Grain and Soybean Industry Dynamics and Rail Service

Trends in Grain and Soybean Economics

Final Report

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EXECUTIVE SUMMARY

The logistics of grain and soybean production and distribution, especially in the North American western regions, is undergoing significant restructuring driven by the desire and need to achieve economies of scale and reach export markets where prices have been at historically high levels. This study examines the factors shaping the grain and soybean sector in terms of *market competition, demand and supply trends,* and *industry dynamics*. This includes the extent to which global market developments are leading to the restructuring underway in the North American production regions as producers seek to improve and leverage their global market competitiveness.

The motivation behind the study is to gain understanding of the factors affecting grain and soybean transportation. An exhaustive literature review reveals that agriculture transportation demand, and more specifically grain and soybean demand, depends on **global trade patterns, competition in production from other countries**, **commodity price fluctuations**, **competition from other products and industries**, **weather disruptions and climate**, **variations in annual crops sizes, and quality concerns**.

The study first considers the **drivers behind grain demand, supply and trade**, and the factors affecting **market competitiveness**. Accordingly, we identify **the major global players and associated historic trends**, and the United States' relative competitive position in international grain and soybean markets. Within this broader context, we examine in more detail **major trends in the U.S. grain industry,** along with insights into its interrelation with the transportation sector.

The main determinants of long-term grain and soybean **demand** include *population and economic growth*, as well as *government policies' impact on the biofuels market*. The role of *population trends* is revealed through a high positive correlation between population growth and soybean consumption in China, the largest global consumer of soybean. However, this is only one side of the equation; equally important is the *economic status* of the population. In China, the growth in Gross Domestic Product (GDP) impacts the demand for different types of grain or oilseed differently. In our data, wheat consumption in China was not highly correlated with GDP growth, and actually exhibited an inverse correlation for GDP values between \$1B and \$2B. As people's purchasing power increases, they often move away from consuming wheat to buying meat (and in turn corn and soybean used for animal feed). On the other hand, soybean and corn consumption in China were highly correlated with the country's GDP.

Aside from the economic environment, *government policies* can also influence consumption and demand patterns. For example, in the case of biofuels, the corn share used for ethanol jumped in the U.S. at the onset of the Energy Policy Act of 2005. The Act mandated that gasoline contain increasing amounts of ethanol, while the Energy Independence and Security Act of 2007 required gasoline producers to blend 15 billion gallons of ethanol into U.S. gasoline supply by 2015. Land farm planted corn acreage increased by 20% in the following year.

Supply, on the other hand, is determined by *technology, production costs and returns*, *price signals* and *weather and climate*. *Technology* is the most prominent determinant, highly discussed in genetically modified organisms (GMO) debates. It was also repeatedly brought up by producers our team interviewed in North Dakota. This report examined this factor through USDA data to observe that average corn yields in the United States grew by 36% since 1996, when the first applications of genetic engineering were introduced in the U.S. agriculture sector.

While technology can boost yield when producers decide to plant and produce more, the factors behind their decision to do so in the first place depend on *the interplay between production costs and price received* for their products, in other words, their profits. To that end, our work highlighted periods in the United States with high incentive to produce soybean based on profitability (post 2006) and an associated increase in soybean planting during that period. This study also analyzed *prices received by producers* through USDA data on soybean prices and production to conclude that: **(1)** price is a signal for production, **(2)** it is a lagged signal with an approximate period of two years between price signals and production responses and **(3)** the current price is more of a signal to producers than is the trend of prices over the past three years. Finally, factors external to both producers and markets, include the *weather and climate*'s role in production volumes. The United States witnessed several droughts that damaged and destroyed crops. Weather in particular was widely brought up in discussions with stakeholders in North Dakota.

Aside from demand and supply drivers that determine grain and soybean market fundamentals, production and transportation are considered within a **global market competitiveness framework** as the U.S. is becoming increasingly export-oriented. In terms of **production,** the U.S. has historically consistently produced more than it consumed, generating sufficient surplus volumes to export grain and soybean after accounting for domestic demand and food security. However, U.S. producers are not cost-competitive in production relative to South American counterparts, in particular Brazil and Argentina, primarily due to the relatively higher cost (rent) of land in the United States.

However, what the U.S. lacks in production cost competitiveness, it finds in **transportation** system efficiency. Indeed, U.S. grain and soybean companies have lower total landed *costs* (i.e. total transportation cost and farm price) from farm to market than South American companies. In general, this can be attributed to an efficient and reliable domestic supply chain, but also more directly to innovations introduced by railroads to increase system throughput and reliability. Most notable in this regard is the introduction of shuttle trains that travel as a single entity from origin to destination without having to stop at classification yards. Aside from transportation costs, the U.S. supply chain's *reliability* gives a competitive edge to domestic producers in their relation with international customers, as was highlighted to the study by stakeholders in North Dakota and Minnesota.

Still, transportation systems in the United States are vulnerable to system disruptions due to, among other things, traffic growth and change in traffic mix. Those, as well as the direction of change in speed relative to changes in volumes should be closely monitored. These factors may contribute to capacity tightening that is reflected in bids in the secondary rail market. Such dynamics are typified in the rail service problems encountered in February to April 2014.

Examining country profiles for **major global players** and their historic **supply, demand and trade trends**, the *United States* is a top producer of corn and soybean, *China* is a major consumer of soybean and producer of wheat, the *European Union (EU)* is a top producer and consumer of wheat and *Brazil* is a major producer of soybean followed by *Argentina*. However, these ranks are not stable over time and relative standings vary somewhat from one year to the next depending on relative harvests and droughts, although the major players in the global market have tended to be the same in recent years.

In trade, the *United States* is the top exporter of corn and second largest top exporter of soybean, leaving the first place to *Brazil*. The *European Union (EU)* is a top exporter of wheat. Finally, *China* is undoubtedly the top importer of soybean**,** *Japan* of corn and *Egypt* of wheat. China's supply and consumption trends are particularly interesting as they highlight how China became completely soybean import-dependent post-2001, with balances varying between 10 and 70 million metric tons (MMT). This helps explains why China's trade share reached 50% in 2005, thus driving world soybeans trade since. It grew to approximately 65% in 2015. The *United States* is also a major grain and soybean trader with historical shares as high as 90% for soybean and 60% for grain. However, it has increasingly been losing market share for the past 20 years. In 2014, U.S. grain shares were as low as 30%. However, our data analysis from USDA forecasts shows that there remains a place for U.S. grain and soybean in the international markets in the next 10 years.

Our analysis shows that the *relative value of international soybean prices* to U.S. market prices can act as an incentive for U.S. producers to export rather than sell locally to maximize profits. Also, the desire to reach international markets should be complemented by a cost-effective domestic production and an efficient and reliable supply chain to allow the United States to reach those markets. This is why both producers and transportation providers restructure their operations to maximize efficiency and minimize costs. To that end, our analysis showed that the share of goods transported by rail for export increased after *shuttle trains* were introduced by U.S. rail companies. Finally, this study also showed that U.S. farmers substituted wheat planting by soybean planting at the onset of Chinese soybean demand, showing *high reactivity of U.S. producers to international demand*.

Although most of the discussion above highlighted that **(1)** the U.S. market is becoming increasingly export-oriented and **(2)** soybean is the major story from a global trade standpoint, the United States currently transports more grain and soybean domestically than for exports. Corn movement is dominant in this regard, with an increasingly large domestic market for locally-sourced corn, driving domestic product flows to ethanol plants.

For local production, our analysis shows that core production areas are well-established. For example, the Plains region has always planted and produced more soybean than any other region in the United States. What is less predictable, and highly dependent on most of the factors discussed in this summary is the annual production level within regions. An example is the number of acres planted in the Southwest that decreased from 550,000 to 187,000 over the span of 7 years but recovered to more than 600,000 in 2015. These shifts reflect volatility due to cropping considerations and relative profitability among alternative crops as well as the impacts of climate and weather.

As part of the study, the team conducted fieldwork in Minnesota and North Dakota, visiting terminal elevator operations and meeting with key stakeholders across the grain supply chain, including grain trading and hedging activities. These stakeholders convey a **positive outlook** towards the railroads' communication with them and their commitment to resolve congestion problems through ongoing capital investment. Specific current and future concerns pertained to *train arrival and departure time*, *loading time*, shuttle system *throughput utilization*, *competition with other commodities* and *pricing*.

Throughout this report we examined the fundamental changes in global grain and soybean markets, providing context for the internal restructuring occurring in the United States. The trends witnessed over the past fifteen years show no sign of abating or changing course; as the global economy and population continue to grow, so will the need for food and in turn for grain and soybean. Furthermore, with growing global competitiveness and infrastructure improvements in competing countries, the ability of producers to scale up demand while maintaining cost competitiveness and quality will be essential. The introduction of shuttle trains as well as improvements in grain elevator operational capacity have placed the U.S. grain industry on an improved course, giving it a competitive edge over competitors in other parts of the world, particularly in South America. However, investment in transportation operations needs to continue because infrastructure improvements in competing producing countries could put the U.S. at a disadvantage. Addressing and mitigating these challenges while remaining competitive will be crucial for the U.S. to remain a major global player in the grain sector, with far-reaching implications for the domestic economy.

Contents

1. Introduction

Throughout history, grain including wheat, corn and soybean have played a key role in global nutrition. Due to their relative ease of cultivation, comparative abundance and varied geographical availability, grain and soybean have remained core components of diets across the globe. However, with the ever-increasing economic and urban growth of the 20th and 21st century, grain and soybean switched from crops predominantly destined to meet domestic needs into global commodities. Indeed, a world trade market was developed with major exporters including the United States shipping grain and soybean worldwide. However, earning a place in the global market is only possible if domestic grain and soybean production and logistics allow it. In fact, U.S. efforts to meet global demand and gain shares in international markets translate into a need for restructuring of grain and soybean production and logistics.

To understand the dynamics behind the market competitiveness described above, this report will examine the factors shaping the grain and soybean sector in terms of demand and supply trends, and industry dynamics particularly in the North American production regions of interest. The study will also assess the extent to which global market developments are leading to the restructuring underway in North American production regions as producers seek to improve and leverage their global market competitiveness. Implications for grain and soybean transportation will be examined. By doing so, the report will seek to answer questions such as:

> *What trends and factors are shaping the grain* and soybean *industry, from production to global markets, and how are the dynamics and reorganization of the industry changing their transport requirements?*
>
> *How have these global trends and developments been leading domestic restructuring?*
>
> *Have rail companies been responsive to industry needs, now and in the future?*
>
> *What can rail companies do differently to better serve the industry, and help mitigate some of the negative developments?*

The report will answer the previous set of questions through four main sections: (1) ***global trade dynamics*** with a discussion on the major determinants of global trade; (2) ***the major global grain and soybean trends***; (3) ***the relationship between global developments and the U.S. grain*** and soybean ***industry*** with an analysis of the implications of global trade on the operations of grain and soybean producers and grain and soybean transportation providers; and (4) ***the U.S. grain*** and soybean ***industry*** including a case study summarizing the field visit of NUTC researchers to producers in North Dakota.

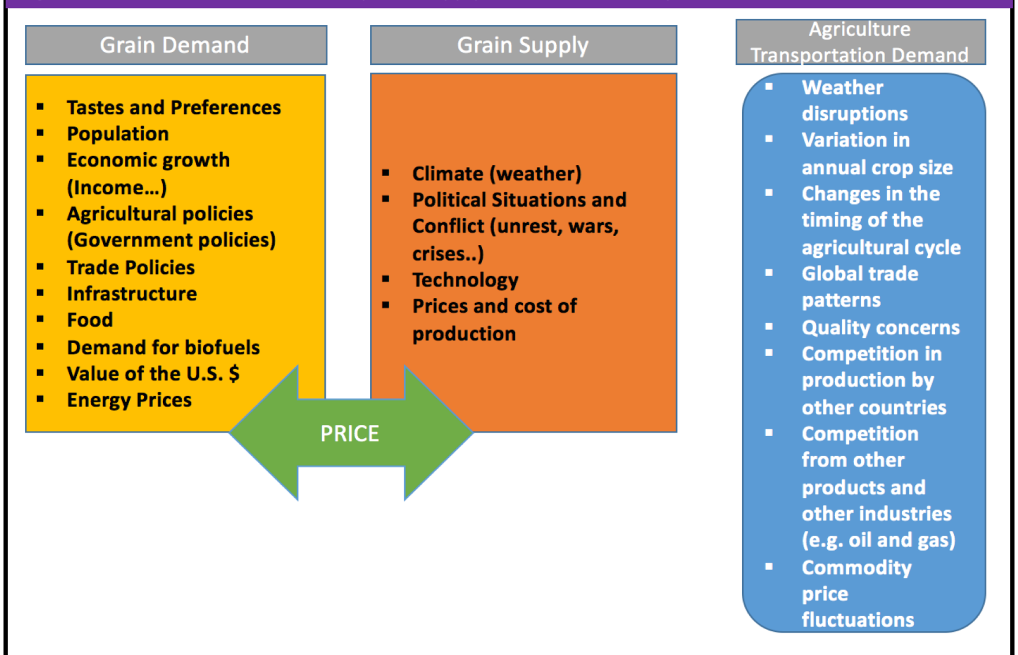
2. Global Trade Dynamics

Before discussing the global trade of grain and soybean and the major underlying trends and implications going forward, the first section of this report will examine the primary drivers shaping the grain and soybean sector. Focus will be given to supply, demand, export and imports as well as historical pricing behavior. While studying the dynamics behind any commodity market, let alone a market as broad as agricultural commodities, is a challenging task, this part of the report will aim at answering questions such as: (1) *What important factors influence the decision-making of producers*? (2) *What is grain* and soybean *consumption sensitive to?* (3) *What features impact exports and imports*? and finally, (4) *what are the major determinants of grain* and soybean *prices*?

2.1. Overview

Figure 1 summarizes the main factors behind grain and soybean demand, supply and the drivers underlying agriculture transportation needs[1]. The bidirectional arrow indicates that price is determined by the intersection of supply and demand. Conversely, price also brings supply and demand into equilibrium when imbalances occur. We argue that the most crucial drivers include: population and economic growth, agricultural policies, demand for biofuels, technology and production costs and returns. These factors will be discussed in further detail in this section.

Figure 1: Drivers Behind Grain and Soybean Supply, Demand and Transportation



Source: Authors; see footnote (7)

2.2. Grain and soybean Demand Dynamics

As noted in **Figure 1**, grain and soybean demand is primarily driven by (1) tastes and preferences, (2) population growth, (3) economic growth, (4) agricultural policies, (5) trade policies, (6) demand for food, (7) demand for biofuels, (8) the fluctuations in the value of the U.S dollar relative to other global

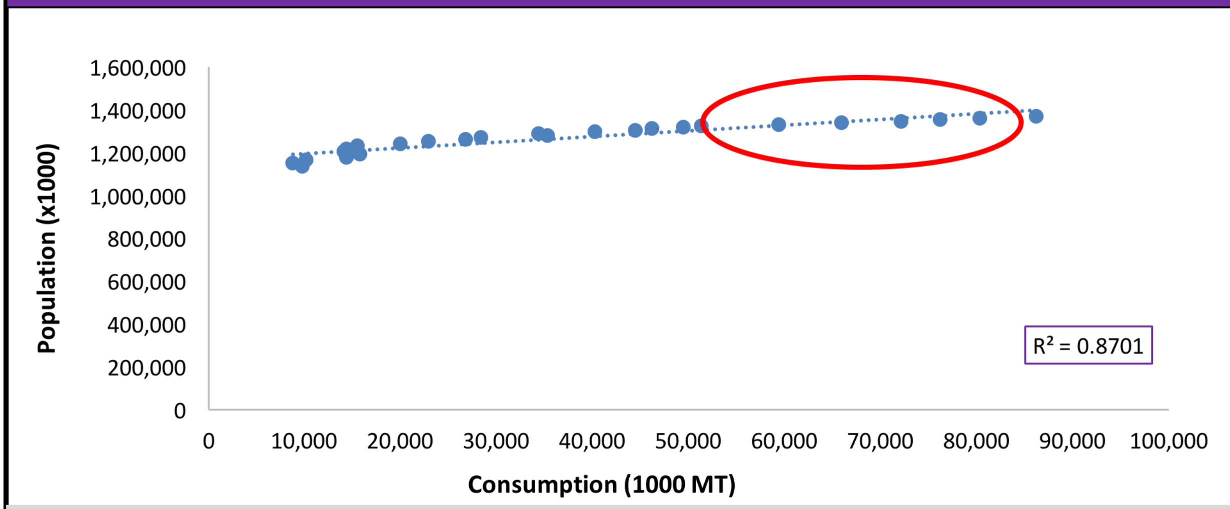
1 Source for Agriculture Transportation Demand: *Wheat Transportation Profile, Agricultural Marketing Service Transportation and*

currencies, and (9) energy prices. In this section we will look at ***population*** and ***economic growth***, ***agricultural policies*** and ***demand for biofuels.*** Trade policies, energy prices, and the relative value of the U.S. dollar will be discussed in subsequent sections as they pertain primarily to price formation, thus impacting market fundamentals (supply and demand) indirectly.

2.2.1. Population Growth

It is widely discussed throughout the literature that population growth is a significant driver behind grain and soybean consumption. We sought to examine that further by studying the correlation between soybean consumption and population[2] in China. Analysis of data pertaining to Chinese demand and population growth confirms the strong relationship between the two by exhibiting a coefficient of determination (R^2) of 0.87 (**Figure 2**). However, **Figure 2** also indicates that population growth may not be the only driver of consumption, which becomes evident towards the latter part of the historical series. Indeed, while soybean consumption and population growth in China throughout much of its history have increased roughly proportionally along a stable trajectory, consumption growth in recent years has increased at a far more rapid pace despite a decline in the rate of population growth. This is due largely to a second crucial driver of demand, economic growth, as the rapid expansion in the Chinese economy through the past two decades has triggered demand growth even despite slower expansion in population. This component will be examined in the following section.

Figure 2: Correlation Between Population and Grain and Soybean Consumption in China (1969-2014)



Source: Authors; see footnote (8)

2.2.2. Economic Growth

Beyond population growth, economic growth also plays an integral role as an engine for grain and soybean consumption. This is confirmed by the large increase in grain and soybean consumption in the United States throughout the 1990's despite slower population growth, driven by a decade-long economic

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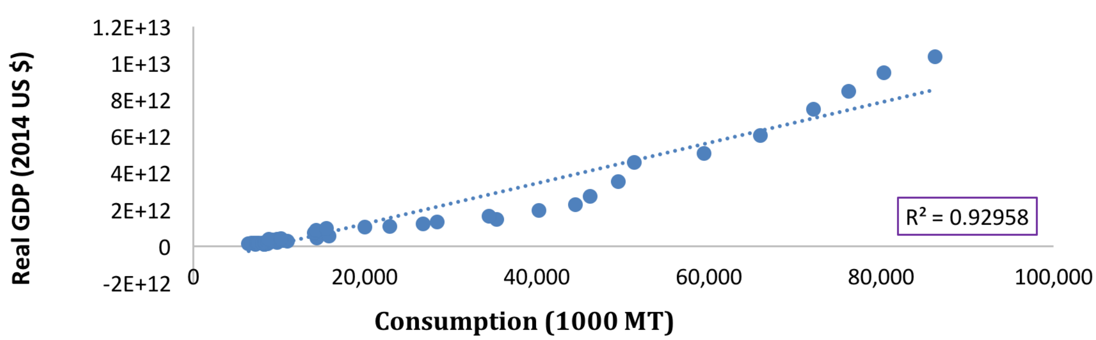
2 *Source for Population from US Census Bureau; Source for Consumption: FAS, USDA.*

expansion. In fact, U.S. average grain and soybean consumption per capita in 2000 (200 pounds per capita) stood 45% higher (in total) than in the 1970s (138 pounds per capita)[3].

Regional economic growth can be examined through different indicators ranging from income per capita to purchasing power, Gross Domestic Product (GDP) and many others. In this study, we looked at Chinese GDP growth[4] in relation to Chinese soybean, corn and wheat consumption to find a strong correlation between soybean and corn consumption and GDP growth reflected by a coefficient of determination of 0.93, 0.80 (**Figures 3, 4**). The correlation between wheat consumption and GDP is not strong but shows an interesting trend that will be discussed. In fact, the Chinese economy witnessed a sharp increase in both income per capita and purchasing power of a population that was largely poor and rural. The increase in purchasing power and rapid urbanization provided the Chinese population with the means to develop a diversified diet and broaden consumption patterns significantly. Often, the diversification of diet means moving away from traditional food such as wheat and rice and increasing consumption of meat, dairy products and vegetable oils[5]. Such behavior is apparent in the relationships plotted below as wheat exhibits an inverse correlation to economic growth, for GDP values between 2 and 3 Billion dollars (**Figure 5**). Corn and soybean, on the other hand, exhibit a more stable trajectory of a roughly proportional increase in GDP and consumption, more so for corn (used in animal feed) than soybean (**Figures 3 and 4**).

Figure 3: Correlation Between GDP and Soybean Consumption in China (1969-2014)



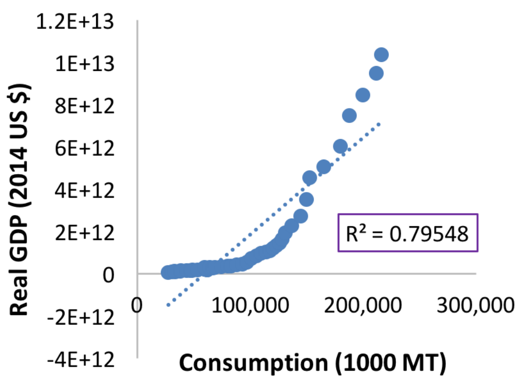
Source: Authors; see footnotes (8,10)

3 *Profiling Food Consumption in America, USDA Fact book.*

4 *Source for GDP US Census Bureau; Grain Consumption: FAS, USDA.*

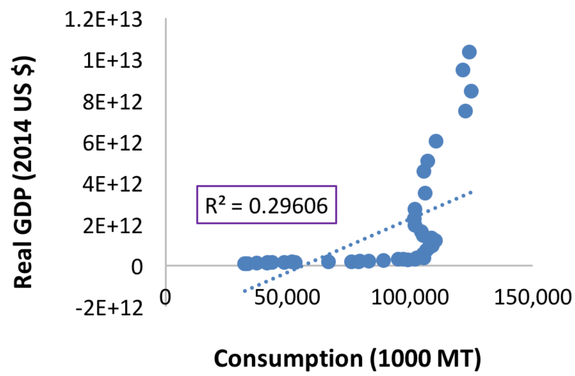
5 *Long-Term Prospects for Agriculture Reflect Growing Demand for Food, Fiber, and Fuel, by Paul Westcott and Ronald Trostle, September 20, 2012.*

Figure 4: Correlation Between GDP and Corn Consumption in China (1969-2014)



Source: Authors; see footnotes (8,10)

Figure 5: Correlation Between GDP and Wheat Consumption in China (1969-2014)



Source: Authors; see footnotes (8,10)

Aside from population and economic growth, government policies can act as direct stimulants of demand and as indirect triggers of supply. The next section will illustrate this concept with the example of biofuels.

2.2.3. Government Policies and the Demand for Biofuels

A popular example of policy-driven agricultural demand is the case of biofuels in the United States and Brazil. Biofuels, used as additives or substitutes in the transportation sector include biodiesel, which is derived from multiple vegetable oils, soybean oils and more importantly ethanol, derived most commonly from corn and sugarcane. In fact, since 2005, the U.S. government has mandated through the Energy Policy Act of 2005[6] that gasoline contain increasing amounts of ethanol as a means to decrease the country's reliance on crude oil and limit GHG emissions. Ethanol is derived almost entirely from corn. The policy's implications have been many especially as it pertains to U.S. producer behavior. In fact, after The Energy Independence and Security Act of 2007 passed requiring gasoline producers to blend 15 billion gallons of ethanol into U.S. gasoline supply by 2015[7], land farm planted corn acreage increased by 20% in the following year. This is an example of a government policy significantly affecting demand for grain and soybean and thereby directly boosting production. To verify this relationship, we examined, in **Figure 6**, data which indicates that the share of U.S. corn crops used for ethanol more than doubled in the two years following the act, from 10% in 2005 to 23% in 2007, surpassing 25% by 2009 and continuing to increase since then. In 2014, it reached 40%. Biofuel mandates also have the potential to impact supply indirectly through pricing, as will be discussed later in this report.

