Factors impacting organic corn production in the U.S.

by

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ABSTRACT

The organic food industry experienced rapid growth over the past several decades. Typically, the majority of this growth is associated with the produce sector, but as consumers demand organic options for more food products, organic grains, dairy, and animal meat have emerged as viable food alternatives. There is currently a shortage of organic grains, specifically corn, to feed the livestock that provide organic meat and dairy products. This shortage has led to increased imports of organic corn in order to satisfy the domestic demand. Previous research comparing organic corn prices and profitability to conventional corn have shown organic corn production to be at least as profitable as conventional. With the declining value of cash receipts for conventional corn and the potential profitability advantage of organic corn, very few farmers are devoting acreage to organic corn in the U.S. This study seeks to determine potential economic reasons for this discrepancy.

This research develops numerous production scenarios for organic corn in order to observe potential break-even yields a farmer could experience. For example, a nine-year low for price per bushel of organic corn was substituted in to actual values for current production to represent a possible break-even yield that could occur. In this study, the elasticity of organic corn is also calculated. The price elasticity of demand for organic corn gives insight as to how sensitive the demand is to a change in price per bushel.

The findings in this study are expected to add insight to the reasons why U.S. farm production of organic corn is less than its domestic demand. It is hoped that famers will

benefit from the results in this research in order to better understand organic corn production.

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CHAPTER I: INTRODUCTION

The agriculture and food industry experienced consistent change over the past several decades. From the transition of horses to tractors, dust bowls to no-till, and pest-ridden crops to pest-resistant crops, agriculture in the United States is ever-changing. A recent influence of change in agriculture comes from the consumer's desire for food transparency and environmental sustainability. The consumer's interest in organically grown food has increased.

In 2015, the U.S. organic industry established record highs for sales of organic goods, reaching $43.3 billion in annual sales (McNeil 2016). This total is an 11% increase from 2014's total organic sales and a 293% increase from 2004's organic sales of $11 billion. In comparison, the overall food market's growth rate from 2014 to 2015 was 3% (McNeil 2016). Of the $43.3 billion in total sales, $39.7 billion of it was organic food sales. The remaining $3.6 billion occurred in household products and cosmetics. With continued growth that spans over a decade, organically grown crops have developed a lifestyle rather than a short-lived trend. As such, large food retailers are taking notice.

Organic food was typically sold in smaller grocery, specialty or natural food stores, and farmer's markets throughout the U.S. According to Greene (2014), in 2014, organic food could be found in approximately 20,000 natural food stores and three out of four conventional grocers in the United States. The Organic Trade Association polled consumers in the U.S. in 2012 and found that 81% had purchased organic products at least a few times that year. With large food retailers such as Wal-Mart, Target, and Kroger selling organics, they have significantly contributed to the growth of the industry. The growth in demand has outpaced production of organics by farmers in the U.S. (T. Delbridge 2014); (McKay 2016).

Although the market for organic foods continues to grow rapidly in the U.S., only 3.7 million acres were devoted to organic production in 2014. The 2014 organic acreage is down from the 2008 survey of 4.1 million acres (USDA 2015). To put those total acres in perspective, farms in the state of Illinois accounted for nearly 27 million acres of the state's land in 2015 (Shander 2016). Organic cropland accounts for less than 1% of the total cropland in the U.S. (T. Delbridge 2014). Today, net imports now outweigh net exports of organic crops in the U.S. Importing organic food has caused concern with consumers as certification processes may not be as thorough in countries outside the U.S. (T. Delbridge 2014). Even crops that are widely grown in the U.S., such as corn, is being imported in significant quantities. Kellee James, CEO of Mercaris, a market data service and trading platform for organic and non-GMO crops, stated, "Year-to-date (2015), total organic corn imports have reached 5,202,698 bushels, which is an increase of 752% compared to last year (2014)." In 2014, Bloomberg reported $11.6 million in corn imports from Romania, up from $545,000 in 2013 (Bjerga 2015).

According to the U.S. Grains Council, American farmers produced over fourteen billion bushels of corn in 2014 on over ninety million acres of corn cropland. With only 0.4% of corn grown in the U.S. being organic (McKay 2016), there is significant room for transition and production of more organic corn. The lack of organic corn has hindered and slowed growth in other organic sectors. Organic dairy is the second largest organic food category with $6 billion in sales in 2015 (McNeil 2016). McNeil (2016) also states that the organic dairy's growth of 10% from 2014 to 2015 could have been greater if organic feed supply would be more readily available in the U.S. The organic livestock sector has also seen substantial growth.

From 1992 to 2011, the head of organic livestock has increased by over 4,000% (McKay 2016). As a consequence, the livestock industry has noted lack of organic feed as an issue with potential growth and reason for increased organic corn imports (Reaves 2015). With prevalent demand and countless studies (Chavas, Posner and Hedtcke 2009); (Delate, et al. 2003); (Delbridge, Coulter, et al. 2011) that found profits from organic corn can exceed those of conventional corn, the transition to organic corn has still been slow in the U.S.

A probable reason for the slow adoption of organic farming methods is the difficult transition period the United States Department of Agriculture (USDA) requires before awarding a certified organic label. Official regulations were set forth by the USDA National Organic Program (NOP) in 2000. This created a uniform definition and process to grant foods the USDA Organic seal. According to the government guidelines for a crop to be labeled as organic, the product must be grown for three years on land that has not had any pesticides or fertilizers that contain synthetic substances not included on the NOP's approved list applied to it. The crops grown during those three years must not contain any transgenic seedlings or GMO's. Farmers must practice the use of cover crops during their transition period and throughout their entire organic operation after the transition (United States Department of Agriclutare 2017). Throughout these three years, farmers are not able to receive organic premium for their crops. The price premiums are not available until after the third year has ended. This usually constrains farm profit during the transition process. Organically grown crops typically yield less than the crops raised under conventional production methods. Producers potentially suffer losses in yield or efficiency due to the learning curve of a different farming style. With less production and without the ability to obtain organic premiums for what is produced, the three-year transition period tends to be costly for farmers.

1.1 Research Problem

Organic agriculture is not a new phenomenon. In fact, it has now come full circle. Agriculture started out as organic and continued that route for many decades before technology advancements started to be applied to farming. To many farmers, the idea of growing crops organically seems foreign since they have only experienced conventional farming throughout their lives. Agricultural production technology has enabled farmers to produce high yielding conventional corn. In 2014, the USDA had the U.S. corn crop yield at 171 bushels per acre and 168.4 in 2015, the highest yields in U.S. history. This increase of supply has put downward pressure on the price of corn and subsequent pressure on farmer net income. Raising organic crops gives an alternative for farmers to receive higher prices and ultimately a higher profit for their corn crop. The purpose of this research is to determine possible factors preventing farmers in the U.S. from growing organic corn.

1.2 Research Objectives

This research is conducted by analyzing various production costs, prices, and yields of organic corn in the United States obtained from recent surveys and actual farm data. The overall objective is to determine if break-even yield and price elasticity of demand are reasons preventing the production of organic corn in the U.S. The specific objectives are:

1. Compare break-even yields for organic and conventional corn systems;
2. Create break-even yield scenarios and forecasts for organic corn; and

3. Determine the industry level demand for organic corn.

CHAPTER II: LITERATURE REVIEW

An ongoing topic of research in the agriculture industry is the profitability comparison of organic and conventional grain cropping systems. Early studies showed that organic and conventional crops earned roughly the same per-acre when both sold at conventional prices, with lower production costs offsetting lower revenues on the organic acres (Lockeretz, Shearer and Kohl 1981). More recent studies, such as Delate (2003), a three-year study in Iowa, showed organic rotations earned greater net returns than conventional when organic premiums were taken in to account. A thirteen-year trial out of Wisconsin came to the same conclusions (Chavas, Posner and Hedtcke 2009). In Minnesota, an eighteen-year trial took place comparing organic to conventional grain cropping systems. The results showed the four-year organic grain and forage rotation exceeded the net returns to both an equivalent rotation and a two-year corn-soybean rotation that were managed conventionally but only when organic price premiums were considered (Delbridge, Coulter, et al. 2011).

A dissertation by Delbridge (2014) focused on whole farm profitability of organic and conventional grain cropping systems. Building on a previous long-term study (Delbridge, Coulter, et al. 2011), Delbridge (2014) takes in to account the differences in farm sizes and overhead costs of the two systems. Results showed that the organically managed crop farm would be preferred by risk neutral and risk adverse individuals to a conventionally managed crop farm. When comparing net returns, organic grain production with full organic premium added outperformed conventional grain. Organic management remained the optimal choice even when only 75% of the organic premium was used.

In the first national examination of wind and solar energy adoption on U.S. farms, a multilevel modeling approach shows farm-level and state-level factors that influence adoption. Borchers (2014) analyzed the results of the 2009 On-Farm Renewable Energy Production Survey that was an add-on survey to the Census of Agriculture. The model sought to measure the impact of farm characteristics and farm locations for each responder, along with whether adoption of renewable energies (RE) had taken place. The study ran three models: one with farm-level covariates, one with state-level, and the third with combined both farm-level and state-level covariates. Results of the report showed that farm characteristics vary significantly between farms that have and have not adopted renewable technologies. On the state-level, farms were more likely to adopt solar or wind energy in states with higher retail electric prices and those with cost and production incentives to do so. On the farm-level, the authors found that farm size, organic operations, and years farming had the most impact on adoption. The longer the farm has been in operation, the less likely they were to transition to RE (Borchers, Xiarchos and Beckman 2014).

Pruitt et al. (2014) studied the adoption of technology, management practices, and production systems (TMPPS) in the beef cow-calf industry. TMPPS is recommended by extension services and the USDA to operations in the beef industry. These recommendations are based on profit and productivity benefits, as well as conservation of resources, but operations have been slow to adopt. Pruitt (2012) draws data from the 2008 Phase III cow-calf version of the USDA Agricultural Resource Management Survey to determine variables that have a positive influence on adoption of TMPPS. The twelve variables studied can be generalized in four categories: vertical integration, farm size, diversification, and demographics. The study found that vertical integration, producers involved in more than just cow-calf such as post-weaning, were more likely to adopt TMPPS than producers who were not. Farm size was also a significant factor in adoption of

TMPPS. This study, as well as Gillespie (2007), found that larger cattle operations, in terms of more cows, were more likely to adopt TMPPS. In a similar study, Ward (2008) also found that farm size, specifically those with higher household net incomes, were more apt to adopt new farm management practices. Lastly, producers that graduated college were more likely to adopt TMPPS than producers without a college degree.

Farm size is a common factor in producer trends. MacDonald, Korb, and Hoppe (2013) focused a study, using farm-level data, to note changes in U.S. farm sizes and the forces driving change. Their report covers influencing factors such as technologies, business relationships, family-owned and operated, and government policies. The data obtained for their report came from the USDA's National Agricultural Statistics Service's Census of Agriculture, as well as the Agricultural Resource Management Survey. These two sources provide comprehensive and historical data on farm consolidation, financial returns, role of family farms, and provide evidence on the use of various production factors. MacDonald (2013) shows that farm size in the U.S. is increasing with midpoint acreage being 589 acres in 1987 to 1,105 acres in 2011. The number of farms in 2001 that had over 10,000 acres were 409 compared to 2011 that had 1,140 farms over 10,000 acres. The study concludes that larger farms continue to experience better financial performance in terms of rate of return on equity and utilizing labor and capital more intensively. The availability of forward contracting and evolving crop insurance has lowered producer risk, enabling larger farms to be more manageable. Technology also showed to play a large role in the growth of farm size. With labor-saving innovations, seed genetics, and precision equipment, a single farmer is able to effectively manage more ground.

