with ASTM specification D6751. Renewable diesel qualifies as a substitute for biodiesel in the blending requirement. In addition, diesel fuel blends sold between October 1 and February 28 may contain additives to prevent congealing or gelling."
Pennsylvania	"All diesel fuel sold in Pennsylvania must contain at least 2% biodiesel (B2) one year after in-state production of biodiesel reaches 40 million gallons. The mandated biodiesel blend level will continue to increase according to the following schedule: 5% biodiesel (B5) one year after in-state production of biodiesel reaches 100 million gallons; 10% biodiesel (B10) one year after in-state production of biodiesel reaches 200 million gallons; and 20% biodiesel (B20) one year after in-state production of biodiesel reaches 400 million gallons."
Washington	"At least 2% of all diesel fuel sold in Washington must be biodiesel or renewable diesel. This requirement will increase to 5% 180 days after the Washington State Department of Agriculture (WSDA) determines that in-state feedstocks and oil-seed crushing capacity can meet a 3% requirement. Renewable diesel is defined as a diesel fuel substitute produced from non-petroleum renewable sources, including vegetable oils and animal fats, meets the federal registration requirements for fuels and fuel additives and ASTM specification D975."

Source: U.S. Department of Energy, Alternative Fuels Data Center (2015)

4.5 Missouri Animal Agriculture

Animal agriculture represents the largest domestic customer for soybean meal. As stated earlier in this report, 98 percent of U.S. soybean meal is used for animal feeding purposes. Several reports and business decisions indicate the value of animal agriculture to the soybean value chain.

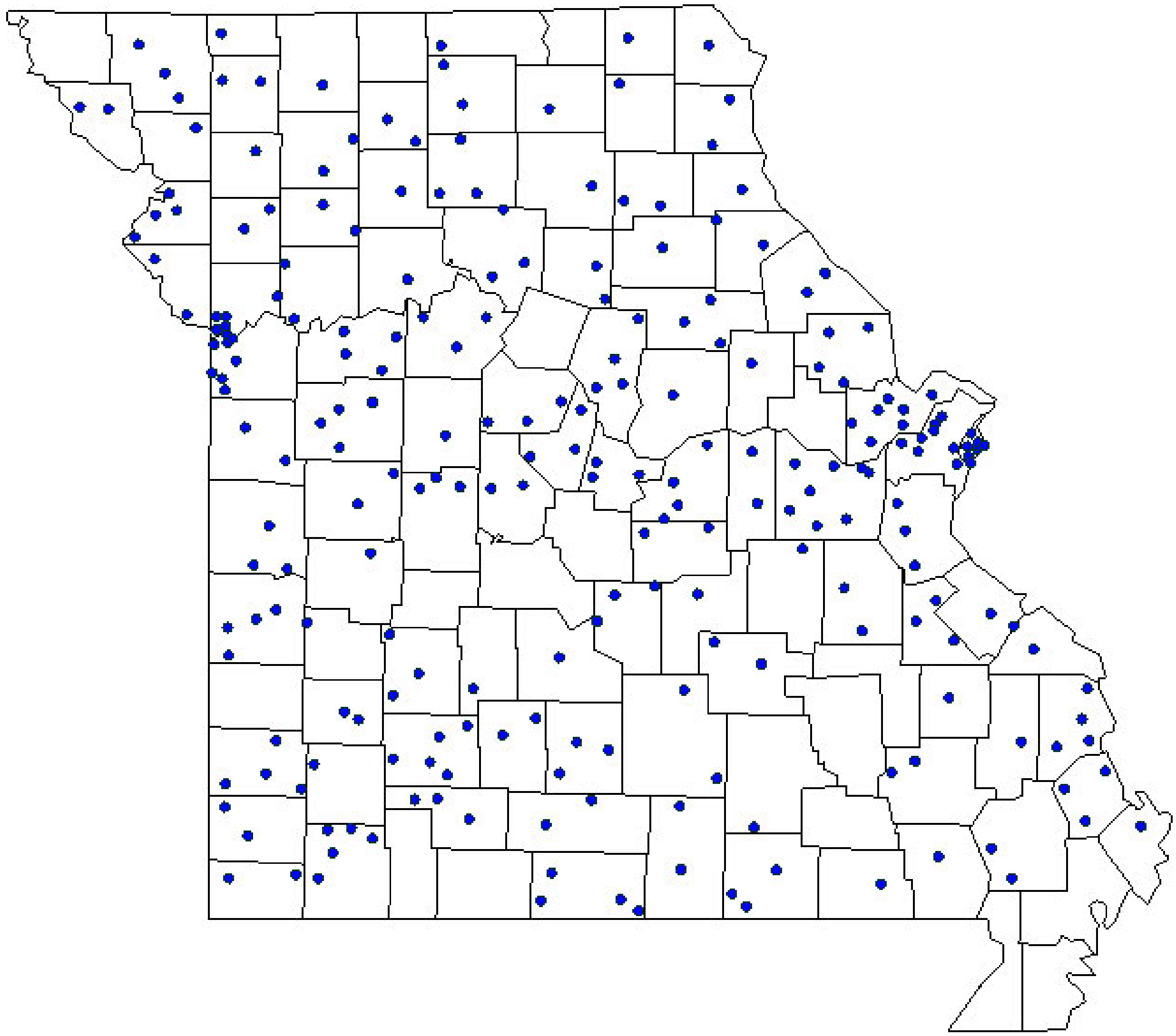
In 2013, the Illinois Soybean Association commissioned Informa Economics to study the economic effect of expanded soybean crushing capacity in the state. When releasing the report, the association challenged the industry to consider opportunities for processing more soybeans in the state. Specifically, by crushing more soybeans locally and using the additional feed to raise animals within its borders, then the state could grow its meat processing and exporting businesses (Roady 2013).

Perdue Agribusiness leveraged its soybean crushing capabilities to create an advantage for its animal agriculture business unit. During the 1950s, the company constructed grain receiving facilities, and later in 1961, Perdue Agribusiness built a soybean crushing facility. With this infrastructure in place, Perdue Agribusiness could purchase grain from farmers and gain a competitive advantage. Presently, more than 23,000 producers sell their grain to Perdue Agribusiness (Perdue Farms Inc. 2015).

A recent study supported by the Michigan Department of Agriculture and Rural Development and its Strategic Growth Initiative found that expanded animal production would be a necessary key to supporting added Michigan soybean processing capacity. However, to make additional in-state livestock production viable, the state would also need to grow its livestock processing capacity. Already, a hog processing facility has committed to opening, and because hogs represent significant soybean meal users in Michigan, producing more of them would accelerate soybean meal demand. The state's dairy, egg, turkey and broiler industries also hold potential for producing and processing more animals, which could create more local soybean meal demand. The Michigan study emphasized that any new soybean processing facility would benefit from locating near areas that produce soybeans and raise animals and areas that don't already experience soybean procurement competition. Because soybean processing tends to be a low-margin endeavor, a processor that has a history with controlling costs, managing margins, operating a processing facility and marketing soybean products may experience fewer barriers to successful operation (Knudson 2015).

One of the main market channels used to direct soybean meal to livestock producers is the feed manufacturing industry. Exhibit 4.5.1 pinpoints Missouri feed manufacturers by location. In fall 2015, Missouri had 362 feed manufacturers, according to the Missouri Department of Agriculture.

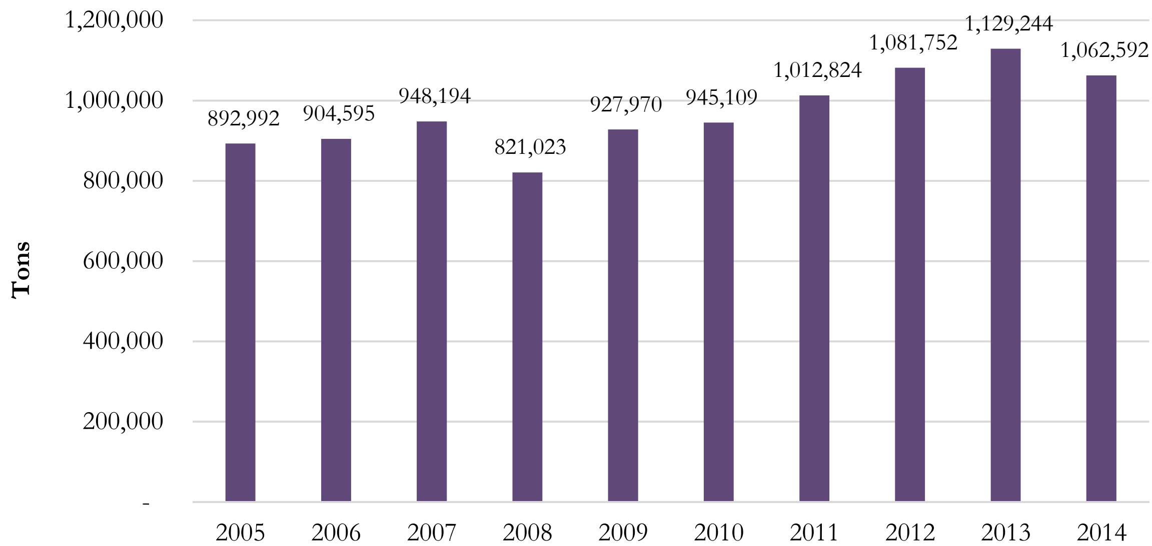
Exhibit 4.5.1 – Missouri Feed Manufacturers, 2015



Source: Missouri Department of Agriculture (2015)

Feed manufacturers have increased the amount of soybean products that they sell. Exhibit 4.5.2 tracks commercial soybean product tonnage sold through Missouri feed manufacturers. In 2014, these facilities sold 1,062,592 tons of commercial soybean product ingredients, which was a 6 percent decrease from 2013. However, tonnage sold had consistently increased from 2009 to 2013. Between 2005 and 2014, Missouri feed manufacturers sold 9.7 million tons of soybean products.