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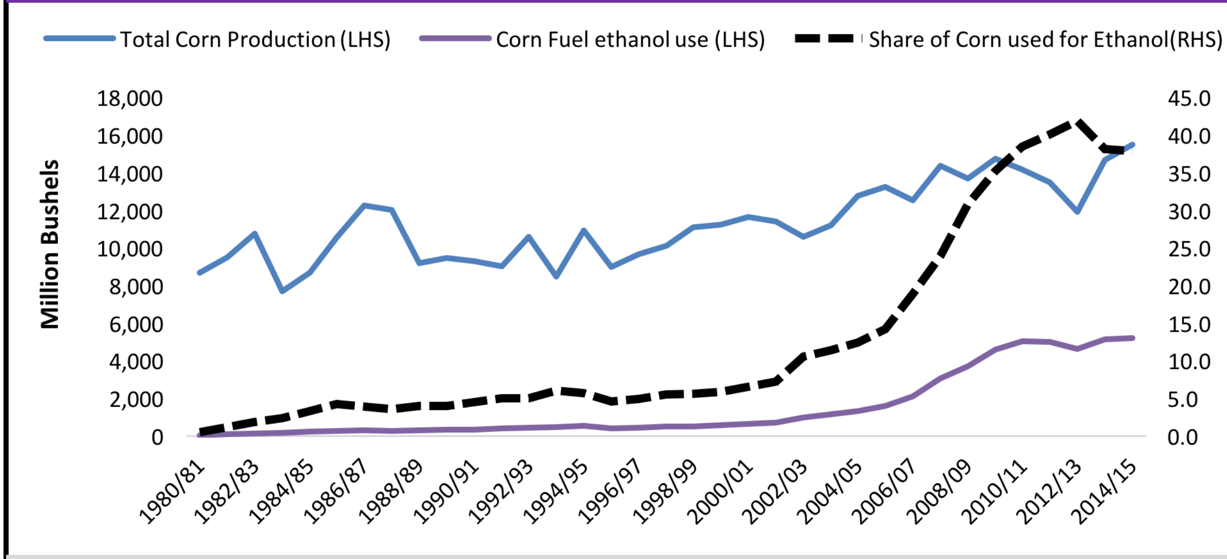
6 *For the official text of the law, see: http://energy.gov/sites/prod/files/2013/10/f3/epact_2005.pdf; For general information on the law: http://en.wikipedia.org/wiki/Energy_Policy_Act_of_2005.*

7 *End the Ethanol Mandate by Bloomberg news August 16, 2012.*

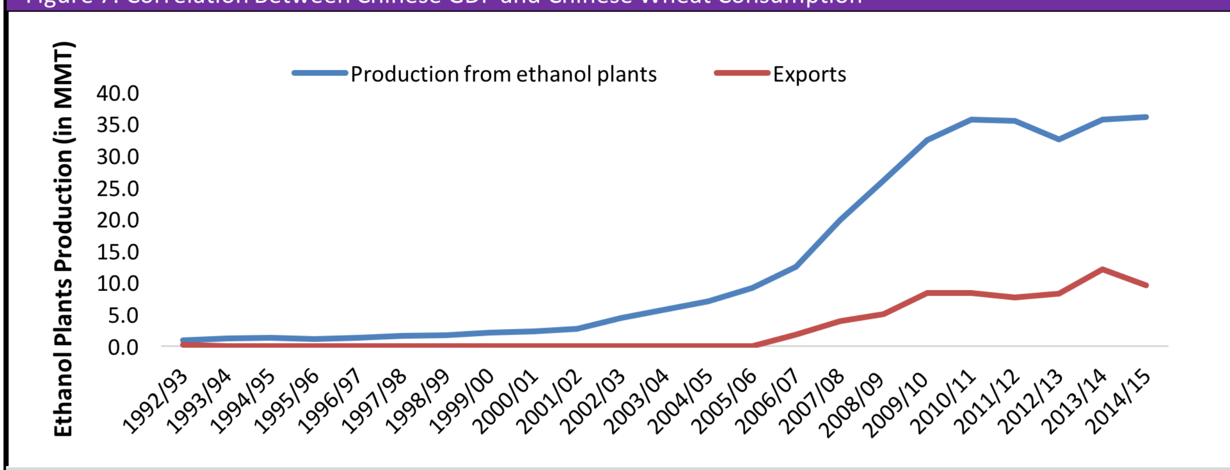
Figure 6: U.S. Corn Use (1980-2014)



Source: Authors, data from ERS, USDA

Simultaneously, the government policy triggered the production of dried distiller grain soluble (DDGS), a co-product of ethanol that can be used as either an energy source similar to grain or as a protein source to replace soybean meal. In fact, DDGS production increased by 29% the year following the mandate (2005-2006) and 187% over the subsequent four years (2006-2010). Likewise, exports grew from zero in 2005 to 9.5 MMT in 2014 (**Figure 7**). This growth has direct implications for rail transportation as DDGS are shipped by rail and truck and emerge predominantly from the Midwest. In fact, preliminary freight statistics data showed that DDGS carloads generated were 31.5% higher in 2006 (22,683) than 2005[8].

Figure 7: Correlation Between Chinese GDP and Chinese Wheat Consumption



Source: Authors, data from ERS, USDA

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8 *Before the surface transportation board, STB ex parte no. 672, rail transportation of resources critical to the nation's energy supply, comments of the U.S. department of agriculture, Bruce I. Knight July 12, 2007.*

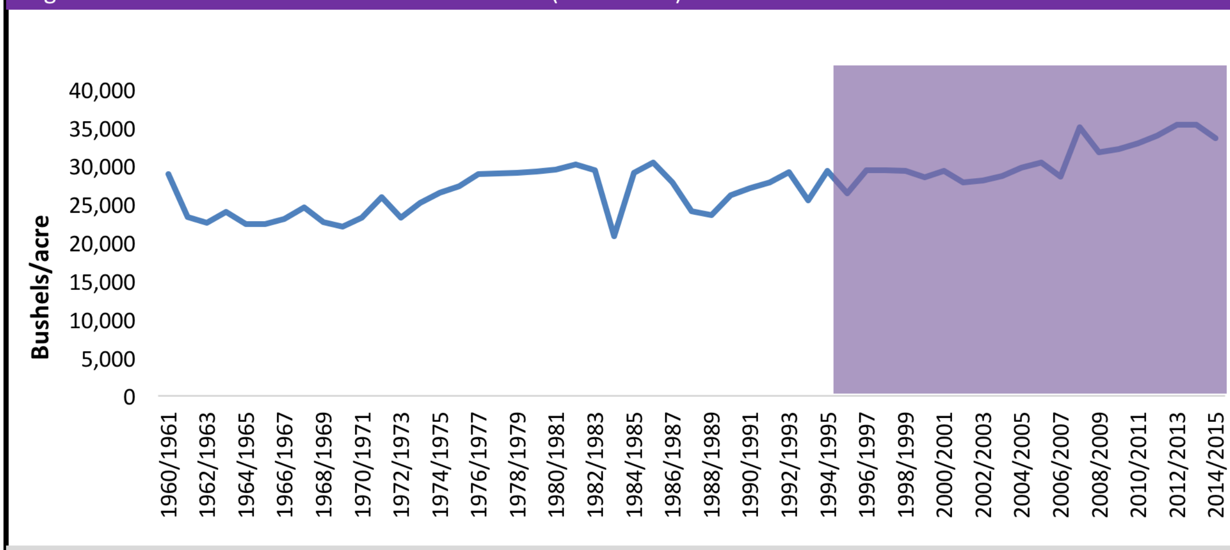
2.3. Grain and Soybean Supply Dynamics

The major global grain supply determinants include (1) **Technology**, (2) **Production Costs and Returns** (3) **Price Signals,** (4) **Climate and weather** (5) **Political Situations (unrest, wars, crises…), (6) agricultural policy and (7) infrastructure**. We will discuss these factors in the following section with the exception of political situations (exogenous of trends) and agricultural policy (discussed in the previous section).

2.3.1. Technology

Technological advances are factors increasingly acknowledged among analysts in evaluating the changes in global grain supply, especially when it comes to the role of genetic engineering in boosting yield to unprecedented levels or reducing costs for producers. **Figure 8** shows that average corn yields[9] in the United States witnessed a total growth of 24% in the last decade and a 36% increase since 1996 (the year where the first applications of genetic engineering were introduced in the U.S. agricultural sector).

Figure 8: Corn Yield Growth in the United States (1960-2014)



Source: Authors, data from FAS, USDA; see footnote (15)

Technology is a tool by which producers increase their yield once they've identified the need for more production. But what are the factors behind their decision to boost production? We will discuss part of the answer below.

2.3.2. Production Costs and Returns

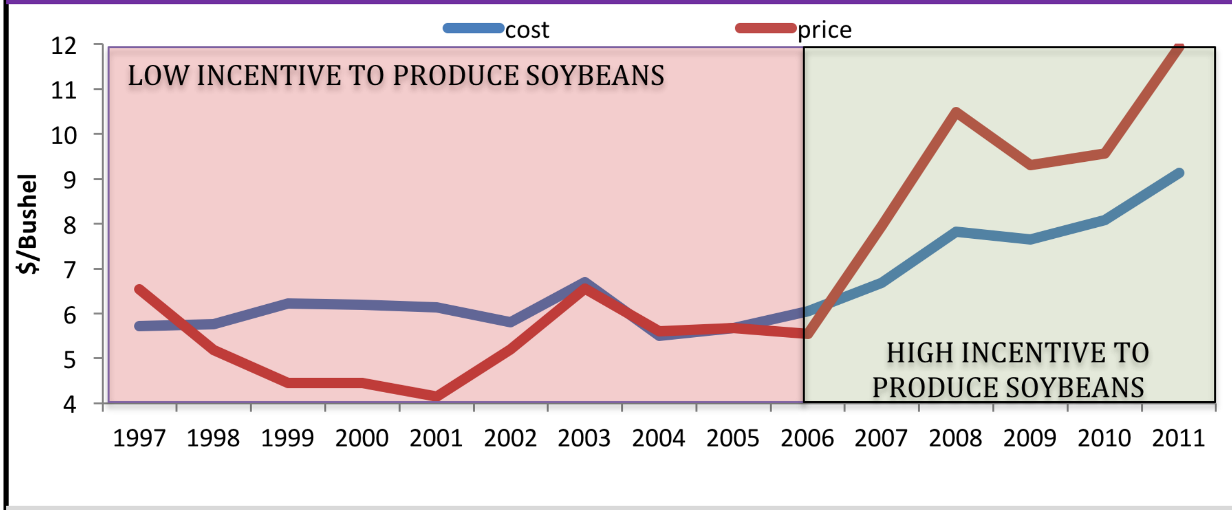
The comparison between production costs and returns is an important indicator of the margin of profitability of producers, as it is of any other good produced in free markets, agricultural or otherwise. Relative profitability impacts production levels by providing producers with the incentive to invest further towards expanding production, or conversely to forego investments and divert land towards other more profitable crops. For soybean in the United States for example, plotting costs and returns[10] over the years

9 *Yield is calculated by USDA as (production) / (harvested area).*

10 *The price (i.e. returns) as defined by the source is determined by NASS, USDA through sampling whereby they collect data on sales from producers to first buyers. The price is determined by dividing sales by quantity sold. This price represents all grade and qualities. Cost*

show that prior to 2005, the margins were very tight for crop producers and negative for several years until the late 1990s and mid-2000s (See **Figure 9**). Starting with the 2006 crop, soybean prices began to quickly move upward to new historic highs, peaking in the summer of 2008. Costs increased as well but did not catch up with prices, thus increasing the margin of profitability of producers significantly. Improving returns incentivized producers to plant more soybean and increase production (see **Figure 10** in following section). However, it should be noted that more factors, such as the price (and demand) of other commodities (wheat and corn) also play a role in such decisions as some degree of flexibility/optionality of which crops to plant for U.S. producers means that they will be sensitive to both the profitability of a given crop, and its relative profitability compared to alternative crops. It can be also noted from **Figure 9** that costs are more stable than returns, due to the close correlation of returns with food prices, which are subject to sharp fluctuations, as attested by the food crisis in 2006-2008, while costs are generally determined by many fixed and operating costs and do not rely significantly on a single driver.

Figure 9: U.S. Soybean Production Cost and Market Price (1997-2011)



Source: Authors, data from USDA, ERS; see footnote (16)

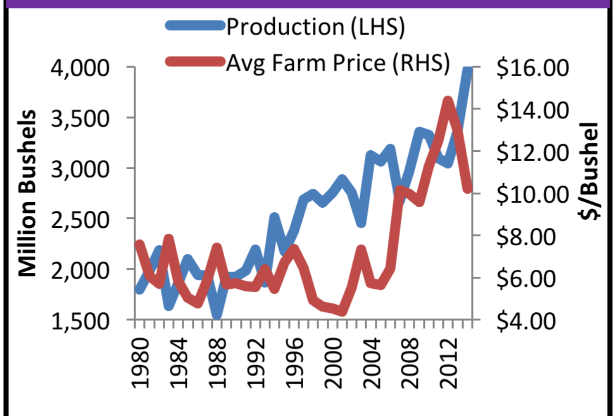
2.3.3. Price Signals

Aside from the direct incentive that profitability gives producers, it is important to understand how price alone has the ability to drive production. Should that be the case, it then becomes an issue of evaluating how responsive production is to given price signals especially that production decisions are usually much slower than daily fluctuations in prices. In other words, this section seeks to answer questions such as: *Does price immediately impact production? Or is there a lag between price signals and when producers make production decisions*? *If the latter, what is that lag?* To answer these questions, we first plotted same year production and returns for historical values (see **Figure 10**). While the overall direction of production and prices appears to be similar, available data does not indicate any significant sign that production reacts immediately to price fluctuation. Rather, when examining **Figure 10**, it becomes

includes operating costs (Seed, fertilizers, soil conditioners, manure, chemicals, custom operations, fuel, lube, electricity, repairs, purchased irrigation water, interest on operating capital) and allocated overhead (hire labor, opportunity cost of unpaid labor, capital recovery of machinery and equipment, opportunity cost of land [rental rate] and taxes and insurance).

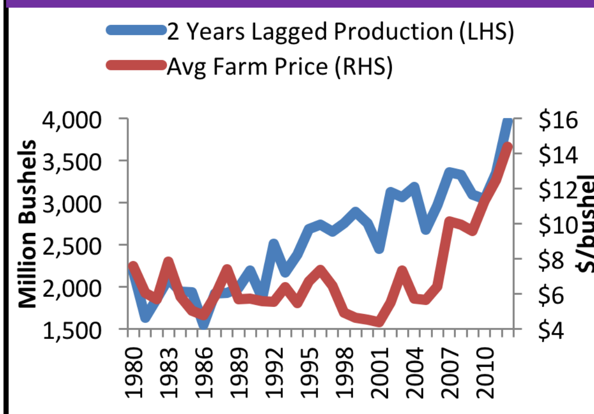
apparent from the plot that turning points occur almost perfectly within 2-year lags and that a plot with production lagged two years would show better correlations of trends (see **Figure 11**). In fact, based on that adjustment, evidence suggests that prices do in fact appear to drive production albeit with a clear time lag. This further confirms our hypothesis that: (1) pricing does have a clear role in farming production decision-making and (2) decision-making is a prolonged process rather than an immediate reaction, taking as long as two years to react to price signals.

Figure 10 : U.S. Soybean Production and Returns (1980-2014)



Source: Authors, data from ERS and FAS, USDA

Figure 11 : U.S. Soybean Production and Average Farm Price [Production lagged 2 years] (1980-2012)

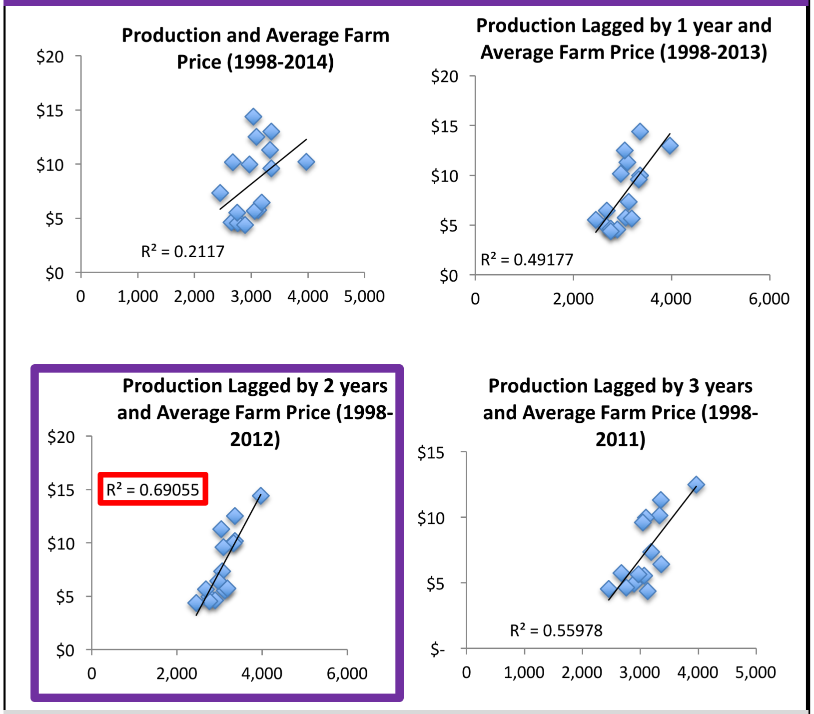


Source: Authors, data from ERS and FAS, USDA

To confirm this observation further, we examined the correlation for same year production, production lagged one year, two years and three years. This analysis showed that the optimal correlation occurs for a two-year lagged production (**Figure 12**). This led us to conclude that prices drive production decisions with a time lag of 2 years.

We were also interested in evaluating whether price trends play any role in the decision of producers, and if so get insight into their relative importance with respect to actual prices. In other words: *Are actual prices more important signals for producers or are price trends (i.e. how prices have behaved for the last three years for example) more important*? To answer this question, we plotted the 3-year price moving average versus production for historic values (See **Figure 13**). We tested several data combinations: current production vs. 3-year moving-average prices, one-year lagged production vs. 3-year moving average prices, and two years-lagged production vs. 3-year moving averages. Based on this analysis, data indicates that the optimal correlation occurs for a one-year lag of production with the 3-year moving average (See **Figure 14**). This suggests that there is a relatively strong correlation between next year's production and the trend of prices for the past three years. Interestingly, a comparison between the data behind historical price and production trends reveals that the actual price is a more statistically significant signal than a price trend (R^2=0.69, see **Figure 12**).

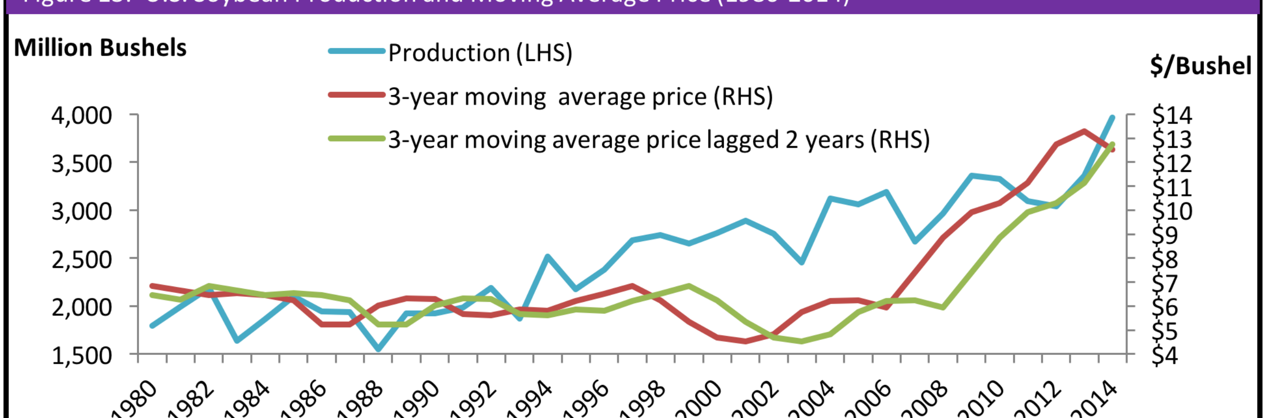
Figure 12: Correlation of Production and Average Farm Price (1998-2014)



Source: Authors, data from ERS, USDA

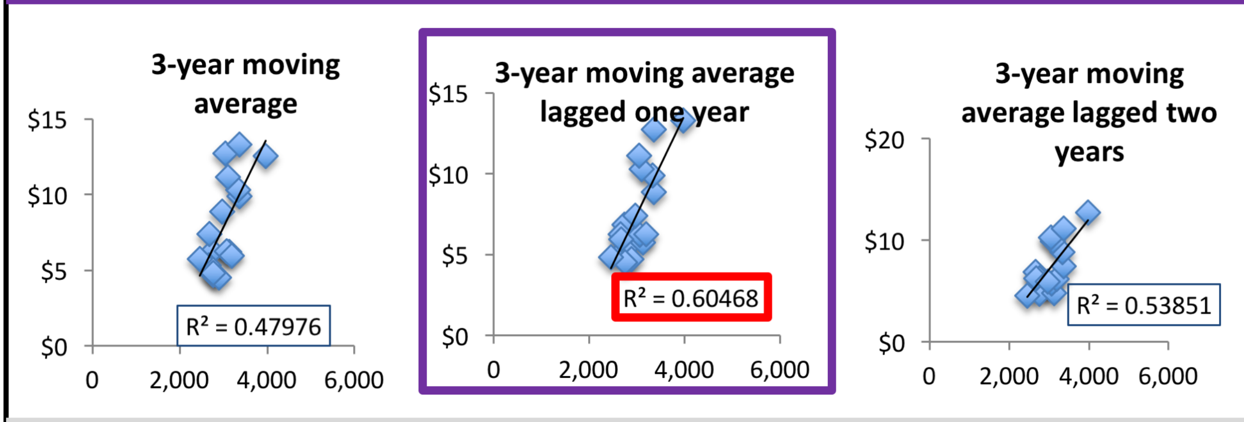
The implications of such results are that even isolated events that drive prices up, such as a bad harvest, a drought or trade shocks are sufficient to generate a strong incentive for production to increase. This illustrates the reactivity of the agricultural supply chain in the United States, albeit a lagged reactivity, where production needs several years to exhibit the response to the price signal.

Figure 13: U.S. Soybean Production and Moving Average Price (1980-2014)



Source: Authors, data from ERS, USDA

Figure 14: Correlation of Production and Average Farm Price (1998-2014)



Source: Authors, data from ERS, USDA

We leave for the last discussion on dynamics behind supply, a factor that lies out of the control of producers and one that they see as the most unpredictable aspect of agricultural production.

2.3.4. Climate and Weather

Climate and weather are fundamental determinants of global grain and soybean supply. In fact, bad weather could either cut down annual production volumes significantly or even damage the quality of crops. The United States for example has faced many droughts that significantly affected grain and soybean production. Two are worth mentioning here: In 1988-1989 drought occurred and spread from the Mid-Atlantic, Southeast, Midwest, and Northern Great Plains, eventually covering 36 % of the United States at its peak. It is thought by analysts to remain the costliest drought in U.S. history. More recently, a 2012 drought damaged and destroyed portions of major field crops in the Midwest, particularly field corn and soybean (USDA, ERS). Both of these can be seen on a plot of U.S. supply where production significantly decreases (See **Section 2, Figure 4**). Conversely, good harvests resulting from a good climate, such as in 2014, could lead production to better outcomes.

2.4. Trade Dynamics

After examining some of the primary drivers behind trends in global production and consumption of grain and soybean, we now turn to review some of the determinants behind global trade. The trade dynamics examined in this section include: (1) exports, (2) imports and (3) prices.

2.4.1. Export Dynamics and Market Competitiveness

Several drivers play a key role in determining whether countries have grain and soybean sectors with the ability to compete in the global marketplace. The primary such factors include: (1) scalability of domestic production (cost and quality) (2) export infrastructure (transportation cost and performance) and (3) trade policies, government food programs and subsidies.

2.4.1.1. Scalability of Domestic Production

This section on the ability of countries to expand domestic production beyond local needs and scale up to export markets will examine (1) production cost (2) production volumes and (3) production quality.

The ability of a given country to become a major grain and soybean producer and hence exporter is ultimately dependent on its agricultural characteristics and favorable conditions that would enable it to produce grain and soybean cost-effectively and at a large scale. For example, despite the best efforts of several Middle Eastern countries to invest in developing agricultural sectors, the natural characteristics of these countries have made the significant development of grain and soybean production nearly impossible. In other words, location, weather, precipitation and adequate rainfall or irrigation are the primary factors required for the development of reliable grain and soybean supply. These conditions are only available in selected regions of the world.

2.4.1.1.1. Production Cost

Production costs in particular, beyond being an integral determinant of producers' decisions of what and when to produce (as discussed in earlier sections of this report), play a very important role in the relative competitiveness of domestically produced grain and soybean on a global marketplace and therefore indirectly impact the international competitiveness of U.S. crops. **Figure 15** shows the relative magnitude of different cost factors[11] in U.S. soybean production in 2013. It is clear from the plot that (1) allocated costs are more significant than opportunity costs and that more importantly (2) the opportunity cost of land (i.e. the land rental rate) makes up the most significant portion of cost. Analysts attribute this portion of the total U.S. production cost to the cost competitive disadvantage of the United States with respect to its South American competitors, where land is less expensive per acre planted. In fact, a study by the ERS in early 2000 shows that the land rental rates in Brazil (Mato Grosso) were at \$6 to \$14 per acre compared to \$88 in Argentina (northern Buenos Aires) and \$63 in the United States (heartland region). On the other hand, the United States has an operating cost advantage over its South American competitors whereby, in 2007, the total U.S. variable costs stood at \$77.88 per acre compared to \$92 per acre for Argentina and \$115 to \$129 per acre for Brazil, predominantly attributed to higher fertilizers and chemical costs in Brazil and higher hired labor costs in Argentina[12]. However, the total cost is still higher in the United States compared to South America due to the significant difference in fixed costs. In fact, a report[13] by the Agricultural Market Service of the USDA illustrates this cost contrast where U.S. Midwest (in the main producing areas) costs stand at \$9.62 per bushel, higher than \$7.14 per bushel in Argentina and \$8.15 per bushel (*Mato Grosso*) or \$7.68 per bushel (*Parana*) in Brazil. Such a comparison shows that strictly speaking, the United States is not the most cost competitive in terms of production. Policies in different countries do also play a role in cost structures as will be discussed later in this report**.** However, what it lacks in cost advantage, it makes up in infrastructure and significant scalability, namely production volume, as will be examined in the following section.