In 2015, the USDA published a report on the profit potential of certified organic field crop production. McBride et al. (2015) examined the profitability of organic corn, wheat, and soybeans by using data from the Agricultural Resource Management Survey for these crops. The authors were able to use propensity-score matching to group conventional and organic farmers in to similar categories based on farm and operator characteristics. This enabled them to measure the difference in production costs between the two systems. Although profitability studies exist for organic crops, this study's findings include the economic costs for each system in order to give a more accurate comparison. The study found that organic field crop production was conducted on smaller farms in terms of total acreage than what conventional field crops had. Organic corn and wheat farmers noted weed control, yields, and certification paperwork as being their most difficult challenges. The organic profit returns resulted in higher values than profits earned from conventional methods. The price paid for the organic crops was the most significant contributor to these high returns. Yields and production costs were not nearly as important as price was. This USDA study implies that some conventional farms may be able to earn greater returns if they transition to organic crop production.

Organic grain shortages that are occurring in the U.S. are causing problems for retailers and end-users. In 2014, a group of companies commissioned the Sustainable Food Lab to report on the challenges and barriers for organic grain farmers. Reaves and Rosenblum (2014) acquired data from USDA organic surveys, Census of Agriculture surveys, and maybe most importantly, from interviews with professionals in the industry. Government officials, academic professionals, grain merchandisers, leaders of non-profit agricultural associations, and extension service officers all provided their insight for assembling barriers and opportunities for organic grain production. The report listed challenges of categories such as social perception, financial, markets, knowledge, transition, equipment, research available, extension services, and production. The challenges were noted, but the authors also included an intervention section after the barrier category. In the intervention section, ideas were listed as possible ways to solve or reduce these barriers. After the intervention section, the report listed companies and activities that had resources or events that could be beneficial to that specific category. In the Census of Agriculture survey, regulatory problems and production issues were reported as the largest challenge. Other surveys had production and marketing as the top challenges. Common themes throughout these surveys and interviews with professionals emerged for organic grain challenges. Farmers are concerned with profit uncertainty due to loss of yield from issues that can be controlled with chemicals in conventional production. The transition process required for organic certification was also noted in the majority of responses. Another reason that was common was the social aspect of peer influence from other farmers.

There are many factors that influence a person, company, or industry to adopt practices that are new or different. The same goes for reasons an industry may be following certain trends. Although the majority of studies have shown growing organic corn to be more profitable than conventional corn, farmers are still slow to change their production methods to organic. The above articles have shown factors that influence a farmer to adopt a new practice, barriers of entry, and potential challenges one may face when entering a new sector. This study seeks to identify factors that are contributing to the slow rate of adoption for organic corn.

2.1 Research Contribution

This study aims to provide additional insight in to the potential reasons why farmers are not producing organic corn, even though the U.S. demand outpaces supply. Numerous studies have shown organic corn to be overall more profitable than conventional corn. By determining the price elasticity of demand and potential break-even yields, this research determines if either of these factors prove to be limiting factors in the supply of organic corn. Focusing on specific issues such as these will enable future research to focus on other production factors, further narrowing the possible barriers in the production of organic corn.

2.2 Organic Agriculture

According to the USDA National Organics Standard Board, the definition of organic agriculture is, “An ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony. 'Organic' is a labeling term that denotes products produced under the authority of the Organic Foods Production Act (United States Department of Agriculture National Agricultural Library 2007)”

Prior to 1990, the U.S. did not have a national standard set for defining the terms or criteria for organic agriculture. A consumer of organic products would depend entirely on the producer or retailer to advertise organic products and meet the ill-defined requirements of organic production. As such, the products were subject to the production methods and prices, which often included crops produced using chemical or synthetic fertilizers and sold at higher prices (Main 2011). In 1990, congress passed the Organic Foods Production Act of 1990 that required the USDA to develop national standards for organic products.

Products that meet these standards and regulations are awarded the right to market their products as USDA Certified Organic. The USDA Organic seal is widely recognized by consumers. To identify organic production, it encircled "USDA" on the top portion and "organic" encircled near the bottom on the package/product. The organic food label can be black and white, green and white, or brown and white.

2.3 Organic Certification

To earn the organic label for food products, an organization must meet and follow the USDA National Organic Program's standards. The USDA, however, does not inspect or certify farms. The USDA certifies third-party companies that are then hired independently by farmers who seek organic certification. According to the USDA's Organic Integrity Database, there are currently forty-eight domestic certifying agencies in the U.S. (United States Department of Agriculture 2016). A review of the top-ten corn producing states based on total production from 2015 show twenty-four different agencies have certified farming operations in Illinois, eighteen in Indiana, sixteen in Iowa, fourteen in Kansas, twenty-one in Minnesota, twenty-two in Missouri, sixteen in Nebraska, eighteen in Ohio, twelve in South Dakota, and nineteen in Wisconsin (United States Department of Agriculture 2016). These certifiers all have different costs and procedures used to verify organic production, but all are approved by the USDA to grant organic certification. The largest organic certifier, California Certified Organic Farmers (CCOF), has certified operations in over forty states, including all of the Corn Belt states, and promotes their process as a six-step transition (CCOF Certified Organic 2013):

1. Producer submits an application and Organic Systems Plan (OSP). The OSP is required by the National Organic Program (NOP) for all producers to become certified organic. Templates are provided on the USDA Organic website and by the

certifying agents. A typical OSP contains detailed descriptions of all practices and procedures, from start to finish, that an operation uses to produce an organic crop. It acts as an agreement and guideline that keep the farm within the NOP's standards. The application process requires a $325 fee to be paid and submitted with the OSP.

2. The certifying agent, CCOF, then reviews the application and OSP to determine if the farm is ready to move forward in the certifying process.
3. If step-two is complete, an on-site inspection is scheduled. The inspector confirms that the farm is following the submitted OSP plan and not violating any of the NOP rules. The inspector may collect samples of water, soil, waste, plants, or anything else relevant to the operation for testing. All certified operations are inspected a minimum of once a year. Inspectors are allowed unannounced farm visits throughout the year.
4. CCOF certification specialists then review the on-site inspection findings. They determine if any issues require further inspection or information.
5. The CCOF then decides whether or not the farm deserves certification. A letter of confirmation status is mailed to the applying operation.
6. After the operation is certified, yearly inspections and fees will occur with the farm operation. OSPs must be kept up-to-date and submitted to CCOF whenever changes occur.

The above process takes place once the cropland is ready for certification. The Organic Food Act requires all ground to be absent of synthetic chemicals, synthetic pesticides, synthetic fertilizers, and transgenic/genetically modified organisms (GMOs) that are on the NOP's prohibited substances list for three years before the crops can be considered organic (National Organic Coalition 2005). The cropland must also be sustainably managed according to the NOP regulations with practices such as crop rotations, usage of cover crops, and erosion control. To ensure ground is being properly transitioned, growers are encouraged to hire a certifying agency to assist in the transition period prior to the certification process, but they are not required to.

The transition period often brings about financial stress and loss for producers. Yields are typically lower for transitional and organic crops when compared to conventional. There can also be machinery conversions or purchases and basic learning curves when undertaking a new process (T. Delbridge 2014). During the three years where organic practices are being followed, producers are not allowed to market their products as organic. This means that with lower yields and possible initial investments, farmers receive conventional prices for their crops, which are significantly lower than organic crops. According to Shander (2016), the net return per acre from 2010-2014 for transitional corn was negative $13.00 and negative $105.00 for transitional soybeans in the U.S. (Shander 2016). The process to achieve organic certification, especially if a transition period is required, which is likely with organic corn production, is a difficult, tedious, and costly process.

2.4 Organic and Conventional Corn Profits

There have been numerous studies over the past few decades, both experimental trials and empirical farm-level, to compare profit per-acre for organic and conventional grain rotations. The majority of which, (McBride, Greene and Foreman, et al. 2015); (T. Delbridge 2014); (Delbridge, Coulter, et al. 2011); (Chavas, Posner and Hedtcke 2009); (Delate, et al. 2003); (Clark 2009), have all found organic grain cropping systems to be more profitable on a per-acre basis than conventional systems. In many cases, the organic systems would not be the most profitable choice without the premium that is paid for organic crops. Lower yields, commonly referred to as “yield drag” and the additional production costs typically not incurred when using conventional methods, require higher price premium to offset the high cost of production in organic crops. A number of studies on organic and conventional grain profitability provide comparisons based on eighteen years of data from the University of Minnesota’s Variable Input Crop Management Systems (VICMS). The VICMS research compared returns on three different crop systems: an organic four-year rotation of corn, soybeans, oats/alfalfa, and alfalfa; a four-year conventionally managed rotation using the same crops as the organic four-year rotation; and a two-year conventional rotation of corn and soybeans. Delbridge et al. (2011) applied costs of machinery, fertilizer, pesticide, seed, and commodity prices to all three rotations. This resulted in a realistic cost of production comparison between the conventional and organic systems. In Table 2.1, Delbridge et al. (2014) shows the average production costs of the two-year conventional input rotation (CI 2-year), the conventional input four-year rotation (CI 4-year), and the four-year organic rotation (OI 4-year). The results show the four-year rotations experienced lower production costs than the two-year system. The CI four-year has the lowest average cost of production by $4.14 on the OI four-year rotation. The standard deviation (std. dev.) is the lowest in the organic system, meaning there is less cost variance from the mean. The organic corn has the lowest average production costs and the lowest standard deviation when compared to the conventional corn in the other two rotations.

Table 2.1: Average Production Costs by Crop for the Two-Year Conventional Rotation (CI 2-Year), Four-Year Conventional Rotation (CI 4-Year), and Organic Input Rotation (OI 4-Year) from 1993-2010

	CI 2-Year Rotation		CI 4-Year Rotation		OI 4-Year Rotation	
			U.S. $/ha			
Crop	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Corn	669.82	79.58	601.56	84.39	586.71	66.06
Soybean	305.35	64.66	310.25	60.85	260.81	9.69
Oat	-	-	280.03	46.62	349.82	96.03
Alfalfa	-	-	428.22	51.69	394.3	30.99
Rotational Average	487.58	198.15	405.02	141.13	409.16	131.09

(Delbridge, Coulter, et al. 2011).

After production costs were figured, Delbridge et al. (2011) calculated the net returns for each rotation. Commodity prices and premiums were obtained from the Farm Financial Management Database and applied to the rotation systems from the VICMS. Table 2.2 shows the average net returns of the CI two-year, CI four-year, and OI four-year.