Exhibit 4.5.2 – Commercial Soybean Product Ingredients Sold by Missouri Feed Mfg



Source: Missouri Department of Agriculture (2015)

Exhibit 4.5.3 documents soybean meal demand by species for Missouri and the U.S. The Missouri pork industry is estimated to demand the most soybean meal by using 347,000 tons annually, based on 2012/2013 marketing year data. In Missouri, the broiler and turkey industries consumed the second and third most soybean meal, respectively, during the 2012/2013 marketing year. Their shares totaled 32.1 percent and 14 percent, respectively. Total demand from Missouri livestock producers was estimated to total 922,000 tons in 2012/2013. For the U.S., the broiler industry demanded the most soybean meal. Its demand totaled 11 million tons, which represented nearly 40 percent of the total U.S. soybean meal utilization by livestock.

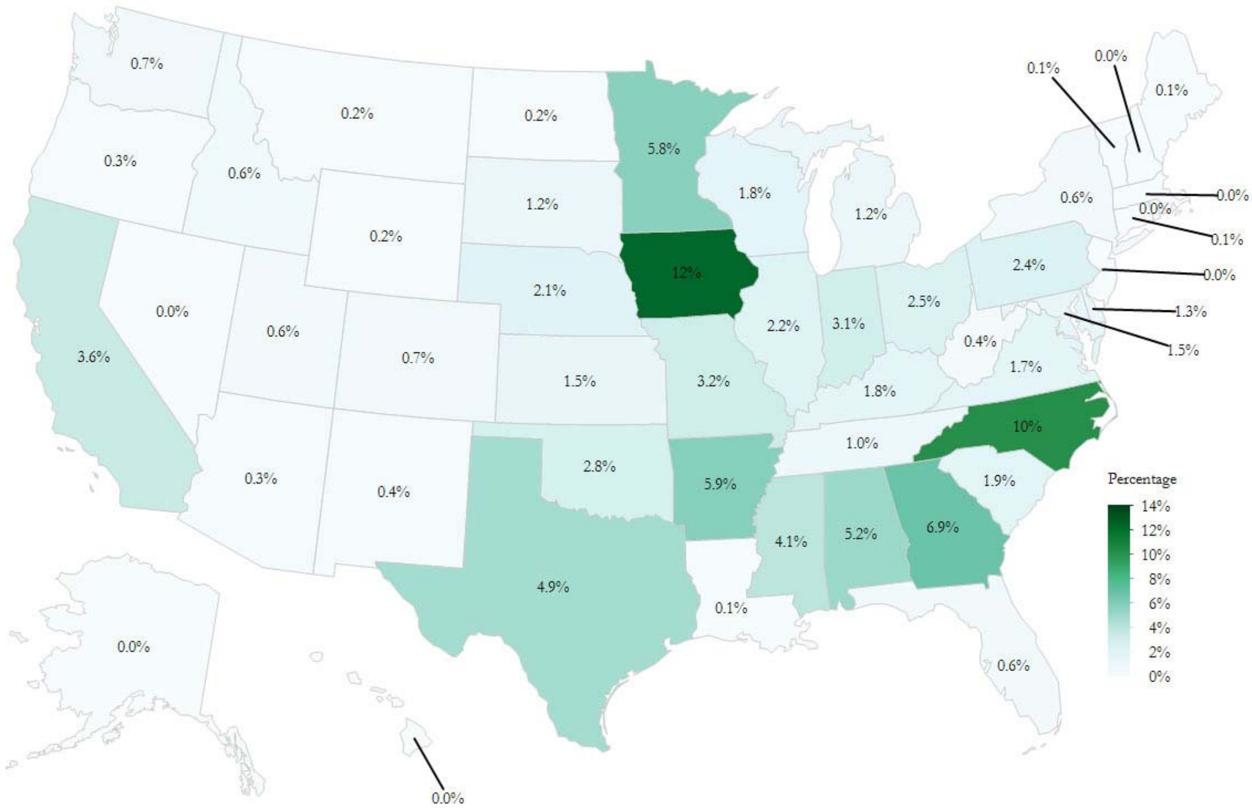
Exhibit 4.5.3 – Utilization of Soybean Meal by Livestock, 2012/2013 Marketing Year

Species	Missouri (short tons)	MO Percent	U.S. (short tons)	U.S. Percent
Pork	347,000	37.6%	8,556,000	30.1%
Broilers	296,000	32.1%	11,243,000	39.6%
Turkeys	129,000	14.0%	1,728,000	6.1%
Other	57,000	6.2%	1,757,000	6.2%
Eggs	44,000	4.7%	1,869,000	6.6%
Beef	37,000	4.1%	1,377,000	4.9%
Milk	12,000	1.3%	1,851,000	6.5%
Total	**922,000**	**100.0%**	**28,382,000**	**100%**

Source: Agralytica Consulting (2014)

Regionally, Missouri was recognized as the 10th largest livestock consumer of soybean meal, based on 2013 data. In 2013, Missouri utilized 3.2 percent of total U.S. soybean meal utilization. See Exhibit 4.5.4. Iowa ranked No. 1 and recorded a 12 percent market share due to its large swine sector. North Carolina was reported as the second largest soybean meal user for livestock feed. It has vibrant broiler and swine industries that use soybean meal as a feed ingredient.

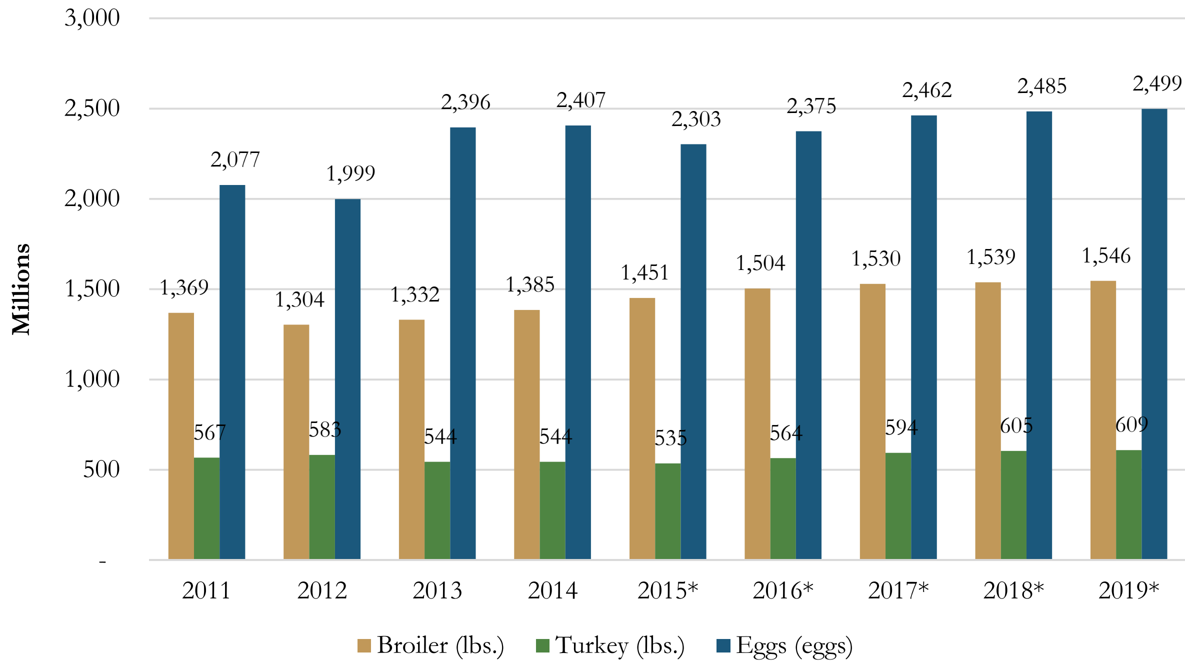
Exhibit 4.5.4 – Percent of U.S. Soybean Meal Utilization as Livestock Feed, By State, 2013



Source: Agralytica Consulting (2014)

Missouri's poultry industry is sizeable and growing, and it will influence in-state soybean meal demand. Exhibit 4.5.5 shares current and forecasted Missouri poultry production. Missouri egg production is projected to increase 3.8 percent during the next five years. In 2014, Missouri's laying hens produced 2,407 million eggs. Broiler production in Missouri totaled 1,385 million pounds during 2014, and this industry is estimated to grow 11.7 percent during the next five years. Turkeys are a small industry, but they represent another growth sector. Production is projected to grow 11.9 percent in five years and reach 609 million pounds during 2019. Note that poultry production could change substantially due to the avian influenza disease outbreak. The disease could possibly kill millions of Missouri birds, and it would consequently alter soybean meal consumption.

