



Corn Production Indicators Report: Trend and Risk Analysis

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Glossary

Average/mean	This is the sum of a collection of numbers divided by the count of numbers in the collection. For past historical data as in this report, this gives an idea of what the producer or decision maker should expect.
Coefficient of variation	This is also known as the relative standard deviation. It is a statistical measure of the dispersion of data points around the mean. While it performs a similar function to the standard deviation, it is advantageous because it can be used to compare dispersion of data between distinct series of data. Furthermore, it is a unitless measure. Generally, a decision maker seeks a lower value because it provides an optimal risk-to-reward ratio with low volatility but high returns.
CYP	Calendar year price (CYP) is the nominal market value of commodity per unit, averaged from January to December. Dollar per bushel (\$/bu) is the unit for price.
CYR	Calendar year revenue (CYR), measured as the product of the nominal calendar year price and production. Dollar (\$) is the unit for revenue.
Decade	A decade is defined as a 10-year interval.
Descriptive statistics	These are brief descriptive coefficients that summarize given data sets. These are classified into the measures of central tendency (mean/average) and measures of variability (minimum, variance/standard deviation and maximum variables).
Ex-ante	These are inferences based on forecasts.
Ex-post	These are inferences based on actual results.
Harvested acreage	Area of planted acreage from which harvesting is done. Acre is the unit for planted acreage.
MYP	Marketing year price (MYP) is the nominal market value of commodity per unit, averaged from September to August. Dollar per bushel (\$/bu) is the unit for price.
MYR	Marketing year revenue (MYR), measured as the product of nominal marketing year price and production. Dollar (\$) is the unit for revenue.
Net farm income	Net farm income refers to the return to farm operators for their labor, management and capital after all production expenses have been paid. This is the gross farm income minus production expenses.
Planted acreage	Area of land used for planting crops. Acre is the unit for planted acreage.
Production efficiency	Production efficiency is concerned with producing goods and services with the optimal combination of inputs to produce maximum output for the minimum cost.
Production	Quantity of commodity produced. This is measured as bushels for both commodities (corn and soybeans).
Productivity	Productivity is the measure of output from a production process per unit of input.
Risk	A risk is the possibility of loss or gain of an event with known probabilities.
Shares	Representative proportion of the total of a variable/indicator.
Standard deviation	This is a quantification of the amount of variation or dispersion of a set of data values. This is most often a complementary information to the mean. Given any mean, there are chances of gain or a loss. Hence, knowing the possible variation can allow the decision maker or producer to plan with bounds.
Trend	A general course or prevailing tendency to take a particular direction or move in some indicated direction. In this report, the trend defines the direction of growth of the respective variable.
Uncertainty	Uncertainty refers to the occurrence of an event for which probabilities cannot be assigned.

Executive Summary

This report presents organized and structured information on corn production indicators across geographical space and through time. The indicators considered are planted acreage, harvested acreage, production, yield, revenue and price. The levels of aggregation are global, U.S. and North Dakota.

The information is presented in the form of trends and descriptive statistics. The former reveals the direction of the growth, while the latter reveals the magnitude of expectations. The descriptive statistics are represented by the mean, standard deviation and coefficient of variation. To gauge potential competition, the share contribution of the indicators to the total also is computed.

The report is presented in four sections: (I) world countries trend and risk, (II) U.S. states trend and risk, (III) North Dakota counties trend and risk and (IV) Risk or variance decomposition and sources of variation.

At the global level, the trends of the indicators are presented in addition to the descriptive statistics of the top 15 producing countries. The trends and descriptive statistics for the top 15 producing states also are provided at the U.S. level. At the North Dakota level of aggregation, we provide the trends and descriptive statistics of the top 15 producing counties.

This report is important because it serves as an informational guide to corn producers in the state, U.S. and the world. In the current environment, the success (productivity and net farm income stability) of agricultural production is dependent on accurate prediction of events and associated decisions to overcome these events. Hence, having a comprehensive and accurate database will enable producers in decision-making with confidence.

To formulate policies based on production indicator variables, we must decompose the sources of risk or variation into the identifiable systematic and random components. The sources of risk are presented in percentages and sum to 100 for each year.

This is important because the decision maker must develop risk management tools based on the source(s) of risk or variation. Based on the sources of risk, producers can develop plans with respect to planting and marketing decisions to optimize net farm income and productivity. The study reveals that.

Trends and Descriptive Statistics

World

- Planted and harvested corn acreage have increased.
- Yields, production and revenue also have increased.
- Prices have declined in recent years.
- U.S. (34.5%), China (22.4%), Brazil (7.33%), Argentina (3.27%) and Ukraine (2.48%) are the top corn producers (share of production) for the period between 2010 and 2019.

U.S.

- Planted and harvested corn acreage have increased slightly.
- Yield and production generally increased despite volatilities.
- Price and revenue also increased but had an inverted “v” shape between 2009 and 2016.
- Iowa (17.7%), Illinois (15%), Nebraska (12%), Minnesota (9.93%) and Indiana (6.63%) are the top corn states for the period between 2010 and 2019.
- North Dakota (2.78%) ranked as the 11th producing state in this period, an increase in share (1.47%) and rank (13th) from the previous decade.

North Dakota

- Planted and harvested corn acreage have increased.
- Yields and production increased with high volatility.
- Richland (13.3%), Cass (12.9%), Stutsman (6.39%), Sargent (6.15%) and Barnes (6.11%) are the top counties based on the production share for the period between 2010 to 2019.

Variance or Risk Decomposition

The major sources of variation for any production indicator variable is estimated using U.S. state and county data.

State Risk or Variance Decomposition

- The sources of variation with the use of U.S. state data are identified with spatial (region and state), temporal (through time) and residual (unknown or unexplained) variations.
- Regional variation mostly contributes to above 60% of the variations for planted acreage and harvested acreage while this percentage has slightly declined below 60% for production and revenue in recent years.
- State variation contributes to an average of 35% of the variations for planted acreage, harvested acreage, production and revenue.
- The unexplained variation is volatile and high for prices but stable and below 2% for planted acreage, harvested acreage, yield, production and revenue.
- The reason for the high volatility and percentage of unexplained sources attributed to prices is due to the markets and differences across states as observed in the graphs.

County Variance or Risk Decomposition

- The sources of variation based on U.S. county data are identified with spatial (region, state, crop reporting district and county), temporal (through time) and residual (unknown or unexplained) sources.
- Regional variation contributes to about 30% of the variations for planted acreage, harvested acreage and production.
- State variation contributes between 20% and 30% of the variations for planted acreage, harvested acreage, production and yield.
- Variations due to the crop reporting district account for between 20% and 30% of the variations in planted acreage, harvested acreage, production and yield.
- County variation also accounts for between 20% and 30% of the variations in planted acreage, harvested acreage and production while it is about 20% for yield.
- The unexplained variations contribute to less than 2% of the variations in planted acreage, harvested acreage, production and yield.

Future Research

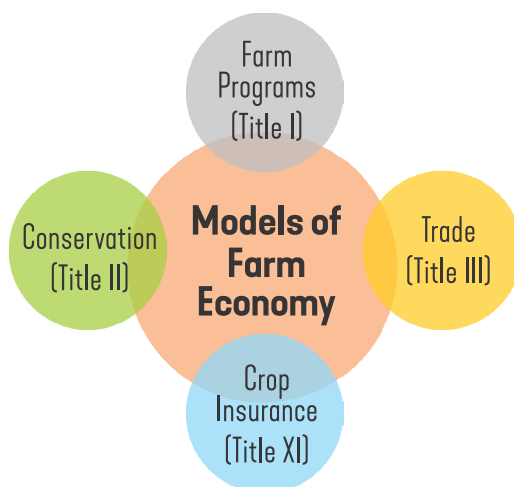
- The finding on the trend of planted acreage highlights the need for an assessment of the determinants of acreage decisions. The objective of future studies will be to evaluate the acreage price elasticities across U.S. and North Dakota counties.
- The second proposed objective is to examine the sources of yield distributions and variability across North Dakota counties.
- Finally, we propose to examine the sources of corn price volatilities.

About the Center

Center for Agricultural Policy and Trade Studies

The vision of the Center for Agricultural Policy and Trade Studies (CAPTS) is to enhance the sustainability of the net farm income of North Dakota producers through in-depth trade and agricultural policy research. After carefully considering stakeholder inputs, interests, risks and uncertainties, the concept of efficiency, technology assessment and productivity growth¹ also are embedded into the center's research.