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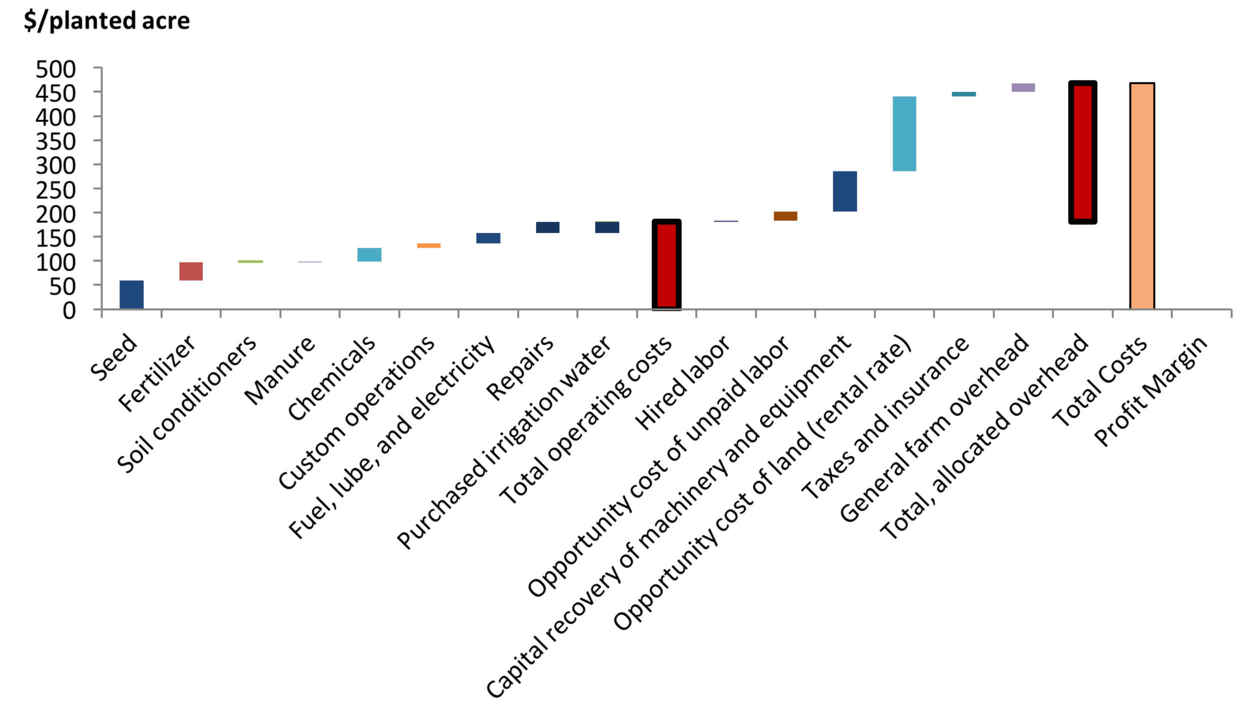
[11] ***The cost segmentation in this plot follows the ERS, USDA data classification.***

[12] ***Improving Transportation Infrastructure in Brazil: An Analysis Using Spatial Equilibrium Model on the World Soybean Market, Rafael F. Costa, C. Parr Rosson, III, Selected Paper prepared for presentation at the American Agricultural Economics Association Meeting, Portland, OR, July 29-August 1, 2007.***

[13] ***Salin, Delmy L. and Agapi Somwaru. Eroding U.S. Soybean Competitiveness and Market Shares: What Is the Road Ahead? U.S. Dept. of Agriculture, Agricultural Marketing Service, August 2014.***

Figure 15: Cost of Soybean Production in the US and Total Gross Value of Production Comparison

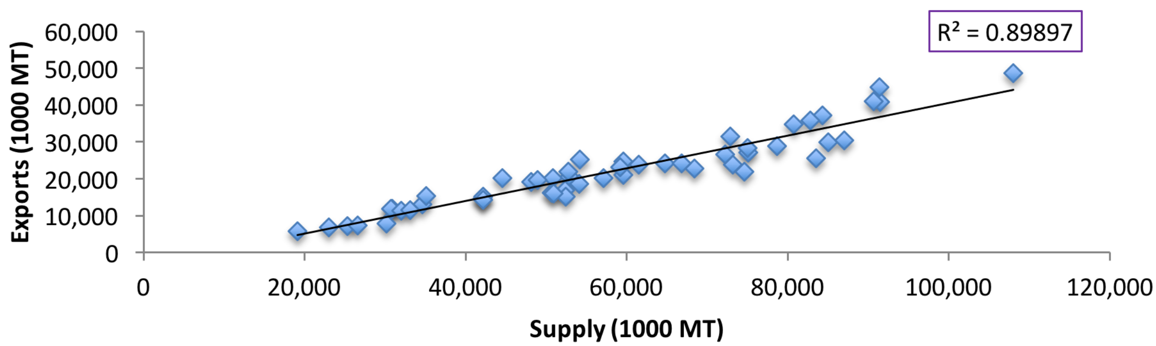


Source: Authors, data from ERS, USDA; see footnote (17)

2.4.1.1.2. Production Volume

In addition to production cost, production volumes are a key determinant of whether the country has the ability to scale crop volumes upwards to the extent needed to feed its population domestically, ensure food security and still have a surplus available for export, all the while remaining relatively cost competitive (which is the challenge Middle East producers cannot overcome). For that reason, and with the objective of testing how well production volumes and export volumes are correlated, we conducted a correlation analysis on both sets of metrics, displayed in **Figure 16**. The data suggests that there is a high correlation between production and export volumes exhibited by the large magnitude of the coefficient of determination ($R^2 = 0.9$).

Figure 16: Soybean Production and Exports for the U.S. (1964-2014)



Source: Authors, data from FAS, USDA

2.4.1.1.3. Production Quality

Finally, production quality is also a key component to international customers as they often have very strict quality requirements. Some requirements such as non- genetically modified corn or soybean are relatively easy to meet. Others pose various challenges to U.S. exporters. An example is wheat free of U.S. pests which imposes a difficulty for inspections at U.S. export facilities that do not have the adequate supervision expertise or time availability to efficiently identify even a portion of weed seeds prevalent in the wheat, incurring a constraint on export flows. This is an example that is gaining importance and seen as a direct threat for the United States losing long-time customers[14]. Wheat, in fact, is the most sensitive crop to quality, with several tests[15] included in trade contracts of wheat attesting to that. These tests determine the classification of wheat and hence its price. North Dakota agricultural stakeholders also confirmed the importance of quality for export and mentioned that some of the elevators might refuse to purchase and store wheat due to its high cost of conditioning even at the level of handling in elevator storage bins.

The section above has shown that several aspects of domestic production are critical in giving the United States a competitive edge and thus securing a place for it as a major global player. However, production has to be complemented by a reliable, resilient, efficient and cost-effective transportation system to be able to enable the United States to maintain a good competitive position internationally. The next section of the report will discuss the factors needed for a robust transportation system.

2.4.1.2. The Transportation System

Several attributes of the transportation system are important to address in the discussion of the role of the transportation system on the market competitiveness of the United States. Below we will focus on transportation costs and service performance.

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[14] ***Comments Regarding Foreign Trade Barriers to U.S. Exports for 2015 Reporting USTR-2014-0014, Full NTE Submission 28 October 2014, U.S. Wheat Associates.***

[15] ***Tests include:** (1) Test Weight (2) Protein (3) Moisture (4) Shrunken/Broken Kernels (5) Foreign Material (6) Total Defects/Damage (7) Sour/Musty (8) Contrasting Classes (9) Deoxynivalendol (DON) or Vomitoxin (10) Falling Numbers and (11) Vitreous Kernels; Reference: O'Brien, D. M. and F. Olson 2014. "The Competitive Position of the Black Sea Region in World Wheat Export Markets." Proceedings of the NCCC-134 Conference on Applied Commodity Price Analysis, Forecasting, and Market Risk Management. St. Louis, MO.*

2.4.1.2.1. Transportation Cost

Cost considerations are very crucial to grain and soybean shippers as they seek to maximize profit by, in part, minimizing total transportation cost. Several options could be available to shippers for domestic transportation including (1) barge, (2) truck and (3) rail. The mode choice is predominantly made based on origin-destination locations as well as shipment size and commodity type. Additionally, infrastructure suitability and shipper requirements affect the specific modal services utilized. For grain and soybean, rail is an attractive mode because it is a low-value, high volume, bulk commodity that travels long distances. However, where barge is available and reliable, shippers often choose that mode as it could offer lower per-unit cost. Transportation costs include fixed cost (land, construction, rolling stock) and operating costs (maintenance, labor, fuel). The rest of the report will focus on rail costs as trucks are predominantly used for domestic end-use and barges are limited in geographic scope.

To appreciate the importance of transportation in market competitiveness, it is instructive to compare transportation costs in the United States to competitive countries. An analysis by the AMS/USDA suggests that transportation costs provide a competitive edge for the United States over its South American competitors. This is manifested in the total transportation cost constituting only 15% of the total landed cost[16] of U.S. soybean to Shanghai, China compared to a range between 14% and 28% for Brazilian soybean to the same destination[17]. This could be attributed to innovations introduced by railroads in the United States to make export shipping more efficient, most importantly the shuttle (blocked train) system. Shuttle systems are 110 railcar unit trains that travel as a single block of railcars from origin to destination, with no need for processing (disassembling inbound trains and reassembling outbound trains) at classification yards. This enables the rail company to reduce transit times by eliminating intermediate stops and associated delays, and turn around their assets faster to maintain higher service rates, hence deliver greater capacity. In addition to providing these higher service levels, the rail industry has also been able to achieve some reduction in operational cost (albeit partly offset by needed capital investment) that translates into lower rates for shippers. However, several analyses show that even with this cost advantage, the United States can lose competitiveness and market share if improvements in infrastructure are made in competing countries (Argentina and Brazil) without a parallel investment in U.S. infrastructure[18].

2.4.1.2.2. Transportation Performance

As explained in the previous section, shuttle trains add significant efficiency to the grain and soybean export transportation system. However, several factors can interfere with the performance of the system. In the section below, we discuss some of the railroad service problems that occurred during 2013 and 2014 in order to explain some of the dynamics behind grain and soybean transportation.

A report by AMS/USDA in January 2015[19] presents an exhaustive analysis of the transportation service problems encountered in 2013-2014 to suggest that service problems could be explained form both supply

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16 *Total landed cost = total transportation cost (for truck, rail and ocean) and farm price.*

17 *See footnote 19.*

18 *References include (1) source in footnote 13, and (2) Improving Transportation Infrastructure in Brazil: An Analysis Using Spatial Equilibrium Model on the World Soybean Market, Rafael F. Costa, C. Parr Rosson, III, Selected Paper prepared for presentation at the American Agricultural Economics Association Meeting, Portland, OR, July 29-August 1, 2007.*

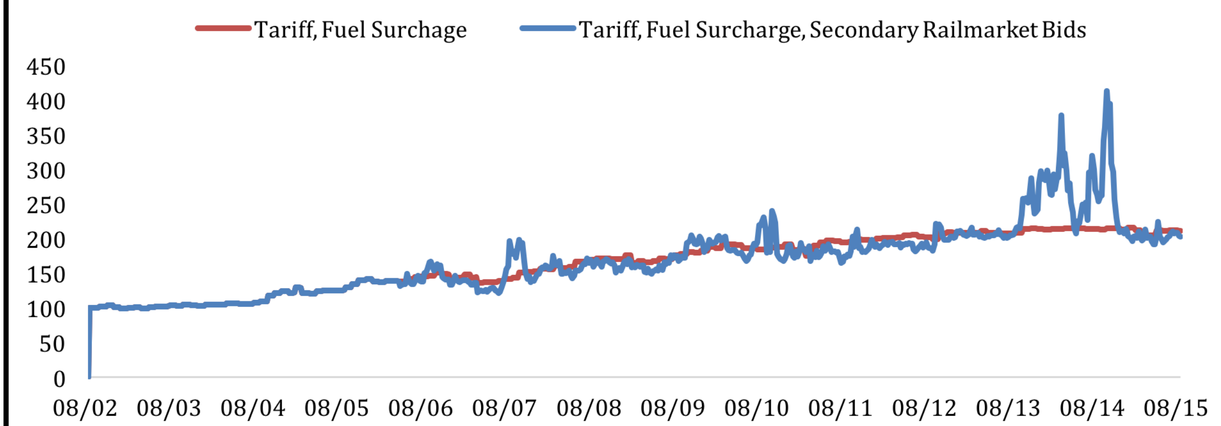
19 *Rail Service Challenges in the Upper Midwest: Implications for Agricultural Sectors – Preliminary Analysis of the 2013 – 2014 Situation, United States Department of Agriculture Office of the Chief Economist and the Agricultural Marketing Service, January 2015.*

and demand sides. Below, we summarize the main points. On the ***supply side*** problems include (1) reduced rail capacity, (2) track maintenance and expansion work, (3) congestion, and (4) a cold winter. On the ***demand side*** the challenges encompass (1) changing commodity traffic mix, (2) traffic growth, (3) record U.S. and Canadian grain and oilseed harvest (leading demand to exceed rail capacity), and (5) seasonality of grain and oilseed shipping. In this discussion, we focus more closely on three aspects **(i)** the manifestation of the problem i.e. how can we detect that service problems occurred? **(ii)** Traffic growth and changing traffic commodity, and **(iii)** reduced rail capacity or congestion.

2.4.1.2.2.1. Service Problem Manifestation

Available data from the USDA allows comparison between historic weekly rail rates including and excluding secondary market rates. An increasing difference between the two indicates increasing difficulty in the allocation of cars in the secondary market, and hence more competitive bids and higher rates. The difficulty of obtaining cars in the secondary market is a direct measure of unusual behavior or performance of the rail system. Interpreting **Figure 17** from this perspective suggests that service problems occurred between 07/03/2013 and 09/03/2014 (with the exception of February to April 2014). Contributing factors to the observed fluctuations are next examined.

Figure 17: Weekly Shuttle Train Rates (2002-2015) [2000=100]



Source: Authors, data from FAS, USDA

2.4.1.2.2.2. Traffic Growth, Rail Capacity Limitations and Congestion

Rail congestion affects railroad operations and causes a threat to the competitiveness of the United States in the global market both in terms of less competitive prices due to higher shipping costs but also, due to product delivery reliability that is very much valued in trade. During normal conditions, and uncongested circumstances, an increase in the number of carloads on the tracks should not incur a decrease in average train speed. Conversely, when the opposite relationship occurs, it is usually an indication of congestion. A look at average train speed versus total carloads on the system between 2004 and 2014 (See **Figure 18**) indicates that starting 2012, an increase in the number of total carloads was associated with a decrease in average train speed, which is a sign congestion or a potential argument of additional traffic imposing pressure on the system.

Figure 18: Total Carloads and Average Train Speed (2004-2014)

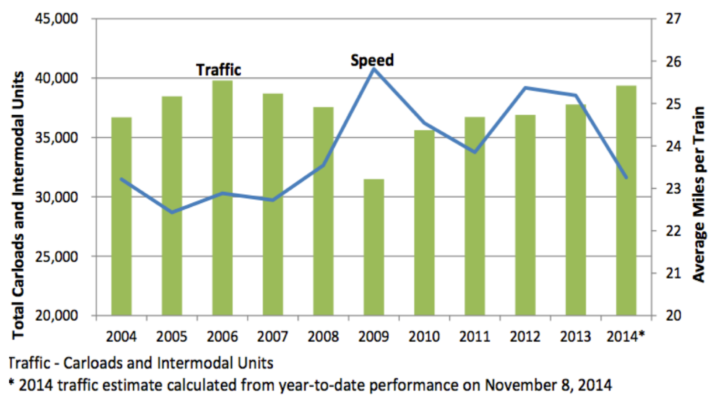


Figure Source: AMS, USDA; see footnote (22)

Some of the factors that could have contributed to this congestion as put forward by the USDA study are discussed below.

2.4.1.2.2.3. Traffic Mix Growth

The railroads are witnessing a significant increase in the mixture of traffic whereby new industries are emerging as strong demanders of railroad capacity. A closer look at the percent change in railroad commodity uses available in **Figure 19**, indicates an increase in railroad use, most significantly expressed for petroleum and petroleum products, grain (and soybean) and nonmetallic minerals respectively. The implications of such observation is the increasing demand among commodities for the same rail capacity and crews, creating an increasing pressure on railroads to efficiently allocate resources across these sectors. Fast changes in mixture imply less predictability and planning time for railroads to account for it.

Figure 19: Growth in Traffic Mix (2013-2014)

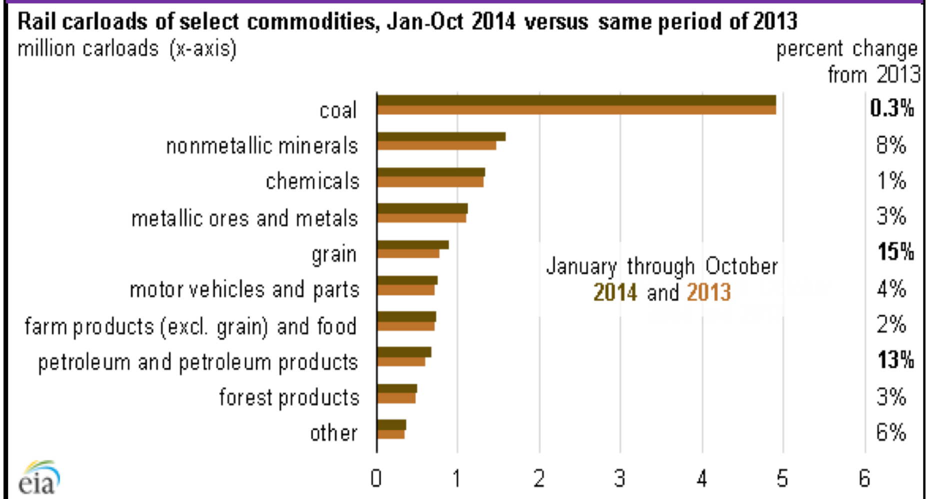


Figure Source: U.S. Energy Information Administration (EIA)

The effect of the increasing mix on grain (and soybean) traffic could be further understood through **Figure 20** where the lower-than-expected growth in BNSF's grain (and soybean) carloads beginning in the 4th quarter of 2013 show the negative impact of growth of traffic and mix on grain (and soybean). The increase is seen to be insufficient given the record harvest, and previous year's drought-impacted harvest.

Figure 20: Growth in Traffic Rail Mix (2013-2014)

Table 1: Increase in Total Cars Year-over-Year (BNSF)

	Coal	Crude Oil	Frac Sand	Intermodal	Grain	Fertilizers	Ethanol	All Commod.
1Q12	(23,409)	13,993	7,057	24,306	(2,010)	(1,677)	(607)	74,578
2Q12	(51,896)	24,718	3,775	9,016	(15,494)	(767)	(1,685)	37,839
3Q12	25,210	36,450	2,865	(16,608)	(6,510)	(790)	(3,128)	127,108
4Q12	(82,712)	46,814	1,765	(20,639)	(24,248)	50	(4,014)	(33,338)
1Q13	(17,867)	50,451	2,048	10,840	(22,144)	1,042	(1,799)	73,896
2Q13	30,088	49,949	4,197	3,511	(28,446)	(827)	362	88,375
3Q13	29,751	30,550	5,913	39,855	(2,988)	(757)	2,047	130,552
4Q13	14,195	29,738	3,912	52,963	16,050	(735)	2,053	139,626
1Q14	19,878	18,390	579	(2,515)	5,437	(2,307)	2,260	22,833
2Q14	30,275	11,650	6,451	12,168	23,699	241	1,367	116,069

Source: Surface Transportation Board, *Quarterly Freight Commodity Statistics*

Figure Source: AMS, USDA; see footnote (25)

This analysis was summarized with the objective of understanding the dynamics behind the grain and soybean movement. That said, the results suggest that a careful look at both the magnitude of traffic as well as the mixture of traffic are essential to providing adequate transportation services in the future.

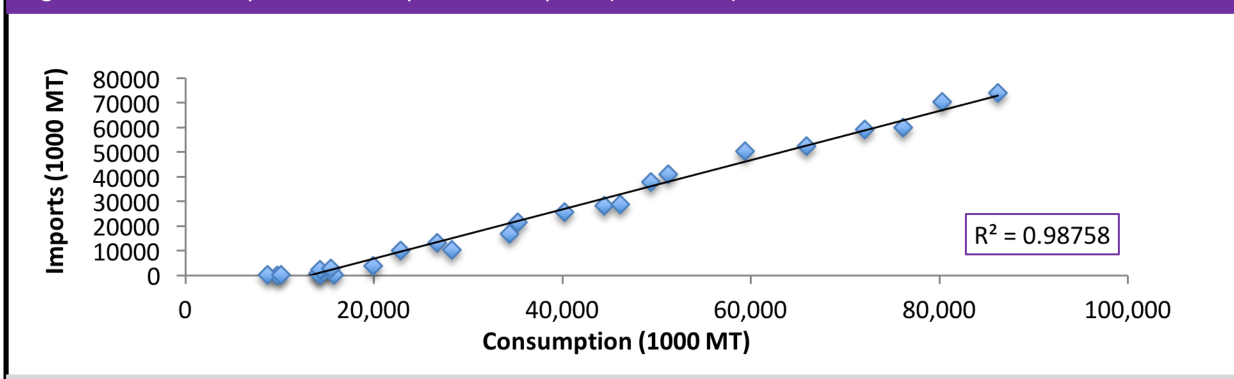
2.4.1.2.3. Changes in the Transportation Infrastructure

Aside from shuttles, changes in waterway transportation could boost the efficiency of grain and soybean export infrastructure and in turn increase the U.S. competitiveness. An example is the expansion of the Panama Canal. The Panama Canal is critical to U.S. grain and soybean exports as it handles three out of every ten bushels of grain and soybean exports in the United States, more than half the Texas Gulf exports and nearly thirty percent of the Atlantic Coast exports. For soybean specifically, the Panama Canal handles 44% of total U.S. exports, 63% of the soybean transiting through the Center Gulf, 57% of those transiting through the Texas Gulf, and more than half the volume exported through the Atlantic Coast. The expansion provides several advantages to U.S. exports by: **1)** allowing for the passage of larger container vessels at deeper drafts, where shippers can take advantage of economies of scale and by that reduce the cost of long-haul trans-ocean shipping of from U.S. ports to Northeast Asia, **2)** doubling the capacity (i.e. a larger loading per vessel) which will mean less congestion and therefore improved reliability and **3)** lower canal transit time, therefore increasing speed and in turn the service quality. All of these operational and logistical improvements will translate into lower shipping cost and therefore more competitive prices that would enable elevators to entirely meet the sizeable capacity needs of destination-markets that require bigger vessels with larger draft capabilities. Studies show that the entities that will benefit most from cost savings include: **1)** companies producing products for export, **2)** ocean carriers that are able to pass the cost savings to their clients, **3)** other carriers in the supply chain because of the extra pricing power and **4)** U.S. consumers.

2.4.2. Import Dynamics

In this section we discuss one final determinant of global trade, particularly with respect to imports. The first section of the report highlighted the importance of population growth with respect to stimulating grain and soybean consumption. It is natural then that population growth would also be correlated with import of grain and soybean for countries with insufficient production to meet consumption needs (affected by population growth). Data used in plotting **Figure 21** indicates that in fact they are highly correlated.

Figure 21: China's Soybean Consumption and Imports (1990-2014)



Source: Authors, data from FAS, USDA

2.5. Price Dynamics

As was mentioned previously, prices are largely determined by the interaction between supply and demand and therefore by many of the factors that were presented above. The approach we take in this section to understand price formation is studying prices in the context of food crises and the determinants that led to price spikes during those crises.

2.5.1. Food Crises Causes

Food crises, traditionally correlated with a surge in food prices, are important to discuss as they highlight key dynamics behind global price formation. While (1) there still is a debate on what could be considered as a direct, indirect or a cause at all, and (2) some factors are very hard to isolate and quantify, literature offers insights into key elements to consider when looking for causes of global food crises. These elements are most often discussed in the context of three major crises: (1) 1972-1974, (2) 2006-2008 and (3) 2010-2011. What is in fact common of the phase preceding the surge in prices for these three periods is **(a) the rise in energy prices, (b) the devaluation of the U.S. dollar**, **(c) trade shocks and (d) weather shocks**. The reason behind the impact of these events on food prices will be further discussed in this section.