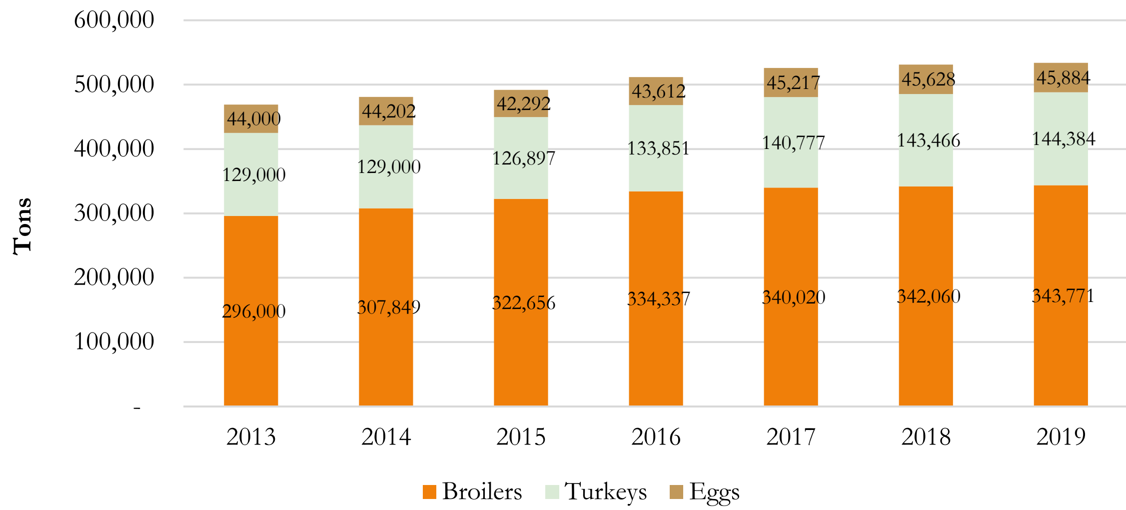
Exhibit 4.5.5 – Missouri Poultry Production, 2011 to 2019



*Forecasted by applying estimated changes in each U.S. poultry sector by year to Missouri's production.
Source: Forecast changes were from the Integrated Policy Group, Division of Applied Social Sciences, University of Missouri (2015). Actual production data from USDA, National Agricultural Statistics Service.

Exhibit 4.5.6 estimates soybean meal demand from the Missouri poultry industry. The exhibit uses Missouri livestock species demand data from Exhibit 4.5.3 as the base, and it estimates data for future years by proportionately increasing production given the year-to-year production changes identified in Exhibit 4.5.5. As poultry production increases, soybean meal demand is expected to increase each year and reach 534,000 tons in 2019.

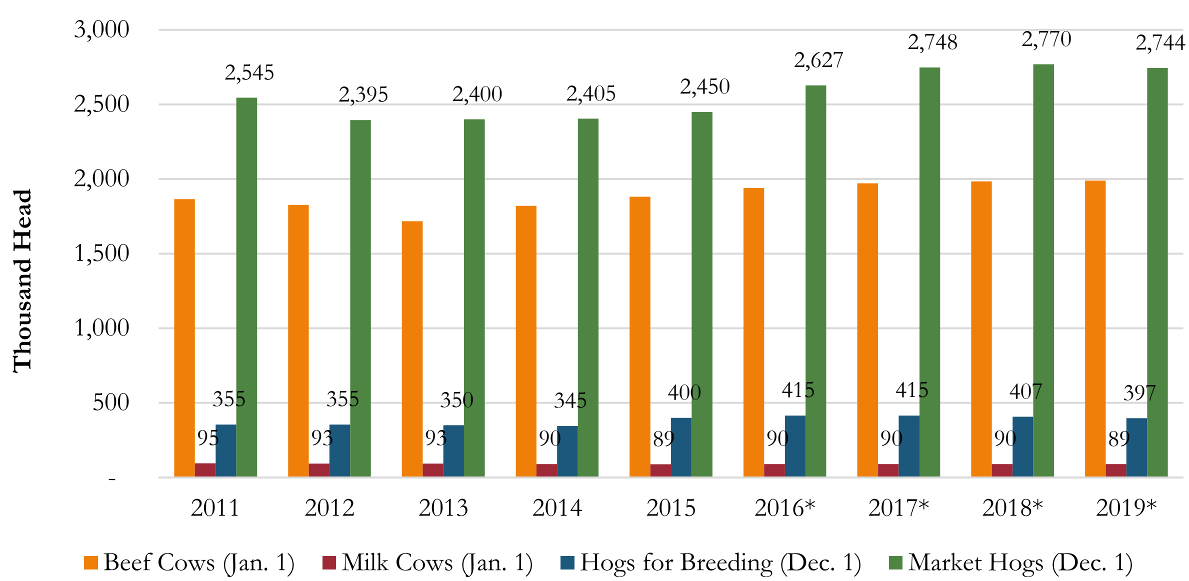
Exhibit 4.5.6 – Missouri Poultry Soybean Meal Demand, 2013 to 2019



Source: University of Missouri Calculations

Missouri's cow and hog industries will also affect local soybean meal demand. Missouri cow and hog inventories, both current and forecasted, are illustrated in Exhibit 4.5.7. Missouri's beef cow inventory is projected to increase 9.3 percent during the next four years. The state's hogs for breeding inventory jumped 55,000 head to 400,000 animals in 2015. The market hogs inventory is expected to increase in 2016 and 2017, but the projections note leveled off growth from that point. The state's milk cows inventory is estimated to stay relatively stable for the foreseeable future.

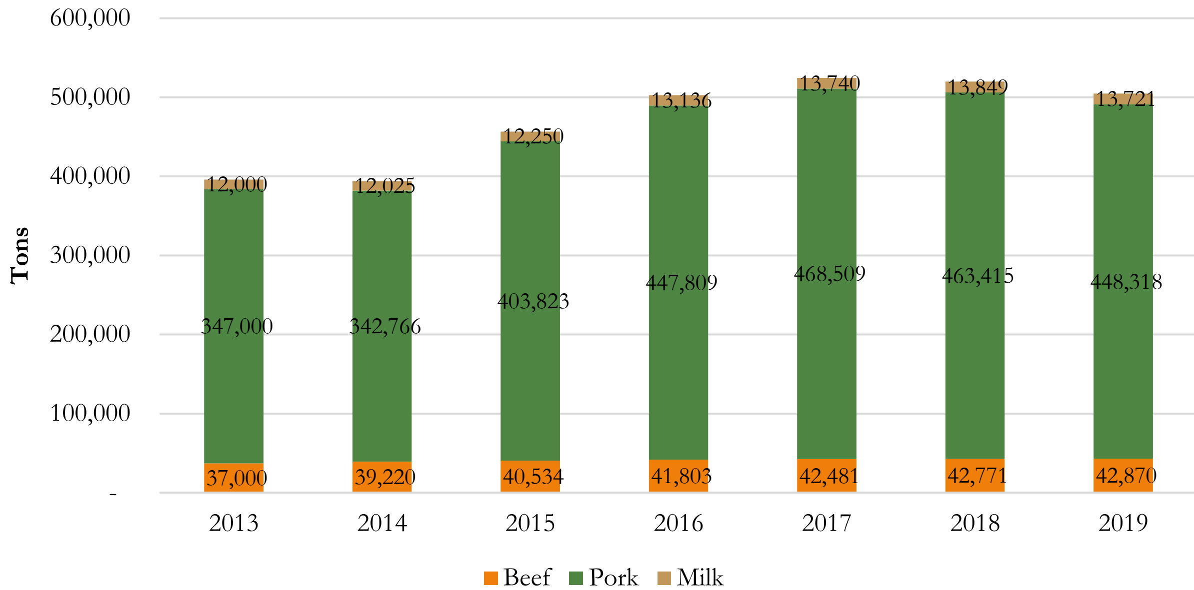
Exhibit 4.5.7 – Missouri Cow and Hog Inventories, 2011 to 2019



*Forecasted by applying estimated changes in each U.S. cattle and hogs sector by year to Missouri's production.
Source: Forecast changes were from the Integrated Policy Group, Division of Applied Social Sciences, University of Missouri (2015). Actual production data from USDA, National Agricultural Statistics Service.