Table 2.2: Average Net Return for the Two-Year Conventional Rotation (CI 2-Year), Four-Year Conventional Rotation (CI 4-Year), and Organic Input Rotation (OI 4-Year) from 1993-2010

Crop Rotation	Price Structure	Net Return	Std. Dev.
		U.S. $/ha	
CI 2-Year	Conventional Prices	845.52	318.59
CI 4-Year	Conventional Prices	675.01	370.4
OI 4-Year	Conventional Prices	659.68	429.65
OI 4-Year	50% of Organic Premium	994.32	607.31
OI 4-Year	100% of Organic Premium	1328.96	870.02

(Delbridge, Coulter, et al. 2011)

As the results in Table 2.2 show, without organic premiums, the two-year conventional cropping system is the most profitable. When organic premiums are applied to the OI system, it results in higher returns than both of the conventional systems. Even when only 50% of organic premiums were applied, the organic system still outperformed the conventional systems. A few years later, Delbridge (2014) built upon the study from 2011 in order to determine net returns for comparable organic and conventional grain rotations based on machinery categories required for that system. Table 2.3 shows the net returns and standard deviations for the conventional and organic rotations for each machinery group size.

Table 2.3: Average Net Returns for the Conventional Two-Year (CI-2 year) and Organic Four-Year (OI 4-year) Rotations for each Machinery Group and Pricing Scenario with Full Trial Yields 1993-2010

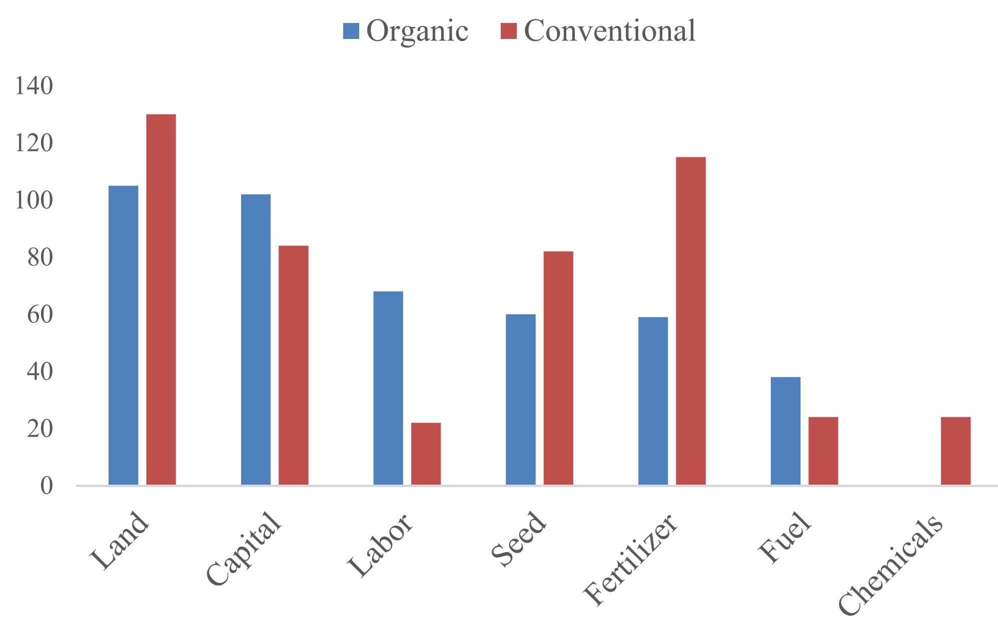
Crop Rotation	Machinery Group	Farm Size	Conventional Prices (US $)		Half Premiums (US $)		Full Premiums (US $)	
		Acres	Net Return	Std. Dev.	Net Return	Std. Dev.	Net Return	Std. Dev.
CI 2-year	#1	320	51,150	33,884				
	#2	880	147,007	93,172				
	#3	1,360	229,249	143,991				
OI 4-year	#1	320	24,942	20,259	68,296	27,358	111,650	36,988
	#2	560	50,858	35,471	126,727	47,897	202,597	64,750
	#3	800	74,021	50,689	182,405	68,438	290,790	92,510

(T. Delbridge 2014).

The net returns are similar to other studies in that conventional two-year systems seem to be more profitable than organic systems when premiums are not taken in to account. At the same acreage in machinery grouping #1, the conventional system doubles that of the organic rotation. When full premium is applied to that first group, the organic system more than doubles the conventional rotation. It is worth noting that the maximum farm size for machinery groupings two and three are significantly larger in the conventional system. With more field passes and farm management, the organic farmer is unable to sufficiently cover as much ground as conventional operations. The maximum farm size for machinery group #3 for conventional is 1,360 acres compared to 800 for organic.

Various research shows organic and conventional corn systems to be similar in production costs. In Figure 2.1, the USDA report calculated costs per acre of organic and conventional corn by input in 2010. The chemical, seed, and fertilizer costs are significantly higher for conventional corn growers. Organic corn is prohibited from using the synthetic chemicals and fertilizers that are common in conventional systems. The organic corn system showed higher costs in capital, labor, and fuel. This is very common for organic systems. More machinery and passes are required for organic systems than with conventional, resulting in more fuel used (T. Delbridge 2014). Labor required to operate machinery for longer as well as partake in manual work, such as weeding, put this category well above conventional systems.

Figure 2.1: Costs per Acre of Organic and Conventional Corn Production by Input in 2010



(McBride, Greene and Foreman, et al. 2015)

McBride et al. (2015) found organic corn, with premiums included, had an average price per bushel of $7.15 in 2010 compared to conventional corn at $4.32. From 2011 to 2012, organic corn reached prices of $16 per bushel putting it over $9 per bushel more than conventional corn prices. In crop year 2013, premiums slightly declined, putting organic corn at a $5 - $7 per bushel advantage to conventional corn. Organic corn premiums rebounded in 2014 while conventional prices struggled, putting organic corn bushels at a $9-$10 advantage.

Profit comparisons for organic and conventional systems do not take in to account the transition period a grower would face in transitioning to organic corn. In a Mercaris presentation at the 2016 Clean Label Conference, Scott Shander presented a comparison of net returns for conventional, transitional, and organic corn, soybeans, and alfalfa in the U.S. from 2010-2014. The results hold true to past mentioned studies, but provide numbers for profits during the transitional period. Table 2.4 shows the average net returns from 2010-2014.

Table 2.4: Net Returns per Acre, 2010-2014

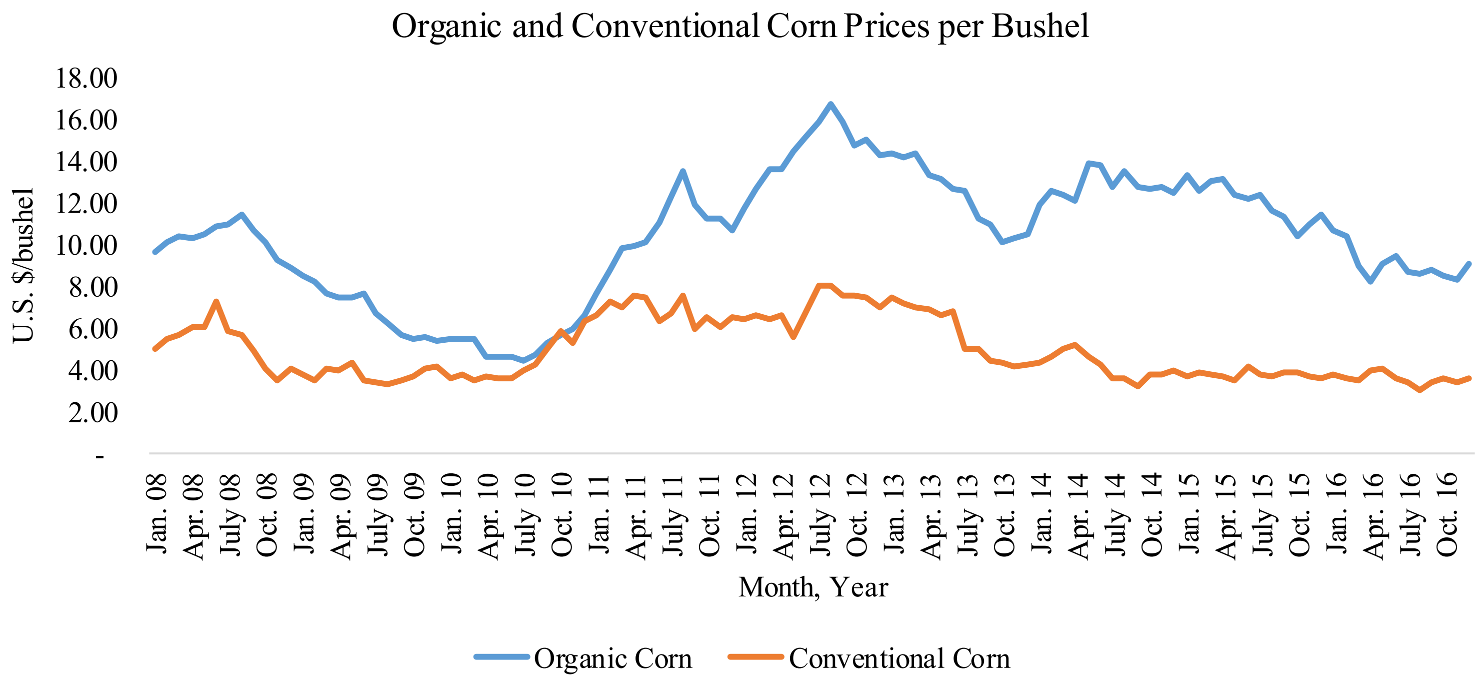
Net Returns Per Acre, 2010-2014 U.S. $			
	Conventional	**Transitional**	**Organic**
Corn	129	-13	552
Soybeans	91	-105	187
Alfalfa	168	134	157
Average	129	5	299

(Shander 2016)

Although negative net returns occur in the transitional years, the organic returns would more than make-up for those losses in years following certification. When transitioning ground from conventional to organic, the crop harvested following the third year of transition can be marketed as organic. Based off of Shander (2016)'s numbers, the end of year three's value for organic corn would be $526 (-13 + -13 + 552) compared to the conventional system of $516 (129 + 129 + 129).

The inclusion of two different studies on production and transition costs provides an opportunity to observe that the two systems are not far off from one another in terms of producing corn. The prices paid for organic corn is what gives it an advantage. Premiums for organic corn can vary depending on geographical regions and distance to end users. The USDA and Mercaris compile data on paid organic prices per bushel and publish weekly and monthly averages for various crops. In Figure 2.2, the USDA and Mercaris monthly organic corn prices are compared to the Chicago Board of Trade's (CBOT) end of the month closing corn price. The USDA did not have accessible prices for years 2014-2016. Prices for 2014-2016 came from the price data published by Mercaris.