To address this vision, the center aims to develop a “*model of farm economy*” to conduct ex-post and ex-ante evaluations for North Dakota. The model will evaluate agricultural and trade policies with its implications on North Dakota producers' net farm income. Additionally, the implications of policy on North Dakota producers' efficiency, technology assessment and productivity growth also will be evaluated.



The model of farm economy based on multiple theoretical frameworks will not only evaluate the implications of existing agricultural and trade policies (Title I, II, III and XI) but also future policies to meet efficiency, productivity and net farm income sustainability goals of North Dakota producers. Our perception of the challenges and the choices made at this juncture in history will determine how to protect farmers in our state and secure our future. The center keeps detailed records of all activities and publishes the information that will be of value to the clientele, including commodity groups and decision makers of the state and region.

Center and Current Project

The center, in collaboration with North Dakota Soybean and Corn councils, is evaluating measures of improving net farm income sustainability for producers in the state. The project is in three dimensions; these are the production indicator report, trade report and policy report.

The phase 1 outcomes of the project include detailed and comprehensive development of databases and the presentation of trends and risks in the production indicator, trade and policy reports. These reports are useful to the producers, commodity groups and decision makers.

Also, this information will form the basis for the development of the “*model of farm economy*” to evaluate the implications of agricultural and trade policies on North Dakota producers' net farm income. Additionally, the implications of technology and policies on North Dakota producers' efficiency and productivity growth will be evaluated.

¹ The efficiency concept allows producers to evaluate input resources (cost) to produce output (revenue). The producers' efficiency will improve through time with adoption of innovative technologies to minimize cost and maximize revenue.

About the North Dakota Corn Utilization Council

The North Dakota Corn Utilization Council (NDCUC) was established in 1991 by the North Dakota Legislature to administer the state corn checkoff. The checkoff is one-fourth of 1% of the value of corn sold at elevators and processing facilities in North Dakota.

The NDCUC consists of a board of seven corn producers elected by their peers. North Dakota is divided into seven corn districts.

Each county within the district elects a county representative. County representatives elect a district representative to serve on the council. Council members are responsible for the investment of corn checkoff in programs to solve production problems, create new market opportunities, provide educational programming and promote the corn industry domestically and internationally.

Corn production in North Dakota has grown significantly since the late 1990s because genetic advancements have led to hybrids suitable for northern climates. Corn is one of the top three crops in North Dakota by acreage. Yield increases have made corn highly profitable during periods of price volatility.

Thanks to corn farmers' investments in checkoff programming, production of renewable fuels has grown in North Dakota to create demand for approximately 50% of our bushels produced. Checkoff investments also are utilized to create market demand internationally. This has led to approximately 40% of the corn grown in North Dakota leaving the state by rail because it is destined to go to ports in the Pacific Northwest and shipped to buyers in Asia.

North Dakota's corn processing facilities are a vital component of the state's rural economy. Our five ethanol plants employ more than 230 workers in high-paying positions such as chemists, engineers, accountants and managers, as well as support staff. Each North Dakota ethanol plant is in a community with a population of less than 2,500 and contributes an average of 46 jobs to these rural communities.

The NDCUC works toward expanding new markets, invests in research to meet current and future needs of farmers, and works to ensure a profitable business climate for northern corn.

The NDCUC serves more than 6,000 corn farmers in North Dakota.

To learn more about the North Dakota Corn Utilization Council, please visit www.ndcorn.org or follow it on social media.

Production Indicator Report

Rationale for This Report

Global agriculture, particularly farm producers, continues to encounter a wide range of challenges due to the dynamic and ever-changing nature of these risks. The risks, therefore, affect the decisions of producers. These decisions include:

- Production decisions (allocation of acreage and inputs to influence yield, and decisions on planting/harvest periods in response to weather forecasts and climate change)
- Marketing decisions (decisions on quantum of production based on price forecasts and market competition that determine the revenue obtained)
- Policy decisions (decisions in response to federal programs and farm bills)
- Financial decisions (implementation of required protocols to obtain price support mechanisms, purchase of crop insurance products for financial security and decision on land conservation to access commodity program payments)

To help producers evaluate risks and make decisions, this report presents annual trends, decadal changes and summary statistics (mean, risk/deviations and coefficient of variation) and intensity of production indicator variables (shares) among countries, states and counties. In most situations, producers can manage these risks based on the year-ahead planning, integrated commodity programs, crop insurance and trade or international markets in consultation with financial institutions.

However, the challenges faced by producers also include random weather conditions and varying domestic demand. In addition, volatile exports not based on economic but geopolitical factors and disputes may lead to producers' loss of net farm income.

Corn farmers in North Dakota also are faced with a number of challenges. These include fluctuations in global financial markets, impact of global trade policies on demand, growing competition of the international markets and unfavorable weather conditions.

For instance, in 2019, harvesting of corn and soybeans ended abruptly across large portions of the Midwest due to the development of an early blizzard. According to U.S. Department of Agriculture (USDA) forecasts, U.S. corn and soybean production in 2019 was expected to be 5% and 20% lower than their respective production in 2018.

As part of its commitment to help mitigate the effects of these challenges faced by producers in North Dakota, the CAPTS frequently performs research. This report is the output of a collaboration between the CAPTS and North Dakota Corn Utilization Council with the aim of overcoming challenges of corn production in North Dakota.

To evaluate the possible effects of these challenges and propose plausible solutions, we have a need for accurate and up-to-date data at different levels of aggregation. This report, as the first of a series of research in line with the collaborative objective, presents data on corn production indicators. This production indicator report presents data on the following variables through time (temporal) and across geographical space (spatial):

- Planted acreage (acres)
- Harvested acreage (acres)
- Production (bushels)
- Yield (bushels/acre)
- Prices (\$/bushel)
- Revenue (\$)

The production indicators are presented for countries across the world, the U.S., states within the U.S. and counties within North Dakota. The data aggregation process presents these indicators as temporal and spatial risks. These are defined as deviations from the normal.

The deviations are expected to be below (downside) or above (upside) the normal. Of major interest to the producer is the impact of the downside deviation.

Why is this report important?

The primary goal of this report is to serve as an informational guide to the corn producers in the states as well as a foundation for future data analysis relevant to the research goals set by the NDCUC and CAPTS. This synthesis report captures the complexity and diversity of corn across world countries through U.S. to North Dakota counties.

It is built upon accurate global, country, U.S., state and North Dakota county data that provide evidence for the integrated analysis of the main concerns necessary to achieve efficiency, productivity and net farm income sustainability. This report is an informational guide presented in an organized framework with tables and graphs based on collection and verification of accurate data.

At the global, country, state and county levels, decision makers must be acutely conscious of the fact that we have diverse challenges, multiple theoretical frameworks and a wide range of options to meet productivity and net farm income sustainability goals. Presenting the data at these levels of aggregation will enable corn producers and decision makers to negotiate in directions of variables that serve to improve their welfare.

Typically, crop production relies on a set of given inputs that yield a target set of outputs. However, we have a number of exogenous and nonbehavioral factors that are likely to influence the outputs.

Some of these factors that tend to influence the outcomes are soil quality, soil moisture, seed quality, planting dates and harvesting durations. The multiplier effects of these exogenous

factors raise questions on the ability to predict the crop production indicators such as yield, acreage (planted/harvested) and production.

For producers to make decisions, we need to not only highlight the changes in the variation of the production indicator through time, but also the sources of the contribution to the overall variation. The sources of variation in production indicator variables stem from spatial (county, district, state and U.S. production regions) and temporal (decadal and annual technology changes) components. This is evaluated using statistical variance decomposition analysis.

In this regard, the responsiveness of production indicator variables to shocks or events such as climate, prices and pandemics is essential in policy formulation. One primary method that has been used previously to highlight these distinctions is the estimated area and yield elasticities.

Previous studies also have looked at various dimensions of these elasticities. Some include crop yield response to prices and climate, effects of crop insurance premium subsidies on crop acreage, impact of increasing temperature on crop yields and acreage decisions. The provision of an accurate data in this project will serve as a foundation for researchers to delve into issues of crop indicator elasticities.

To address the diverse needs and interests of corn producers in North Dakota, we have a need for a shared approach to sustainability. Escaping our predicament by simply dwelling on untested hypothetical views is not possible.