Exhibit 4.5.8 estimates soybean meal demand by the Missouri beef, dairy and pork industries. To generate these estimates, the Missouri livestock species demand figures in Exhibit 4.5.3 were used as the base values, and future years were estimated to increase proportionately by the year-to-year production changes identified in Exhibit 4.5.7. With the production increases, soybean meal demand is expected to increase until 2017 and then decrease to more than 504,000 tons in 2019. Most of the soybean meal demand originates from the swine sector.

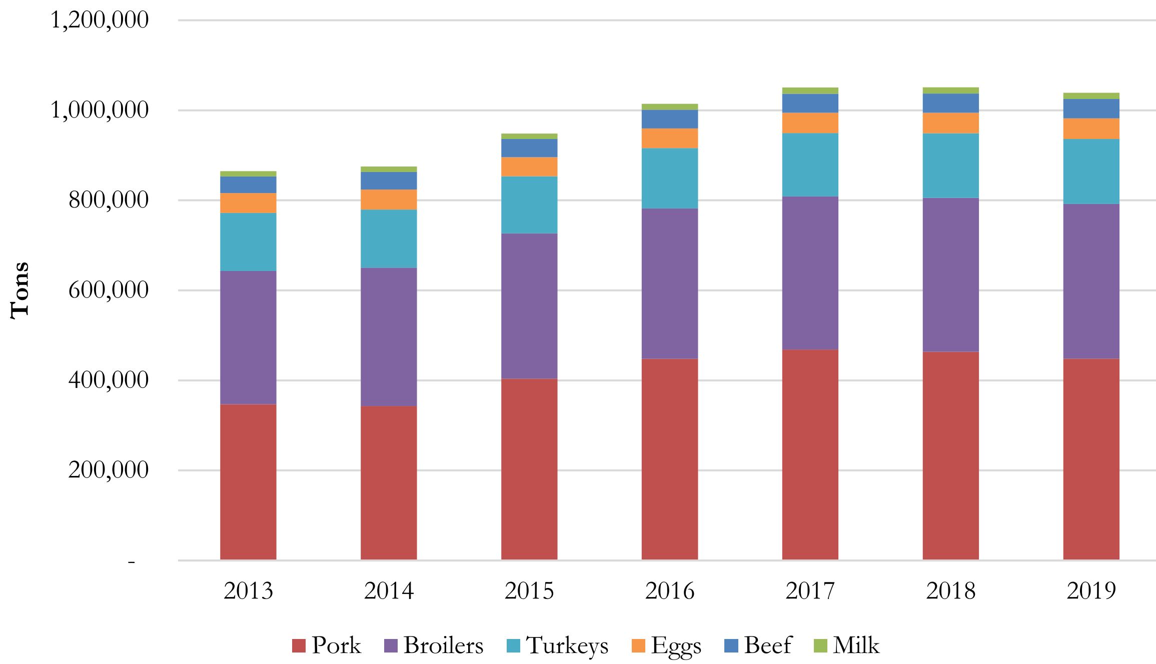
Exhibit 4.5.8 – Missouri Beef, Dairy and Pork Soybean Meal Demand, 2013 to 2019



Source: University of Missouri Calculations

Exhibit 4.5.9 reports the combined soybean meal demand data from previous exhibits. Please note that soybean meal demand in Missouri largely originates from the pork and broiler industries. As these industries expand and grow, opportunities to grow soybean meal demand – and corn demand – within the state may arise.

Exhibit 4.5.9 – Missouri Livestock Soybean Meal Demand, 2013 to 2019



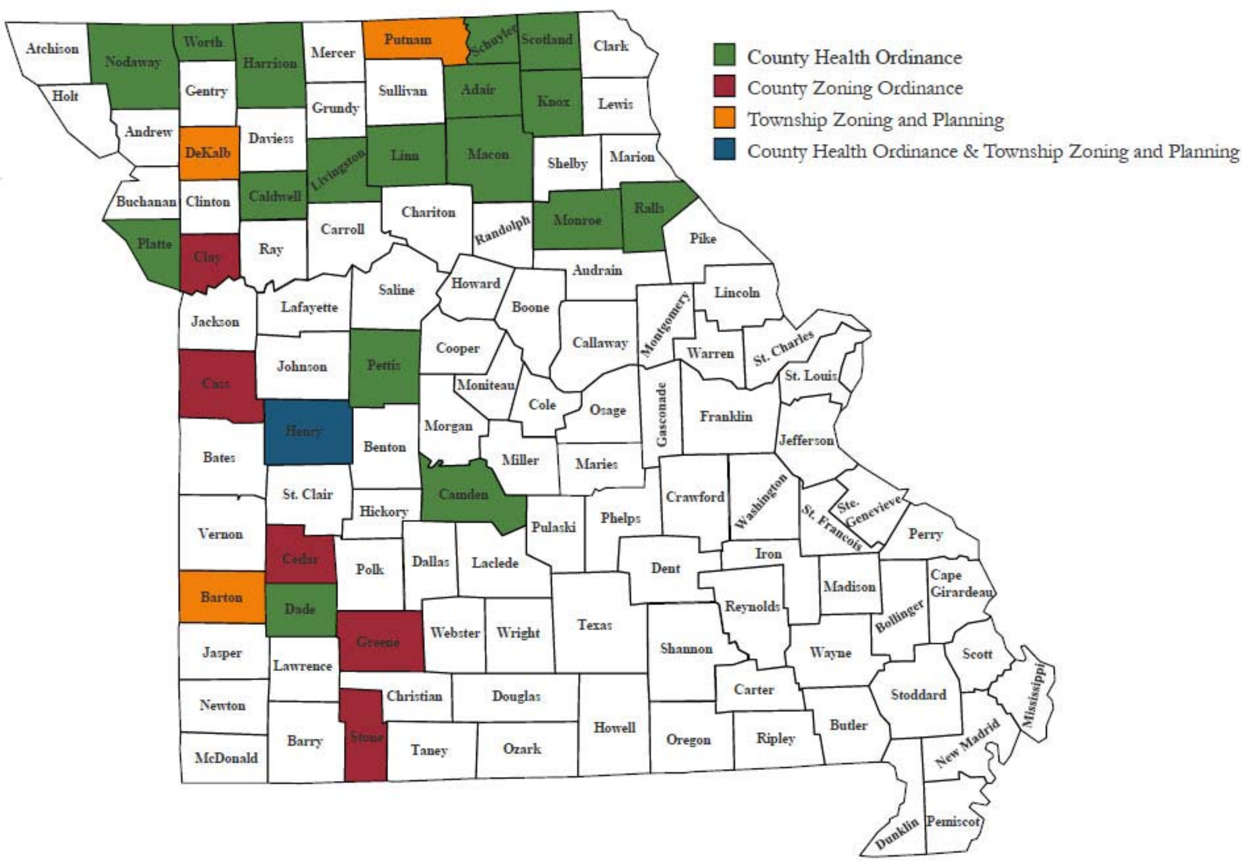
Source: University of Missouri Calculations

Other than these traditional animal agriculture demand centers, the soybean industry may have the opportunity to respond to other needs, too. Aquaculture is an example. According to the Indiana Soybean Alliance, U.S. seafood imports represent 91 percent of the total domestic supply, and an estimated half of the imports originate from aquaculture production. As a result, the U.S. has an opportunity to close the trade deficit and raise more seafood domestically. Within aquaculture rations, displacing other ingredients – namely, fish meal – would improve the aquaculture industry's economic and environmental sustainability (Indiana Soybean Alliance 2013). To encourage aquaculture industry development in Indiana, the Indiana Soybean Alliance made several investments, including those for studies that illustrate soybean meal's potential as a fish meal replacement in fish diets. Following such investments, the state's aquaculture industry has grown. Between 2007 and 2014, 32 fish producers entered into production to lead to 50 producers operating during 2014 (Indiana Soybean Alliance 2014).

From a processing perspective, the Indiana Soybean Alliance in 2007 developed a goal to support opening an in-state aquaculture feed mill. During 2014, the organization realized that goal as Bell Farms opened a mill focused on producing fish feed. Each month, the facility can produce as much as two million pounds of feed, and soybean meal serves as an ingredient for products developed at the mill. The mill provides a local feed source for Indiana aquaculture producers and a new local market for Indiana soybean producers (Indiana Soybean Alliance 2014). Identifying such developing meal markets and supporting them may create other opportunities for soybean processing ventures.