Figure 2.2: Organic and Conventional Corn Prices, 2008-2016

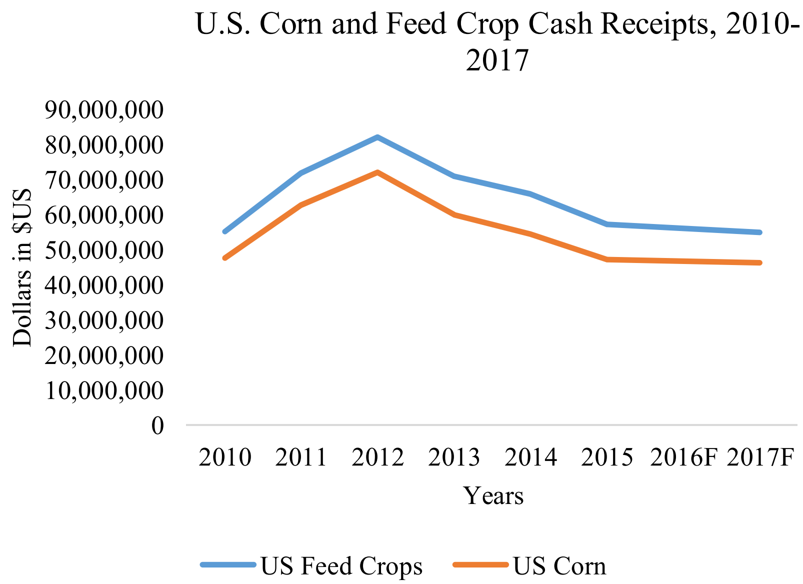


(Mercaris 2017); (Investing 2017); (United States Department of Agriculture 2014)

Previous studies indicate the price for organic corn is typically higher than conventional corn. In 2009-2010, the price of organic corn narrowed to resemble conventional prices. The narrow spread (or the difference) between organic and conventional corn during this period is likely attributed to the 2008 recession that reduced the consumer's willingness to pay premiums for products when household financial security was in question. Following the recession, organic corn prices soared and have maintained a steady gap between conventional corn prices.

Figure 2.2 characterizes conventional corn prices on the CBOT as moderately unchanged since 2013. Price stability at a lower price per bushel level puts significant stress on some conventional farmers as they are not receiving as much money for their bushels. This is reflected in the USDA's report on cash receipts by commodity. Cash receipts are the amount paid to a farmer in a calendar year (StatCan 2016). It includes revenue from the sale of agricultural commodities, program payments from government agencies, and payments from private crop insurers. The value of cash receipts for corn and feed crops in the U.S. has been declining since 2012 (United States Department of Agriculture 2017). In Figure 2.3, the average amount of cash receipts for U.S. farmers is shown from 2010-2017. During the data collection period of this research, information was not available for years 2016 and 2017 and cash receipts have not been officially posted by the USDA, but the amounts are forecasted by the USDA.

Figure 2.3: U.S. Cash Receipts for Corn and Feed Crops, 2010-2017



(United States Department of Agriculture 2017)

With U.S. cash receipts for corn dropping from market highs in 2012 and arguably the continuance of low payments, farmers may find it increasingly difficult to pay the bills and purchase new equipment while depending solely on raising conventional corn.

2.5 Certified Organic Acreage

With the growing organic food demand by U.S. consumers, organic food production increased by 240% from 2002-2011 (McKay 2016). According to the USDA's National Agricultural Statistics Service (NASS) surveys, the total certified organic acreage in the U.S. was 4,077,337 in 2008 and 4,361,849 in 2015, a mere 0.07% increase (United States Department of Agriculture 2017). In Table 2.5, organic farm statistics are compared to total U.S. farm statistics for 2015 based off of NASS's Certified Organic Survey of 2015 and the USDA Acreage Report of 2015.

Table 2.5: Total Certified Organic Operations, Acres, Cropland Acres, and Corn Acres for Organic Operations and U.S. Farm Totals, 2015

	Organic Farms	All Farms
	2015	
Certified Operations	12,779	-
Total U.S. Acres	4,361,849	406,000,000
Cropland Acres	2,409,869	318,510,000
Corn Acres	220,020	87,999,000

(United States Department of Agriculture 2016); (United States Department of Agriculture 2016)

Of all the agricultural land in the U.S., just 1.07% is organic certified. Table 2.6 further breaks down the organic corn acreage numbers to specifically look at the states in the Corn Belt and their production of organic corn compared to their total corn production.

Table 2.6: Organic and Total Corn Production for the U.S. Corn Belt and Total U.S. Production, 2015

	Organic Corn	All Corn	Organic %
		2015	
Illinois	9,425	11,700,000	0.081%
Indiana	6,433	5,650,000	0.114%
Iowa	25,192	13,500,000	0.187%
Kansas	3,738	4,150,000	0.090%
Kentucky	698	1,400,000	0.050%
Michigan	12,506	2,350,000	0.532%
Minnesota	25,404	8,100,000	0.314%
Missouri	4,183	3,250,000	0.129%
Nebraska	10,288	9,400,000	0.109%
Ohio	9,987	3,550,000	0.281%
South Dakota	4,805	5,400,000	0.089%
Wisconsin	37,048	4,000,000	0.926%
Total U.S.	220,020	87,999,000	0.250%

(United States Department of Agriculture 2016); (United States Department of Agriculture 2017)

In a country that plants almost 88,000,000 acres of corn (137,500 sq. mi.), roughly the size of Germany (137,849 sq. mi.) (British Broadcasting Corporation 2014), less than 1% of it is organic. Some states in the Corn Belt have seen decreases in growth over the past years. Table 2.8 shows the number of organic acres of corn each Corn Belt state had in 2008, 2011, 2014, and 2015 according to USDA organic reports.

Table 2.7: Total Organic Corn Acres in the Corn Belt States and Total in the U.S., 2008, 2011, 2014, 2015

	Organic Corn Acreage				
	2008	**2011**	**2014**	**2015**	**% of Growth**
Illinois	7,016	7,453	10,405	9,425	34.3%
Indiana	1,527	2,109	4,755	6,433	321.3%
Iowa	22,328	19,907	25,454	25,192	12.8%
Kansas	3,746	3,688	3,681	3,738	-0.2%
Kentucky	133	61	363	698	424.8%
Michigan	14,181	13,689	13,554	12,506	-11.8%
Minnesota	22,799	24,486	24,714	25,404	11.4%
Missouri	3,298	1,382	4,007	4,183	26.8%
Nebraska	8,991	9,111	9,291	10,288	14.4%
Ohio	8,662	8,271	11,712	9,987	15.3%
South Dakata	3,245	4,664	3,315	4,805	48.1%
Wisconsin	30,394	28,625	29,231	37,048	21.9%
U.S.	168,303	168,900	215,249	220,020	30.7%

(United States Department of Agriculture 2017)

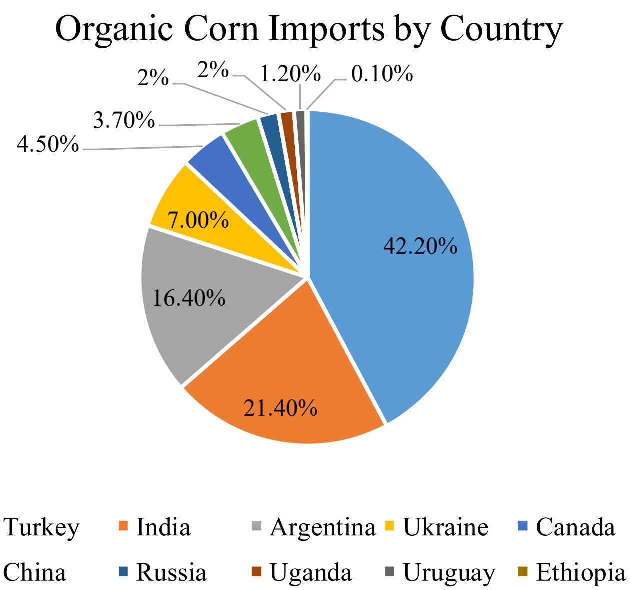
As Table 2.7 shows, there has been some growth of organic corn in the U.S. and in the majority of the Corn Belt states from 2008 to 2015. Kansas and Michigan have seen small decreases in acreage since 2008. Although there is some growth shown, it is important to recall Table 2.6 that shows each Corn Belt state's organic corn acres accounted for less than 1% of their total corn acres in 2015. With the small percentage of land dedicated to organic corn production in the U.S., the demand is outpacing domestic supply causing shortages for various companies and other industries (Reaves, Organic Grain Shortages 2015).

2.6 Demand for Organic Corn

The demand for organic grains is rising in the U.S. Organic production has steadily increased but not enough to meet the domestic demand (Reaves 2015). This shortage of organic grains has led to increased organic corn imports from Canada, Europe, and South Africa. The largest demand for organic grains comes from the animal feed markets (McKay 2016). Animal feed grains mainly consist of corn. The USDA had corn accounting for 95.3% of the U.S. feed production. Sorghum, oats, and barley account for the rest. According to USDA data on U.S. organic livestock and poultry, the livestock industry grew from 11,647 certified animals in 1992 to 492,353 in 2011 and poultry grew from 61,363 to 37,028,242 certified animals during that same time frame. Organic produce has long dominated the market share of organic food sales, but by breaking produce into separate categories of fruits and vegetables, both ranked second and third respectively behind livestock and poultry products in 2014 (USDA 2015). The organic dairy sector has been one of the largest growing of all organic sectors in recent years and is the second biggest organic food category behind produce. It saw a growth of over 10% in 2015 from previous year earnings and accounts for 15% of organic food sales (McNeil 2016). In an interview with the Star Tribune in 2015, Meg Moynihan, the organic program administrator for the Minnesota Department of Agriculture, claimed that organic dairy supply was very tight and companies were looking for new producers to enter the market as they were struggling to fill orders with retailers who wanted organic dairy products (Meersman 2015). A shortcoming for organic livestock and dairies is the inability to keep pace with demand for organic feed. Organic livestock producers frequently state that finding a reliable source of organic feed is difficult and often involves shipment over a long distance, which results in substantial cost to the feed (Barth 2015). According to the 2014 Organic Survey, the top expense for organic farmers, which includes operations that do not have livestock, was organic feed, accounting for $927 million or 23% of all production expenses (USDA 2015). When organic livestock producers have problems acquiring organic feed or are unable to afford it, they must turn to conventional feed to keep their animals from going hungry. The animals eat the non-organic feed are unable to receive organic premiums for their production. This not only hurts the producer, but the problem makes it down the supply chain to retailers whom are in need of the organic products. Perdue, the largest producer of organic chicken and a producer of organic sausage, has seen these feed shortages first-hand. In recent years, they have had to import organic corn and soybeans from Argentina, India, and Turkey (Singh 2015). Perdue has decided to conduct research on organic corn and soybeans in test plots in Maryland and Delaware in order to share information with organic farmers. This type of assertive action from Perdue has been common for organic retailers in response to organic grain shortages.

In order to counter organic grain shortages, retailers have been forced to import corn from other countries. According to Mercaris import data, the U.S. imported over twenty-one million bushels in 2016 (Mercaris 2017). In January of 2017, organic corn imports were over two million bushels, an increase of 134% from the previous month and an increase of 10% from the previous year (Mercaris 2017). Figure 2.4 shows the percentage of organic corn the U.S. imported from each country in 2016.