To achieve sustainable net farm incomes and equitable collective outcomes for corn producers in North Dakota, incentives are needed to influence the choices individual producers make. For instance, issues on land conservation require collective agreements on concerted action and governance across scales that go beyond an appeal to individual benefit. Hence, having accurate data on planted and harvested acreage will serve as a valuable information upon which the foundations of such decisions could be laid.

Finally, prices form the bedrock of net farm incomes. Meanwhile price fluctuations on commodity markets are affected by varied sources of events.

Some of these events, such as COVID-19, are rare, with massive implications, while others, such as exchange rate pegging, are frequent with substantial negative implications, too. Hence, having this report with the price distributions of corn across space and time will serve as a foundation for assessment of the magnitude of volatilities and an evaluation of the sources of these volatilities. Knowing these will help corn producers in North Dakota evaluate their options and plan based on expected prices ex-ante (when predicted) and ex-post (after occurrence) adverse events.

Data and Methods

The USDA's National Agricultural Statistics Service (NASS) is the source of data on U.S., state and county level corn production indicators. All the indicators are measured in imperial units.

The global and country level production data were obtained from the Food and Agriculture Organization of the United Nations database (FAOSTAT). This database contains information for diverse agricultural commodities. For consistency and given that data from this source is measured based on metric units, they were converted to imperial units. The conversion rates used are:

- 1 hectare = 2.47105 acres
- 1 metric ton of corn = 39.368 bushels

The empirical framework for this report includes annual trends, decadal changes and summary statistics (mean, risk/deviations and coefficient of variation) and intensity of production indicator variables (shares) among countries, states and counties.

1. Annual trends: The annual trends of global harvested acreage, production, yield, prices and revenue of corn are presented in the report. These indicators also are presented by trends for the top 15 countries ranked by their production. At the U.S. level, the trends of these indicators, including planted acreage, are presented. The trends for top 15 U.S. states ranked by their corn production are presented for all the production indicators. The trends are presented for acreage, production and yields at the North Dakota level. Finally, the trends for the top 15 counties (also ranked by their production) within North Dakota are presented for the acreage, production and yields. Presenting these trends in the report will provide a framework to gauge the changes through time across countries, states and counties. Knowing these trends can serve as a basis for estimating the volatilities and their sources. This can help forecasting future possibilities over desired horizons for advance decision making. This is essential for farmers because success in agricultural production is dependent on proactive rather than passive choices.
2. Decadal changes: This report further presents histograms of the decadal sums of the production indicators at the various levels of aggregation (from global to county level). Having the indicators at decadal levels in the report will provide a framework to evaluate the increase/decrease or shifts across decades.
3. Summary statistics: The summary statistics are provided for the various levels of aggregation for all the production indicators enumerated. This will provide a framework to evaluate the magnitude of the variables using totals, averages, risks, coefficient of variation and intensity of production variables in the form of market share.
4. Statistical analysis: Using hierarchical linear models, the variance decomposition and price elasticities associated with quantity and acreage are presented. The variance decomposition provides information on the sources of

variation. This will provide a framework to evaluate the magnitude and contribution of individual sources to the overall variation of the variable of interest. The price elasticity with respect to the quantity (yield or production) and acreage will help predict agricultural supply.

The methodology used in this project is the computation of the basic statistics (average, deviations, minimum, maximum and the sums). This information was computed and presented for five-year periods and decades.

The average statistic represents a single value that summarizes or represents the general significance of a set of unequal values. The standard deviation is a measure of the dispersion of a frequency distribution.

The sums for these periods present a general idea of what quantum of production to expect within a given period. It helps decision makers forecast demand and supply, which leads to shifts in acreage and price expectations.

Key Findings

World Countries Trend and Risk

World trends of harvested corn acreage have been increasing from 1960 to 2019 (Figure 1). The period between 2010 and 2019 had the highest planted acreage (4.12 billion acres) in the world. The lowest coefficient of variation for this indicator was 2.4 between 1990 and 1999. This value suggests that this period had the lowest risk-return tradeoff for world harvested acreage. The yield and production quantity also have increased during the period (Figure 1). The highest global production was observed for the period between 2010 and 2019 (360 billion bushels). The period with the lowest coefficient of variation for global production was between 1990 and 1999, with 9.5. The highest average global yield was 87.39 bu/acre for the period between 2010 and 2019. The lowest coefficient of variation for yield (6.5) was observed for two periods: 2000-2009 and 2010-2019.

The global revenue had an upward growth until 2013, followed by a sharp decline. The highest revenue (U.S. \$1.6 trillion) was observed in the 2010-2019 decade. This decade also was characterized as having the lowest coefficient of variation, 13.6. Evidence indicates large spikes in global corn prices occurred during the period. A downward trend has been observed during the period from 2012 (Figure 1). The highest average price of U.S. \$6.08/bu was observed between 2010 and 2019. The lowest coefficient of variation for global price was 17.1 for 2010 to 2019.

The top 15 producers (share of global production) of corn based on the period between 2010 and 2019 are:

1. U.S. (34.5%)
2. China (22.4%)
3. Brazil (7.33%)
4. Argentina (3.27%)
5. Ukraine (2.48%)
6. India (2.39%)
7. Mexico (2.37%)
8. Indonesia (2.13%)

9. France (1.43%)
10. Canada (1.29%)
11. South Africa (1.18%)
12. Romania (1.12%)
13. Russia (1.03%)
14. Nigeria (0.94%)
15. Egypt (0.76%)

The trends of all the indicators for the top five countries are presented from Figure 2 to Figure 6. The details for other indicators at the global level can be found in the **appendix**.

U.S. States Trend and Risk

Planted and harvested corn acreage have seen slight upward trends with high volatilities during the period (Figure 7) at the U.S. level. The decade with the highest planted and harvested acreage was 2010 to 2019, with 836 million and 914 million acres, respectively. The lowest coefficient of variation for planted and harvested acreage was 3.5 and 3.2, respectively, between 2010 to 2019.

Corn yield and production revealed an upward trend during the period with several volatilities (Figure 7). The period with the highest production was 2010 to 2019, with 135 billion bushels produced. The lowest risk-return tradeoff was between 2010 and 2019, with 9.7.

Similarly, the period between 2010 and 2019 had the highest yield, with 161.5 bu/acre. The period with the lowest coefficient of variation for yield was from 2000 to 2009, with 7.3.

U.S. corn revenue has been on the decline since 2011 (Figure 8). Despite this, the highest revenue was observed between 2010 and 2019. Based on the calendar year revenue, the period with the least coefficient of variation was between 1950 and 1959, with 10.2.

Corn prices for the U.S. have been unstable during the period, with downward trends in recent years (Figure 8). The period with the least coefficient of variation for the calendar year price is 1960 to 1969, with 7.3.

The top 15 states in terms of production for 2010 to 2019 were:

1. Iowa (17.7%)
2. Illinois (15%)
3. Nebraska (12%)
4. Minnesota (9.93%)
5. Indiana (6.63%)
6. South Dakota (5.22%)
7. Kansas (4.36%)
8. Ohio (3.95%)
9. Wisconsin (3.63%)
10. Missouri (3.35%)
11. North Dakota (2.78%)
12. Michigan (2.33%)
13. Texas (1.91%)
14. Kentucky (1.51%)
15. Colorado (1.16%)

The trends of the indicators for the top five states are presented in Figure 9 to Figure 16. The details for other indicators at the global level can be found in the **appendix**.

North Dakota Counties Trend and Risk

The planted and harvested corn acreage had upward volatile trends during the years (Figure 17). The least coefficient of variation for planted acreage was 7.8 for the period between 1950 and 1959, while the lowest for harvested acreage was 18.4 for the same period.

The yield and production show increasing but volatile trends (Figure 17). The highest yield was between 2010 to 2019, with 130.2 bu/acre. In addition, this period had the highest production, with 3.75 billion bushels.

The coefficient of variation for the state's production was lowest for the period between 1950 and 1959, with 23, while it was the least for yield in 2000 to 2009, with 5.9. The trends for these indicators for the top 15 counties are presented from Figure 19 to Figure 22.

The top 15 counties based on the production in 2010 to 2019 were:

1. Richland (13.3%)
2. Cass (12.9%)
3. Stutsman (6.39%)
4. Sargent (6.15%)
5. Barnes (6.11%)
6. Dickey (5.73%)
7. LaMoure (5.48%)
8. Grand Forks (4.71%)
9. Traill (4.43%)
10. Ransom (4%)
11. Steele (3.44%)
12. Emmons (3.31%)
13. Wells (2.17%)
14. McClean (1.93%)
15. Ramsey (1.61%)

Variance Decomposition and Sources of Variation

Apart from understanding the trend and risk of production indicator variables, identifying the sources of the variation or risk is important. To formulate policies based on risk or variation of production indicator variables, we must decompose the sources of variation into the identifiable systematic (known or explained) and random (unknown or unexplained) components.