One impediment that could limit Missouri livestock industry growth are local restrictions. Some local governments have imposed additional requirements and fees on animal feeding operations beyond those required by the Missouri Department of Natural Resources. County health and zoning ordinances are two strategies used by these local governments to add requirements. Typically, these strategies have stopped any expansion or new entrants in the pork, dairy and poultry industries for counties that have adopted such restrictions. Exhibit 4.5.10 color codes counties based on their adoption of animal feeding operation restrictions. Those with no shading have no county or township restrictions imposed on animal feeding operations.

Exhibit 4.5.10 – Missouri County and Township Restrictions on Animal Feeding Operations

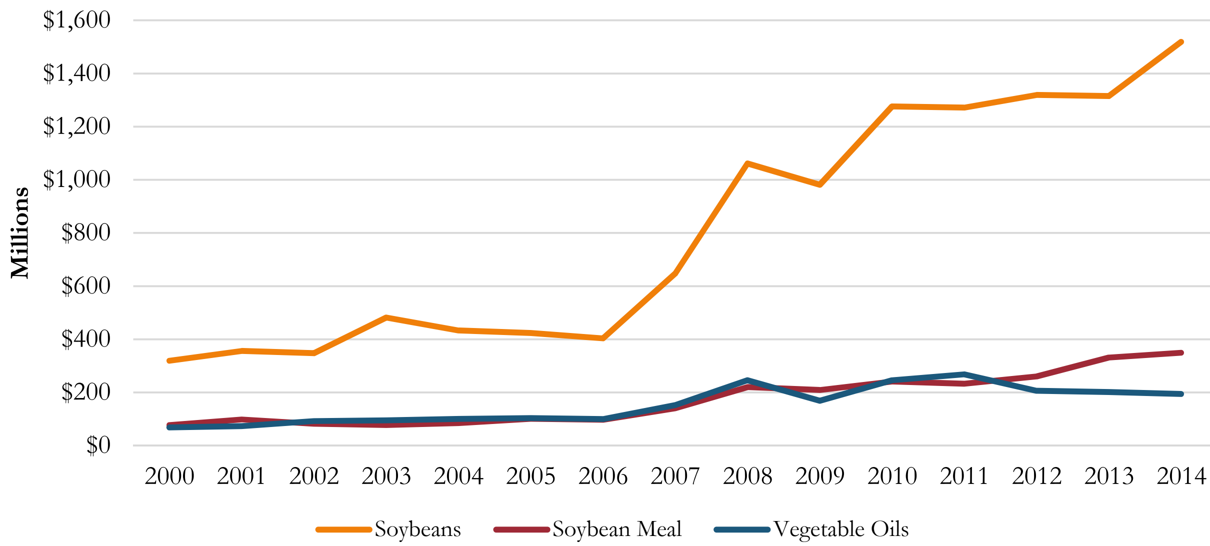


Source: University of Missouri

4.6 Missouri Soybean Industry Exports

The USDA Economic Research Service estimates the value of state-level U.S. agricultural exports. Exhibit 4.6.1 shows export data for Missouri soybeans, soybean meal and soybean oil. Since 2006, Missouri has rapidly increased its level of soybean exports. In 2014, Missouri soybean exports reached $1.5 billion dollars in value. This data point would suggest that Missouri exported approximately 152 million bushels in 2014, assuming a $10.00 per bushel season-average soybean price. The value of soybean oil and soybean meal exports experienced less change during the time period observed. Those values totaled $194 million and $349 million, respectively, in 2014.

Exhibit 4.6.1 – Missouri Soybean Exports, 2000 to 2014



Source: USDA, Economic Research Service

During 2014, Missouri ranked in the top 10 for soybean, soybean meal and soybean oil exports based on value. See Exhibit 4.6.2. Missouri ranked seventh in each category during the 2014 calendar year. Illinois, Iowa, and Indiana were the top three states in each soybean-related export category.

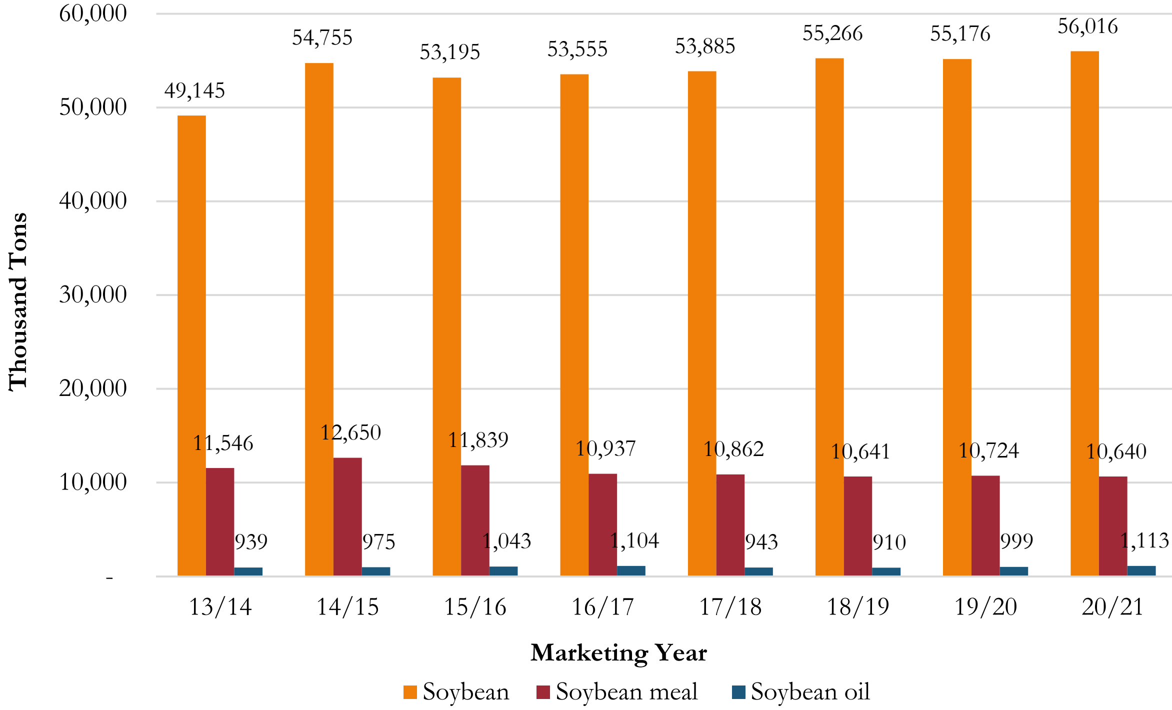
Exhibit 4.6.2 – State Soybean, Soybean Meal and Soybean Oil Exports, 2014

Rank	**State**	**Soybean** (millions)	**State**	**Soybean Meal** (millions)	**State**	**Vegetable Oil** (millions)
1	Illinois	$3,393	Illinois	$780	Illinois	$433
2	Iowa	$3,089	Iowa	$710	Iowa	$394
3	Indiana	$2,010	Indiana	$462	Indiana	$257
4	Minnesota	$1,950	Minnesota	$449	Minnesota	$251
5	Nebraska	$1,729	Nebraska	$398	Nebraska	$221
6	Ohio	$1,611	Ohio	$370	Ohio	$206
7	Missouri	$1,519	Missouri	$349	Missouri	$194
8	South Dakota	$1,296	South Dakota	$298	South Dakota	$179
9	North Dakota	$1,070	North Dakota	$246	North Dakota	$175
10	Arkansas	$996	Arkansas	$229	Arkansas	$127

Source: USDA, Economic Research Service

Future U.S. soybean, soybean meal and soybean oil exports are projected in Exhibit 4.6.3. U.S. whole soybean exports are estimated to slightly increase over time. Soybean meal exports will decline over time; they are projected to drop to 10.64 million tons in 2020/2021. Soybean oil exports are estimated to slightly increase and decrease from year to year during the observed period.