Figure 2.4: Organic Corn Imports by Country, 2016



(Mercaris 2017)

With the uncertainty of quality and organic practice of countries outside the U.S., retailers are taking action domestically. Similar to Perdue conducting research on organic corn and soybean plots, companies are getting more involved with farmers and the production processes. Nature's Food Path's frustration with organic grain supply for their cereals and food-bars resulted in the purchase of 2,800 acres of farmland in the U.S. and hiring farmers to grow crops on it (Brat 2015). Pacific Foods of Oregon Inc. and Chipotle are hiring full-time headhunters to recruit organic farmers and are also paying more than conventional prices for farmers who are in the transitional process (Brat 2015). Clif Bar and Organic Valley named the University of Wisconsin-Madison as the recipient of the nation's first endowed chair focused on plant breeding for organic crops (Reaves 2015). General Mills is financially supporting organic farmer internships with the Villicus Farm Program (Reaves 2015). Not only are companies getting more involved with organic production and education, they are also trying to make the process more appealing for growers by offering longer-term purchasing contracts. The Hain Celestial Group Inc., which owns brands such as Health Valley and Earth's Best, was struggling to keep supply of organic tortillas and tortilla chips. To counter this shortage, they began offering farmers five-year contracts for organic blue and yellow corn (Reaves 2015). The demand for organic grains has become so dire, that companies and competitors have come together to form the U.S. Organic Grain Collaboration. The goals of this venture is to increase the number of acres and domestic supply, improve productivity and profitability for the farmer, and improve the resiliency of organic grain production (Sustainable Food Lab 2016). Some of the partners in this collaboration are Clif Bar, Stonyfield Organic, Organic Valley, Nature's Path, Whole Foods, and General Mills.

The domestic demand for organic corn is significant. Other industries that use organic corn, like organic meat and dairy, are not able to reach their full potential due to the lack of supply of organic corn for feed. The U.S. imports organic corn in increasing numbers to try and meet this demand. The domestic price for organic corn remains well above the stagnant conventional corn prices. Operating costs of conventional and organic corn are similar to one another. Although the demand and favorable price for organic corn are apparent, very little acreage has been dedicated to its production.

CHAPTER III: METHODOLOGY AND DATA

3.1 Break-Even Analysis

Determining the break-even point is an important consideration for decision makers. A break-even analysis is used to determine the point in which profit is zero based on either the output or sales needed to cover expenses. The factors used to conduct a break-even analysis in this study include: fixed costs, variable costs, and price per unit. Fixed costs are the expenses that do not vary with the amount of units sold. Common fixed costs are expenses such as rent, insurance, and interest rates. The variable costs will fluctuate with the amount of units sold. Variable costs are expenses such as packaging and shipping. A break-even analysis shows the amount of units a company needs to sell in order to cover all cost and be at $0.00 profit. From here, a business is able to determine what amount of units sold begins producing a profit.

This study compares the break-even point for the production of organic corn and the production of conventional corn. The fixed and variable cost categories are the same for both production systems with the addition of an organic certification fixed cost for the organic system. With yield being one of the top concerns for farmers who are hesitant to switch to organic production (McBride, Greene and Foreman, et al. 2015), the break-even point this study calculates is the number of bushels per acre one must produce in order to cover costs. The formula for the break-even calculation is:

$$Breakeven = \frac{FC}{P - \left(\frac{VC}{Y}\right)}$$

In this formula, FC is the fixed costs of production per acre, P is the price per bushel, VC represents the variable costs per acre, and Y equals the yield per acre. The costs, price, and yield are all from the same year of production. In this analysis, three factors attributing to the break-even analysis for conventionally and organically produced corn was left out of the calculation – marketing costs, miscellaneous costs, and professional costs. Marketing costs incur from how the producer sells grain. When a farmer sells corn bushels, the use of specialty contracts and options to hedge grain can be used. These type of marketing strategies require a fee per bushel paid to a broker or grain facility. The cost for marketing is based on producer preference and is not subject to organic or conventional systems. Marketing for organic corn is also different than conventional. For the most part, farmers do not grow organic corn unless they have a guaranteed contract or facility near-by that will accept it (Midwest Organic & Sustainable Education Service 2012). Conventional corn farmers can contract their grain or they can wait if they think the price will go higher. The next cost that was not used was miscellaneous expenses. When taking under consideration the lack of a widely agreed upon definition of this cost, it is left out in order to keep the organic and conventional corn costs comparable to the specific cost category. The last cost that was excluded from this study was dues and professional fees. Whether or not a producer is part of a farmer's cooperative or association that requires a fee is based on their preference, similar to the marketing cost. Additionally, there is a fixed cost and variable cost for the machinery lease per acre and hired labor per acre categories. The contract for machinery leases can be a fixed cost when charged for a certain amount of time regardless of usage or a variable cost when charging for the amount of hours or miles it is used. Hired labor is a fixed cost when the labor is paid on salary and a variable cost when the labor is hourly. The cost for fixed hired labor does not change by how much they are required to work in order to produce bushels. Variable cost hired labor is subject to change based on how often the employees are required to work in order to produce bushels.

3.2 Scenario Analysis

One of the limitations of a break-even analysis is that it only looks at one year of data. A certain cost might be unusually low one year, which will still give the correct break-even value, but not may be an accurate representation of what it typically would be. For most businesses, there are outside factors that can influence the prices an operation must pay. Prices within the agriculture industry are highly influenced by outside markets, governments, and nature. In order to gain additional perspective on potential break-even yields, this study creates scenario analyses by altering the values of variables used. Yield is a common concern for farmers transitioning from conventional to organic corn. Along with yield, the cost of labor is also of concern due to organic production being more labor intensive. One of the top costs according to the 2014 Organic Survey is labor. Another cost that can vary greatly for a producer is its location to the elevator or end-user that purchases organic corn. For a conventional producer, finding an elevator to accept its corn is typically an easy task. Finding a location that accepts organic corn for a premium price can require extra costs in terms of trucking for the farmer (Reaves and Rosenblum 2014). An important consideration when conducting a financial analysis is to evaluate the prospect of variability and the effect on profit. As such, the price of inputs and outputs are high priorities. Many studies have shown organic corn production to be less profitable when the organic premiums are not taken in to consideration. The higher price for organic corn is what gives it the ability to be more profitable than conventional. The scenario analyses in this study are conducted by altering values in for the 2015 production costs of organic corn and are as follows:

1. Decrease yield per acre by 50%, ceteris paribus. Using 50% as a reduction gives the grower an idea of the break-even yield if that crop year has undergone significant

stress. The 50% yield is believed to bring large changes that could have a profound effect on a farmer's decision.

2. Decrease price per bushel, while leaving all other variables unchanged. The price per bushel used is the lowest monthly organic corn price posted by the USDA, which occurred in July of 2010. The USDA price data for organic corn dates back to 2008.
3. Increase all fixed costs and variable costs by 50%, while leaving price and yield unchanged. The variable cost for trucking and hauling was significantly lower for 2015 in comparison to 2011-2014. In order to give this cost a more accurate value, this study chose the highest value for hauling and trucking for organic corn in the past five years, which occurred in 2013. The price for the fixed cost of custom hire did not have a value in the 2015 data. The value used in this scenario was the highest cost from the past five years of organic production for fixed cost custom hire, which occurred in 2011. With costs such as labor, trucking, and fieldwork being more of a concern for organic corn, increasing costs gives a look at what happens to break-even yield when production costs increase.
4. Increase all fixed costs and variable costs by 30% and decrease yield per acre and price per bushel by 30%. The values for hauling and trucking as well as custom hire that were used in scenario 3 were also increased by 30%. This last scenario gives the producer a look as to what the break-even yield could be when everything that decreases revenue happens in the same year.

These scenario analyses give a better look as to what the possible break-even yield can be when costs, yields, and price change.

3.3 Forecasted Break-Even Analysis

The conversion process from conventional to organic systems requires a three-year transitional period, experience of initial profit losses, and more paperwork, getting an idea of the future break-even yields is beneficial to a farmer who is debating transitioning. Having data for organic corn fixed costs, variable costs, price per bushel, and yield per acre specific to years 2011-2015, allows for a forecast of what the potential break-even costs could be in future years. In order to forecast for years 2016, 2017, and 2018, this study calculates the compound annual growth rate (CAGR) of the fixed costs, variable costs, yields, and prices of the organic corn production data from years 2011-2015. The CAGR is not a true return or growth rate, but rather a representative figure of how much each category annually increased if it had increased at a steady rate. Calculating CAGR is in no way a definite future value, but more a prediction of where it could be given past years of values. A CAGR ignores volatility and implies steady increases. CAGR is calculated in this study as:

$$CAGR = \left(\frac{e}{b}\right)^{\frac{1}{n}} - 1$$

In this calculation, value *e* represents the value associated with the 2015 production data. Value *b* represents the value associated with the 2011 production data. For the exponent *n*, that is the number of years in the study. In this study, the changes observed between years would be four. Once the CAGR is calculated, a forecasted potential value for future years can be determined. For example, in the case of fixed costs, the forecasting calculation would be as follows:

$$(FC * CAGR) + FC$$

The *fixed costs* (FC) for 2015 is multiplied by the *CAGR* and that value is then added to the fixed cost of 2015. That calculated number will be the forecasted value for fixed costs in 2016. In order to calculate values for 2017, the same calculation is used, but the 2016 fixed costs is multiplied by the same CAGR and then added to the 2016 fixed costs. This study forecasts values for fixed costs per acre, variable costs per acre, price per bushel, and yield per acre which allows a look at potential break-even yields for years 2016, 2017, and 2018.

3.4 Organic Corn Industry Level Quantity Demand Analysis

When a decision is made to raise or lower prices, there will be a response from the buyer that is reflected in the quantity demanded for that product. This response of quantity is its elasticity. The price elasticity of demand is a measure of the relationship between the price of a good and its demand. This method is commonly used when looking at price sensitivity of a good. It is measured according to the extent of the change, and is characterized in terms of being either elastic, inelastic, or unitary. If a small change in price results in a large change in quantity demanded, the demand is considered elastic. If the opposite occurs, a large change in price results in a small change in quantity demanded, it is considered inelastic. If the percentage change in quantity demanded is equal to the percentage change in price, it is considered price unitary. This calculation shows how much total revenue changes with the price charged for a good. There are multiple data sets price elasticity of demand can be calculated from. In this study, a time series dataset, which is a series of observations made over time for a certain variable, is being used. This research is looking at price per bushel of organic corn and bushels demanded of organic corn. The formula for price elasticity of demand is as follows:

$$E_{(d)} = \frac{\%\Delta Q}{\%\Delta P}$$

In this formula, the percent change in *Q* represents the change in the quantity of bushels demanded and the percent change in *P* represents the change in price per bushel. For this study, the quantity demand is calculated as acreage of organic corn planted in the U.S. multiplied by yield. That value is then added to the amount of bushels of organic corn that is imported in to the U.S. for that given year. The price is the average amount paid per bushel of organic corn for that given year. If the value of price elasticity of demand is less than one, it is considered inelastic and greater than one is considered elastic. If a product is inelastic, the demand sees minimal change when price changes. If a product is elastic, demand will see significant change with a change in price. This information is valuable to a producer as it would signify what prices of organic corn may do as demand increases.