The systematic component is explained by spatial (region, state, crop reporting district and county) and temporal (annual and decadal) variations. The unexplained variation commonly is referred to as residuals or errors. This is important for the decision maker to identify the source(s) of variation to develop risk management tools.

Some of the measures include the use of traditional farm management solutions. Others include insuring through markets or obtaining government support. Based on the sources of variation, producers also can develop plans with respect to planting decisions (acreage) and marketing decision (production, yield, prices and revenue) to optimize net farm income.

The major sources of variation for any production indicator variable is estimated using the U.S. state data and U.S. county data. The sources of variation with the use of U.S. state data are identified with spatial (region and state), temporal (through time) and residual (unknown or unexplained) variations.

With U.S. county data, the sources of variation are identified with spatial (region, state, crop reporting district and county) and temporal (through time) and residual (unknown or unexplained) variations. The sources of variation are presented as percentages if the sources of variation are statistically significant.

This also will help in identifying additional sources of variation that have not been considered in the analysis. This could include additional risk factors such as climate and soil characteristics and uncertainty factors such as COVID-19.

State Variance Decomposition

The state level variance decomposition for the six production indicators are presented in this section. The yearly variance decomposition in percentages for planted acreage, harvested acreage, production, yield, revenue and prices are presented from Figure 23 to Figure 28. The percentage of variation of planted acreage attributed to the unexplained components is below 2% for the period (Figure 23).

Similarly, the amount of unexplained variation for harvested acreage, production, yield and revenue for the period is less than 2% (Figures 24 to 27). Prices had the highest percentage of unexplained sources of variation. During the period, the unexplained variation for prices varied stochastically between 5% and 90% (Figure 28).

County Variance Decomposition

The variance decompositions for the various indicators at the county level are presented in this section. For planted acreage, harvested acreage and production, the decomposition of the variance shows that the region accounted for about 30% of the variation during the period (Figure 29 to Figure 31).

The variation attributed to the county and state ranged from 20% to 30% for all the production indicators. The unexplained variation during the period was less than 2% for planted acreage, harvested acreage, production and yield (Figure 29 to Figure 32).

Future Research Proposal

- The finding on the trend of planted acreage highlights the need for an assessment of the determinants of acreage decisions. The objective of future studies will be to evaluate the acreage price elasticities across U.S. and North Dakota counties.
- The second proposed objective is to examine the sources of yield distributions and variability across North Dakota counties.
- The third objective will be to examine the sources of corn price volatilities.

■
Section I

World Countries Trend and Risk

Figure 1: Global Harvested Acreage, Annual Trends

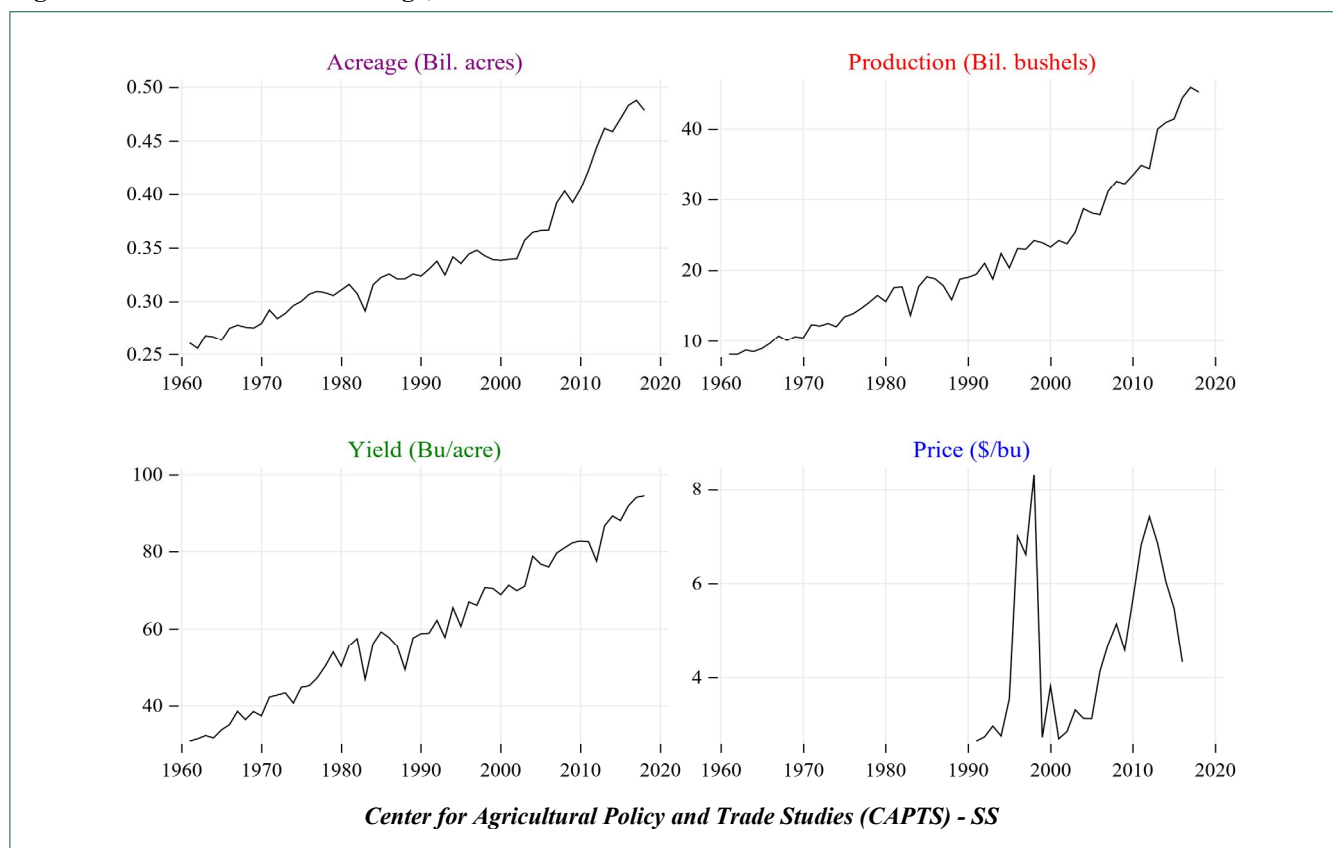


Table 1: Global Production Indicators, Annual Trends

Year	Harvested (Acres)	Production (Bushels)	Yield (Bu/acre)	Price (\$/bu)
2000	338,354,911	23,307,379,463	68.9	3.81
2001	339,481,752	24,217,320,195	71.3	2.70
2002	339,842,170	23,760,633,325	69.9	2.86
2003	357,306,965	25,394,535,948	71.1	3.32
2004	364,557,498	28,719,662,695	78.8	3.14
2005	366,221,179	28,116,278,138	76.8	3.13
2006	366,650,695	27,870,072,123	76.0	4.13
2007	392,088,425	31,208,308,335	79.6	4.71
2008	403,134,396	32,645,528,509	81.0	5.15
2009	392,451,126	32,284,612,133	82.3	4.58
2010	405,301,658	33,528,919,304	82.7	5.67
2011	423,049,876	34,906,841,113	82.5	6.82
2012	444,274,957	34,448,541,651	77.5	7.41
2013	461,981,192	40,006,044,341	86.6	6.84
2014	458,963,462	40,912,274,954	89.1	6.04
2015	470,922,172	41,420,150,617	88.0	5.47
2016	483,348,668	44,367,365,350	91.8	4.32
2017	487,948,018	45,840,131,954	93.9	.
2018	478,725,333	45,179,580,455	94.4	.