Exhibit 4.6.3 – U.S. Soybean Product Exports, Actual and Forecasted



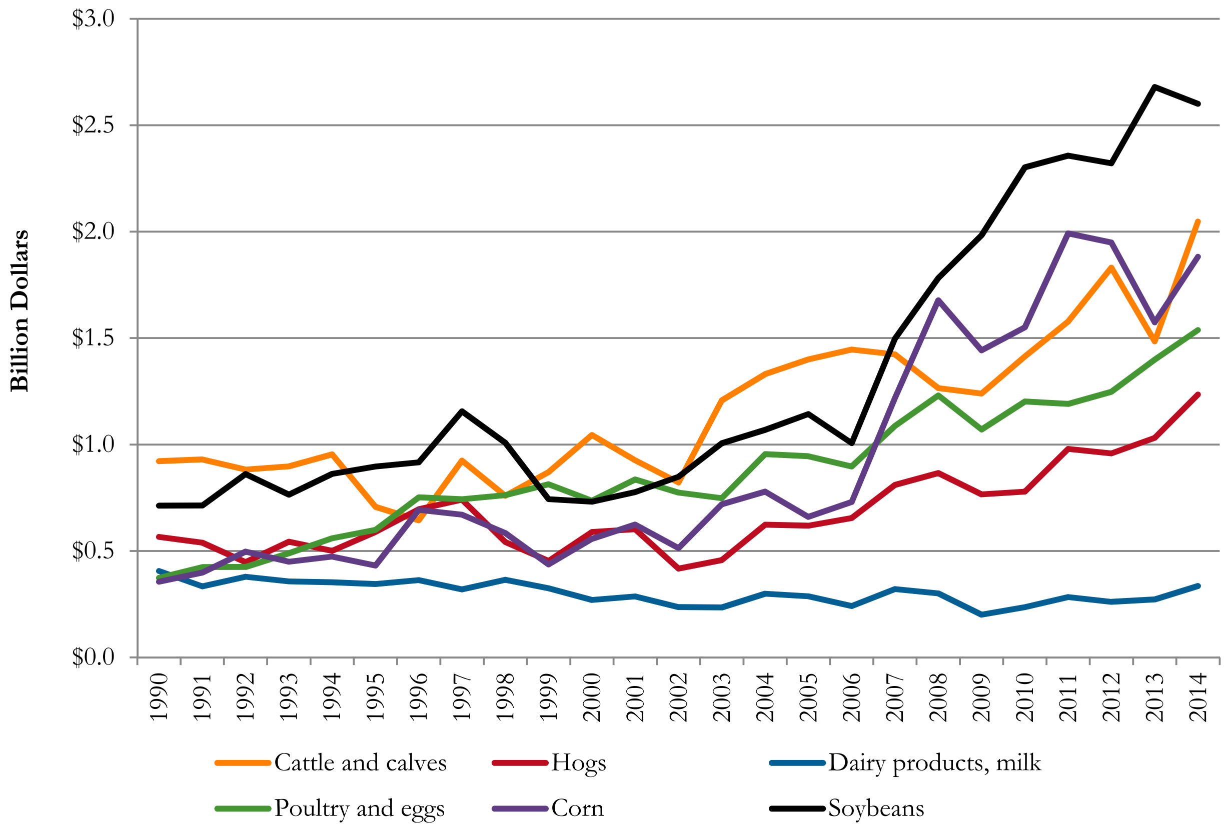
Source: Integrated Policy Group, Division of Applied Social Sciences, University of Missouri (2015).

5. Missouri Soybean Financial Flows

5.1 Soybean Farm Cash Receipts

Soybean production generates cash sales for farmers, and it provides income to pay expenses and generates profits. Relative to cash receipts for other Missouri agricultural commodities, soybean cash receipts ranked first by producing $2.6 billion in cash receipts during 2014. As a result, soybean cash receipts represented 24 percent of total 2014 commodity cash receipts in Missouri. Exhibit 5.1.1 presents historical cash receipts for Missouri soybeans along with other major commodities. Missouri soybean cash receipts increased 265 percent from 1990 to 2014.

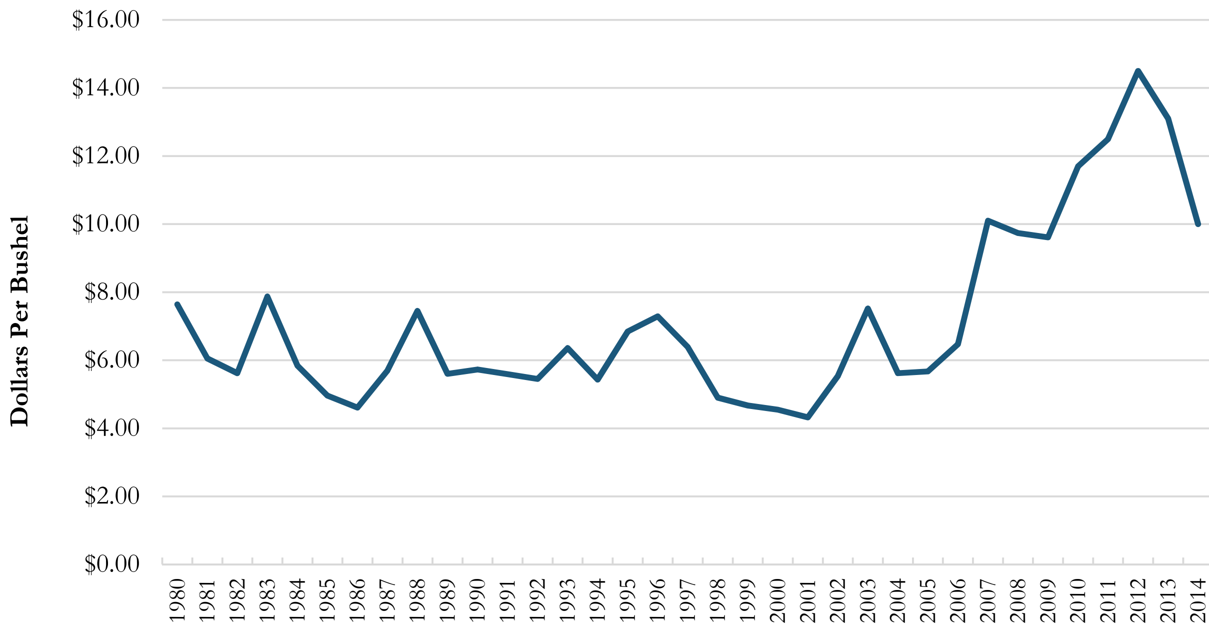
Exhibit 5.1.1 – Missouri Cash Receipts by Commodity, 1990 to 2014



Source: USDA, Economic Research Service

Exhibit 5.1.2 shows the Missouri average annual price for soybeans from the past 25 years. In 2014, the Missouri-reported annual soybean price averaged $10 per bushel, which represented a 24 percent decrease relative to the previous year. Prices had increased significantly between 2004 and 2012.

Exhibit 5.1.2 – Missouri Soybean Price Received by Marketing Year, 1980 to 2014

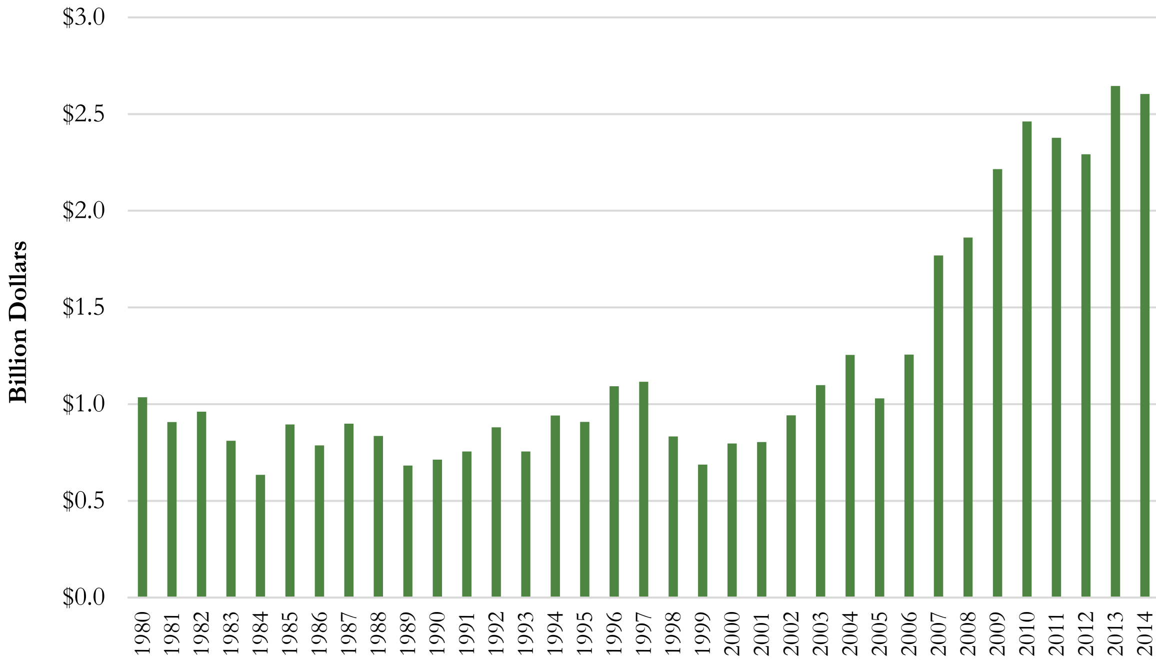


Source: USDA, National Agricultural Statistics Service

5.2 Soybean Value of Production

Value of production provides an alternative view of the Missouri soybean industry's financial importance. Cash receipt figures developed by USDA have had quantity adjustments for on-farm usage (feed) and other inventory and accounting corrections to more accurately represent a commodity's true cash receipts produced in a certain year. Value of production reflects the overall quantity and value of soybeans produced for a certain year without these adjustments. In 2014, Missouri soybean value of production totaled $2.604 billion, which was based on the $10 average price per bushel and 260.4 million bushels produced in Missouri. Exhibit 5.2.1 shares historical Missouri soybean value of production estimates reported by USDA.