3.5 Data

In dealing with crop production, quality and quantity can greatly vary from one farm to another. Some farms have great soil that holds nutrients better than others which results in lower fertilizer costs. Certain areas in the U.S. receive better weather conditions or more optimal rainfall than other areas which can result in better yields. In order to obtain accurate cost of production data, a study would have to focus on fields in a certain area in which they were able to obtain all the specific costs for or receive data from a source that is uniform for those who contribute. With this study focusing on the organic corn in the U.S., production data was obtained from a database used in multiple locations throughout the country. The Farm Financial Management Database (FINBIN), provides custom reports of financial information from farm producers. The information from farmers is submitted to FINBIN through a software product known as FINPACK. The FINPACK program provides a suite of tools that help producers make better financial decisions for their operation. In order for a FINPACK report to be generated, the producer is required to work with a professional agricultural educator or farm business consultant to complete the analysis. Current farm organizations that are assisting producers through their FINPACK analysis are Western Illinois Farms Business Farm Management Association, Michigan State University Extension, Minnesota State Colleges and Universities Farm Business Management Education, Southwest Minnesota Farm Management Association, Missouri Farm Business Management Analysis, North Dakota Farm Business Management Education, Nebraska Farm Business, Inc., The Ohio State University Extension, South Carolina Farm Management Association, South Dakota Center for Farm and Ranch Management, Utah Farm/Ranch Business Management, and Wisconsin Technical College System. With each producer being guided through the process by a professional and the same forms/methods used to assign values from producers, the reports created on FINBIN are uniform and standardized, making them of great value to this study.

For the break-even analysis, costs, yields, and prices were collected from conventional corn fields and organic corn fields. This study uses FINBIN to generate a report for both organic and conventional corn production on cropland that the producer owns and not cropland that is rented. The fixed costs in the break-even analysis does not include a cost for renting land. Although it is common for farmers to rent ground, farmers who are looking to rent ground for organic grain production can find higher prices or resistant landowners due to the idea of lower production (if rent cost is based off production) and residual weed pressures that could occur (Reaves and Rosenblum, Barriers an Opportunities: The Challenge of Organic Grain Production in the Northeast, Midwest, and Northern Great Plains 2014). This was left out of the fixed costs due to the uncertainty that renting can bring. The FINBIN reports were generated for organic corn and conventional corn production systems from 2011-2015. The values for each category are averages from all the submitted data specific to that category by FINPACK for a specific year.

When calculating the price elasticity of demand, it is a must to have quantity demanded and prices. When determining demand for this method, domestic organic corn acreage is multiplied by yield and then added to domestic organic corn imports. For the acreage values in years 2014 and 2015, the number of acres reported for production in the USDA's organic survey were used to conduct this analysis. The acreage for organic corn used from grain, silage, sweet corn, and popcorn were added together for a total acreage amount in that given year. The USDA has not released an organic survey for the production year of 2016 at the time of this study. The acreage for 2016 is an estimation of organic corn acres by the specialty grain trading platform Mercaris. The import values are also from Mercaris. Given the time and resource constraints of the researcher, Mercaris served as an exclusive source of information for import values. Production and price data were available for more than years 2014-2016, but Mercaris has only tracked imported organic corn bushels since 2014. For this research, the calculation for elasticity of demand does not include the equilibrium price and quantity for organic corn.

For this study, the organic corn yield used is 75% of the USDA posted corn yield for all corn grown in the U.S. for that year in their Crop Production report. There is much debate on yield of organic corn compared to conventional in the U.S. The decision to use 75% comes from Delbridge and King (2014), who found that organic corn yielded an average of 75% of conventional corn on the same fields. This study takes into consideration for its calculations that domestic imports added to U.S. production of organic corn determine the demand for organic corn bushels in the U.S.

The price data used in this study for price elasticity of demand comes from values of organic corn sold through Mercaris and through outside data Mercaris obtains. Mercaris posts weekly price reports for organic corn dating back to 2012. The prices in this study are a yearly average of the weekly prices in that corresponding year.

CHAPTER IV: RESULTS AND CONCLUSION

4.1 Break-Even Yield

In determining potential reasoning for a farmer to not grow organic corn, this study looks at the break-even yield for both organic and conventional corn systems in order to discern if the break-even yield for organic corn could be a possible deterrent for farmers. In order to calculate a break-even yield, the costs associated with production are required. Table 4.1 lists the fixed and variable costs for conventional corn from 2011-2015. Table 4.2 shows the fixed and variable costs for organic corn from 2011-2015. Both tables also show the price, yield, and number of farms that contributed data for each year. These costs show the organic system having higher fixed costs in every year when compared to the conventional system. For 2015, interest paid comes in as the organic fixed cost that is the highest when compared to its conventional counterpart. Organic farms have a harder time accessing affordable loans due to banks not knowing how to value them and there not being historic county records of organic production (Reaves and Rosenblum 2014). The fixed cost that had the largest difference was the cost of conventional seed compared to the cost of organic seed. In 2015, organic seed cost $11.43 less per acre than what conventional seed did. Organic seed does not have the biotechnology costs of modifying genes and organisms like what conventional seed does. The variable costs of the two systems were mixed with the organic system having lower variable costs in every year except 2015. The cost of machinery repairs came in as the biggest difference between the two systems. Repairs in the organic system were $34.57 more per acre than in the conventional system. This is consistent with research by Delbridge (2014) that had organic grain rotation requiring more field passes with equipment than the conventional grain rotation. The more use of machinery and equipment, the more they wear and need repaired. The other variable cost that had a significant difference was the cost of crop chemicals for the conventional system compared to the non-chemical crop protectant in the organic corn. As noted earlier in the requirements to be certified organic, synthetic chemicals are prohibited in organic production. The cost of synthetic chemicals is typically higher, $25.04 per acre in 2015, than what non-synthetic chemicals to protect and treat crops are. In this data, the organic system yielded 65% of what the conventional corn yields were. As was noted in the methods data section of this study, Delbridge and King (2014) had conventional and organic corn fields on the same ground that had organic corn yielding an average of 75% of what conventional corn did.

Table 4.1: Fixed Costs, Variable Costs, Yields, and Prices for Conventional Corn, 2011-2015

Conventional Corn	2011	2012	2013	2014	2015
Fixed Costs per Acre					
Seed	95.14	103.33	110.49	115.47	112.98
Crop insurance	23.04	24.35	25.10	22.18	22.38
Storage	0.87	0.88	0.86	1.30	1.26
Operating Interest	8.61	8.14	7.02	8.21	9.95
Custom Hire	1.40	0.76	0.56	0.65	0.94
Hired Labor	11.81	12.76	14.22	12.83	12.46
Machinery Leases	1.81	2.81	2.17	2.51	2.73
Building Leases	1.02	0.83	1.05	1.13	1.19
Property Taxes	20.58	22.68	24.81	28.80	30.62
Farm Insurance	8.07	8.60	9.38	10.53	11.01
Utilities	5.07	5.12	6.17	6.15	5.81
Interest	57.37	57.16	58.21	55.56	62.14
Machine and Building Depreciation	53.84	57.60	65.97	67.13	65.93
Total Fixed Costs	288.63	305.02	326.01	332.45	339.40
Variable Costs per Acre					
Fertilizer	140.58	167.59	168.74	151.19	139.16
Crop Chemicals	26.83	30.29	33.32	35.09	36.52
Drying Expense	5.10	4.00	19.10	19.30	8.73
Fuel & Oil	33.64	34.22	34.91	33.61	24.27
Repairs	45.97	47.30	48.74	45.36	43.33
Custom Hire	10.16	10.90	10.02	10.71	11.81
Hired Labor	2.52	2.15	2.20	2.97	3.28
Machinery Leases	1.01	1.17	1.45	1.32	1.68
Utilities	1.01	0.83	1.04	1.26	1.25
Hauling and Trucking	1.81	1.43	1.37	1.20	1.57
Total Variable Costs	268.63	299.88	320.89	302.01	271.60
Number of Farms	1516	1531	1408	1347	1285
Price per Bushel	5.75	6.53	4.32	3.75	3.43
Yield per Acre (Bushels)	151.3	155.92	153.05	155.12	186.67

(FINBIN 2017)

Table 4.2: Fixed Costs, Variable Costs, Yields, and Prices for Organic Corn, 2011-2015

Organic Corn	**2011**	**2012**	**2013**	**2014**	**2015**
Fixed Costs per Acre					
Seed	64.48	83.09	84.57	102.63	101.55
Crop insurance	37.48	29.71	25.02	20.95	27.79
Storage	2.16	-	-	2.05	0.38
Operating Interest	12.41	12.02	2.48	1.78	15.39
Custom Hire	8.07	0.21	0.73	-	-
Hired Labor	23.41	36.49	46.70	26.74	17.05
Machinery Leases	2.69	3.64	6.11	2.42	0.72
Building Leases	0.69	0.46	3.54	5.94	0.12
Property Taxes	21.46	20.53	27.06	25.06	36.22
Farm Insurance	9.48	11.41	9.06	13.39	13.13
Utilities	9.52	12.07	9.54	12.17	8.58
Interest	66.58	70.33	94.77	65.24	72.70
Machine and Building Depreciation	39.39	54.67	58.21	82.63	73.98
Organic Certification	3.66	1.14	1.81	4.41	3.91
Total Fixed Costs	301.48	335.77	369.60	365.41	371.52
Variable Costs per Acre					
Fertilizer	53.40	89.99	95.69	98.30	132.72
Non-chemical crop protect	23.93	0.28	10.69	0.50	11.48
Drying Expense	3.27	4.49	8.39	9.53	13.59
Fuel & Oil	38.44	48.13	42.37	36.17	36.64
Repairs	60.45	59.02	62.88	63.09	77.90
Custom Hire	7.56	23.18	16.41	34.87	28.35
Hired Labor	2.35	8.36	6.07	4.34	3.83
Machinery Leases	-	2.24	2.03	8.70	0.50
Utilities	1.14	0.35	1.26	0.31	2.79
Hauling and Trucking	-	2.61	4.21	0.09	0.16
Total Variable Costs	190.54	238.65	250.00	255.90	307.96
Number of Farms	18	20	20	14	22
Price per Bushel	10.60	13.92	10.88	10.84	10.37
Yield per Acre (Bushels)	99.43	117.86	91.78	82.15	132.48

(FINBIN 2017)

The variables and formula used in calculating the break-even yield is:

$$Breakeven\ Yield = \frac{fixed\ costs\ per\ acre}{price\ per\ bushel - \left(\frac{variable\ costs\ per\ acre}{yield\ per\ acre}\right)}$$

Table 4.3 shows the calculated break-even yield for the conventional corn system and Table 4.4 shows the break-yield for the organic corn system. Although the fixed and variable costs were similar for organic and conventional corn, the break-even yields are significantly different. The conventional break-even is more than double of the organic system for 2011 and 2012. For years 2013-2015, the break-even yield for conventional corn is more than three times that of the organic corn's break-even yield. With production costs being similar and the yield for organic corn being less than conventional, it points to the price per bushel being the significant factor in making the break-even yield for organic corn less than conventional.