Figure 2: Top 5 Countries Harvested Acreage, Annual Trends

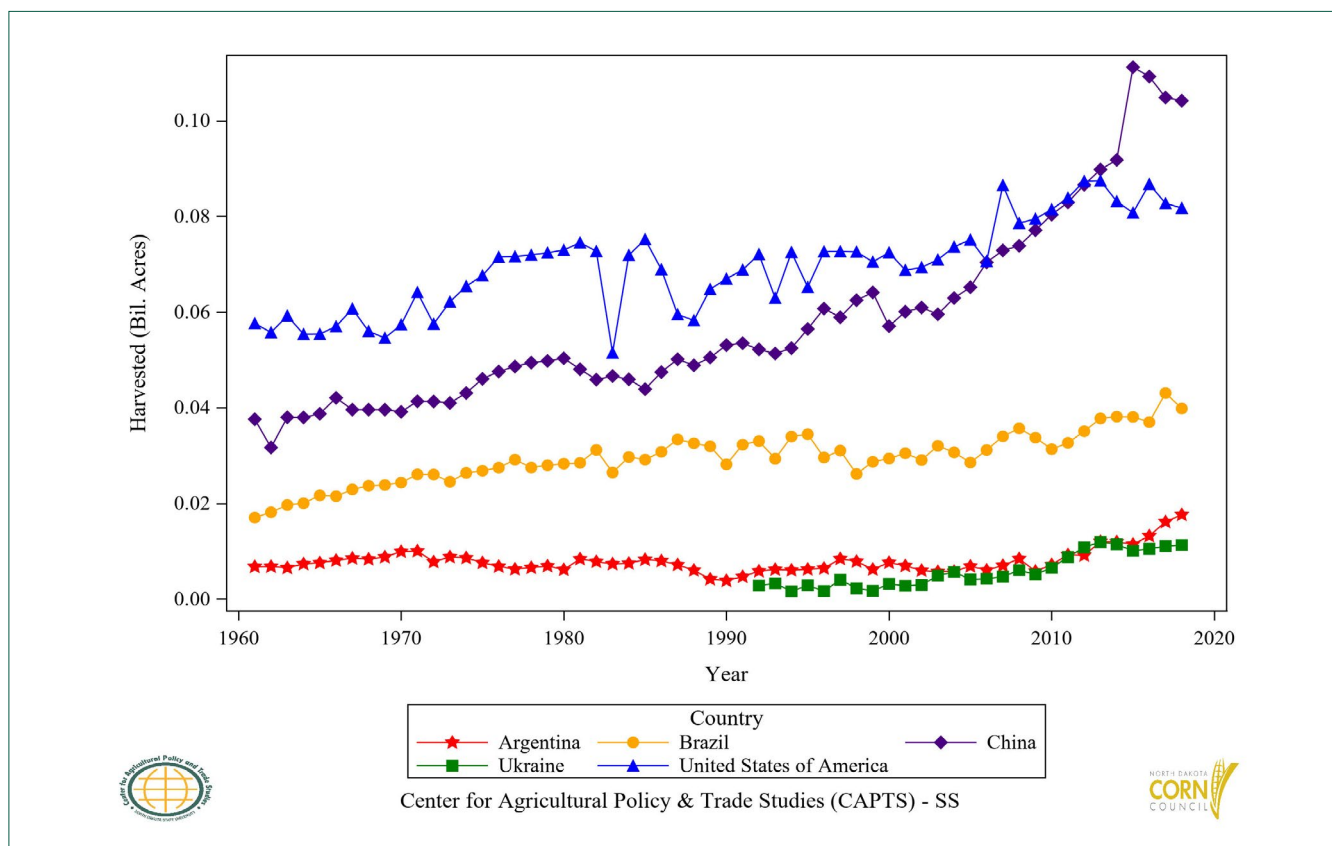


Table 2: Top 15 Countries Harvested Acreage, Annual Trends

Country	Harvested (Acres)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	
U.S.	81,446,747	83,879,768	87,365,801	87,451,819	83,136,772	80,749,738	86,748,805	82,733,769	81,740,753	
China	80,353,574	82,928,102	86,601,567	89,796,502	91,800,484					
Brazil	31,330,134	32,664,543	35,085,194	37,756,784	38,135,490	38,071,821	36,992,859	43,063,497	39,836,160	
Argentina	7,176,016	9,261,095	9,133,742	12,018,695	11,951,616	11,433,252	13,211,699	16,137,620	17,639,887	
Ukraine	6,542,352	8,756,660	10,803,183	11,927,511	11,433,301	10,090,533	10,507,399	11,072,034	11,278,366	
India	21,135,385	21,695,819	21,522,846	23,302,002	22,876,981	21,473,425	24,463,395	22,783,081	22,733,660	
Mexico	17,663,177	14,997,030	17,109,303	17,533,657	17,446,293	17,543,773	18,775,495	18,107,061	17,600,573	
Indonesia	10,209,578	9,549,847	9,779,415	9,443,127	9,481,466	9,358,773	10,982,258	13,672,737	14,036,454	
France	3,910,998	3,945,553	4,225,337	4,555,324	4,509,965	4,045,309	3,565,243	3,547,684	3,513,747	
Canada	2,972,426	2,969,461	3,503,702	3,658,142	3,030,990	3,241,276	3,256,103	3,474,791	3,535,331	
South Africa	6,775,619	5,862,072	6,669,858	6,872,484	6,642,677	6,555,325	4,810,517	6,495,402	5,729,994	
Romania	5,174,994	6,392,858	6,726,643	6,216,028	6,188,545	6,421,352	6,371,659	5,938,670	6,035,695	
Russian Federation	2,533,274	3,960,127	4,787,763	5,737,432	6,423,571	6,597,849	6,862,153	6,677,827	5,870,328	
Nigeria	10,253,152	13,483,383	14,211,750	14,239,920	15,682,645	16,731,947	16,258,748	16,160,667	11,992,868	
Egypt	2,393,259	2,195,105	2,573,216	2,546,019	2,568,016	2,621,774	2,539,454	2,709,951	2,312,354	