2.5.1.1. The Rise in Energy Prices[20]

Various reports and analyses highlight the significant link between international fuel prices and food or agricultural commodity prices more broadly. This link can be understood through several intermediaries: *(1) energy inputs used in agricultural production, (2) prices of fertilizers, (3) transportation costs and (4) cross-sectorial demand such as biofuels*.

First of all, most commodities in general have a significant portion of their input costs derived from oil or oil-related products primarily for transportation and extraction, which make up a large share of their production cost. This is even more so in the supply chain of agricultural commodities, which is almost exclusively dependent on oil for its energy use. In fact, data indicate that agriculture is second only to transport in the oil intensity of its energy usage. This all shows the significant role that changes in energy prices could play in production costs and therefore in food prices. Second, energy prices can also have an effect on food prices through the impact of fertilizers, a petrochemical product produced from natural gas, which is an essential component of agriculture. In fact, fertilizers supply costs are highly dependent on energy prices where it can constitute up to 90 % of their production costs. The other link between energy prices and food prices is transportation, which is highly dependent on fuel, especially with the increase of global agricultural trade over the past several decades.

2.5.1.2. Depreciation of the U.S. dollar

Many analysts in literature have tried to quantify the effect of the depreciation of the U.S. dollar on the price of agricultural commodities (and on their exports). The role of the dollar stems from the fact that global prices for most commodities in general (including agricultural commodities) are denominated in U.S. dollars in the international market. Thus when the dollar weakens, food prices are relatively more expensive in the United States and cheaper in the rest of the world, all else being equal. This increases the global demand for dollar-denominated agricultural commodities due to the increase in global purchasing power, in turn driving prices up. The report by the International Food Price Research Institute[21] synthesizes research that found that depreciation of the U.S. dollar increases dollar commodity prices with

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[20] ***See footnote (26).***

[21] ***Reflections on the Global Food Crisis How Did It Happen? How Has It Hurt? And How Can We Prevent the Next One? By Derek Headey and Shenggen Fan, IFPRI (international Food Policy Research Institute), 2010.***

elasticity between 0.5 and 1.0. Other research suggests that depreciation of the dollar by 22 % increased food prices by about 20 percent, assuming an elasticity of 0.75. The same research uses USDA's agricultural trade-weighted index of real foreign currency per unit of deflated dollars, to find that from 2002 to 2007, when the U.S. dollar depreciated by 22 percent, the value of agricultural exports increased 54 percent.

2.5.1.3. Trade Shocks

The most common examples of trade shocks (defined as export restriction or import surges) as driver of food crises are the wheat shock in 1972-1974 driven by the large demand from the Soviet Union and the surge in Chinese import demand in 2004-2008. Aside from demand, export restrictions can also result in significant trade shocks. An example is the Russian export ban in 2010. According to an Oxfam report[22], the immediate impact of the ban was an additional rise in prices by impeding the ability of Russian agricultural commodities (Russia was a net exporter of agricultural goods, primarily grain) to reach the global market, thus signaling a "tighter" supply/demand balance in the global grain market.

2.5.2. Food Crises Manifestation: Price Surges

The implications of the factors discussed in this report are increases in food and agricultural prices delineating a period of food crises. Two such periods occurred in the last decade: one in 2006 and another one in 2010. **Figure 22**, shows the historic price indices for food, cereal and oils[23]. Both crises are very clearly manifested with jumps in prices. Another apparent trend is the unprecedented increase in food prices in the past decade. From the lows in 2000, food prices increased by 46% in total and 2.6% annually[24], cereal prices by 51% (CAGR: 2.7%) and oil prices by 66.6% (CAGR: 3.46%). Prices have however been dropping from the peak in 2012 to values in 2015 below July 2010 values after a slowdown in the global economy and strong harvests especially in the United States.

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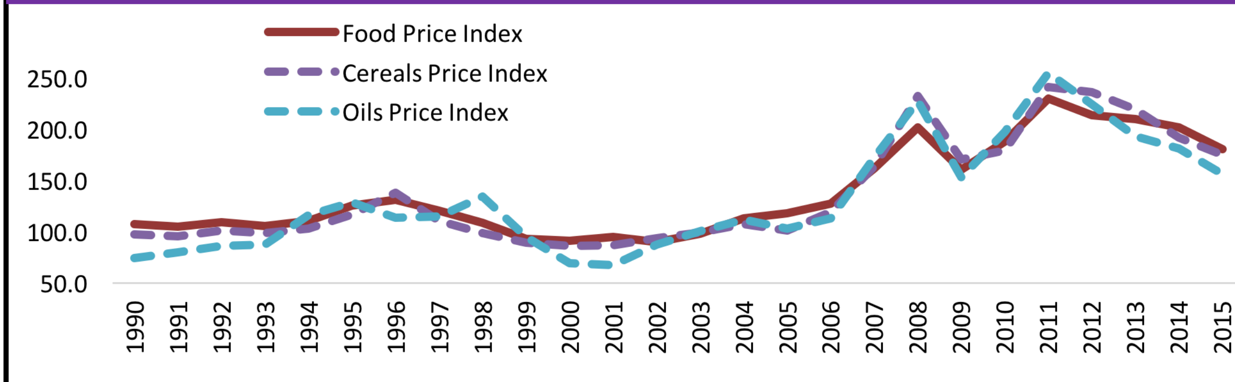
22 ***The Impact of Russia's 2010 Grain Export Ban, Oxfam Research Report, June 2011.***

23 ***<u>Indices definitions as taken from the data set:</u> Food Price Index: Consists of the average of 5 commodity group price indices (meat, dairy, cereal, vegetable oil and sugar) weighted with the average export shares of each of the groups for 2002-2004: in total 73 price quotations considered by FAO commodity specialists as representing the international prices of the food commodities noted are included in the overall index. Each sub-index is a weighted average of the price relatives of the commodities included in the group, with the base period price consisting of the averages for the years 2002-2004; Cereals Price Index: This index is compiled using the International Grains Council (IGC) wheat price index, itself an average of 10 different wheat price quotations, 1 maize export quotation and 16 rice quotations. Within each variety, a simple average of the relative prices of appropriate quotations is calculated; then the average relative prices of each of the three varieties are combined by weighting them with their assumed (fixed) trade shares. Subsequently, the IGC wheat price index, after converting it to base 2002-2004, the relative prices of maize and the average relative prices calculated for the rice group as a whole are combined by weighting each commodity with its average export trade share for 2002-2004; Vegetable Oil Price Index: Consists of an average of 10 different oils weighted with average export trade shares of each oil product for 2002-2004.***

24 ***Annual growth rate is calculated as a compound annual growth rate (CAGR) given by: ((Final Value/Initial Value) ^ (1/number of years)) – 1.***

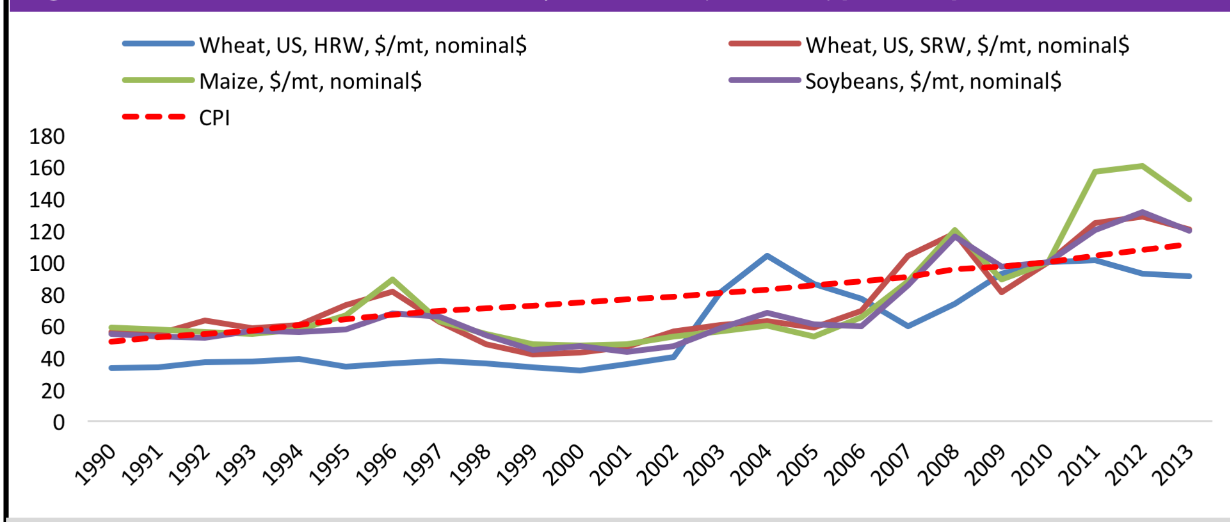
Figure 22: Annual World Nominal Food Price Indices (1990-2015) [2002-2004=100]



Source: Authors, data from Food and Agriculture Organization (FAO) of the United Nations ; see footnote (29)

We also looked at the international prices of U.S. agricultural commodities (See **Figure 23**). The plot shows that U.S. international prices follow a similar trend to food prices discussed earlier, in the sense that they have increased at an unprecedented rate for the past 15 years. Plotted next to the Consumer Price Index (CPI), price data indicates that after 2011, grain prices have increased more significantly than the typical basket of consumers' commodities. **Figure 24** also plots monthly prices for 2014 through October. For the period after 2013, data suggests that in the first quarter of 2014, international wheat prices[25] increased by 18% and corn prices rose by 12%. After that, between April and August 2014, international food prices declined by 6%, hitting a four-year low and fully reversing price increases in the first quarter of 2014. In particular, wheat prices decreased by 27% and maize prices fell by 25%.

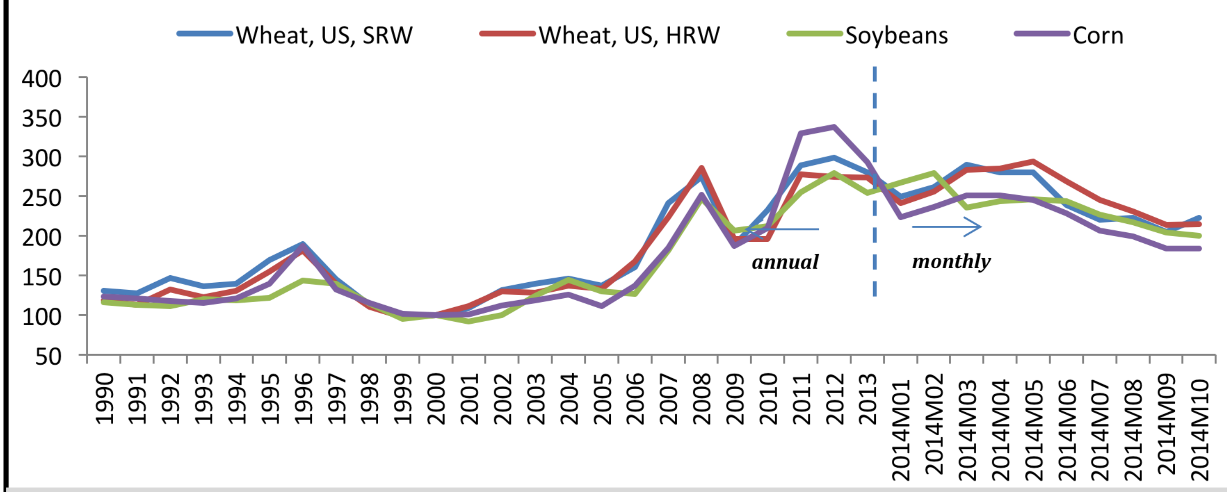
Figure 23: World Benchmark Prices of Grain, Soybean and CPI (1990-2014) [2010-100]



Source: Authors, data from the World Bank

25 *Original source as mentioned by the World Bank: SRW: USDA, WB; HRW: Bloomberg,USDA,WB: Soybean: ISTAmoilworld,USDA,WB; Corn: USDA,WB; *Wheat and Corn : export price delivered at U.S. gulf; Soybean: C.i.f. Rotterdam.*

Figure 24: Index of World Benchmark Prices of Grain (1990-2014) [2010=100]



Source: Authors, data from the World Bank

3. Global Trade

After examining factors driving global trade dynamics in the previous section, this section turns to quantify historical regional trends that shaped the current global trade map. While the objective of the previous section was to understand the forces underlying global trends more broadly, here we seek to understand how they can be characterized for different countries. In other words, we aim at answering questions such as: *who are the major global trade players? How has trade of grain* and soybean *evolved over time? Is it stable? To what extent do major global players' trends reflect some of the factors discussed in previous sections?*

The section starts with an identification of the major global players, then turns to major supply and demand trends, and then moves to major export and import trends in the global market. Finally, this section will conclude with an outlook for global grain and soybean trade going forward.

3.1.Major Grain and Oilseed Traders

Many entities form the global grain and soybean market, from producers, grain and soybean elevator owners/operators and major grain and soybean trading houses to governments and end-users. Below, we identify the major producers, consumers, importers and exporters of grain and soybean, in the objective of (1) gaining a general overview of the major players shaping the market and (2) identifying three major trends to look at for the rest of the report. The rankings[26] (see **Table 1**) show that the **United States** is a top producer of corn and soybean, **China** is a major consumer of soybean and producer of wheat, the **European Union (EU)** is a top producer and consumer of wheat and **Brazil** is a major producer of soybean followed by **Argentina**. These ranks are not stable over time however, and relative standings vary somewhat from one year to the next depending on relative harvests and droughts, although the major players in the global market have tended to be the same in recent years overall.

[26] *The actual volumes of production, consumption, export and import are included in the appendix of the report (Exhibit A).*

Table 1: Major Global Producers and Consumers of Grain and Soybean						
	Producers			**Consumers**		
	Corn	**SB**	**Wheat**	**Corn**	**SB**	**Wheat**
United States	1	1	--	1	2	5
China	2	4	2	2	1	2
Argentina	--	3	--	--	3	--
Brazil	3	2	--	4	4	--
European Union	4	--	1	3	5	1
India	--	5	3	--	--	3
Russia	--	--	4	--	--	4
Ukraine	5	--	--	--	--	--
Mexico	--	--	--	5	--	--
Canada	--	--	5	--		--

** **Value indicates rank**; -- indicates that the country is not in the top 5; Source: Produced by authors based on data from the Foreign Agricultural Service/USDA Office of Global Analysis.*

As for the major players in the global grain trade, the **United States** is the top exporter of corn and second largest top exporter of soybean, leaving the first place to **Brazil**. **EU** is a top exporter of wheat. Finally, China is undoubtedly the top importer of soybean**, Japan** of corn and **Egypt** of wheat (See **Table 2**).

Table 2: Major Global Importers and Exporters of Grain and Soybean

	Importers			Exporters		
	Corn	SB	Wheat	Corn	SB	Wheat
United States	--	--	--	1	2	4
Argentina	--	--	--	4	3	--
China	--	1	--	--	--	--
Brazil	--		4	2	1	--
European Union	4	2	--	5	--	1
Ukraine	--	--	--	3	--	--
Japan	1	4	--	--	--	--
Mexico	2	3	--	--	--	3
S. Korea	3		--	--	--	--
Egypt	5	--	1	--	--	--
Indonesia	--	--	2	--	--	--
Canada	--	--	--	--	5	2
Australia	--	--	--	--	--	5
Taiwan	--	5	--	--	--	--
Algeria	--	--	3	--	--	--
Paraguay	--	--	--	--	4	--

***Value indicates rank**; -- indicates that the country is not in the top 5; Source: Produced by authors based on data from the Foreign Agricultural Service/USDA Office of Global Analysis March 2015; Note: Trade definitions included in the footnote[27]; SB=Soybean*

In addition to the rankings above, some markets do not necessarily rank high on the global level but are important to mention here because they are major markets for U.S. exports. These include: Indonesia and Taiwan for soybean, Philippines, South Korea and Nigeria for wheat and finally Columbia and Peru for corn[28].

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27 *Source: PSD online at FAS, USDA tables are balanced on the different local marketing years. All trade tables contain Trade Year (TY) data which puts all countries on a uniform, 12-month period for analytical comparisons: wheat is July/June; coarse grains, corn, barley, sorghum, oats, and rye are Oct/Sept; and rice is calendar year.*

28 *For Soybean: (1) Indonesia (243,797 metric tons in December 2014), (2) Taiwan (230,474 metric tons in December 2014); For Wheat:(1) Philippines (276,527 metric tons in December 2014) which is the major export market for the U.S. in 2014, exceeding Japan, (2) South Korea*

Throughout the remainder of this report, we focus on three distinct geographical trade entities which will be most representative of global trade, exporters and importers respectively: (1) world (2) United States and (3) China. Specifically, we will examine trends in the soybean market, since it is a widely traded commodity relative to grains. We first start below by supply and demand trends.

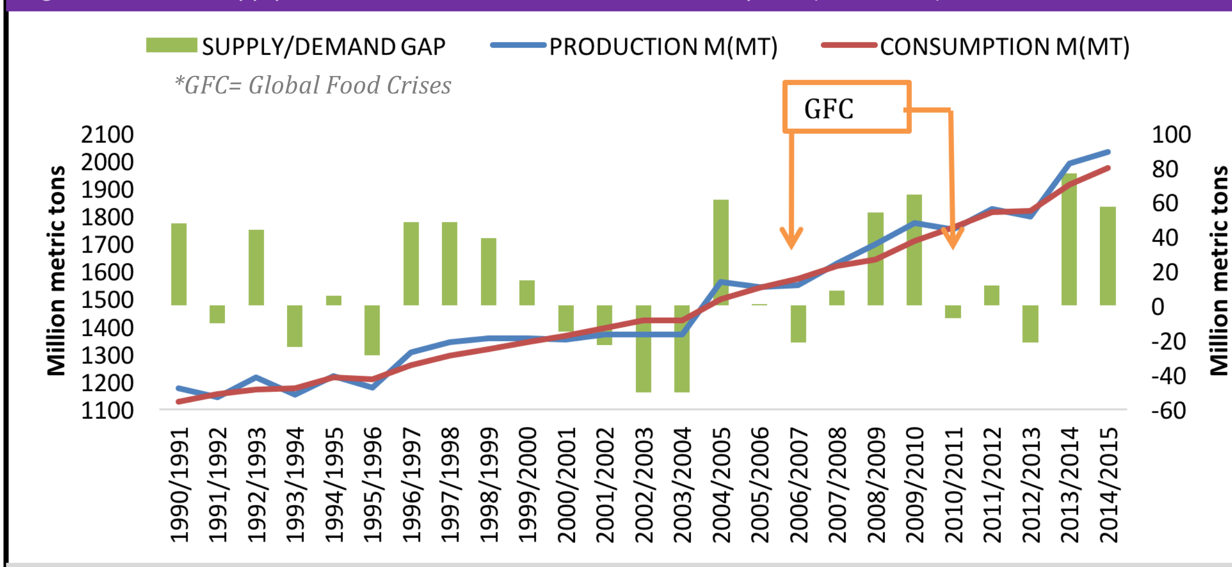
3.2. Supply and Demand Trends

Both domestic and global supply and demand trends are crucial to the understanding of the global flow of grain and soybean as they often determine prices and export and import positions among other things. Below we will present an overview of the supply and demand trends for all of the three indicative regions mentioned above.

3.2.1. Overview

Before delving deeper into the United States and China, we discuss here the overall growth in global supply and demand. **Figure 25** shows that on the global scale, both demand[29] and supply of grain (i.e. wheat, corn and) soybean have grown significantly in the past 14 years, especially when compared to the decade before that. First, for demand, the total growth between 1990 and 2000, equivalent to 21% (corresponding to a CAGR of 1.76%), more than doubled in the last 15 years summing up to 44% between 2000 and 2014 (corresponding to an annual compound rate of 2.47%). On the other hand, global supply jumped from 15 % (CAGR of 1.9%) between 1990 and 2000 to 50% (CAGR of 2.47%) between 2000 and 2014.

Figure 25: Global Supply, Demand and Net Balance of Grain and Soybean(1990-2014)



Source: Authors, data from FAS, USDA ; see footnote (35)

Global supply and demand figures are not surprising if we look at the growth in demand and supply for China in particular. In fact, while the growth was the same for supply and demand between 1990 and

(146,097 metric tons) and (3) Nigeria (120,897 metric tons in 2014); For Corn: (1) Columbia (294,604 metric tons in 2014) (2) Peru (538,257 metric tons).

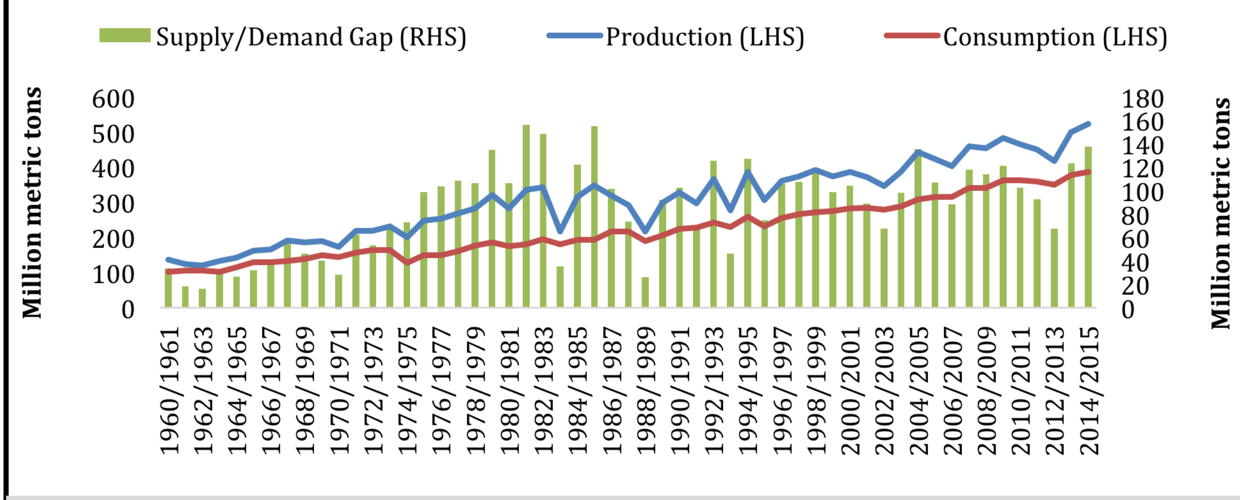
29 ***Demand = Consumption:** World totals for consumption reflect total utilization, including food, seed, industrial, feed, and waste; as well as differences in local marketing year imports and local marketing year exports. Consumption statistics for regions and individual countries, however, reflect food, seed, industrial, feed, and waste only.*

2000 amounting to a total of 24% and a compound of 1.9%, over the past 15 years, both supply and demand grew significantly albeit with supply increasing at a higher rate than demand. In fact, demand growth reached 47% in total, corresponding to a 2.62 % compound annual growth. Supply, however has reached 66% growth in the past 15 years which is equivalent to a 3.43% annual compound growth. For China in particular, it is interesting to look at cases including and excluding soybean. U.S. growth is not an exception to the previous two cases, albeit at a slower rate with similar growth for demand and supply in the past 14 years amounting to a total of 35%.

3.2.2. The United States

U.S. supply and demand trends tell a unique story where production has been consistently higher than consumption as can be seen in **Figure 26**. This means that the United States has maintained throughout most of recent history a significant grain and soybean capacity available for export. We recognize that several factors also go into that equation but nonetheless this remains a critical factor when examining the role of the United States in global trade and efforts to maintain its standing as a major global supplier. Second, we notice that demand and supply increase and decrease together, with supply fluctuating much more than demand, due to several factors from climate to trade shocks that impact relative supply levels from year to year, as was discussed in **Section 1**. Two significant decreases that we notice in production occur in 1988 and the second in 2012 both corresponding to major droughts discussed in **Section 2**.

Figure 26: U.S. Supply, Demand and Net Balance of Grain of Soybean (1960-2014)



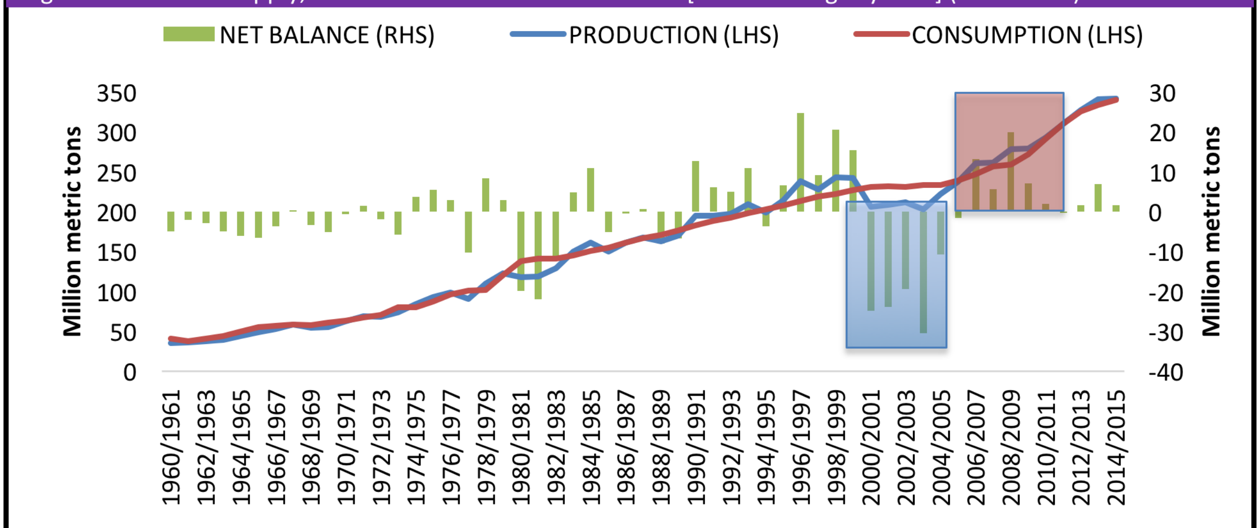
Source: Authors, data from FAS, USDA

3.2.3. China

China is unique for different reasons. While it is true that all countries have unique dynamics and approach with respect to supply and demand for different grain commodities, China in particular has adopted fundamentally different strategies across grains and oilseeds, as attested by market dynamics of grain and soybean. This is why we discuss each case separately below.