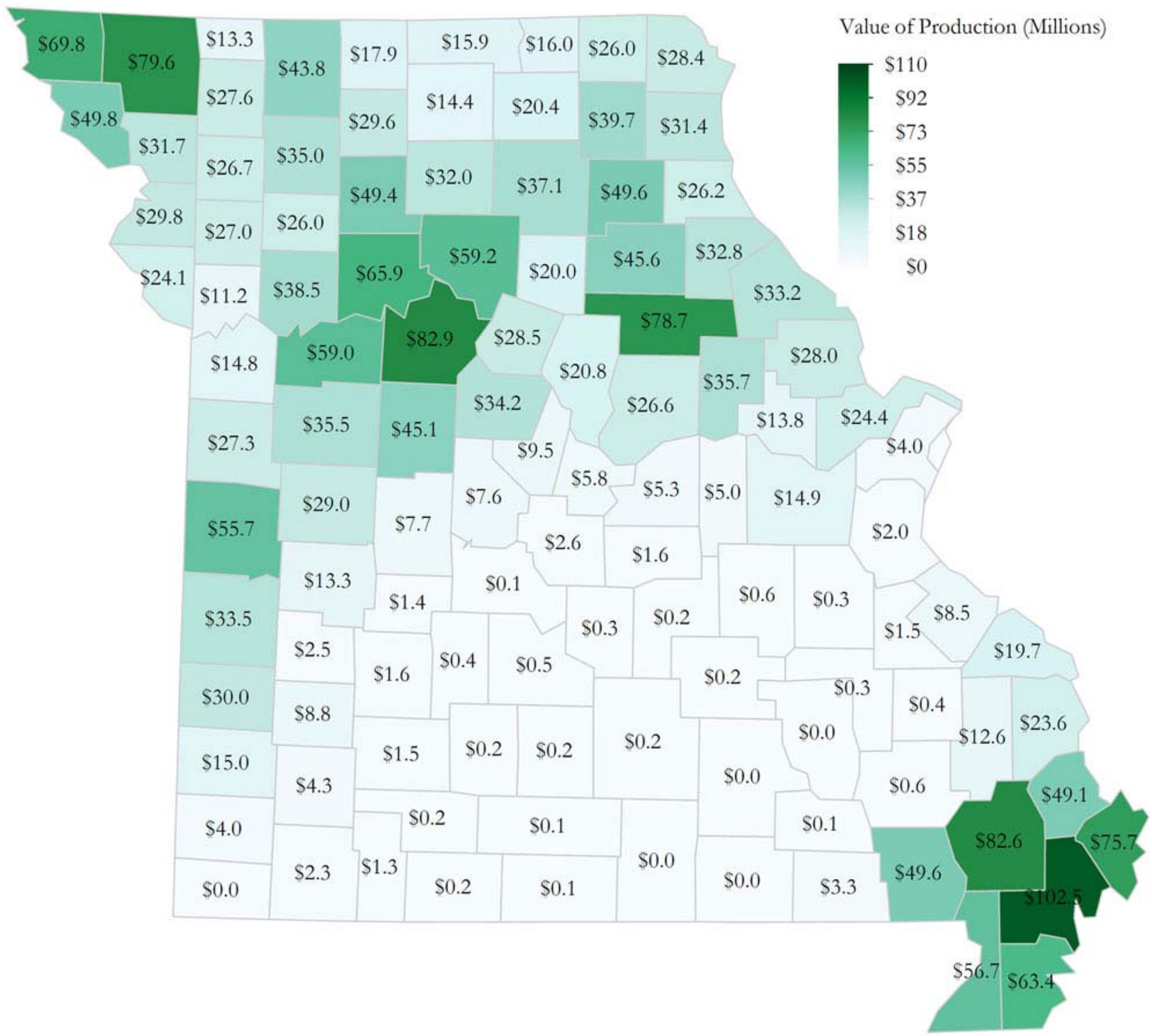
Exhibit 5.2.1 – Missouri Soybean Value of Production, 1980 to 2014



Source: USDA, National Agricultural Statistics Service

Exhibit 5.2.2 estimates Missouri's soybean value of production by county for 2014. The USDA National Agricultural Statistics Service reports county soybean production data in bushels for most Missouri counties. However, data for certain counties are not reported due to limited production and/or confidentiality issues. Data for these counties are combined and reported by USDA districts as "other combined counties." For the analysis in Exhibit 5.2.2, counties with no individual production data reported by USDA were derived by using IMPLAN oilseed farming sector data to determine the appropriate way to distribute value of production for the "other counties" and estimate value of production by county. Several geographic areas in southeast, northwest and central Missouri contribute significantly to Missouri soybean production and the value that it generates.

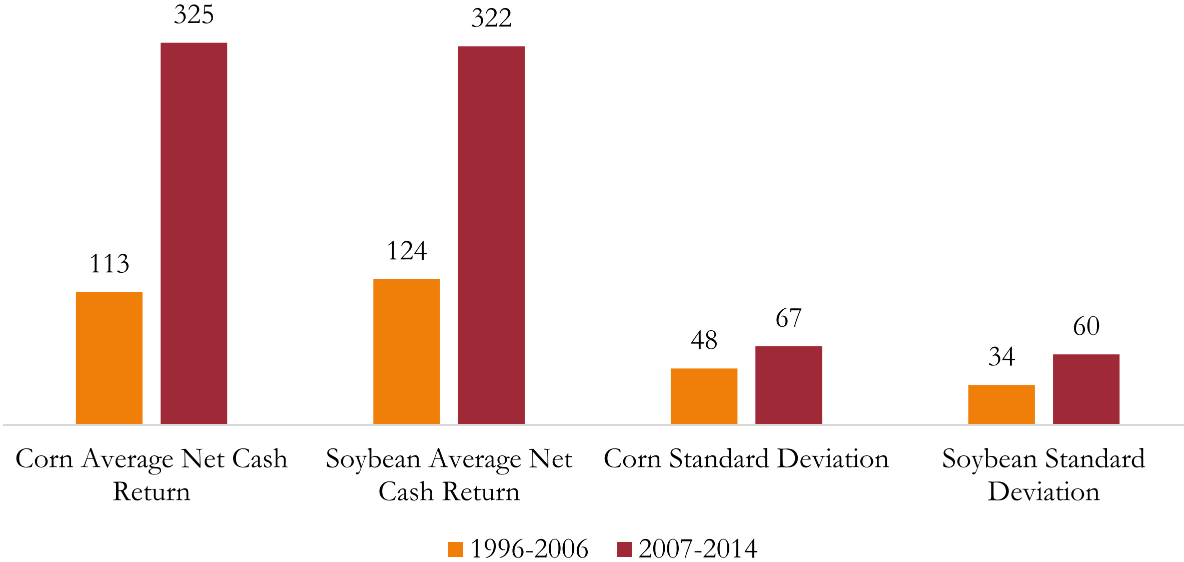
Exhibit 5.2.2 – Missouri Soybean Value of Production, By County, 2014



Source: USDA, National Agricultural Statistics Service and Derived from IMPLAN Data

An analysis of USDA ERS data by Zulauf (2015) showed the average net cash return per acre for growing corn and soybeans between 1996 to 2006 and 2007 to 2014. The data indicate that soybeans were more profitable than corn in the 1996-to-2006 period by about $11 per acre, but they were less profitable during the 2007-to-2014 period by $3 per acre. See Exhibit 5.2.3. During both periods, soybean profitability had a lower standard deviation. Zulauf suggests that "the 1996-2007 period may be more representative of the future than the 2007-2014 period." Soybean production offers three benefits compared with corn production: 1) lower input costs per acre, 2) greater than or equal to returns over time and 3) less income variability over time.