Figure 3: Top 5 Countries Production, Annual Trends

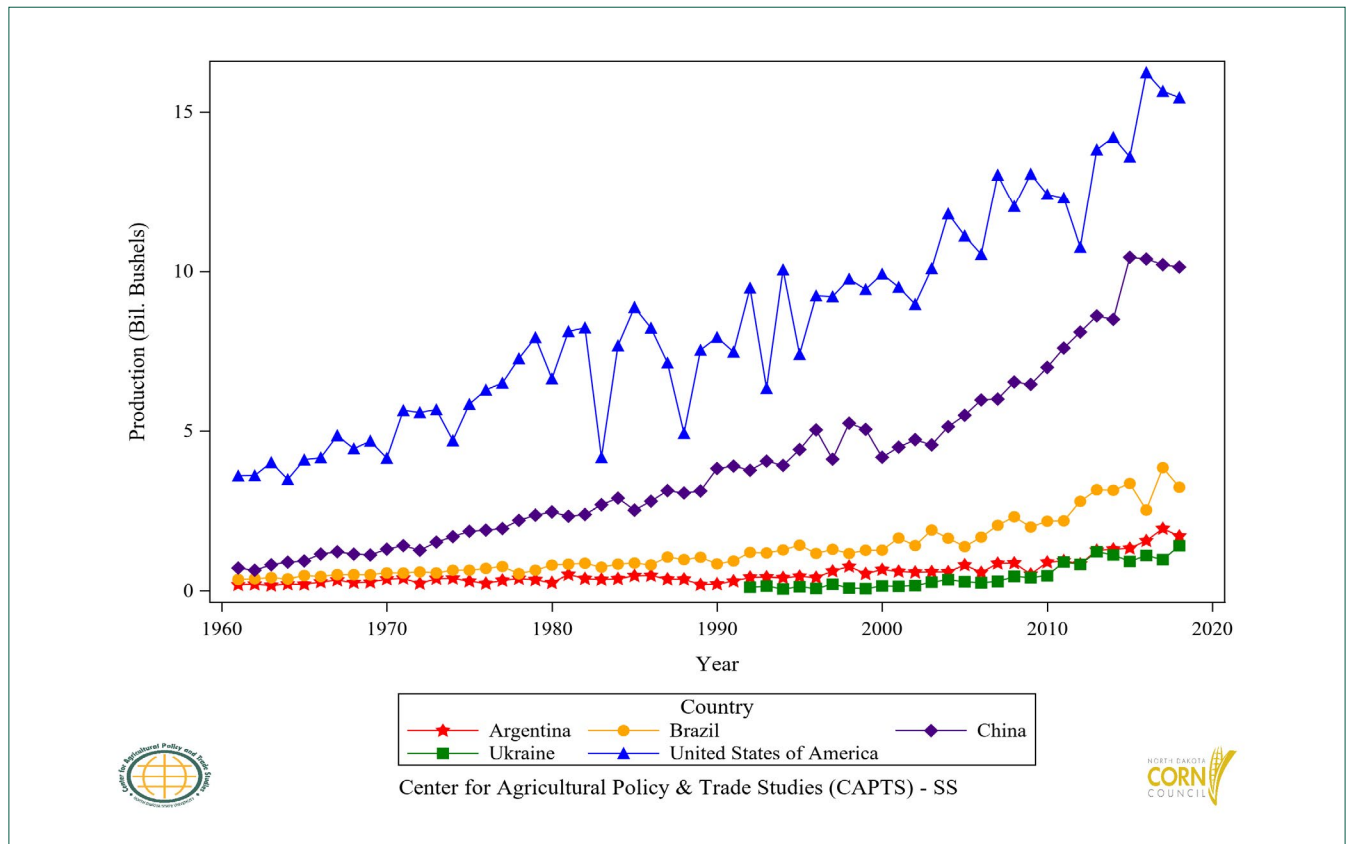


Table 3: Top 15 Countries Production, Annual Trends

Country	Production (Bushels)								
	2010	2011	2012	2013	2014	2015	2016	2017	2018
U.S.		12,313,873,022	10,755,038,403	13,828,870,978	14,215,436,000	13,601,106,233	16,229,937,502	15,652,830,574	15,450,004,669
China	6,989,425,742	7,594,253,805	8,098,756,773	8,606,707,156	8,496,090,753	10,438,712,862	10,384,402,462	10,206,401,979	10,131,302,008
Brazil	2,179,580,621	2,191,232,131	2,797,994,384	3,160,194,235	3,144,779,380	3,357,424,057	2,526,965,546	3,854,546,784	3,239,525,716
Argentina	892,200,724	936,951,707	834,469,205	1,264,469,099	1,302,575,512	1,331,336,946	1,566,565,076	1,947,767,034	1,711,024,732
Ukraine	470,565,704	899,082,447	825,204,458	1,218,421,884	1,121,862,416	918,359,776	1,105,241,246	971,159,350	1,409,415,736
India	855,301,294	856,647,680	876,331,680	955,048,390	951,524,560	888,535,760	1,019,631,200	1,131,830,000	1,095,217,760
Mexico	917,348,372	694,271,096	868,822,391	892,234,502	916,221,582	972,155,203	1,112,152,299	1,092,981,776	1,069,627,655
Indonesia	721,522,374	694,579,466	763,228,282	728,774,629	748,323,715	772,102,341	928,234,963	1,138,680,623	1,191,037,031
France	550,179,020	626,507,116	606,011,190	592,142,985	722,139,822	539,973,378	466,106,451	572,209,825	498,689,928
Canada	474,120,634	447,169,302	514,150,017	558,659,478	456,920,755	538,534,556	546,782,152	554,903,770	546,616,806
South Africa	504,500,920	407,852,480	477,165,985	464,959,701	560,994,000	391,908,440	306,223,988	662,169,760	492,493,680
Romania	355,966,716	461,298,122	234,371,562	445,058,980	471,965,355	355,154,593	423,063,763	563,989,787	734,761,951
Russian Federation	121,424,730	274,097,259	323,326,392	458,044,436	446,123,609	518,606,317	601,605,793	519,976,284	449,543,979
Nigeria	302,222,231	349,527,056	342,300,823	331,583,673	396,001,452	415,806,784	454,620,877	410,214,560	399,783,103
Egypt	277,193,985	270,712,989	318,630,656	313,235,153	317,302,379	307,195,708	307,764,852	336,306,455	287,386,400

Figure 4: Top 5 Countries Yield, Annual Trends

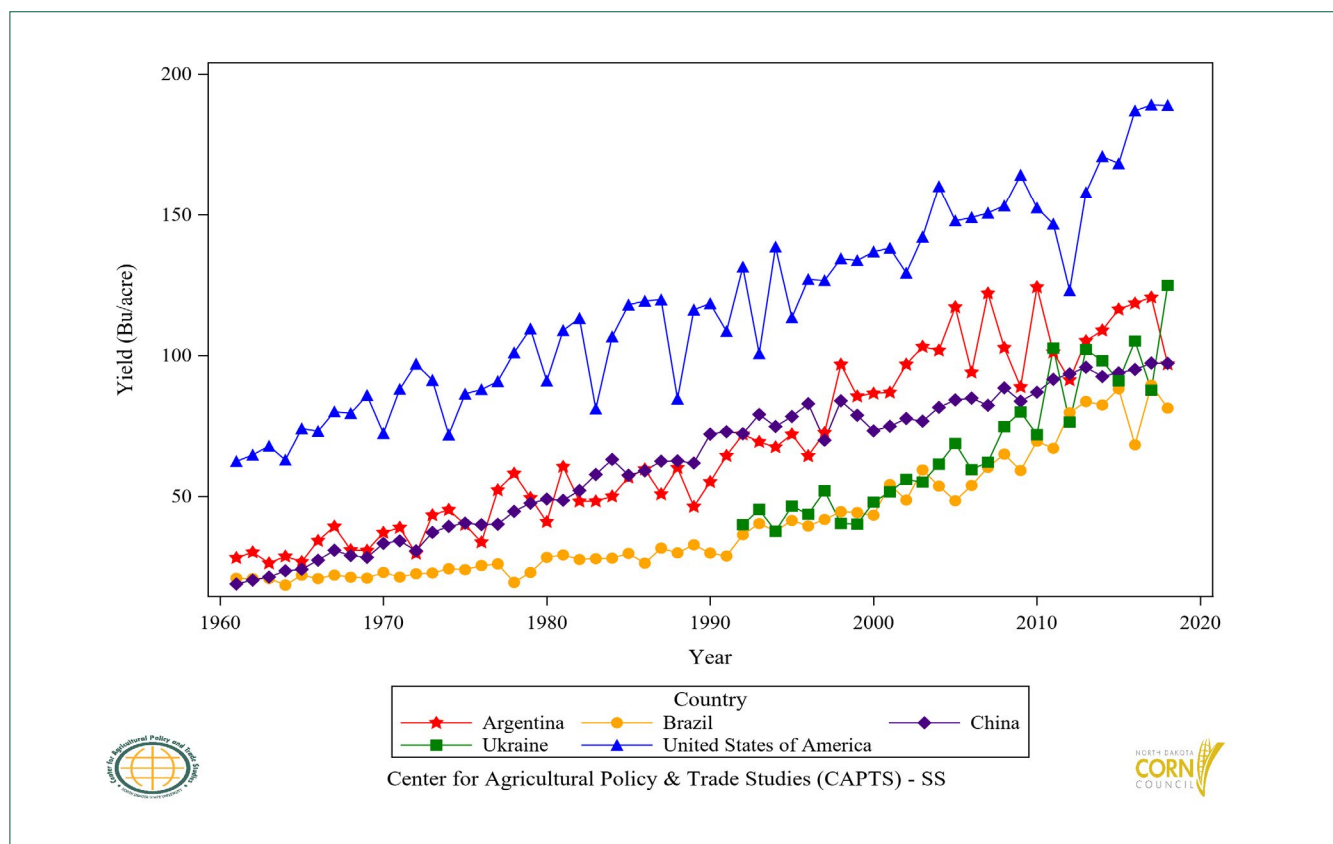


Table 4: Top 15 Countries Yield, Annual Trends

Country	Yield (Bu/acre)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	
U.S.	152.56	146.80	123.10	158.13	170.99	168.44	187.09	189.20	189.01	
China	86.98	91.58	93.52	95.85	92.55	93.88	95.06	97.35	97.25	
Brazil	69.57	67.08	79.75	83.70	82.46	88.19	68.31	89.51	81.32	
Argentina	124.33	101.17	91.36	105.21	108.99	116.44	118.57	120.70	97.00	
Ukraine	71.93	102.67	76.39	102.15	98.12	91.01	105.19	87.71	124.97	
India	40.47	39.48	40.72	40.99	41.59	41.38	41.68	49.68	48.18	
Mexico	51.94	46.29	50.78	50.89	52.52	55.41	59.23	60.36	60.77	
Indonesia	70.67	72.73	78.04	77.18	78.92	82.50	84.52	83.28	84.85	
France	140.67	158.79	143.42	129.99	160.12	133.48	130.74	161.29	141.93	
Canada	159.51	150.59	146.74	152.72	150.75	166.15	167.93	159.69	154.62	
South Africa	74.46	69.57	71.54	67.66	84.45	59.78	63.66	101.94	85.95	
Romania	68.79	72.16	34.84	71.60	76.26	55.31	66.40	94.97	121.74	
Russian Federation	47.93	69.21	67.53	79.83	69.45	78.60	87.67	77.87	76.58	
Nigeria	29.48	25.92	24.09	23.29	25.25	24.85	27.96	25.38	33.34	
Egypt	115.82	123.33	123.83	123.03	123.56	117.17	121.19	124.10	124.28	