First, **Figure 27** illustrating grain market dynamics, reveals an important trend in supply and demand. In fact, beginning the early 2000s, sharply increasing consumption growth and economic expansion was accompanied by an associated production decrease where harvest declined by 18% between 1998 and 2005, from 392 to 323 million tons. This decline was due to: (1) loss of irrigation water, (2) desert expansion, (3) conversion of cropland to nonfarm uses, (4) conversion of grain land to higher value fruits and vegetables, and (5) rapid urban migration which led to a loss of rural labor[30]. All of this resulted in five shortfalls in China (from 2000 to 2005) depleting stocks throughout the years. This incentivized policymakers to intervene and expand their agricultural budget and supportive subsidies for non-soybean grain as part of China's 11th Five-Year plan (2006-2011)[31]. This resulted in a production boost where supply jumped from 377 mt (million tons) in 2005 to 500 mt in 2013, an increase of 33% in 8 years. This is an example of some of the dynamics behind supply and demand.

Figure 27: Chinese Supply, Demand and Net Balance of Grain [i.e. Excluding Soybean] (1960-2014)



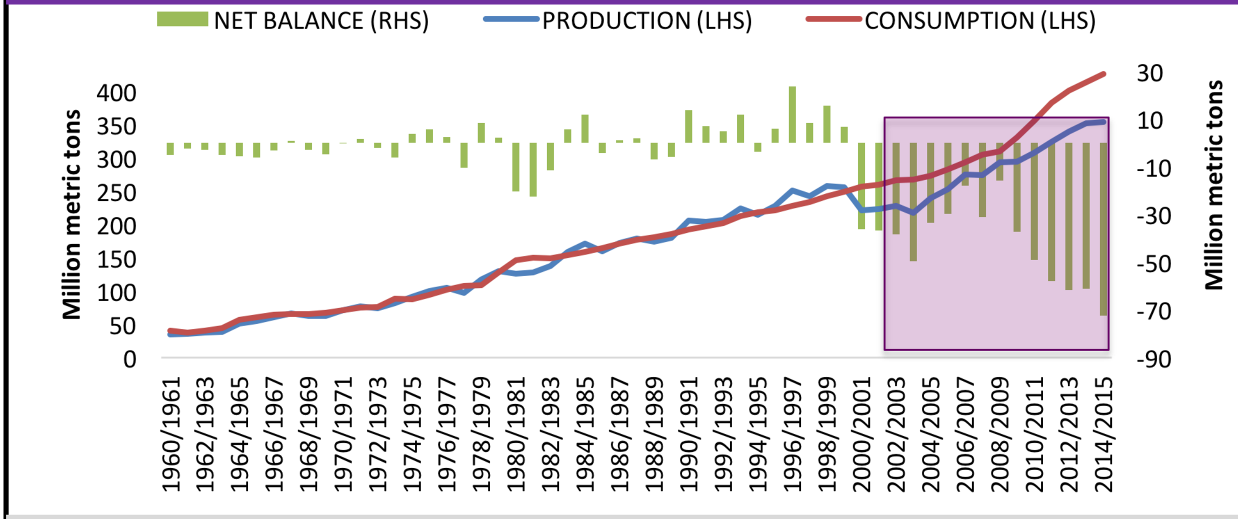
Source: Authors, data from FAS, USDA

On the other hand, when we look at supply and demand of grain and soybean (See **Figure 28**), we notice an entirely different picture. Data indicates that the gap between supply and demand shifted firmly into negative territory after 2000, a difference with the previous analysis which could be predominantly explained by soybean. In fact, our analysis indicates that China was producing15 MMT of soybean in 2000 and consuming 26 MMT compared to a production of 12 MMT in 2014 contrasted to 86 MMT in consumption. China's apparent neglect of soybean production likely reflects a political decision over the past few decades to focus on being self-sufficient in grain. While the substitution of production between different commodities and governmental policies are two important dynamics here, another is that the growth of this gap highlights the birth of the world's largest importer of soybean.

30 ***China's Shrinking Grain Harvest: How It's Growing Grain Imports Will Affect World Food Prices, Lestler Brown, March 10, 2004.***

31 ***China's Agricultural Trade: Competitive Conditions and Effects on U.S. Exports By Joanna Bonarriva.***

Figure 28: Chinese Supply, Demand and Net Balance of Grain and Soybean (1960-2014)



Source: Authors, data from FAS, USDA

This overview of some of the major trends in global markets invites further examination of exports and imports trends which will be discussed in detail in the next section.

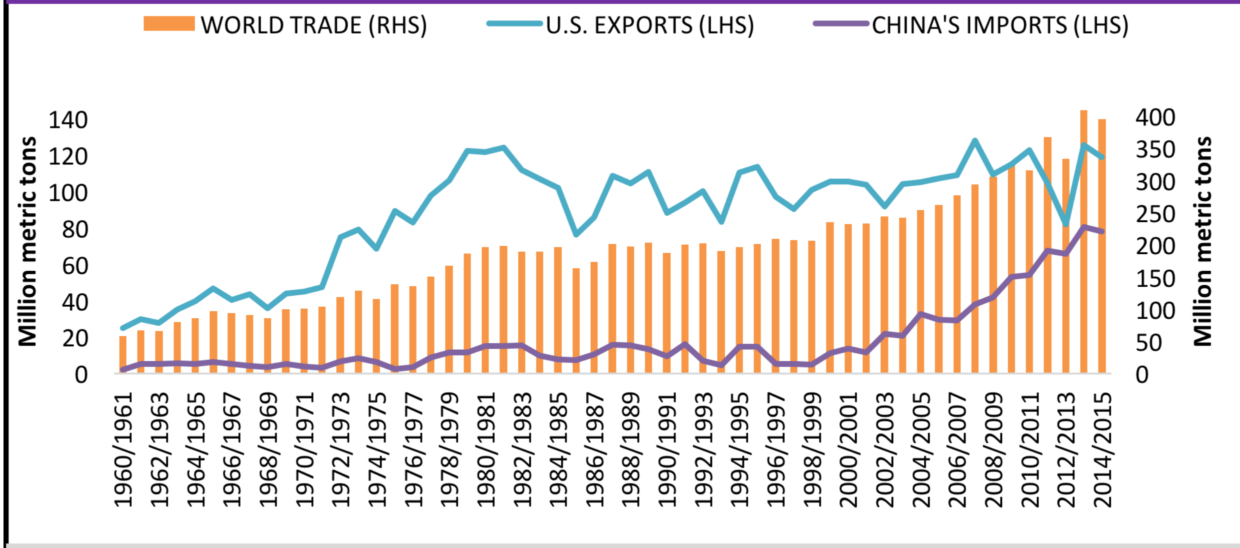
3.3.Export and Import Trends

3.3.1. Major Export and Import Trends

Similar to demand and supply, world grain and soybean trade[32] has witnessed significant growth, more so in the last 15 years than the decade before it. In fact, this is clear when we compare a 70% (Compound Annual Growth Rate (CAGR): 2.05%) growth in world trade in the last 14 years compared to a 17% (CAGR: 3.53%) between 1990 and 2000 (**Figure 29**). Again this increase is largely due to the Chinese import of grain and soybean, which grew in the past 14 years by more than a factor of 4 (total= 476%; CAGR: 14%). This is even more important if we contrast it with a moderate growth of 19% (CAGR=1.58%) between 1990 and 2000. On the other hand, the United States exhibits a reverse behavior whereby the growth in export has slowed down in the past 14 years to a total of 13% (CAGR=0.81%) compared to a total of 19.5% between 1990 and 2000. Some analysts also suggest that fluctuations starting 2006 in U.S. exports could be due to the rising competition from the Black Sea region (Russia and Ukraine primarily) with respect to wheat in particular. We will talk more about competitiveness and more specifically the U.S. share of trade further down in the section.

[32] *Definition from PSD online at FAS, USDA: Local Marketing Year (displayed as "Imports" or "MY Imports"): The quantity of a commodity declared upon entry by a country, usually at specified prices/terms, from a foreign seller during a specified 12-month period corresponding to that country's marketing year, and measured in metric tons. For wheat, USDA estimates include grain, flour, and products in grain-equivalence.*

Figure 29: Major Grain and Soybean Export and Import Trends (1960-2014)

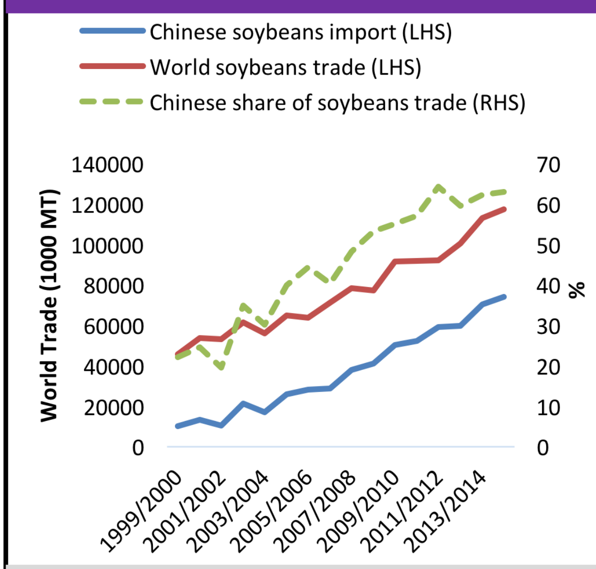


Source: Authors, data from FAS, USDA ; see footnote (38)

3.3.2. China's Position in Global Trade

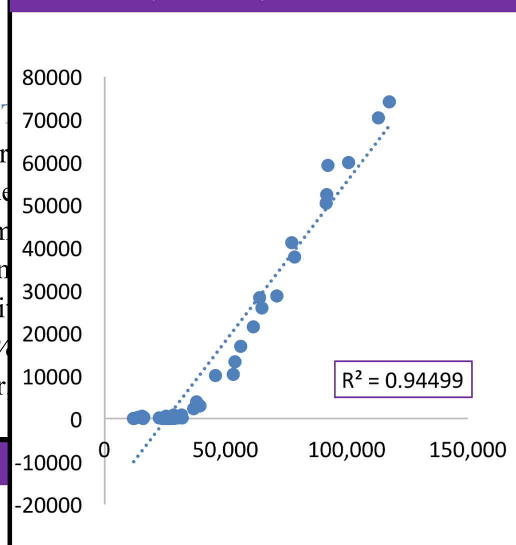
The previous section highlighted the need for China to completely depend on imports for domestic soybean consumption. This observation alone should be able to conclude then, that Chinese imports began to drive global soybean trade in 2000. This hypothesis was verified by plotting world exports of soybean and Chinese imports of soybean on the same graph (**Figure 30**) and the correlation coefficient between them (**Figure 31**). **Figure 31** shows that starting 2007, Chinese soybean imports made up more than half of the global soybean trade, thus driving this trade.

Figure 30: World and Chinese Soybean Trade (1999-2014)



Source: Authors, data from FAS, USDA

Figure 31: World and Chinese Soybean Trade Correlations (1985-2014)



Source: Authors, data from FAS, USDA

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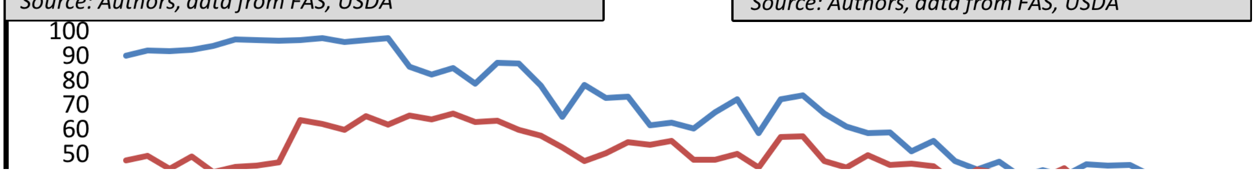


leaving 50% for the United States. Following this competition, the U.S. market share of grain declined from 56% in 1992 to 45 % in 2000 and further to 31% in 2014.

3.4.Global Trade Outlook

3.4.1. Short-Term Outlook: 2015-2016

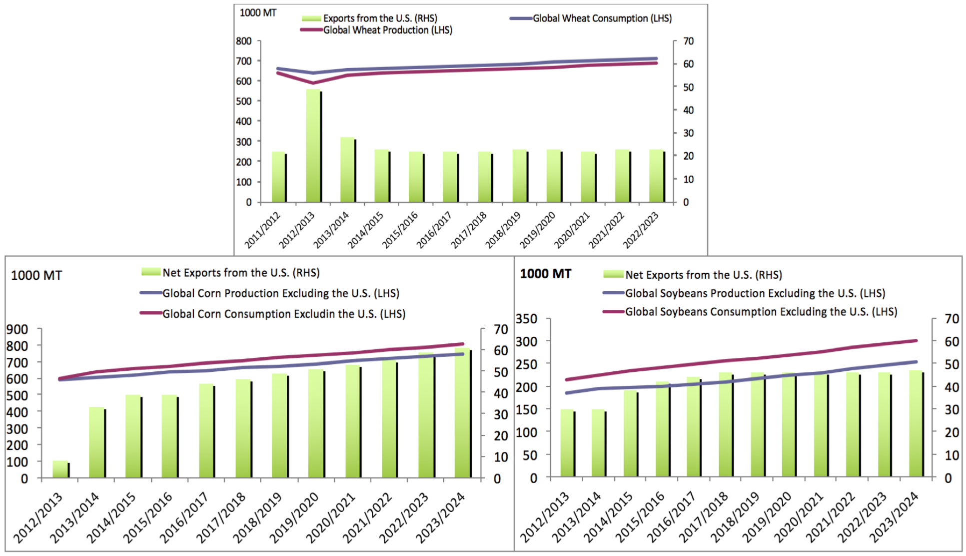
According to USDA's forecast estimations[34], China is expected to (1) continue driving global soybean trade, importing as much as two-thirds of world trade (2) exhibit a slower growth in soybean imports in 2015/2016 (3) witness increases in imports of corn along with the Europe and Union and Mexico. The United States is on the other hand expected to (1) witness increases in exports of all three commodities and (2) face competition in soybean trade because of both a stronger dollar and a record South American supply. South American supply is also going to cause challenges to U.S. wheat trade. For corn trade, in addition to South America (Argentina and Brazil) the United States will face competition from Ukraine.

3.4.2. Long-Term Outlook: 2023/2024

We were also interested in this report, in looking at the long-term global situation with the specific objective of understanding where the United States will stand. To do so, we looked at future world consumption and production excluding the United States for all three commodities, to discover that the U.S. supply of grain and soybean is needed to bridge the gap between global consumption and production (See **Figure 33**).

[34] *Source: Grains and Oilseeds Outlook, USDA, agriculture outlook forum, February 2015.*

Figure 33: World Trade Outlook of Grain and Soybean (2012-2023)



Source: Authors, data from FAS, USDA ; see footnote (40)

4. Implications of Global Developments for the U.S. Grain and Soybean Industry

After examining the forces causing fundamental changes in grain and soybean markets over the past two decades, this section will delve into the implications of global market developments on the U.S. system. In fact, the evolution of the global market is leading to a restructuring in North American grain and soybean producing regions across the supply chain as both producers and associated transportation infrastructure providers seek to improve the industry's efficiency and its relative competitiveness in an increasingly competitive global marketplace.

The relationship between the U.S. grain and soybean industry and global market developments stems from both the interest of U.S. stakeholders in reaching profitable markets internationally and their need to market their surplus in production (as discussed in previous sections). However, to be able to compete on the global market, major restructuring of both transportation and production is needed. This will be discussed next.

4.1. Opportunities for U.S. Grain and Soybean Industry in Global Trade: The Role of Grain and Soybean Prices

An interesting metric to evaluate the opportunities of export markets for U.S. firms is a comparison of U.S. prices[35] at the farm level to international soybean prices. This allows us to evaluate the threshold beneath which logistical costs of exports have to be in order for U.S. exports to be economically viable for U.S. producers. In this analysis, the international price[36] is the global benchmark price for soybean, the delivered price at Rotterdam (CIF- *including Cost, Insurance and Freight*). Examining the data in **Figure**

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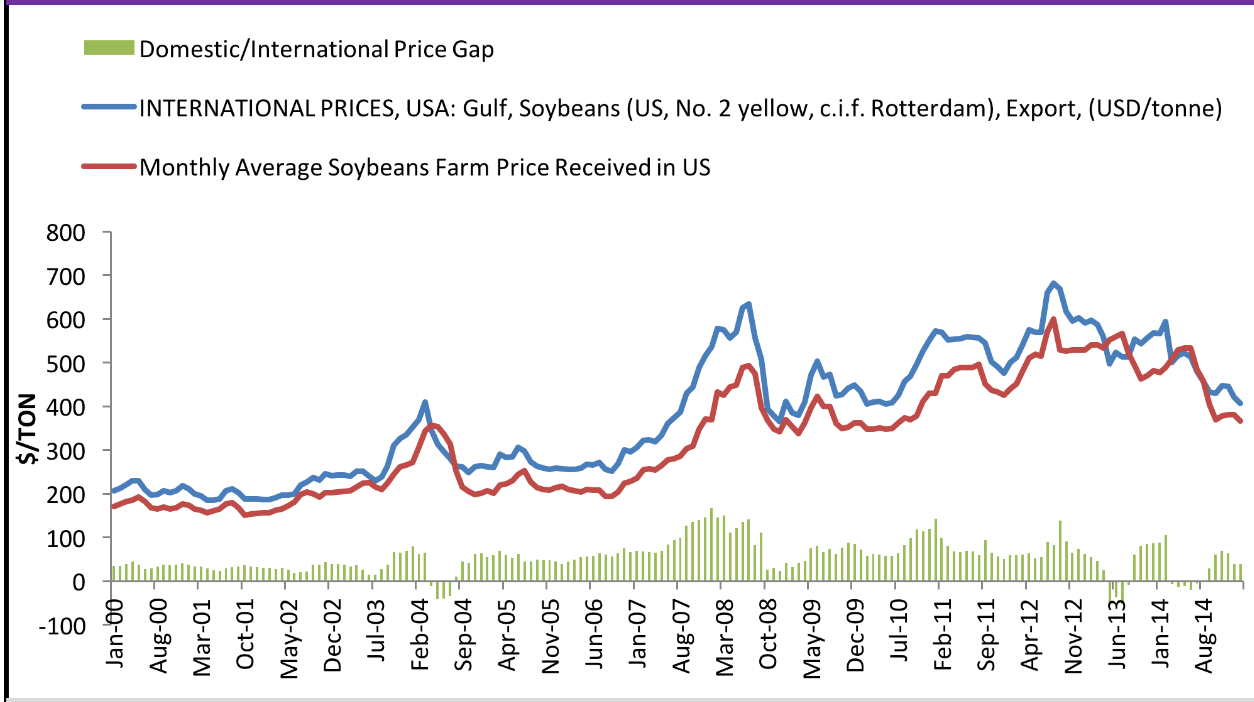
35 ***The prices at the farm level are computed by USDA as the price between the producer and the first buyer.***

36 ***International prices from FAO, domestic prices from Illinois university (farm doc).***

34, the grey bars represent the "gap" between domestic and global prices, in other words, the potential maximum profit margin. We notice that starting in 2005 the gap widened, with peaks in 2007-2008 and again in 2010. In fact, this gap, representing the profitability of exporting versus selling into the domestic market, has consistently averaged higher levels post-2005 than it did in the early 2000s. Of course, several other factors must be accounted for in the overall relationship governing export decision-making and profitability, however this is an interesting factor to look at, as it delineates the upper and lower profitability bounds within which domestic producers operate.

Figure 34: U.S. Domestic and International Soybean Prices (2000-2014)



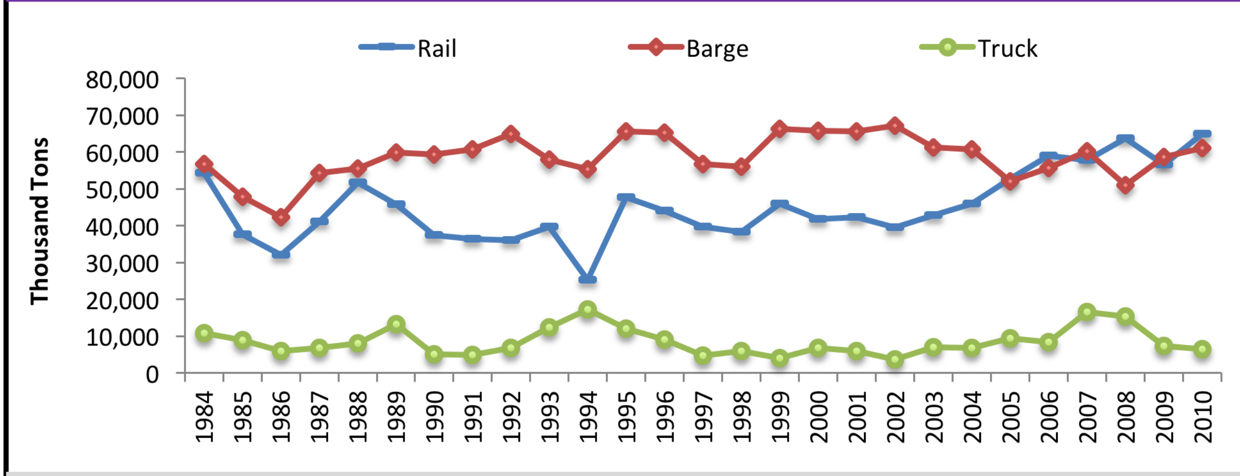
Source : Authors; see footnote (41 and 42)

It is easy enough to see from the results presented above, that transportation has a major role to play in the relative margin of profitability. Next, we turn to a more detailed discussion of transportation.

4.2. Transportation Implications of U.S. Role in the Global Market

The opportunities for U.S. grain and soybean in global markets and the desire to achieve economies of scale and reach export points to foreign markets in the most cost-effective way has created important needs from a transport standpoint: (1) capacity to move larger loads from the production region to the main export ports, and (2) lower transit times from origin to destination to minimize the time that the grain and soybean stocks are in transit, getting them to market as soon as possible while freeing up further logistical capacity for subsequent shipments. Along with barge transport, largely down the Mississippi and into the Gulf Coast from the agricultural heartland, rail is another predominant transportation mode used domestically for grain and soybean due to its flexibility in terms of destinations. To achieve these dual goals, the rail industry has responded by offering **shuttle trains**, which travel as a single block of railcars from origin to destination, with no need for processing (disassembling inbound trains and reassembling outbound trains) at classification yards. This enables rail service providers to reduce transit times by eliminating intermediate stops and associated delays and turnaround their assets faster to maintain higher service rates, hence delivering greater capacity. In addition to providing these higher service levels, the rail industry has also been able to achieve some reduction in operational cost (albeit partly offset by needed capital investment) that translates into lower rates for shippers. Looking at the share of grain and soybean moved[37] to exports by mode (see **Figure 35**) shows a jump in the movement of rail starting in 1994 (corresponding to the date of the introduction of the shuttle system) becoming the dominant mode for exports.

Figure 35: U.S. Grain and Soybean Moved for Export by Mode (1978-2010)



Source: Authors, data from AMS, USDA; see footnote (40)

Other considerations for the transport sector are the implications of the geographic location of the importing countries for specific corridor demand and activity. For example, Chinese demand for soybean is met by production regions in the Upper Midwest and is exported via Pacific Northwest ports. Thus, an increase in soybean demand from China impacts predominantly the Great Northern Corridor, linking the two regions. Indeed, the effect of international demand on the spatial distribution of U.S. grain and soybean transportation is exhibited in **Figures 36 and 37** through different shares of rail deliveries to export ports.