Table 4.3: Break-Even Yield per Acre for Conventional Corn, 2011-2015

Conventional Break-Even Analysis	2011	2012	2013	2014	2015
Fixed Costs per Acre	288.63	305.02	326.01	332.45	339.40
Price per Bushel	5.75	6.53	4.32	3.75	3.43
Yield per Acre	151.3	155.92	153.05	155.12	186.67
Variable Costs/Yield per Acre	1.78	1.92	2.10	1.95	1.45
Break-Even Yield	72.62	66.21	146.63	184.38	171.85

Table 4.4: Break-Even Yield per Acre for Organic Corn, 2011-2015

Organic Break-Even Analysis	2011	2012	2013	2014	2015
Fixed Costs per Acre	301.48	335.77	369.60	365.41	371.52
Price per Bushel	10.60	13.92	10.88	10.84	10.37
Yield per Acre	99.43	117.86	91.78	82.15	132.48
Variable Costs/Yield per Acre	1.92	2.02	2.72	3.12	2.32
Break-Even Yield	34.72	28.23	45.32	47.30	46.18

4.2 Scenario Analyses of Break-Even Yield

Costs, yields, and prices vary each year for a farmer. Even during the same year, these factors can vary greatly from one farmer to another. The values provided in the break-even analysis in the previous section may not reflect the values other producers see on their farms. By creating different scenarios for break-even yields, this study looks to find potential situations that increase the break-even yield to a point where it may be deterring farmers from wanting to grow organic corn. All the scenarios created in this study are done by altering values in the 2015 organic corn production data that is shown in Table 4.2. With yield of organic corn being a top concern for farmers (McBride, Greene and Foreman, et al. 2015); (Reaves and Rosenblum 2014), the first scenario figured was with half of the yield from 2015. The yield used is 66.24 bushels per acre and no other variables were changed. As noted in the break-even analysis, price per bushel looks to be a major factor in determining the break-even yield for organic corn. In the second scenario, the price per bushel used was the lowest monthly price per bushel of organic corn the USDA posted since 2008. The price per bushel for organic corn that is used in the second scenario is $4.38 and all other variables are unchanged. The third scenario increases all fixed and variable costs by 50% and leaving both yield and price unchanged. As noted in the methods section, the value for custom hire used is $8.07 per acre and hauling and trucking used is $4.21 per acre. These two categories had values that were significantly lower and were replaced by using the high for that category from the past five years of organic corn production data. The last scenario is one where nothing goes the farmer’s way. All the fixed and variable costs are increased by 30%, including the custom hire and trucking and hauling values that were used in the third scenario. The yield and price also saw a 30%

change, but to the lower side. Table 4.5 shows the actual 2015 production values and the various scenarios created that are mentioned above. The fixed costs per acre, variable costs per acre, yield per acre, and price per bushel are shown for each scenario.

Table 4.5: Production Scenarios for Fixed Costs per Acre, Variable Costs per Acre, Yield per Acre, and U.S. $ Price per Bushel for Organic Corn, 2015

Organic Corn	2015	Scenario 1: Lower Yield	Scenario 2: Lower price	Scenario 3: 50% Higher Costs	Scenario 4: 30% Higher Costs, 30% Less Price & Yield
Fixed Costs per Acre					
Seed	101.55	101.55	101.55	152.33	132.02
Crop insurance	27.79	27.79	27.79	41.69	36.13
Storage	0.38	0.38	0.38	0.57	0.49
Operating Interest	15.39	15.39	15.39	23.09	20.01
Custom Hire	-	-	-	8.07	10.49
Hired Labor	17.05	17.05	17.05	25.58	22.17
Machinery Leases	0.72	0.72	0.72	1.08	0.94
Building Leases	0.12	0.12	0.12	0.18	0.16
Property Taxes	36.22	36.22	36.22	54.33	47.09
Farm Insurance	13.13	13.13	13.13	19.70	17.07
Utilities	8.58	8.58	8.58	12.87	11.15
Interest	72.70	72.70	72.70	109.05	94.51
Machine and Building Depreciation	73.98	73.98	73.98	110.97	96.17
Organic Certification	3.91	3.91	3.91	5.87	5.08
Total Fixed Costs per Acre	371.52	371.52	371.52	565.35	493.47
Variable Costs per Acre					
Fertilizer	132.72	132.72	132.72	199.08	172.54
Non-chemical crop protect	11.48	11.48	11.48	17.22	14.92
Drying Expense	13.59	13.59	13.59	20.39	17.67
Fuel & Oil	36.64	36.64	36.64	54.96	47.63
Repairs	77.90	77.90	77.90	116.85	101.27
Custom Hire	28.35	28.35	28.35	42.53	36.86
Hired Labor	3.83	3.83	3.83	5.75	4.98
Machinery Leases	0.50	0.50	0.50	0.75	0.65
Utilities	2.79	2.79	2.79	4.19	3.63
Hauling and Trucking	0.16	0.16	0.16	4.21	5.47
Total Variable Costs per Acre	307.96	307.96	307.96	465.91	405.61
Price per Bushel	10.37	10.37	4.38	10.37	7.26
Yield per Acre (Bushels)	132.48	66.24	132.48	132.48	92.74

These scenarios provide potential values that could occur in a growing season for a farmer of organic corn. These scenario values enable a break-even yield to be figured. Table 4.6

shows the break-even yield for the 2015 actual production and the four scenarios with varying values.

Table 4.6: Break-Even Yield per Acre for Scenarios 1, 2, 3, and 4, 2015

Organic Break-Even Analysis	2015	Scenario 1: Lower Yield	Scenario 2: Lower price	Scenario 3: 50% Higher Costs	Scenario 4: 30% Higher Costs, 30% Less Price & Yield
Fixed Costs per Acre	371.52	371.52	371.52	565.35	493.47
Price per Bushel	10.37	10.37	4.38	10.37	7.26
Variable Costs/Yield per Acre	2.32	4.65	2.32	3.52	4.37
Break Even-Yield	46.18	64.94	180.75	82.49	171.04

When using half of the yield for scenario one, the break-even yield naturally increases, but not by a significant amount. The break-even yield for scenario one would put the profits to the farmer close to zero. The yield needed to break-even is 64.94 bushels per acre and the yield achieved is 66.24 per acre. At these values, one could assume the organic corn production as not worth producing. Scenarios two and four see break-even yields that result in the organic farmer losing money. Scenario two, which uses the lowest price per bushel for organic corn, has a break-even yield of 180.75 compared to an achieved yield of 132.8. Scenario four, which increases costs by 30% and lowers yield and price by 30%, has a break-even yield of 171.04 compared to an achieved yield of 92.74. Scenario three experiences similar results to scenario one in that the break-even yield does not quite double the actual break-even yield from 2015. In scenario three, by increasing fixed and variable costs by 50%, the break-even yield is 82.49 and the yield achieved is 132.48, leaving plenty of profit potential to the producer. The variable that sees the greatest change in break-even yield is price per bushel. Price per bushel being the key factor in profitability for producing organic corn in this research is consistent with previously mentioned studies.

Although yield is a commonly noted concern for producing organic corn, it does not show near as great of impact in the break-even yield as what price does.

4.3 Forecast of Break-Even Yield

A factor that could prevent a farmer from producing organic corn is the potential break-even yield in future production years. In order to give perspective of future years, the compound annual growth rate (CAGR) was calculated for fixed costs per acre, variable costs per acre, yield per acre, and price per bushel for organic corn. The CAGR was figured based on the production values in Table 4.2. The CAGR formula is:

$$CARG = \left(\frac{2015\ value}{2011\ value}\right)^{\frac{1}{4}} - 1$$

The CAGR value is then multiplied by the original value for that year and added to that same year. For example, in order to get a value for fixed costs per acre for 2016, the calculation would be:

$$(2015\ fixed\ costs\ per\ acre * CAGR\ for\ fixed\ costs\ per\ acre) + 2015\ fixed\ costs\ per\ acre$$

Once the CAGR is calculated for each production category, a potential break-even yield that could occur in future years is able to be determined. This study looks ahead to years 2016, 2017, and 2018. Table 4.7 shows the CAGR for total fixed costs per acre, total variable costs per acre, price per bushel, and yield per acre for organic corn.

Table 4.7: Forecasted Organic Corn Values for Total Fixed Costs per Acre, Total Variable Costs per Acre, Price per Bushel, and Yield per Acre Using Compound Annual Growth Rate, 2016- 2018

Organic Corn	2011	2012	2013	2014	2015	2016F	2017F	2018F	CAGR
Total Fixed Costs per Acre	301.48	335.77	369.60	365.41	371.52	377.71	397.96	419.29	5.36%
Total Variable Costs per Acre	190.54	238.65	250.00	255.90	307.96	347.23	391.51	441.44	12.75%
Price per Bushel (U.S. $)	10.60	13.92	10.88	10.84	10.37	10.31	10.26	10.20	-0.55%
Yield per Acre (Bushels)	99.43	117.86	91.78	82.15	132.48	142.33	152.92	164.30	7.44%

The fixed costs, variable costs, and yield all show a positive CAGR from 2011-2015, signifying that value has been increasing over the years. As noted in the methods section, the CAGR assumes values have been increasing at a steady rate, although is not always the case. For example, fixed costs in 2014 were actually less than 2013, but the overall value has shown an increase from the year 2011 to the year of 2015. The price per bushel for organic corn has a negative CAGR implying the price paid for organic corn has decreased since 2011. With forecasted values for fixed costs, variable costs, yield, and price, potential break-even yields can be calculated for future production. Table 4.8 shows the previously calculated break-even yield for 2011-2015 and the forecasted break-even yield for 2016-2018 for organic corn.

Table 4.8: Break-Even Yield per Acre for 2011-2015 and Forecasted Break-Even Yield for 2016-2018

Organic Break-Even Analysis	2011	2012	2013	2014	2015	2016F	2017F	2018F
Fixed Costs per Acre	301.48	335.77	369.60	365.41	371.52	377.71	397.96	419.29
Price per Bushel (U.S. $)	10.60	13.92	10.88	10.84	10.37	10.31	10.26	10.20
Variable Costs/Yield per Acre	1.92	2.02	2.72	3.12	2.32	2.44	2.56	2.69
Break-Even Yield	34.72	28.23	45.32	47.30	46.18	47.97	51.71	55.80

The break-even yield increases in each forecasted year for organic corn. Although increases occur, the farmer is achieving yields greater than the break-even yield. In 2018, the forecasted break-even yield is 55.80 bushels per acre with an achieved yield of 164.3 bushels per acre. By looking at forecasted production values, one can determine that the future break-even yield is in the producer's favor in terms of profit.