Figure 5: Top 5 Countries Revenue, Annual Trends

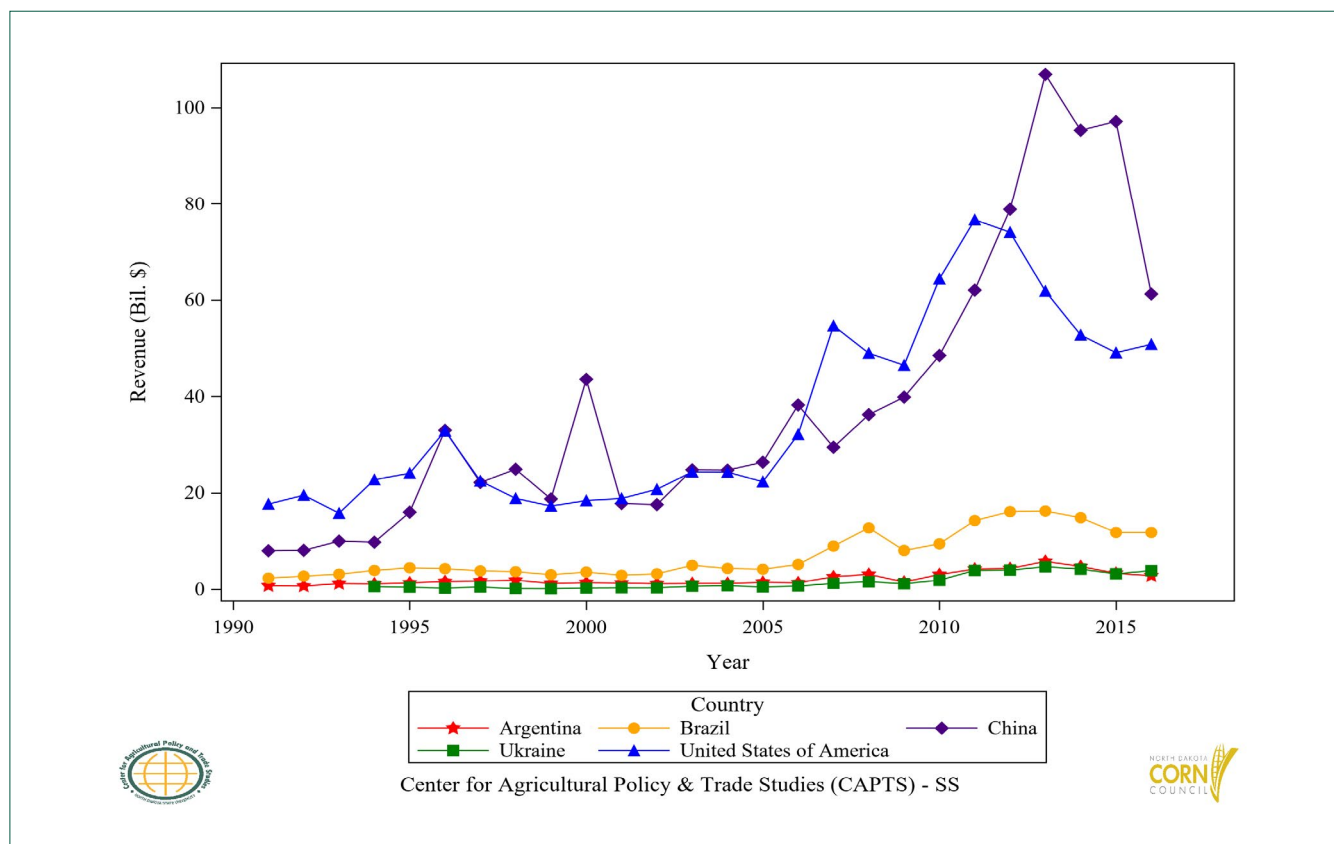


Table 5: Top 15 Countries Revenue, Annual Trends

Country	Revenue (\$)						
	2010	2011	2012	2013	2014	2015	2016
U.S.	64,386,055,680	76,633,278,050	74,035,140,400	61,823,849,120	52,719,306,440	49,059,060,280	50,790,681,480
China	48,482,009,889	62,028,027,213	78,827,611,859		95,301,700,377	97,138,448,862	61,226,699,820
Brazil	9,409,769,036	14,251,987,190	16,102,720,737	16,226,349,700	14,852,919,515	11,777,866,576	11,780,742,158
Argentina	3,061,670,855	4,196,213,410	4,305,637,943	5,790,968,514	4,739,190,268	3,317,097,653	2,790,832,423
Ukraine	1,876,778,570	3,915,447,177	3,974,002,369	4,685,219,004	4,183,423,762	3,192,968,612	3,878,598,779
India	5,190,798,915	5,554,721,813	5,385,128,583	5,119,963,262	5,308,860,163	5,000,565,287	5,810,774,182
Mexico	5,193,866,645	5,788,603,570	6,719,249,843	5,972,626,275	5,455,688,558	5,333,250,839	5,343,776,987
Indonesia	5,915,161,135	6,250,129,342	6,827,921,627	6,167,892,535	5,880,123,431	5,534,010,539	6,266,743,241
France	3,452,039,655	4,124,566,745	4,249,415,364	3,420,606,495	3,572,141,056	2,383,722,533	2,133,621,337
Canada	1,954,192,928	2,549,977,913	3,378,124,836	3,190,100,944	1,927,439,247	2,039,857,639	1,805,823,050
South Africa	1,759,142,814	2,184,392,146	2,908,378,023	2,453,850,442	2,506,598,484	1,824,976,185	1,703,806,253
Romania	2,020,152,528	3,843,586,883	1,785,215,985	3,397,048,704	2,720,461,093	1,711,641,744	1,949,677,020
Russian Federation	475,430,956	1,402,091,996	1,797,851,917	2,405,038,616	1,712,207,169	1,697,635,070	1,905,965,874
Nigeria	2,556,429,750	3,025,462,565	3,034,683,717	2,983,856,246	3,604,787,940	2,699,775,894	1,654,580,882
Egypt	2,353,318,989	2,243,930,299	2,905,451,935	2,587,218,037	2,586,190,854	2,731,174,500	2,026,398,413