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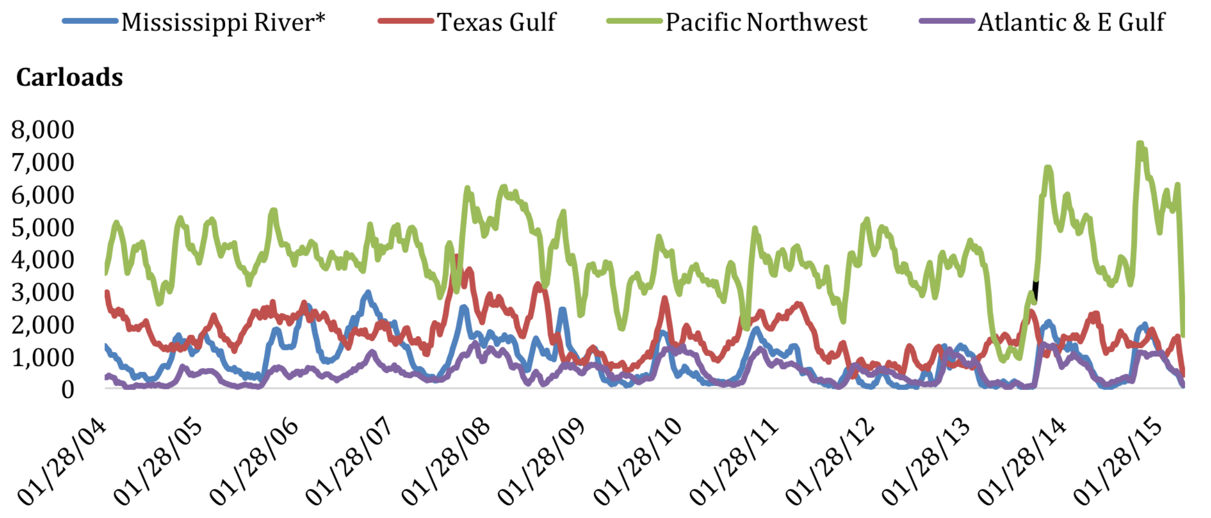
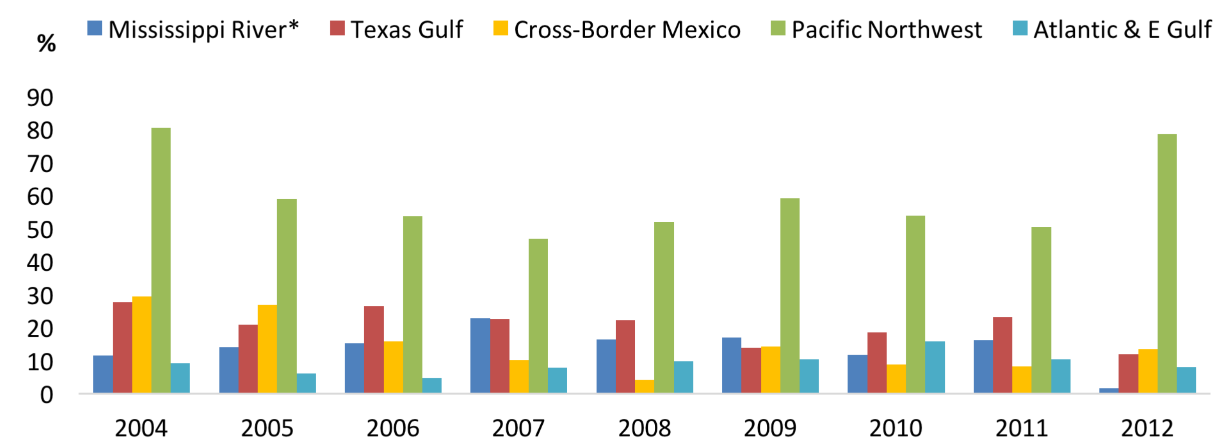
[37] ***This analysis uses the Waterborne Commerce Statistics of the U.S. Army Corps of Engineers to calculate tonnages of barged grain and uses the Carload Waybill Sample from the Surface Transportation Board to estimate the amount of railed grain. Trucking data are derived from known grain production data, as compared to the estimates of the railed and barged volumes of grain. The estimates of modal tonnages and shares are based on the amount of grain moved to commercial markets. Truck tonnages are estimated by subtracting barge and rail tonnages from total tonnages transported. For each crop, total movements are determined first, and then exports are subtracted from the total to get domestic movements (as taken from the source's website).***

Figure 36: Weekly Average Grain and Soybean Rail Deliveries to Ports (2004-2015)



Source: Authors, data from AMS, USDA

Figure 37: Share of Grain and Soybean Moved to Ports (2004-2012)



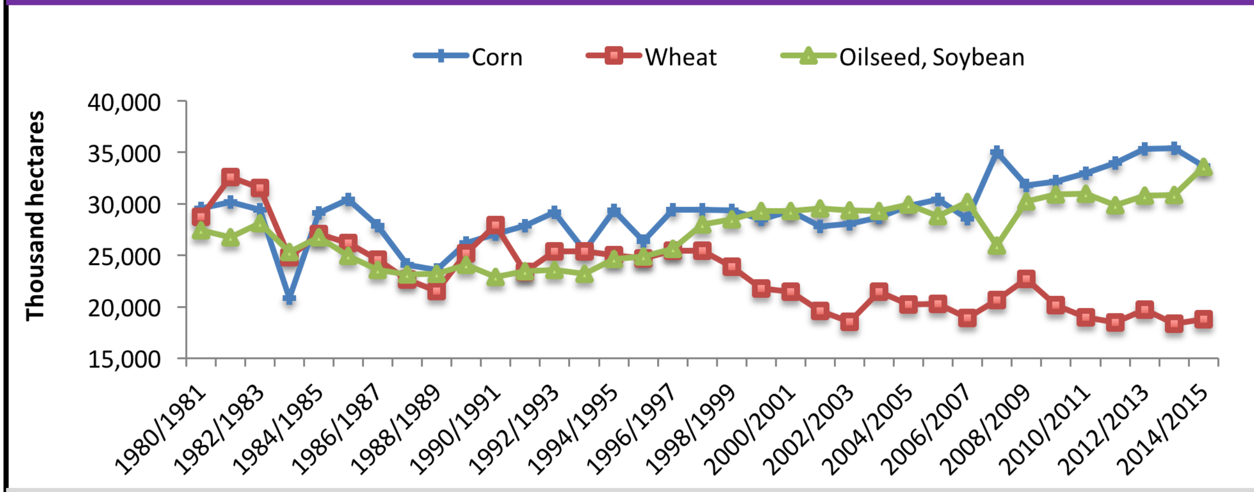
Source: Authors, data from AMS, USDA

Following the discussion on the implication of global developments on prices and transportation we turn to production in the section below.

4.3. The U.S. Role in the Global Market

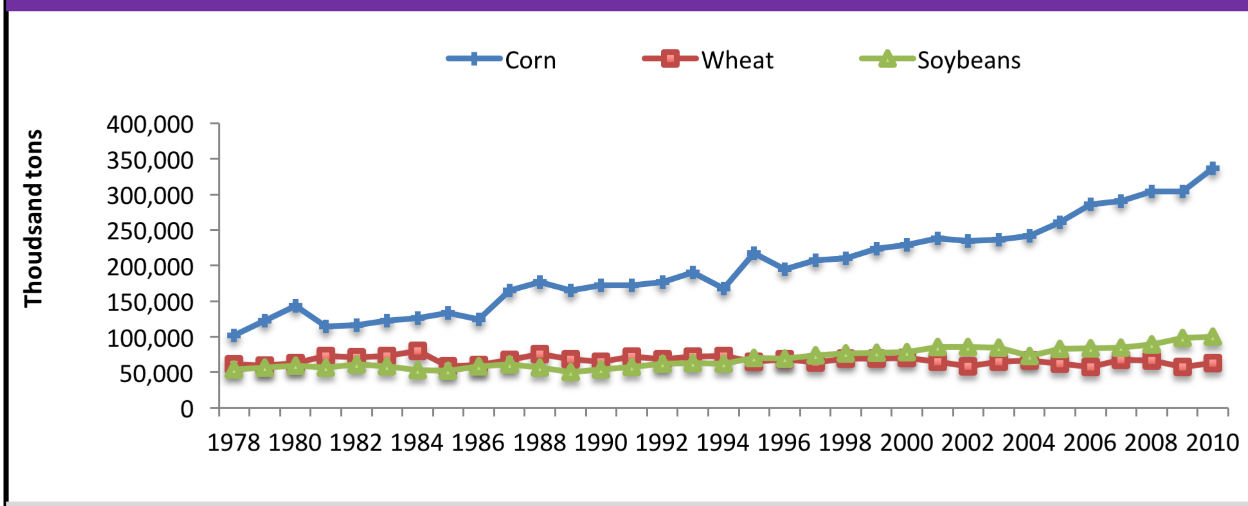
As mentioned previously, the U.S. agricultural industry is significantly reliant on export markets for its grain and soybean output due to its large production capacity and efficient transportation system. As such, the domestic farming activity has had to monitor trends in global markets to ensure their crops find customers on the global market at economically viable prices. Alternatively, other crops might offer potentially better returns in the future due to increasing global demand and higher prices. One example of such considerations impacting domestic production is the result of Chinese demand for soybean starting in 1995 (discussed in Section **2.2.3**). In fact, as Chinese reliance on soybean imports has significantly increased in recent years, U.S. production of such crops increased despite being a minor consumer, thus clearly indicating export considerations underlying decision-making. **Figure 38** shows that in 1995, soybean area harvested grew while wheat area harvested decreased, indicating land use substitution impacted by global developments. In turn, this was translated into a larger movement of soybean and a decreasing movement of wheat (by tonnage) as **Figures 39 and 40** show.

Figure 38: Area Harvested by Commodity in the U.S. (1980-2014)



Source:Authors, data from AMS, USDA

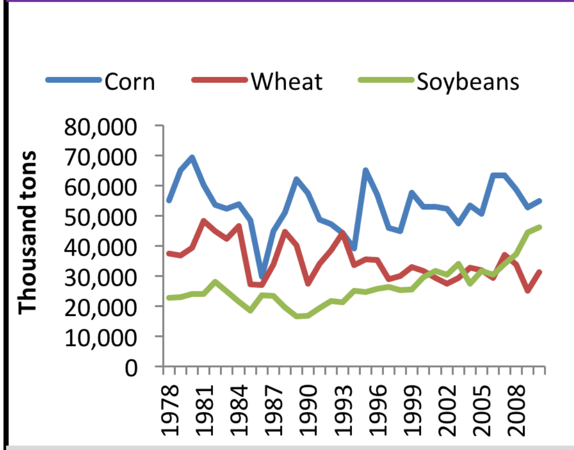
Figure 39: Total U.S. Tonnage of Grain and Soybean Transported by Commodity (1978-2010)



Source: Authors, data from AMS, USDA

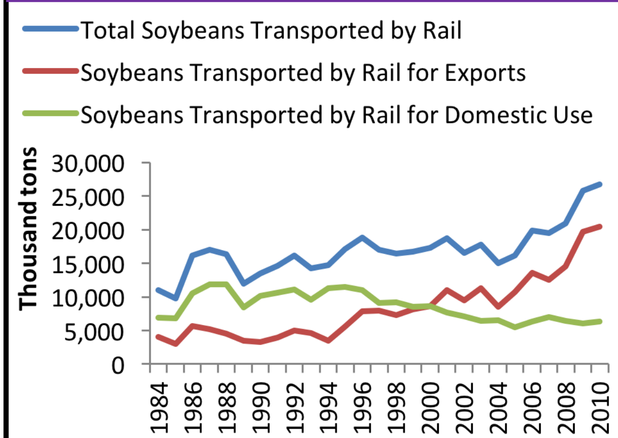
Likewise, the export-oriented feature of the grain and soybean market in general, or soybean in particular, is evident in shares of export growing with respect to domestic consumption. In fact, starting in 2000, soybean exports surpassed domestic consumption, a trend that has been sustained ever since (See **Figure 41**). Currently, less than a third of U.S. soybean production is consumed domestically.

Figure 40: U.S. Tonnage of Grain and Soybean Transported for Exports (1978-2010)



Source: Authors, data from USDA, AMS

Figure 41: Percentage of U.S. Tonnage of Soybeans Transported for Exports (1978-2010)



Source: Authors, data from USDA, AMS

The role of the United States as a major exporter means that the consistent inter-dependency between trends in global markets and domestic production decisions and strategies adopted will be sustained in the future. In the following section, we turn from a macroscopic view of the grain and soybean market and global developments to a deeper focus on the characteristics and dynamics of the U.S. grain and soybean industry specifically.

5. The U.S. Grain and Soybean Industry

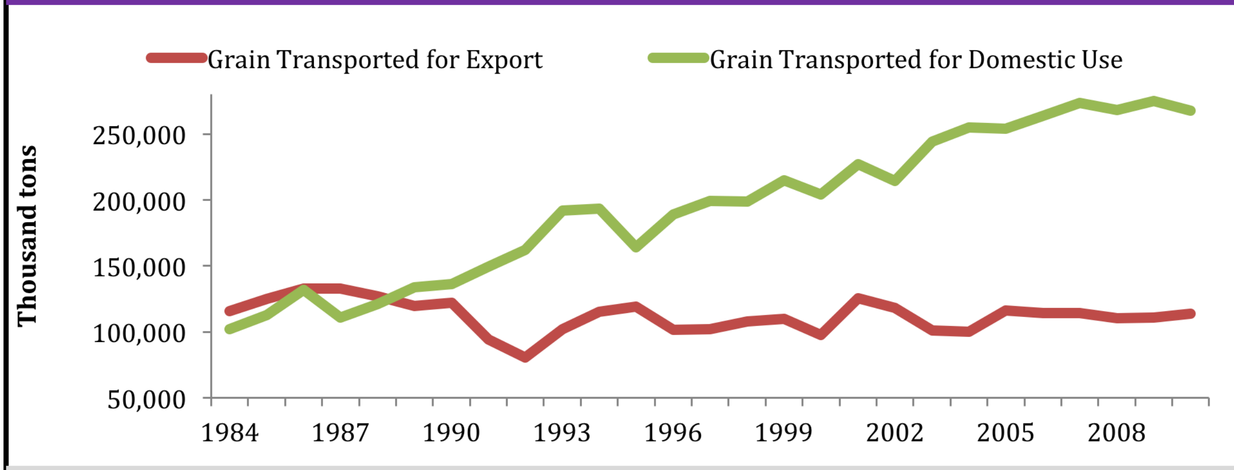
After looking at the global trends and establishing their impacts on the U.S. grain and soybean industry, we aim in this section at looking closer at the specific features of grain and soybean transportation and production in the United States. We seek to answer questions such as: *what is the dominant mode used to move grain* and soybean *in the United States? Which commodities make up the largest share of grain* and soybean *transport? Is more grain* and soybean *consumed domestically or exported? What is the physical structure of the grain industry in the United States? How do grain* and soybean *elevators operate? How does grain* and soybean *merchandising work? What is the spatial distribution of grain in the United States and how stable is it? And finally, what do we know about the relationship of the railroads with grain* and soybean *industry stakeholders?* We aim to do so by both analyzing secondary statistical data for transportation and production as well as a summary of the results of the NUTC's visit to Minnesota and North Dakota.

5.1. Transportation

Several interesting features of grain and soybean transportation in the United States are worth mentioning in the discussion on domestic grain and soybean within a growing global trade. Below we discuss (1) destinations, (2) mode shares and (3) commodity types.

First, grain and soybean movements remain dominated by movements to local destinations despite evidence, presented throughout the report, that the grain and soybean industry is becoming increasingly export-oriented. Indeed, eventhough exports are increasing, domestic movements have continued to rise as a share of total movements. For example, grain and soybean moved to local destinations jumped from 53% in 1990 to 70 % in 2010 (See **Figure 42**).

Figure 42: U.S. Tonnage of Grain and Soybean Transported (1978-2010)

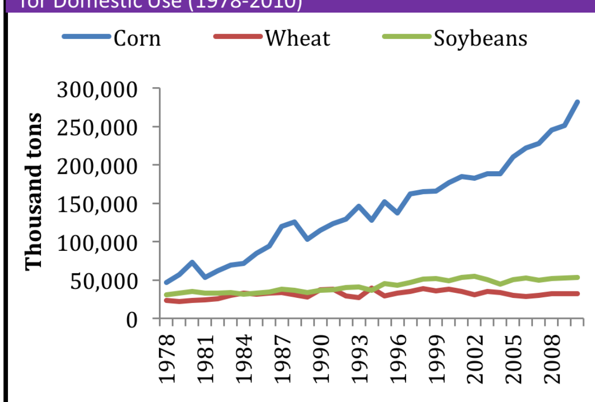


Source: Authors, data from AMS, USDA

Second, truck is the dominant mode for all U.S. transportation (for all end-users), followed by rail and barge respectively (see **Figure 43**). This result can be explained by the dominance of corn transportation within grain and soybean transportation as a whole (see **Figure 44**) and the dominance of local destinations within corn movements (see **Figure 45**). These results confirm that corn is the commodity that is predominantly moved, with this movement occuring mostly domestically, largely owing to the fact that a significant share of these movements have local ethanol plants as destinations. The next hierachy could be explained by the limitation imposed by geography on barges.

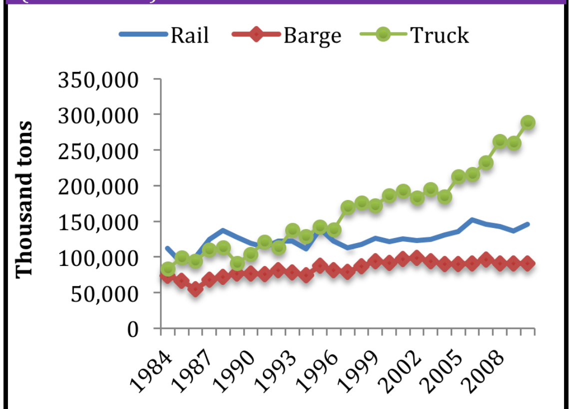
Finally, corn transportation increased most significantly, growing by 96% (CAGR = 3.4 %) between 1990 and 2010, mainly attributed to an increase in the movement by truck. Soybean and wheat grew much slower.

Figure 44: U.S. Tonnage of Grain and Soybean Transported for Domestic Use (1978-2010)



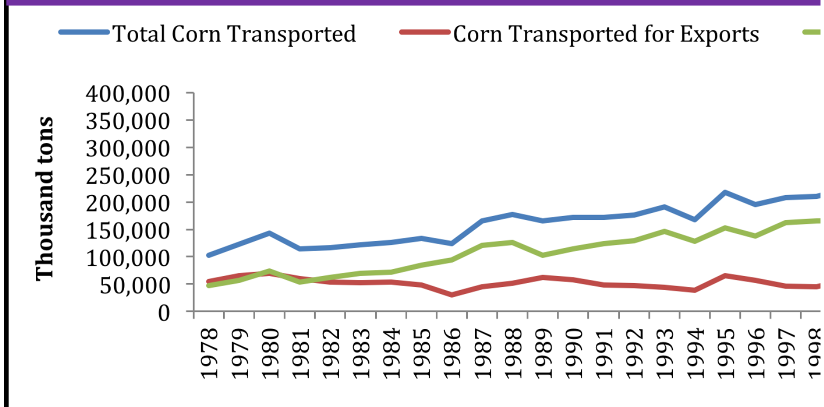
Source: Authors , data from AMS, USDA

Figure 43: U.S. Grain and Soybean Moved by Mode (1984 - 2010)



Source: Authors , data from AMS, USDA

Figure 45: U.S. Tonnage of Corn Transported (1978-2010)



Source: Authors , data from AMS, USDA

From transportation, we move in the section below to the discussion on grain and soybean production in the United States.

5.2. Production

This section examines the spatial distribution of soybean production within the United States. For that purpose, we followed the Bureau of Economic Analysis (BEA)[38] segmentation in **Figure 46**.

Figure 46: BEA U.S. Regional Segmentation Map

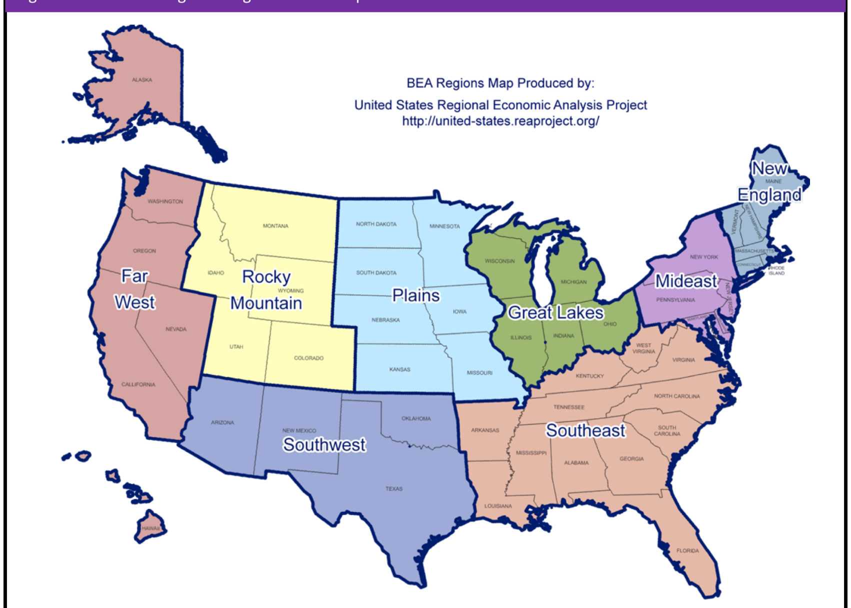
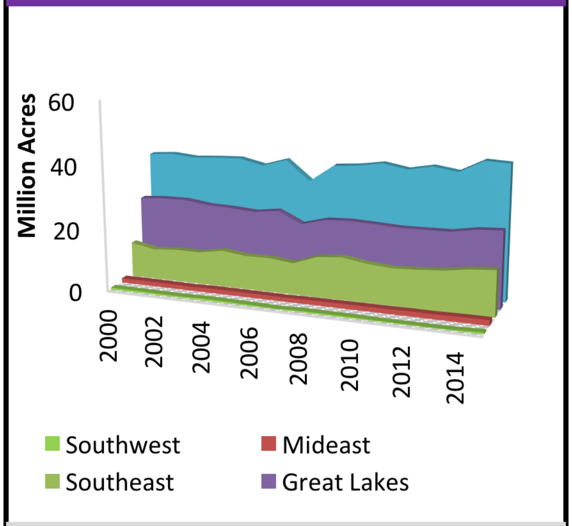


Figure Source: BEA website https://united-states.reaproject.org

[38] *Regions as defined by source (i.e. BEA) : the Mideast is comprised of Delaware, D.C., Maryland, New Jersey, N.Y and Pennsylvania; the Great Lakes is the region including Illinois, Indiana, Michigan, Ohio, Wisconsin; the Plains contour Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota; the Southeast includes Virginia, West Virginia, Mississippi, North Carolina, South Carolina, Tennessee, Louisiana, Alabama, Arkansas, Florida, Georgia, Kentucky and finally the Southwest is composed of Arizona, New Mexico, Oklahoma, Texas.*

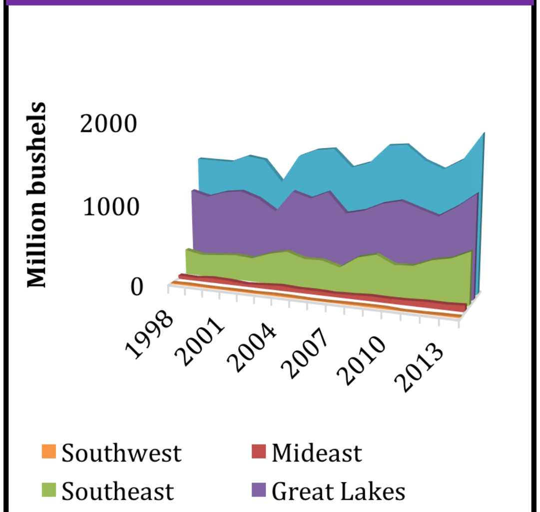
An interesting aspect of domestic production that is particularly relevant to examine with regards to marketing prospects is whether production quantities and regions are stable or dynamic over time. This has important implications for reliability and predictability of U.S. grain and soybean production. Our analysis shows that U.S. regions are stable in general in their relative productivity (**Figures 47 and 48**). For example, the Plains region consistently dominates in volumes, followed by the Great Lakes, then the Southeast, then the Mideast and finally the Southwest. However, production volumes within these regions are more dynamic with an example of acres planted in the Southwest decreasing from 550,000 to 187,000 over the span of 7 years but recovering to more than 600,000 in 2015. These shifts reflect volatility due to cropping considerations and relative profitability among alternative crops. (**Figure 49**).