Exhibit 5.2.3 – Average and Standard Deviation of Per Acre Net Cash Return by Period, Government Payments Excluded, Corn and Soybeans, U.S., 1975 to 2014



Source: Zulauf (2015)

5.3 Economic Contribution of the Missouri Soybean and Related Industries

A multi-industry economic contribution analysis was prepared using the IMPLAN economic impact software system. The 2013 IMPLAN data set for Missouri was used to estimate economic effects by industry. Three Missouri industries were examined for their economic importance: oilseed (soybean) farming, soybean and other oilseed processing and biodiesel production.

Three components influence total economic contribution for agricultural sectors: direct contributions, indirect contributions and induced contributions (English, Popp and Miller, 2014). Direct contributions are created by crop production and processing. Indirect contributions accumulate when agribusinesses purchase materials and services from other Missouri businesses. Induced contributions accrue when employees or suppliers of these businesses spend income locally.

Several terms communicate the importance of these industries. Employment refers to the annual monthly jobs average; jobs may be either full-time or part-time. The value-added impact measures labor income; indirect taxes; and other income such as corporate profits, net interest and rent. Additionally, value-added represents a measure of gross domestic product (GDP) made by an industry. Labor income refers to employment income, which includes proprietor income and employee compensation, such as wages and benefits. Tax revenues are also included in the value-added classification. Tax impact values convey the tax revenue generated from employee compensation, proprietor income, indirect business taxes, households and corporations.

Exhibit 5.3.1 details the Missouri soybean farming industry, soybean and other oilseed processing industry and biodiesel production industry's contribution to the state's economy in 2013. Note that this information includes all direct, indirect and induced contributions from each industry sector.

Soybean and oilseed processing and biodiesel production data will only capture the economic effects after the preceding industry to avoid double counting economic contribution effects across sectors. The combined industries supported 24,786 Missouri jobs and provided $1.128 billion in labor income. Total value added to the state's economy totaled approximately $2.98 billion in 2013. The Missouri biodiesel, soybean processing and soybean farming industries also provided $183 million in state and local taxes and $311 million in federal taxes during 2013.

Exhibit 5.3.1 – Economic Contribution of Missouri Soybean and Related Industries, 2013

Industry Sector	Jobs (#)	Labor Income (millions)	Value Added (millions)	Taxes	
				State/local (millions)	Federal (millions)
Soybean Farming	15,802	$651	$2,124	$98	$199
Soybean and Other Oilseed Processing	6,361	$338	$618	$64	$80
Biodiesel Production	2,623	$139	$238	$21	$32
Total	**24,786**	**$1,128**	**$2,980**	**$183**	**$311**

Note: May not sum due to rounding
Source: University of Missouri, using data from the IMPLAN economic modeling software

5.4 Economic Contribution of the Missouri Soybean Farming by Legislative District

Exhibit 5.4.1 details an economic contribution estimation for the Missouri soybean farming sector by Missouri congressional district. The IMPLAN software system – the 2013 IMPLAN data set – and soybean value of production data were used to develop this estimate. Note that this information includes all direct, indirect and induced contributions. The analysis assumed that a county's value of production was equally geographically distributed across a given county. For example, if a county had 10 percent of its area in one legislative district and 90 percent in another legislative district, then the soybean value of production estimated for that county was allocated by these percentages to its respective legislative districts. Congressional District No. 6 contributed the most to the Missouri soybean farming industry. In 2014, it supported 5,430 jobs and added $767 million in value added to the state.

Exhibit 5.4.1 – Missouri Soybean Farming Economic Contribution by Missouri Congressional District, 2014

Congressional District	Soybean Value of Production	Total Jobs Supported	Total Labor Income	Total Value Added
1	$1,363,400	7.5	$285,017	$848,186
2	$6,881,400	36.4	$1,328,667	$4,275,612
3	$134,425,200	732.4	$21,919,224	$82,385,515
4	$387,558,730	1,710.8	$63,414,172	$238,353,102
5	$245,300,600	1,094.2	$46,207,562	$150,905,318
6	$1,251,172,400	5,430.6	$227,045,863	$767,403,566
7	$24,981,270	140.8	$4,596,498	$15,301,176
8	$552,317,000	2,102.2	$94,727,184	$341,123,828

Source: University of Missouri, using data from the USDA, National Agricultural Statistics Service and IMPLAN economic modeling software

Exhibit 5.4.2 details the economic contribution by Missouri senate district using the same methodology as used in Exhibit 5.4.1. The top three senate districts, according to jobs supported by the Missouri soybean farming industry, were senate districts No. 12, No. 18 and No. 25.

Exhibit 5.4.2 – Missouri Soybean Farming Economic Contribution by Missouri Senate District, 2014

Senate District	Soybean Value of Production	Total Jobs Supported	Total Labor Income	Total Value Added
1	$441,100	2.5	$88,364	$276,084
2	$15,641,600	74.5	$2,601,879	$9,645,096
3	$11,850,000	79.2	$1,935,599	$7,299,962
4	$80,200	0.4	$16,766	$49,893
5	$0	0	$0	$0
6	$20,250,000	92	$3,251,415	$12,411,728
7	$2,067,800	14.6	$419,226	$1,281,950
8	$6,203,400	43.8	$1,257,679	$3,845,850
9	$1,920,100	13.6	$389,282	$1,190,382
10	$201,750,000	931.9	$30,294,913	$123,793,611
11	$4,578,700	32.4	$928,287	$2,838,604
12	$510,170,600	2,098.4	$83,933,680	$316,152,598
13	$601,500	3.4	$120,496	$376,478
14	$521,300	2.9	$104,430	$326,281
15	$761,900	4.3	$152,629	$476,873
16	$0	0	$0	$0
17	$3,689,400	24.2	$695,787	$2,305,511
18	$469,810,000	2,002.8	$73,105,757	$288,927,133
19	$55,000,000	293.5	$9,363,766	$33,857,248
20	$1,446,500	10.6	$277,052	$892,580
21	$318,740,000	1,357.5	$48,837,827	$196,143,411
22	$960,000	8	$157,361	$589,655
23	$8,798,400	41.9	$1,463,557	$5,425,366
24	$721,800	4.1	$144,596	$451,774
25	$503,180,000	1,586.4	$85,323,401	$310,683,224
26	$15,762,200	99	$3,054,428	$9,799,907
27	$20,021,000	84.6	$3,343,919	$12,325,919
28	$142,930,000	533.1	$21,665,125	$88,055,109
29	$6,630,000	34.7	$1,109,420	$4,094,102
30	$220,500	1.6	$42,717	$136,606
31	$178,050,000	791.3	$29,648,515	$109,676,583
32	$29,143,000	140.6	$5,021,359	$17,820,640
33	$18,149,000	106.1	$2,878,824	$11,141,819
34	$53,910,000	295.3	$9,755,032	$33,253,579

Source: University of Missouri, using data from the USDA, National Agricultural Statistics Service and IMPLAN economic modeling software

The top ten soybean value of production Missouri house districts are identified in Exhibit 5.4.3. Additionally, economic contribution by these districts were calculated using the same methodology as in preceding exhibits. Missouri house district No. 1 brought the largest contribution from soybean production, with 750.7 jobs supported and $129 million in value-added to the state's economy.

Exhibit 5.4.3 – Missouri Soybean Farming Economic Contribution by Top Missouri House Districts, 2014

Ranking	House District	Soybean Value of Production	Total Jobs Supported	Total Labor Income	Total Value Added
1	1	$212,510,000	750.7	$31,140,338	$129,363,538
2	149	$166,894,000	455.8	$27,857,156	$101,946,974
3	4	$148,199,520	591.6	$21,579,373	$89,884,834
4	39	$146,714,660	662.3	$22,206,334	$89,306,505
5	2	$134,314,550	545.5	$19,767,813	$81,616,723
6	48	$113,181,600	437.9	$17,458,641	$69,081,497
7	40	$105,637,200	420.0	$15,125,270	$64,193,729
8	7	$104,901,900	542.6	$16,933,090	$63,869,205
9	43	$93,534,370	388.4	$14,190,930	$56,768,652
10	126	$83,453,910	345.3	$14,247,061	$51,040,920

Source: University of Missouri, using data from the USDA, National Agricultural Statistics Service and IMPLAN economic modeling software

5.5 Missouri Soybean Checkoff Program

Missouri's soybean checkoff program supports research and promotion efforts. It requires soybean producers to pay 0.5 percent of the soybean market price per bushel sold. By fiscal year (July to June), Exhibit 5.5.1 illustrates checkoff revenues generated by Missouri soybean producers between 2002 and 2014. The checkoff revenue is allocated equally between the United Soybean Board (USB) and the Missouri Soybean Merchandising Council (MSMC). In 2014, checkoff collections received from Missouri soybean sales reached $14.3 million dollars, which was the highest level recorded during the observed period.

Exhibit 5.5.1 – Missouri Soybean Checkoff Net Collections, 2002 to 2014

Source: Missouri Department of Agriculture

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