4.4 Organic Corn Industry Level Quantity Demand

Knowing whether or not a product is elastic or inelastic is import in every industry. It determines how demand changes with a change in price. When the demand is elastic for a product, the consumers are more sensitive to a change in price of that product. For an elastic good, a price change of 1% will lead to a decrease in demand of more than 1%. An inelastic good is just the opposite. A 1% increase in price will lead to a decrease in demand by less than 1%. This study looks at the price elasticity of organic corn in order to determine if the product is elastic or inelastic as that could be a potential reason for farmers not growing organic corn. As this study has discussed, the price per bushel of organic corn is crucial in its ability to be more profitable than conventional corn. In general, conventional corn is thought to be fairy price inelastic, requiring a significantly large price change to alter consumption (Good 2014). Gasoline is a prime example of an inelastic product. It takes a large price swing in the cost of a gallon of gas for consumer demand to change. This is similar to conventional corn in that people and animals need to eat, regardless of price. Conventional corn is also used in ethanol production, which is required in the U.S. Renewable Fuel Standard Program. In order to calculate the price elasticity of demand for organic corn, bushel demand and price per bushel are needed. For this study, demand was figured by taking the U.S. organic corn acreage and multiplying that by 75% of the USDA corn yield for that specific year. Those organic corn bushels are then added to the amount of organic corn bushels that were imported for that specific year. The price per bushel for the corresponding demand years is the average price paid for organic corn from data obtained from Mercaris. Table 4.9 shows the organic corn acreage planted, the USDA yield for U.S. corn, organic yield (75% of the U.S. corn yield), imported organic corn bushels, the calculated demand for organic corn, and the price per bushel of organic corn for 2014-2016.

Table 4.9: Organic Corn Bushel Demand and Price per Bushel, 2014-2016

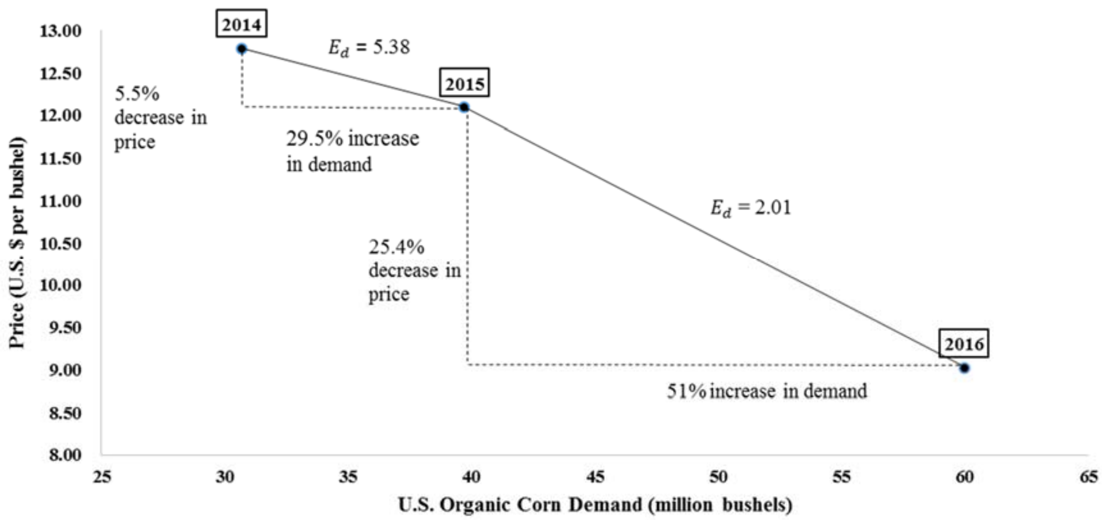
Year	Organic Corn Acres	USDA Conventional Corn Yield	Organic Corn Yield	Imported Organic Corn Bushels	Organic Corn Demand (bushels)	Price per Bushel (U.S. $)
2014	215,249	171	128.3	3,075,165	30,680,849	12.79
2015	220,020	168.4	126.3	11,929,071	39,717,597	12.09
2016	292,919	174.6	131.0	21,611,540	59,969,283	9.02

From 2014-2016, the U.S. production of organic corn and the amount of imported organic corn has been steadily increasing. As demand has been increasing, the price for organic corn has been falling. There is a large increase in demand from 2015-2016 as well as a large decrease in price during those same years. To calculate the price elasticity of demand from these values, the formula is:

$$E_{(d)} = \frac{\%\Delta\ in\ Bushels\ Demanded}{\%\Delta\ in\ Price\ per\ Bushel}$$

From 2014 to 2015, the percent change in quantity demand was 29.5% and the percent change in price per bushel was -5.5%. The calculated price elasticity of demand from 2014 to 2015 comes to -5.38. Due to the inverse relationship in quantity demanded and price, the elasticity of demand coefficient will be a negative value. Being that elasticity of demand focuses on the magnitude of change, the ending value used is the absolute value, which would be 5.38. From 2015 to 2016, the percent change in demand was 51% and the percent change in price was -25.4%. The calculated price elasticity of demand from 2015 to 2016 comes to -2.01 or 2.01. Figure 4.1 shows the changes in price per bushel, bushel demand, and price elasticity of demand for organic corn from 2014-2016.

Figure 4.1: Industry Level Quantity Demand for Organic Corn, 2014-2016



The price elasticity of demand values from 2014-2016 for organic corn are considered highly elastic as they have a value greater than one. The demand for organic corn is greatly influenced by price. Although conventional corn is considered inelastic, organic corn is elastic. This is likely due to conventional corn being an alternative or substitute good for organic corn. If the price increases for organic corn, the demand will decrease. With the price elasticity of organic corn being more than one and with there being a cheaper alternative, organic corn is more of a luxury good. This could pose as a deterrent for producers to enter the organic corn market. The price per bushel for organic corn is what gives it the ability to be more profitable than conventional corn, which will decrease as demand increases.

4.5 Conclusion

With a growing consumer desire for organic food, the supply of organic corn in the U.S. has fallen short of domestic demand. In a country that excels in growing corn and produces more corn than any other county in the world, there has been a growing amount of bushels of organic corn imported in to the U.S. The amount of acres dedicated to organic corn production is less than 1% of the total corn acres. This study aims to determine possible factors preventing farmers in the U.S. to produce organic corn by looking at break-even yields and the price elasticity of demand for organic corn. Different scenarios of fixed costs per acre, variable costs per acre, yield per acre, and price per bushel were created and forecasted to represent possible changes a farmer could experience in raising organic corn. These values have been used in the break-even yield calculation in order to understand how the yield needed to cover costs can change and if those changes are logical reasons for a producer to not grow organic corn. The production of organic corn bushels, imported organic corn bushels, and price per bushel of organic corn in the U.S. were used in the price elasticity model.

When comparing the break-even yield for organic corn and conventional corn for 2015, Table 4.4 shows the organic system requires a substantially lower break-even yield than what the conventional corn system needs, shown in Table 4.3. The fixed and variable costs of the two systems are fairly similar from 2011-2015. The yield per acre and price per bushel produced for those four years showed substantial differences. Yields for the conventional system experienced consistently higher values as did the price per bushel for organic corn. The yield per acre, price per bushel, and production costs of conventional and organic corn are represented in Tables 4.1 and 4.2. The break-even yield for the organic system does not identify itself as a barrier of entry for growing organic corn. The lower break-even yield is favorable in organic corn production versus conventional corn production.

In the first scenario break-even analysis the organic corn yield was half of the quantity of its 2015 production, shown in Table 4.6, the break-even yield equaled two bushels above the actual yield achieved. In this scenario, the organic corn system would not be a profitable choice for the farmer. Producing organic corn with half of the typical yield is a factor preventing farmers from growing organic corn. When the lowest average monthly price per bushel of organic corn since 2008 is plugged in to the break-even analysis, the break-even yield, represented in Table 4.6, surpasses the level in the conventional corn system. This break-even yield is at a level that would cause a loss of profit to the farmer. The risk of lower price per bushel is a factor preventing farmers from producing organic corn. Similar results occur when production costs are increased by 30% and when price and yield are decreased by 30%. A break-even yield of 171.04, shown in Table 4.6, is a yield that is not profitable for a farmer and is therefore a factor preventing organic corn production. The one break-even yield scenario that still works in favor of organic corn is when fixed and variable costs are increased by 50%, shown in Table 4.6. The break-even yield of this model only increases by nineteen bushels from the base break-even yield of 2015 and is still well below the yield that is produced. Increased fixed and variable costs are not factors that prevent farmers from producing organic corn.

The forecasted break-even yields for 2016-2018 are calculated by using the compound annual growth rate for 2011-2015 of production values in the organic corn system. Table 4.8 shows the forecasted break-even yields for organic corn in 2016, 2017, and 2018. Although each forecasted year saw an increase in yield needed to break-even, these yields came in significantly lower than the yields achieved in Table 4.7. The forecasted break-even yield using the compound annual growth rate for fixed costs per acre, variable costs per acre, yield per acre, and price per bushel are not factors preventing farmers from growing organic corn. The break-even yields compared to the yields achieved are at profitable levels for the producer.

The price elasticity of demand for organic corn results in values that qualify it as an elastic product. Figure 4.1 shows elasticity values of 5.38 and 2.01 between the years 2014-2016. If the price for organic corn increases, the demand will decrease. With organic corn having conventional corn as a substitute, it is a luxury item that consumers can avoid purchasing if price gets too high. As demand keeps increasing the quantity produced of organic corn, the prices will likely decline. With price being the key factor in organic corn profitability and break-even yield, the elasticity is a factor preventing farmers from producing organic corn.

Overall, this study does not find break-even yield to be a factor causing farmers to not produce organic corn when a typical production year occurs. Even with increased costs, the organic system still produces a profitable break-even yield. When prices and yields are changed, the organic break-even yield does become a profit loss system. Price per bushel is a key factor in organic corn's low break-even yield. The price elasticity of demand does look to be a potential reason farmers are not growing organic corn. Conventional corn is looked at as inelastic whereas organic corn is elastic.

4.6 Research Limitations

There are several issues that must be kept in mind when considering the results of this study. The production values used in the break-even analyses were not representative of a specific region or farm. The values were from actual farms, but are certainly not equal to what every producer may encounter on their farm. The sample size (producers who contributed) and the average acreage of the corn field for the break-even production values are different in the organic and conventional systems. The number of organic corn producers that the report consisted of was significantly less than the number of conventional corn producers. Also, the acreage of the organic corn field was significantly smaller than the conventional field. As this study has discussed, the amount of farmers and acres dedicated to organic corn production are less than 1%. The uneven sample size and acreage reflect the current status of the industry.

A certified organic operation for organic corn requires a crop rotation of at least three different crops to meet the NOP organic standards. Conventional corn does not have any required rotations. This study only looks at organic corn and does not take in to consideration the break-even yields or elasticity of the other crops an organic producer may grow. Future research accounting for break-even yields and elasticities of all crops in a rotation would be beneficial to help understand the organic grain shortage in the U.S.

Despite these caveats, it is surprising that more farmland is not dedicated to organic corn production. Organic corn prices remain well above conventional corn while conventional corn profits continue to suffer. This again raises the question as to why more farmers are not producing organic corn. While this study has shown break-even yields and price elasticity of demand, future analyses should be looked at in order to gain more understanding as to why domestic supply of organic corn is not meeting demand.

4.7 Future Research

This research saw organic corn break-even yields being lower than what conventional corn was. Previous studies also found organic corn to be more profitable than conventional corn. Although these factors exist, organic corn acres remain low. Future research that focused on what the level of difference needed to convince farmers to plant organic corn would be beneficial to understanding the lack of production.

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