Figure 47: Soybean Acres planted in the U.S. by Region (2000-2015)



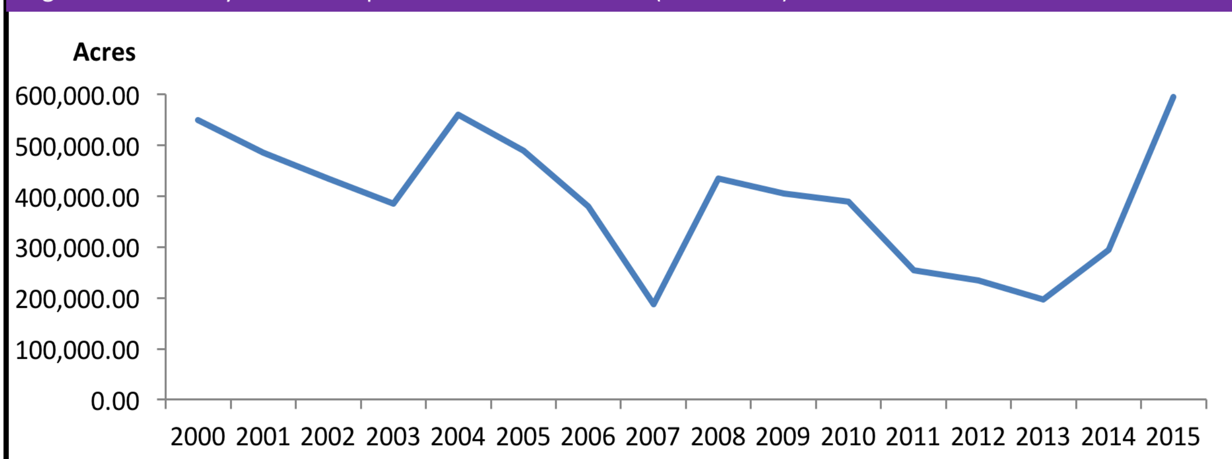
Source: Authors, data from NASS, USDA

Figure 48: Soybean production in the U.S. by Region (2000-2015)



Source: Authors, data from NASS, USDA

Figure 49: U.S. Soybean Acres planted in the Southwest (2000-2015)



Source: Authors, data from NASS, USDA

In the final section of the report we focus specifically on the Plains region (the dominant region of production presented in this section) and more particularly on North Dakota and Minnesota.

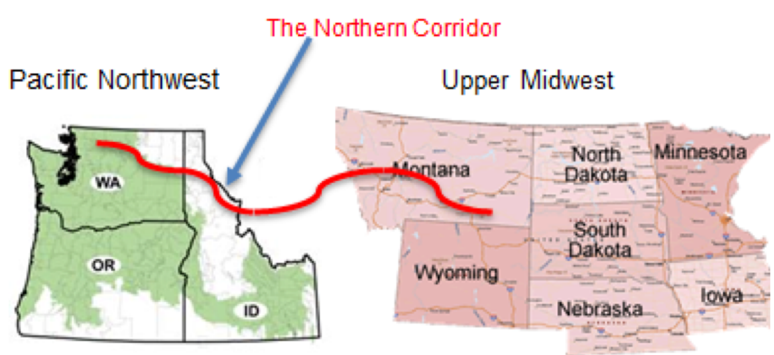
5.3. Case Study: The Case of North Dakota

The NUTC researchers visited North Dakota and Minnesota in an effort to better understand (1) the structural changes of the grain and soybean industry, (2) the changes in logistical service offered to grain and soybean producers and shippers – mainly terminal elevators and shuttle trains, and (3) the interrelationship between (1) and (2). Furthermore, an objective was to improve the understanding of the specific problems and concerns that producers, grain and soybean elevators, and grain and soybean companies are facing through a discussion with industry stakeholders. An enhanced understanding of their problems and concerns will allow us to better examine how transportation providers can meet stakeholder needs now and in the future.

5.3.1. Area of Analysis

The considerations for choosing the Upper Midwest to the Pacific Northwest (i.e. the Northern Corridor, as schematized in **Figure 50**) as our area of analysis include the fact that (1) it is an origin which produces grain and soybean heavily, (2) it is an area where there is potential for use of shuttle trains and (3) it is a destination which exports grain and soybean. Commodities produced in this area must be moved to reach consumers and ports across long distances.

Figure 50: The Northern Corridor Grain and Soybean Transport Route



Source: Authors [images from google search]

5.3.2. Site Visits

Several stakeholders make up the grain and soybean industry in the United States including (1) producers (2) elevator operators (both country and terminal elevators), (3) export terminals, (4) grain and soybean companies, and (5) transportation suppliers (trucks, rail and barge/ocean vessels). The work undertaken in this study has highlighted throughout the report the importance of each of these stakeholders in the overall operations of the grain and soybean industry. To complete this work, we describe below in details the operations of producers and terminal elevators as seen first-hand during the visit to North Dakota. The visit included **two producer representatives** (1) the North Dakota Grain Growers Association (NDGGA), (2) the North Dakota Wheat Commission (NDWC), **four terminal elevators** (1) Maple River Grain and Agronomy (MRGA) (2) South West Grain (SWG) (3) Alton Grain Terminal LLC (AGT) (4) The Arthur Companies (AC) and **two grain companies** (1) Archer Daniels Midland (ADM) and (2) Cenex Harvest Sates (CHS). The profiles of these companies are included in the appendix (Exhibit B) and their locations are mapped in **Figure 51**.

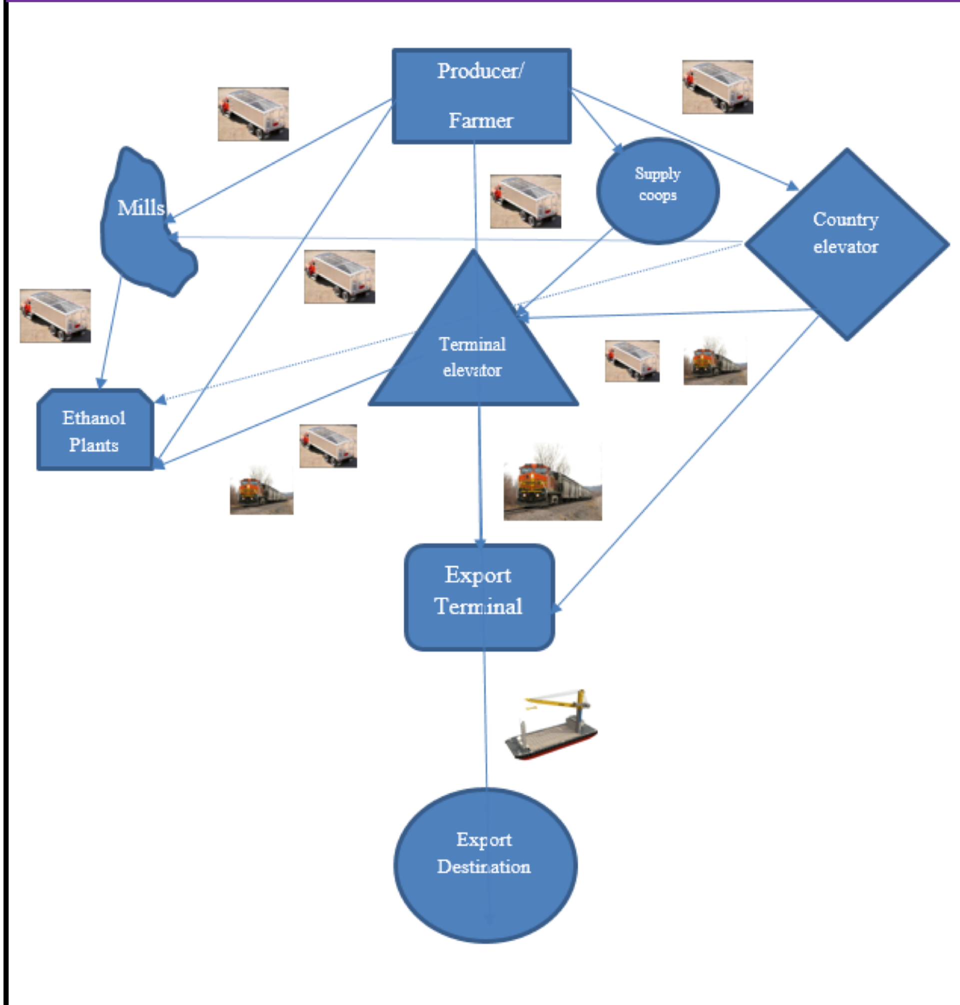
Figure 51: North Dakota Grain and Soybean Infrastructure

Source: Authors [images from google search]

5.3.2.1. The Physical Network of Grain and Soybean Flow

The physical network of grain and soybean flow was constructed following our visit and illustrated in **Figure 52.** The network is composed of four nodes: (1) producers, (2) terminal elevators, (3) export elevators and (4) export destinations and three major links in-between served by trucking (between farm and elevator), rail (between terminal and export elevator) and ocean vessels (between export terminals and export destinations).

Figure 52: The U.S. Grain and Soybean Supply Chain



Source: Authors

5.3.2.1.1. Producers

Producers in North Dakota confirmed the grain and soybean supply and demand determinants discussed in this report with focus on climate and weather, price, cost and technological advancement. Besides market fundamentals, the market structure through storage techniques was discussed with focus on the large storage capacity of producers in North Dakota (as much as one shuttle train) and thus their ability to choose when to sell the grain and soybean. The decision of where to sell depends on a sense of loyalty that exists between producers and elevators whereby producers are either part owners of elevators or at least tend to sell to only one elevator. Finally, the producers are affected to a large extent by the restructuring process as grain and soybean elevator consolidation meant that longer trucking distances had to be traveled to get the crops from farm to elevators. Because only one-third of the 300 elevators that existed before the shuttle program began in North Dakota still exist today (as indicated by agricultural stakeholders in North Dakota), the average distance traveled from farm to reach elevators more than doubled according to North Dakota producers and elevator operators. Indeed, the 5-15 miles distances traveled by truck before consolidation turned to 30-50 miles after consolidation.

5.3.2.1.2. Terminal Elevators

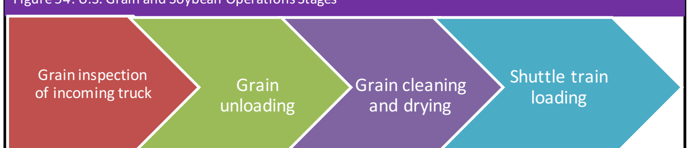
Terminal elevators (**Figure 53**) are at the center of the restructuring process of domestic grain and soybean production that occurred following the introduction of shuttle trains by the railroad to gain competitive advantage and compete on the global level. In fact, these facilities had to change their entire operation in order to benefit from the incentives made by the railroad to optimize shuttle-loading time (and ultimately the total shuttle turns).

Figure 53: Terminal Elevators Visited in North Dakota

Source: Authors

We gained knowledge of handling operations from weighing, probing, testing, and unloading to cleaning and storing. These operations are described below and schematized in **Figures 54 and 55**.

Figure 54: U.S. Grain and Soybean Operations Stages



Source: Authors

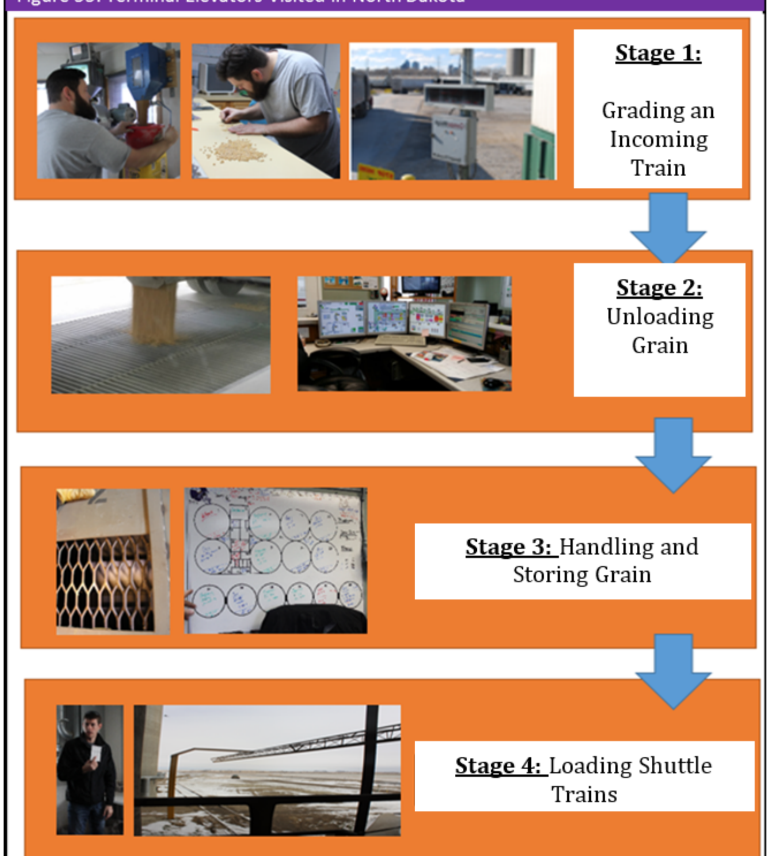
Stage 1: The train comes in and a sample is retracted by probe. A team from the North Dakota Grain Inspection (NDGI) immediately analyzes the sample to obtain moisture levels, grain and soybean quality and the amount of cleaning necessary. The information is then recorded using NDGI software and the truck is routed to the facility. The research team learned that automation helped a lot with grain and soybean inspection. The terminal elevators that we visited are utilizing a new form of technology called the CPM-U-WEIGH truck smart system for the inspection.

Stage 2: The truck goes into one of the channels of the elevator depending on the type of crop it is carrying. Next, the crop is weighed and it drops into a grid, which leads to a channel underground. The unloading rate can be done at 40,000 bushels/hour = 1,000 metric tons per hour. Some elevators can unload as many as 440 trucks/day without queue formation. The unloading rate is dependent on the quality of grain and soybean.

Stage 3: The grain is elevated into bins/silos while being dried and cleaned. The operator selects the bin where grain and soybean will be stored depending on its type and quality. The cleaning rate can be close to 10,000 bushels/hour at some elevators. Additionally, some elevators have two, 6,000 bushel/hour grain and soybean dryers.

Stage 4: Loading into a shuttle train. All inbound grain and soybean are usually sampled and graded before being unloaded onto a railcar at the terminal. According to Maple River, five crew members are required to load a shuttle train. One crew member controls the flow of grain and soybean, one member drives the locomotive, two crew members are in and/or around the railcar moving the grain and soybean around as it flows into the car, and essentially one utility member who serves a number of roles. This process should be done in less than 15 hours. Certain facilities do it as fast as 6 hours.

Figure 55: Terminal Elevators Visited in North Dakota



Source: Authors

5.3.2.2. Grain and Soybean Markets

In addition to operationally controlling incoming trucks and preparing them for transportation to port elevators, grain and soybean elevators are significant and active market players. In fact, all grain and soybean industry stakeholders are engaged in commodity trading techniques to hedge against uncertainty due to the volatile nature of grain and soybean prices. Producers, for example, who would profit most from high prices, need mechanisms by which to reduce future potential losses due to unexpected decreases in grain and soybean prices. To understand how they do so, it is necessary to think of the local cash market price as being made of the futures prices (largest component) and the basis. Producers may sell futures contracts (gaining a hedge position) as a temporary substitute for selling grain and soybean in the local cash market[39] thus eliminating, to a certain extent, the risk of fluctuation in prices. By hedging, a producer is substituting the basis risk for the price risk. Basis is generally less volatile than prices and therefore less risky. To understand that further, assume that for example when the producer places a hedge, (i.e. a futures contract) the local cash price is $3.75, the futures price is $4 and the basis is $0.25. Then, when the producer lifts the hedge (i.e. buys back the futures contract), the local cash price is $2.75, the futures price is $3 and the basis is $0.25. In this example (See **Footnote 45**), the producer gained $1 in the futures market and the net price he gets is $3.75 thus eliminating any impact of declining prices. This example is not comprehensive as prices could increase and basis could change but it is meant to illustrate the concept of hedging. Like the futures market, storage could be used as a hedging mechanism whereby producers have the chance to wait for the most profitable conditions (demand, price) to sell.

Aside from grain and soybean merchandising, grain and soybean companies trade transportation capacity. In general, booking shuttle trains can be done through either (1) the auction system (COTS[40]) owned and governed by BNSF, (2) a secondary market (independent of BNSF), or (3) a broker who would have reserved trains through the COTS system or the secondary market. As we learned during the visit to North Dakota, the secondary market in particular, offers many advantages to shippers over the auction system including- but not limited to – a larger number of trains (25 shuttles running per month as opposed to 3 in the auction market) as well as the capacity to track the train. Furthermore, grain and soybean companies described the specific mechanisms by which the shuttle trains are provided to shippers in the secondary market to the team. First, the trading desk of the third party (i.e. Grain and Soybean Companies) takes on a commitment to provide a certain customer with the train type and quantity (i.e. a certain capacity) requested. Then, the trading desk gets backing from the carrier (i.e. railroad) and has 10 days to provide the shuttle. Failure to provide a train within 10 days can be subject to a financial penalty. This process does not involve the railroad (i.e. BNSF) in any way.

5.3.2.3. The Grain and Soybean Industry and the Transportation Sector

The interdependency between grain and soybean industry stakeholders and transportation providers and its significance in enabling an efficient and competitive movement of grain and soybean from farm to port is highlighted throughout the report. From that realization stemmed our efforts at understanding how stakeholders perceived their relationship with the railroads. On one hand, all stakeholders had positive outlook towards the railroad's communication with the industry stakeholders and their commitment to

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[39] ***Grain Price Hedging Basics. Ag Decision Maker, Iowa State University, University Extension, File mA2-60, January 2010.***

[40] ***As explained by BNSF on their website: BNSF's COT program allows BNSF Agricultural Products customers to bid for covered hopper cars according to a weekly schedule, subject to availability. All COTs provide customers with a car placement date guarantee and Monthly COTs also provide a rate-lock option. Car reservations are awarded to the highest bidders and require a nominal pre-payment.***

resolve congestion problems. On the other hand, several specific concerns were raised including: (1) insufficient advance notice about arrival time, (2) rigid loading times for shuttles, (3) delays in shuttle train departures, (4) not utilizing the throughput that the shuttle system can offer, (5) perceived competition of grain and soybean with other commodities possibly resulting in: (a) more congestion on the transportation system, (b) a lower resilience for the overall transportation system, (c) higher basis (meaning lower prices) for producers and (6) pricing (fuel surcharge in particular).

6. Conclusion

Throughout this report we have examined the fundamental changes in global grain and soybean markets, providing the global context for the internal restructuring occurring in the U.S. system. The trends witnessed over the past fifteen years show no sign of diminishing and as the global economy and populations continue to grow, so will the need for food and in turn for grain and soybean. China, the main demand factor since the mid-1990s is expected to experience slower economic growth, reducing pressure on global trade but several areas of the world including India and Africa most importantly, may experience significant demand growth in the future. The ability of producers to scale up to the demand challenge while maintaining cost competitiveness and quality will be critically important in order to maintain the U.S. competitive advantage over other export competitors. Throughout most of the last decade U.S. grain and soybean producers were challenged with high production costs in general and land costs in particular, reducing their competitive edge relative to South American producers. This was often offset by a robust and efficient transportation system. However, competing countries could quickly catch up if more infrastructure investments are made outside the United States. This illustrates just how important the current restructuring of the domestic grain and soybean industry and its interrelationship with the transportation system is for the future of U.S. competitiveness.

The relationship of the U.S. grain and soybean industry with global developments is twofold. On one hand, the United States grain and soybean industry is very reliant on global markets because the nature of the local industry has meant the country has consistently posted annual supply surpluses, requiring export markets to accommodate excess production. On the other hand, high world prices and the challenge of government price controls and generally lower costs in several importing countries incentivizes U.S. stakeholders in the grain and soybean industry to restructure operations to meet global demand. This could enhance their competitive advantage relative to other exporters as well as restructure logistical operations to ensure it keeps its place as a major exporter in the global market.

The introduction of shuttle trains as well as improvements in grain and soybean elevator operational capacity have placed the U.S. grain and soybean industry on an improved course, giving it a competitive edge over its South American competitors. However, investment in transportation infrastructure needs to continue because improvements in competing South American countries could put the United States at a disadvantage. Mitigating these challenges, while remaining competitive, will be crucial for the United States to remain a major global player in the grain and soybean sector of the economy.

APPENDIX

EXHIBIT A – Major Global Players: Production, Consumption, Import and Export

Exhibit A1: Soybean

Table 04: Major Oilseeds: World Supply and Distribution (Country View)

Million Metric Tons

	2011/12	2012/13	2013/14	2014/15	Aug 2015/16	Sep 2015/16
Production						
United States	92.44	93.32	99.02	117.17	115.40	116.07
Brazil	70.02	84.55	90.01	97.44	100.06	99.61
Argentina	44.82	53.68	56.92	65.68	61.01	61.01
China	59.60	59.79	58.89	57.56	54.89	54.79
India	37.11	37.52	36.80	34.66	37.94	36.81
Other	143.67	147.00	164.43	164.71	159.77	158.89
Total	447.65	475.86	506.06	537.22	529.05	527.17
Imports						
China	62.29	63.52	75.60	81.81	82.45	82.45
European Union	16.89	17.02	17.66	16.87	16.81	16.76
Mexico	5.39	5.08	5.58	5.84	5.84	5.84
Japan	5.34	5.54	5.49	5.57	5.52	5.52
Turkey	2.03	2.02	2.40	2.99	3.07	2.94
Indonesia	2.15	2.14	2.55	2.46	2.67	2.65
Taiwan	2.29	2.29	2.34	2.36	2.39	2.39
Thailand	1.99	1.96	1.88	2.17	2.19	2.19
Russia	0.90	0.83	2.11	2.11	2.08	2.08
Egypt	1.73	1.80	1.74	1.95	2.02	2.02
Other	10.86	11.04	13.95	14.52	15.35	15.28
Total	111.86	113.25	131.32	138.64	140.38	140.12
Exports						
Brazil	36.35	42.02	46.99	50.14	54.62	54.63
United States	37.81	37.16	45.55	50.91	47.94	47.97
Canada	11.66	10.63	12.69	13.02	11.27	11.27
Argentina	8.10	8.41	8.49	10.40	10.59	10.59
Paraguay	3.61	5.54	4.82	4.62	4.62	4.62
Ukraine	2.83	2.72	3.57	4.42	4.45	3.80
Uruguay	2.61	3.53	3.19	3.23	3.28	3.23
Other	8.34	8.39	8.11	8.39	7.96	7.66
Total	111.30	118.39	133.42	145.13	144.73	143.76
Crush						
China	96.29	102.64	107.63	112.03	115.47	115.37
United States	50.32	50.25	51.46	55.07	54.62	54.98
European Union	41.06	42.07	45.36	46.75	45.45	45.35
Argentina	39.95	36.25	38.77	42.71	44.60	44.64
Brazil	41.02	37.51	39.73	41.92	42.17	41.77
India	28.59	29.30	28.60	26.65	29.38	28.60
Russia	11.86	11.01	13.85	13.75	14.05	14.05
Ukraine	10.36	9.21	12.16	11.32	11.20	11.15
Indonesia	8.35	8.99	9.66	10.29	10.80	10.80
Canada	8.41	8.27	8.52	9.06	8.50	8.70
Mexico	5.86	5.70	6.08	6.50	6.52	6.52
Pakistan	5.60	5.30	5.58	6.35	6.61	6.46
Malaysia	4.99	5.34	5.53	5.54	5.72	5.72
Japan	4.35	4.38	4.40	4.53	4.45	4.45
Paraguay	1.07	3.17	3.47	3.84	4.24	4.24
Other	37.01	37.70	38.51	41.23	42.23	42.07
Total	395.07	397.08	419.30	437.51	446.01	444.86
Ending Stocks						
Argentina	16.64	22.42	27.34	34.60	35.61	34.97
Brazil	13.22	15.41	16.01	18.23	18.45	18.19
China	17.05	13.17	15.56	18.92	16.83	16.92
United States	5.61	5.76	3.95	7.26	14.47	14.05
European Union	4.95	3.71	3.33	3.84	2.02	2.24
Other	9.49	7.60	11.95	10.08	8.71	8.51
Total	66.96	68.07	78.14	92.93	96.08	94.88

Exhibit A2- Wheat

World Wheat, Flour, and Products Trade
July/June Year, Thousand Metric Tons

	2011/12	2012/13	2013/14	2014/15	2015/16 Oct	2015/16 Nov
TY Exports						
Argentina	11,951	7,450	1,675	4,200	5,500	5,500
Australia	23,031	21,269	18,339	16,575	18,500	17,500
Brazil	1,860	1,753	81	1,688	1,000	1,500
Canada	17,603	18,584	22,157	24,832	19,500	20,500
European Union	16,728	22,786	32,033	35,401	33,000	33,500
Kazakhstan	11,069	6,801	8,000	5,507	6,500	6,500
Mexico	790	729	1,322	1,104	1,100	1,100
Russia	21,627	11,289	18,568	22,800	23,500	23,500
Turkey	3,678	3,583	4,293	4,136	4,000	4,000
Ukraine	5,436	7,190	9,755	11,269	15,000	15,000
Others	11,850	18,040	14,642	11,081	9,892	10,292
Subtotal	125,623	119,474	130,865	138,593	137,492	138,892
United States	28,142	27,734	31,518	22,752	23,000	22,000
World Total	153,765	147,208	162,383	161,345	160,492	160,892
TY Imports						
Afghanistan	2,200	1,600	2,050	2,000	2,000	2,000
Algeria	6,500	6,484	7,484	7,257	7,700	7,700
Bangladesh	2,039	2,725	3,354	3,804	3,600	3,600
Brazil	7,053	7,547	7,061	5,869	6,700	6,300
China	2,933	2,960	6,773	1,926	2,500	2,000
Egypt	11,650	8,300	10,170	11,063	11,500	11,500
European Union	7,362	5,276	3,974	5,973	6,000	6,000
Indonesia	6,457	7,146	7,392	7,478	7,800	7,800
Iran	2,400	5,600	6,600	5,006	4,500	4,500
Iraq	3,784	3,948	3,246	2,253	3,200	3,200
Japan	6,354	6,598	6,123	5,878	5,800	5,800
Korea, South	5,188	5,439	4,288	3,942	4,200	4,200
Mexico	5,020	3,823	4,636	4,446	4,400	4,400
Morocco	3,671	3,825	3,892	4,073	2,800	2,800
Nigeria	3,903	4,138	4,580	4,244	4,400	4,400
Peru	1,585	1,683	2,078	1,907	1,800	1,800
Philippines	4,075	3,645	3,482	5,099	4,800	4,800
Saudi Arabia	2,904	1,921	3,429	3,487	3,800	3,800
Sudan	2,360	1,793	2,664	2,632	2,800	2,800
Thailand	2,646	1,845	1,693	3,489	2,800	3,200
Tunisia	1,473	1,523	1,634	1,461	2,000	2,000
Turkey	4,413	3,312	4,154	5,960	3,800	3,800
Uzbekistan	2,698	1,863	2,224	2,230	2,200	2,200
Vietnam	2,711	1,671	2,158	2,296	2,400	2,600
Yemen	2,685	3,149	3,425	3,245	3,300	3,300
Others	44,807	43,469	46,861	47,326	48,111	48,261
Subtotal	148,871	141,283	155,425	154,344	154,911	154,761
Unaccounted	1,857	2,449	2,173	3,014	2,231	2,781
United States	3,037	3,476	4,785	3,987	3,350	3,350
World Total	153,765	147,208	162,383	161,345	160,492	160,892

TY=Trade Year, see Endnotes.

World Wheat Production, Consumption, and Stocks

Local Marketing Years, Thousand Metric Tons

	2011/12	2012/13	2013/14	2014/15	2015/16 Oct	2015/16 Nov
Production						
Argentina	15,500	9,300	10,500	12,500	10,500	10,500
Australia	29,905	22,856	25,303	23,666	27,000	26,000
Canada	25,288	27,205	37,530	29,420	26,000	26,000
China	117,400	121,023	121,930	126,170	130,000	130,000
Egypt	8,400	8,500	8,250	8,300	8,360	8,100
European Union	138,182	133,949	144,428	156,466	155,263	157,274
India	86,874	94,882	93,506	95,850	88,940	88,940
Iran	12,400	13,800	14,500	13,000	14,000	14,000
Kazakhstan	22,732	9,841	13,941	12,996	14,000	14,000
Morocco	5,800	3,870	7,000	5,100	8,000	8,000
Pakistan	25,000	23,300	24,000	25,500	25,000	25,000
Russia	56,240	37,720	52,091	59,080	61,000	60,500
Turkey	18,800	16,000	18,750	15,250	19,500	19,500
Ukraine	22,324	15,761	22,278	24,750	27,000	27,000
Uzbekistan	6,300	6,700	6,800	7,150	7,200	7,200
Others	50,668	52,697	56,195	54,777	55,183	55,130
Subtotal	641,813	597,404	657,002	669,975	676,946	677,144
United States	54,244	61,298	58,105	55,147	55,840	55,840
World Total	696,057	658,702	715,107	725,122	732,786	732,984
Total Consumption						
Algeria	8,950	9,450	9,850	10,050	10,250	10,250
Brazil	11,200	10,900	11,400	10,700	11,200	10,600
Canada	9,852	9,530	9,407	9,115	9,000	9,000
China	122,500	125,000	116,500	118,500	116,500	118,000
Egypt	18,600	18,700	18,500	19,100	19,600	19,600
European Union	127,234	119,250	117,300	123,500	125,850	126,750
India	81,408	83,824	93,848	93,130	94,540	93,940
Indonesia	6,250	6,950	7,165	7,365	7,650	7,650
Iran	15,200	16,000	17,000	17,500	18,000	18,000
Morocco	8,800	8,300	9,000	9,000	9,800	9,800
Pakistan	23,100	23,900	24,100	24,500	24,600	24,600
Russia	38,000	33,550	34,100	35,500	37,000	36,500
Turkey	18,100	17,650	17,750	17,500	18,000	18,000
Ukraine	14,950	11,400	11,500	12,000	12,700	12,500
Uzbekistan	7,800	8,000	8,400	8,900	9,100	9,100
Others	145,443	146,981	150,995	153,625	156,670	157,345
Subtotal	665,560	641,442	664,365	675,515	683,232	684,196
United States	31,962	37,768	34,287	31,530	33,177	33,177
World Total	697,522	679,210	698,652	707,045	716,409	717,373
Ending Stocks						
Australia	7,051	4,663	4,557	4,273	5,003	4,998
China	55,946	53,960	65,274	74,067	89,567	87,067
European Union	13,522	10,711	9,780	13,318	15,480	16,342
India	19,950	24,200	17,830	17,200	11,900	11,900
Iran	825	5,086	7,221	7,821	7,321	7,321
Morocco	3,305	2,472	4,185	4,120	4,870	4,870
Russia	10,899	4,952	5,175	6,282	7,132	7,132
Others	65,959	51,578	63,528	64,110	63,782	62,879
Subtotal	177,457	157,622	177,550	191,191	205,055	202,509
United States	20,211	19,538	16,065	20,501	23,433	24,794
World Total	197,668	177,160	193,615	211,692	228,488	227,303

Exhibit A3- Corn

World Coarse Grain Trade
October/September Year, Thousand Metric Tons

	2011/12	2012/13	2013/14	2014/15	2015/16 Oct	2015/16 Nov
TY Exports						
Argentina	22,308	29,497	16,630	20,997	18,505	20,505
Australia	7,279	6,410	7,003	7,293	7,325	7,325
Brazil	12,677	26,078	22,059	21,954	31,015	33,015
Canada	3,853	4,658	5,460	3,699	3,700	3,900
European Union	7,177	8,914	7,837	14,905	8,305	9,305
India	4,858	5,541	4,524	1,450	2,500	2,000
Paraguay	2,188	2,861	2,718	3,017	2,305	2,305
Russia	5,997	4,365	7,043	9,125	8,110	7,110
Serbia	2,345	628	1,755	2,925	1,725	1,725
Ukraine	17,447	15,527	24,125	24,020	20,680	18,680
Others	7,127	7,106	8,690	11,634	7,045	6,845
Subtotal	93,256	111,585	107,844	121,019	111,215	112,715
United States	40,106	20,586	56,772	56,340	58,335	53,835
World Total	133,362	132,171	164,616	177,359	169,550	166,550
TY Imports						
Algeria	3,741	3,289	4,946	4,881	4,810	4,810
Canada	764	523	714	1,635	1,610	1,610
Chile	1,523	1,327	1,621	1,600	1,750	1,750
China	7,924	5,604	12,445	25,699	21,250	17,250
Colombia	4,103	4,090	4,795	4,730	4,830	4,830
Dominican Republic	1,054	1,046	1,011	1,100	1,100	1,100
Egypt	7,252	5,096	8,776	7,905	8,055	8,055
European Union	6,908	11,777	16,262	9,175	16,255	16,255
Indonesia	1,724	2,719	3,501	3,200	3,000	3,000
Iran	5,700	4,800	6,600	8,000	5,500	6,000
Israel	1,530	1,564	2,073	1,675	2,175	1,975
Japan	17,730	17,743	17,501	16,725	17,075	16,975
Jordan	1,311	1,406	1,672	1,450	1,475	1,575
Kenya	490	202	894	1,000	1,100	1,100
Korea, South	7,726	8,265	10,499	10,263	10,090	10,090
Libya	829	1,220	1,493	1,600	1,450	1,550
Malaysia	3,309	3,048	3,476	3,400	3,600	3,600
Mexico	12,819	7,627	11,317	11,498	10,775	11,225
Morocco	2,479	1,831	2,858	2,300	2,300	2,300
Peru	1,927	2,404	2,336	2,850	2,625	2,625
Saudi Arabia	10,485	12,390	11,331	11,025	11,025	11,525
Taiwan	4,478	4,398	4,356	4,300	4,400	4,400
Tunisia	1,071	1,610	1,449	1,550	1,500	1,500
Venezuela	2,596	2,154	2,627	2,000	2,000	2,000
Vietnam	1,600	1,700	2,800	3,500	3,000	3,000
Others	15,944	15,462	17,468	18,000	16,300	16,400
Subtotal	127,017	123,295	154,821	161,061	159,050	156,500
Unaccounted	3,203	2,361	6,473	13,011	7,450	7,050
United States	3,142	6,515	3,322	3,287	3,050	3,000
World Total	133,362	132,171	164,616	177,359	169,550	166,550

TY=Trade Year, see Endnotes.

World Coarse Grains Production, Consumption, and Stocks

Local Marketing Years, Thousand Metric Tons

	2011/12	2012/13	2013/14	2014/15	2015/16 Oct	2015/16 Nov
Production						
Argentina	30,105	37,246	35,665	33,532	32,461	34,061
Australia	12,257	11,414	12,158	11,663	12,775	12,775
Brazil	75,884	84,253	82,603	87,603	82,583	84,083
Canada	22,921	24,445	28,745	21,992	23,628	23,668
China	198,635	212,192	225,070	222,170	231,500	231,500
Ethiopia	12,264	12,286	14,468	13,350	12,400	12,400
European Union	149,923	145,942	158,915	170,546	149,344	150,456
India	42,058	39,910	43,216	41,971	41,100	40,100
Indonesia	8,850	8,500	9,100	8,800	9,600	9,600
Mexico	25,689	28,881	32,020	32,390	31,975	31,325
Nigeria	17,421	18,573	19,292	19,015	17,950	17,950
Russia	33,077	28,658	35,735	40,386	39,800	39,000
South Africa	13,268	12,873	15,518	11,277	14,105	13,370
Turkey	11,299	10,595	13,075	9,475	14,075	14,075
Ukraine	33,476	29,527	39,918	39,345	34,775	32,825
Others	147,174	146,783	148,475	156,278	154,038	154,217
Subtotal	834,301	852,078	913,973	919,793	902,109	901,405
United States	322,451	285,311	367,089	377,234	365,138	368,156
World Total	1,156,752	1,137,389	1,281,062	1,297,027	1,267,247	1,269,561
Domestic Consumption						
Argentina	10,510	12,050	13,595	14,332	14,976	14,976
Brazil	54,653	55,803	58,028	59,928	61,843	61,843
Canada	20,285	20,339	22,372	21,271	21,511	21,511
China	196,192	209,671	223,600	228,550	243,475	234,775
Egypt	12,736	12,910	14,080	14,809	15,408	15,458
European Union	151,460	153,095	164,105	163,270	161,320	160,420
India	37,650	35,075	37,600	40,000	39,850	39,450
Indonesia	10,500	10,900	11,900	12,200	12,500	12,700
Iran	10,320	10,520	11,320	12,020	12,520	12,720
Japan	17,990	18,030	17,640	16,975	17,225	17,125
Mexico	37,985	36,195	40,885	41,940	42,590	42,790
Nigeria	17,321	18,700	19,350	18,950	18,150	18,150
Russia	27,728	25,134	28,619	31,139	31,600	31,600
Turkey	11,755	13,005	13,430	13,080	14,130	14,130
Ukraine	15,559	14,661	15,927	15,185	13,955	13,905
Others	216,118	220,045	228,074	236,119	238,163	238,412
Subtotal	866,937	859,936	928,803	953,462	962,383	950,843
United States	288,857	275,537	305,048	311,344	313,164	314,689
World Total	1,155,794	1,135,473	1,233,851	1,264,806	1,275,547	1,265,532
Ending Stocks						
Brazil	4,821	9,559	14,259	11,816	15,544	10,041
Canada	3,390	3,024	4,648	3,227	3,254	3,294
China	60,362	68,378	82,260	101,541	91,780	115,441
European Union	15,745	13,083	15,501	17,838	12,815	14,474
Iran	4,684	4,654	5,094	7,234	6,074	6,174
Mexico	1,857	1,628	3,583	4,724	4,372	3,984
Saudi Arabia	3,211	3,391	3,888	3,873	3,693	3,993
Others	39,898	36,455	47,368	45,931	41,665	40,593
Subtotal	133,968	140,172	176,601	196,184	179,197	197,994
United States	27,819	23,531	34,313	46,951	43,698	49,170
World Total	161,787	163,703	210,914	243,135	222,895	247,164

EXHIBIT B- Profiles of Interviewed Industry Stakeholders

1.1 Producers' representatives

The information obtained regarding producers' organization operations, opinions, satisfaction and complaints came from talking to the North Dakota Grain Growers (NDGG) and the North Dakota Wheat Commission (NDWC). These two entities were formed as a means of organizing producers in order for them to lobby for producers' interests. Both NDGG and NDWC facilitate dialogue with politicians around producers' needs and operations in the grain industry and logistics processes as a whole.

1.1.1 The North Dakota Grain Growers Association (NDGGA)[41]

The mission of the NDGGA as stated on their website is "*to serve North Dakota wheat and barley producers with education, leadership, information and representation to increase profitability and enhance value added opportunities*". The team met with Brad Thykeson, the prior president of NDGGA in Fargo, ND. Mr. Thykeson emphasized the NDGGA's role in maintaining the dialogue with different stakeholders and keeping agriculture at the forefront of politician's minds.

1.1.2 The North Dakota Wheat Commission (NDWC)[42]

As stated on their website, NDWC "*works to sustain and expand the use of wheat grown by North Dakota producers by creating worldwide market opportunities through efforts including opening overseas markets, reinforcing consumption of grain foods, developing new wheat varieties and influencing international import and export policies. Wheat producers fund these program with a checkoff of a penny and a half on each bushel sold*." The NDWC dues also fund research and overseas offices (with help from other entities such as USDA). NDWC conducts a yearly survey at harvest time on milling, baking, and testing so that companies overseas can better understand what wheat producers in North Dakota are doing. The team met with Jim Peterson, the marketing director in Bismarck, ND. Before the meeting, Mr. Peterson suggested relevant references such as the work that is being done at the Upper Great Plains Transportation Institute[43] and the Mountain Plain Consortium (rural-urban traffic).

1.2 Grain elevators

Country elevators and terminal elevators are the two types of elevators used by the grain industry to store and handle grain. Due to the introduction of shuttle systems and the restructuring of the grain industry, there are significantly fewer country elevators than even 5-10 years ago. Unfortunately, we were unable to convince a country elevator to meet with us. This is why all the elevators discussed below are terminal grain elevators. However, we believe that we gained insight into the operations of country elevators through other stakeholders. The team visited four grain elevators: 1) Maple River Grain and Agronomy LLC, 2) Alton Grain Terminal LLC (AGT), 3) Arthur Companies and 4) Southwest Grain (SWG).

1.2.1 Maple River Grain and Agronomy LLC [44] (MRGA)

[41] http://www.ndgga.com
[42] http://www.ndwheat.com/
[43] http://www.ugpti.org/
[44] http://www.maplerivergrain.com

Maple River Grain & Agronomy, LLC was formed on June 1, 2004, with the merger of the producer's Cooperative Elevator Company of Prosper, AGP Grain of Casselton, and Chaffee-Lynchburg producer's Elevator – all North Dakota based elevators. The construction of a new grain facility began on April 16, 2004 in Casselton. The grain facility became fully operational in April of 2005. On May 7, 2008, the fertilizer plant construction was started. The first fertilizer shuttle train was unloaded on February 24, 2009, and the first fertilizer loading took place April 16, 2009. The mission of this elevator as stated on its website is to "serve producers, access markets and build relationships, while generating returns – to strengthen the long term viability of Maple River Grain and Agronomy, LLC." Maple River moves approximately 20 million bushels per year and has a capacity of around 6 million bushels. At MRGA the team met with Alex Richards, Grain Merchandiser in Casselton, ND. Unlike the other elevators we visited, MRGA's elevator was not located on BNSF's main line. It is interesting to note that an ethanol plant is located less than 5 miles from MRGA.

1.2.2 Alton Grain Terminal[45] (AGT)*

Alton Grain Terminal LLC, formed in 2001, is the first shuttle elevator in the United States. Its crew is comprised of two grain traders, a grain department manager, a grain merchandiser, a controller, two bookkeepers, a plan operations manager and four full time production employees. It is located on a BNSF mainline halfway between Grand Forks, ND and Fargo, ND. This facility stores and treats soybean, corn and wheat. It has 4.1 million bushels of storage capacity, which is equivalent to 112,000 metric tons, and serves the area producers and grain elevators with competitive prices, quick efficient truck unloading, and knowledgeable service that includes the fairness of official weights and grades of the North Dakota Grain Inspection. AGT's crop procurement area extends 50 miles. The crew at the facility can load 110 railcars in 8-10 hours. The average annual throughput is 25 million bushels, which is equivalent to 680,000 metric tons. The 25 million bushels are divided into 11 for soybean, 9 for corn, and 5 for spring wheat. Under normal operating conditions, the facility can move up to 40 million bushels per year and load as many as 1 shuttle/day. Currently, they load 60 shuttle trains per year. The majority of shuttles are bound for PNW export destinations but occasionally travel to the Great Lakes, St. Louis, the Gulf regions and a small percent goes to domestic markets. At AGT the NUTC research team met with Cory Tryan (grain manager) and Robin Stene (general manager) as well as the grain inspection team in Hillsboro, ND.

1.2.3 The Arthur Companies [46] (AC)

Arthur Companies currently operate multiple facilities. Their Ayr facility was turned into a shuttle elevator and expanded in 2001. They have a shuttle facility at Harvey on CP's mainline and they are building a facility in Pillsbury on BNSF's mainline. They also have a grading facility. They handle a little over 28 million bushels per year. Their grain is procured from farms within a 20-30 mile radius. The Ayr facility is able to unload as many as 440 trucks/day without a queue forming. The last cycle of crops (October-September) generated 36-38 shuttle trains from Ayr. They can load a shuttle train in 11 hours. They need 3-4 people to load a shuttle. Their shuttles are obtained through a third party (ADM). At Arthur companies in Arthur, ND, the research team met with Joel Moore, grain manager and Tom Burchill, specialty crops/merchandiser.

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45 http://www.altonterminal.com (*taken from AGT factsheet)

46 *http://www.arthurcompanies.com*

1.2.4 Southwest Grain (SWG) [47]

Between 1980 and 1984, a group of cooperatives decided to build an elevator facility to serve 52 car trains. SWG's newest facility is a terminal elevator in New Salem (2008-2009) which primarily stores and treats wheat. SWG works exclusively with BNSF. SWG suggested that they like the switching system of Union Pacific (UP) but cannot work with the ordering system of UP. SWG works mostly with producers, as opposed to country grain elevators. Their storage capacity is 1.2 million bushels. Their hauling area from which producers bring their grain is 20-40 miles. SWG doesn't own trucks and requires producers to transport their crops to the elevator. SWG also unloads fertilizers. At SWG the research team met with Brian Fadness (from marketing) and the grain manager Cory Trina (for a shorter period of time), in Taylor, ND.

1.3 Grain companies

Grain companies play a key role in the movement of grain, as they are often brokers of shuttle trains, owners of elevators, and in direct contact with export destinations. Several grain companies were mentioned during our visits as key players in the export and domestic grain industry. These include Bunge, Cargill, Louis Dreyfus, ADM and CHS. The research team had the chance to meet with Cenex Harvest States (CHS) and Archer Daniels Midland (ADM) in Minneapolis, MN. Their company profiles are given below.

1.3.1 Cenex Harvest States (CHS)[48]

CHS, founded in 1929 is based in St. Paul Minnesota. As explained by Dan Mack, the vice president of rail transportation and terminal operations, CHS has two main business platforms: 1) An energy business built for the refinement, production, distribution and marketing of petroleum; and 2) An agricultural business. CHS also has a financial and risk management segment in their business. CHS operates various food processers, is a grain wholesaler, sells farming supplies, produces and sells Cenex brand fuel, provides financial services and retail businesses, and is a co-owner of Ventura Foods, a vegetable oil processor. BNSF is CHS's primary carrier in the Upper Midwest. Relative to its main competitors – Cargill and ADM – CHS is not as vertically integrated. They move more than 2 billion bushels of grain annually. CHS makes use of yearly COTS from BNSF but will also move grain on the spot market. They operate terminals on the Mississippi, Minnesota, Ohio and Illinois rivers. At CHS, the research team also met with Brock Lautenschlager, rail services director.

1.3.2 Archer Daniels Midland (ADM)[49]

ADM was founded in 1902 and is one of the largest agricultural processors in the world. It is headquartered in Chicago. It is vertically integrated and has more than 270 processing plants and more than 470 sourcing facilities. It transforms crops into 1) food ingredients, 2) animal feed ingredients, 3) renewable fuels, and 4) naturally derived alternatives to industrial chemicals. ADM also trades, transports (barge, ocean-going vessel, truck, and rail freight services), stores and processes corn, oilseeds, wheat and cocoa. Furthermore, ADM connects crops to more than 140 countries on 6 continents. Its business segments are comprised of oil seed processing, corn processing, agricultural services and other financial administrative services. The company also has ADM logistics, which includes railroad operations and

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47 http://www.swgrain.com

48 http://www.chsinc.com

49 http://www.adm.com/en-US/Pages/default.aspx

bulk trucking. At ADM, the research team met with Scott Nagel, President; Kur Harstad, corn merchandising manager; Kirk Gerhardt, BN freight merchandising manager; and Randy Narlock, Vice President of transportation/elevator operations.

EXHIBIT C- Field Visit Agendas and Question Outlines

Grain Companies

Source:

Tell us a little about where you get your grain from

- Sources
- Types/Quantities
- Relative Importance of each Type
- Risks
- Lead Time
- Predictability
- Elevator Types

Transportation

- Pick Up or Delivery of Grain
- Elevator Types
- Modes (Barge, Rail, Truck)
    - Competition for Upper Midwest
- In-house vs. Outsourced Logistics
    - Ownership of Rolling Stock
- Unit Trains vs. Conventional Rail Service

Storage, Handling and Processing

- Description of Handling Stages
    - Grain Drying, Aeration, Moisturization, Storage, Cleaning
- Operational Challenges
    - Shrinkage, Hot Spots, Insects, Mold, Quality Deterioration
- Separation of GMO and non-GMO
- Processing?

Distribute, Market and Sell

- Strategies for maximizing profit
    - Export vs. Domestic
    - Processed vs. Raw
        - What type of Products
        - Decision for what to process it into
    - Demand for your product
    - Competition

- Location – advantage or disadvantage

Country and Terminal Elevators

Schedule

- Typical Lead Time for Reserving Capacity
- Interactions and Coordination with producers
  - Describe Communication with producers – Pricing to Delivery
- Fixed Schedule or Fixed Capacity

Procurement

- How many farms are in your geographical area?
- How do you get the grain? Do you contact producers or do producers contact you?
- How does input and output of grain changed seasonally (monthly)?
- What are the typical quantities that you receive from a producer?
- How far do producers have to truck the grain to your facility on average?

Storage

- What is your storage capacity?
- Breakdown of storage costs.
- What percentage of this capacity do you actually use?
- What facilities does a terminal elevator have that you do not? (e.g. grading, cleaning, etc) How are these things handled along the supply chain if you cannot do them?
- How long are producers willing to store grain at their own farm?

Handling

- How quickly can you load a grain hopper?
- What is the average number (range) of grain cars that you order?
- Do you process them in parallel or sequentially?
- What are the stages that the grain go through from the moment you receive it at your facility to the moment it leaves your facility?
- What is the average time of each stage of the process? (Cleaning, aerating, loading, unloading…)
- When the trains arrive how many trucks can you process at once? Can you process different types of grain at the same time?

Grain Growers Association and Wheat Commission

General Overview

- What is the purpose of your organization?
- How many grain growers are in your association?
- How many storage elevators do you work with?
- How do you make decisions about accepting or rejecting prices?
- How do you get your grain to a grain elevator?

- How far do you typically drive to get to a grain elevator?
- Do you typically store grain on your farm?

Distribute, Market and Sell

- Do you work with producers to strategize which crops to grow
  - Export vs. Domestic
  - Specialty Grains
    - E.g. GMO
  - Processed vs. Raw
    - What type of Products
    - Decision for what market to sell
      - (e.g. quality needs for flower vs. raw grain)
  - Demand for your product
  - Competition
  - Location – advantage or disadvantage
- Backlogs for moving grain to market
- What affects your decision to sell or store

General Questions about the grain industry (for all stakeholders)

What are the main challenges faced by grain companies, as you see them? *(World market prices/domestic prices of grain, different cost elements from production to market, political factors, bottlenecks in moving grain, and financing, operational factors)*

What are the most promising opportunities, as you see them? *(For example, new technologies, service innovations, markets, policies, facing the grain industry?}*

Are there any specific areas where the transportation sector can, in the short run, help the grain industry? In the long run? *(More stable rates, investment in capacity, change in service types, reliability in the transport sector, and competition in the transport sector...)*

What are the main advantages and disadvantages of the US grain industry compared to other countries? What can the US do to increase competitiveness? *(Competitiveness of US grain industry due to good infrastructure and storage, good soil, technology…)*