Figure 6: Top 5 Countries Price, Annual Trends

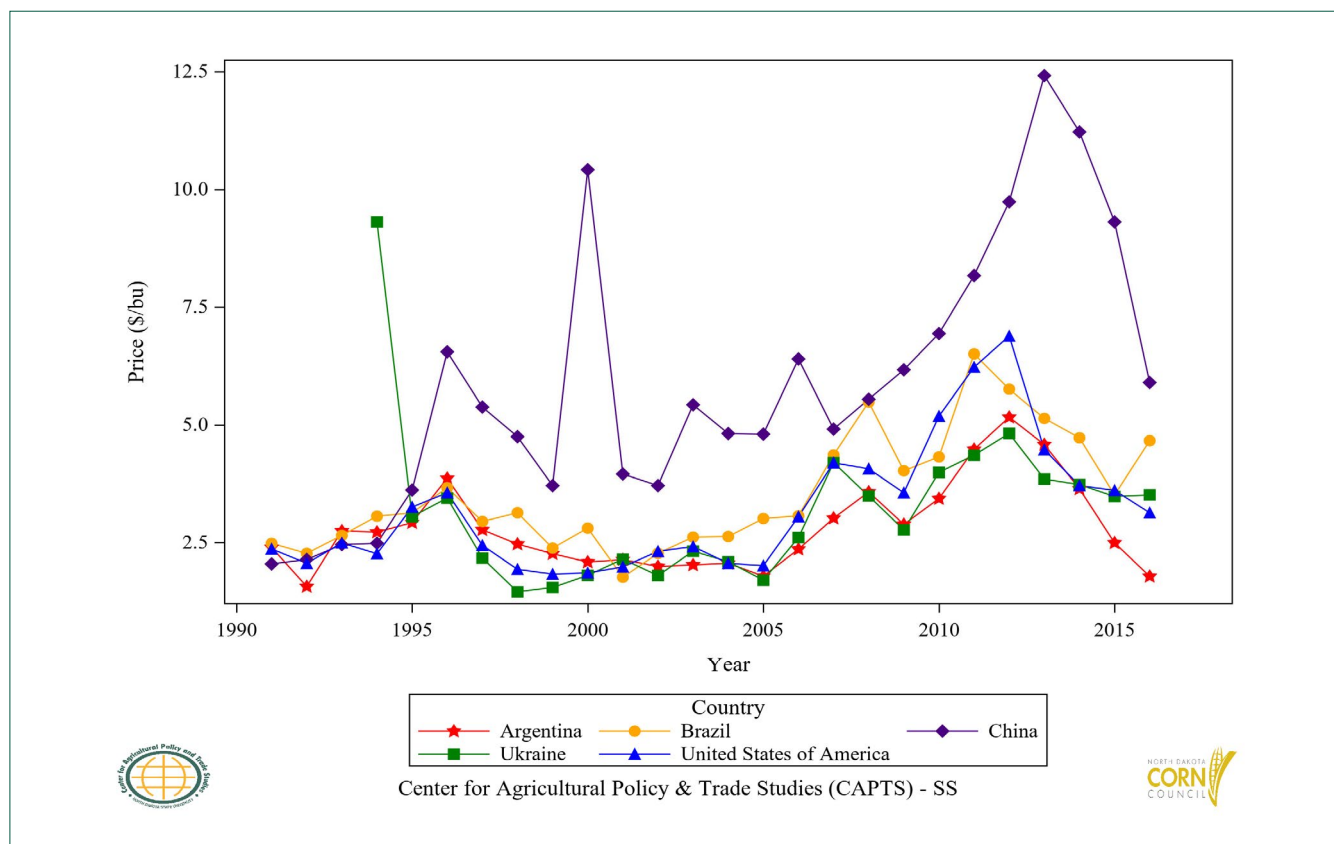


Table 6: Top 15 Countries Price, Annual Trends

Country	Price (\$/acre)						
	2010	2011	2012	2013	2014	2015	2016
U.S.	5.18	6.22	6.88	4.47	3.71	3.61	3.13
China	6.94	8.17	9.73	12.41	11.22	9.31	5.90
Brazil	4.32	6.50	5.76	5.13	4.72	3.51	4.66
Argentina	3.43	4.48	5.16	4.58	3.64	2.49	1.78
Ukraine	3.99	4.35	4.82	3.85	3.73	3.48	3.51
India	6.07	6.48	6.15	5.36	5.58	5.63	5.70
Mexico	5.66	8.34	7.73	6.69	5.95	5.49	4.80
Indonesia	8.20	9.00	8.95	8.46	7.86	7.17	6.75
France	6.27	6.58	7.01	5.78	4.95	4.41	4.58
Canada	4.12	5.70	6.57	5.71	4.22	3.79	3.30
South Africa	3.49	5.36	6.10	5.28	4.47	4.66	5.56
Romania	5.68	8.33	7.62	7.63	5.76	4.82	4.61
Russian Federation	3.92	5.12	5.56	5.25	3.84	3.27	3.17
Nigeria	8.46	8.66	8.87	9.00	9.10	6.49	3.64
Egypt	8.49	8.29	9.12	8.26	8.15	8.89	6.58



Section II

U.S. States Trend and Risk

Figure 7: U.S. Planted Acreage, Harvested Acreage, Production and Yield, Annual Trends

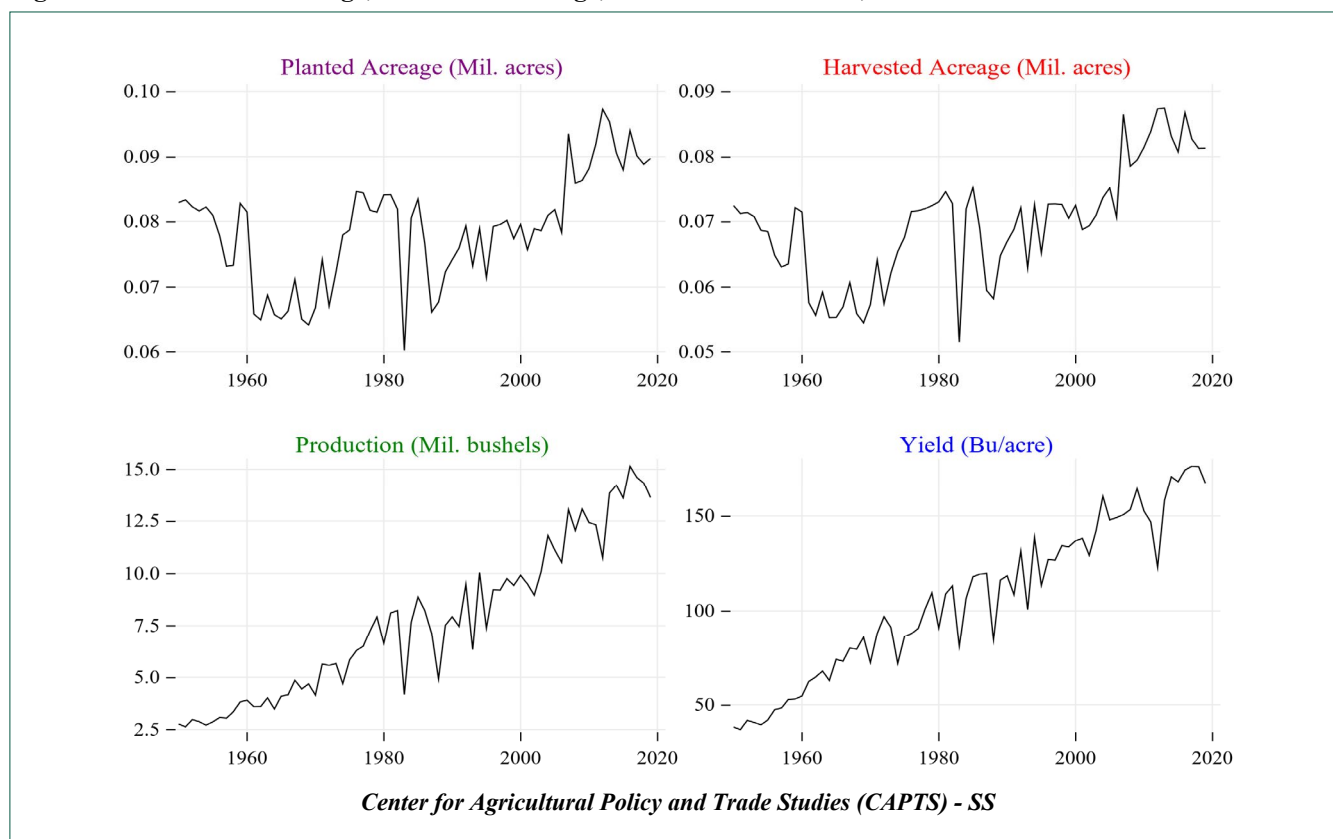


Table 7: U.S. Production Indicators, Annual Trends

Year	Planted (Acres)	Harvested (Acres)	Production (Bushels)	Yield (Bu/acre)
2000	79,551,000	72,440,000	9,915,051,000	137
2001	75,702,000	68,768,000	9,502,580,000	138
2002	78,894,000	69,330,000	8,966,787,000	129
2003	78,603,000	70,944,000	10,087,292,000	142
2004	80,929,000	73,631,000	11,805,581,000	160
2005	81,779,000	75,117,000	11,112,187,000	148
2006	78,327,000	70,638,000	10,531,123,000	149
2007	93,527,000	86,520,000	13,037,875,000	151
2008	85,982,000	78,570,000	12,043,203,000	153
2009	86,382,000	79,490,000	13,067,156,000	164
2010	88,192,000	81,446,000	12,425,330,000	153
2011	91,936,000	83,879,000	12,313,956,000	147
2012	97,291,000	87,365,000	10,755,111,000	123
2013	95,365,000	87,461,000	13,830,704,000	158
2014	90,597,000	83,146,000	14,217,292,000	171
2015	88,019,000	80,753,000	13,601,964,000	168
2016	94,004,000	86,748,000	15,148,038,000	175
2017	90,167,000	82,733,000	14,609,407,000	177
2018	88,871,000	81,276,000	14,340,369,000	176
2019	89,745,000	81,337,000	13,619,928,000	168

Figure 8: U.S. Revenue and Prices, Marketing and Calendar Year, Annual Trends

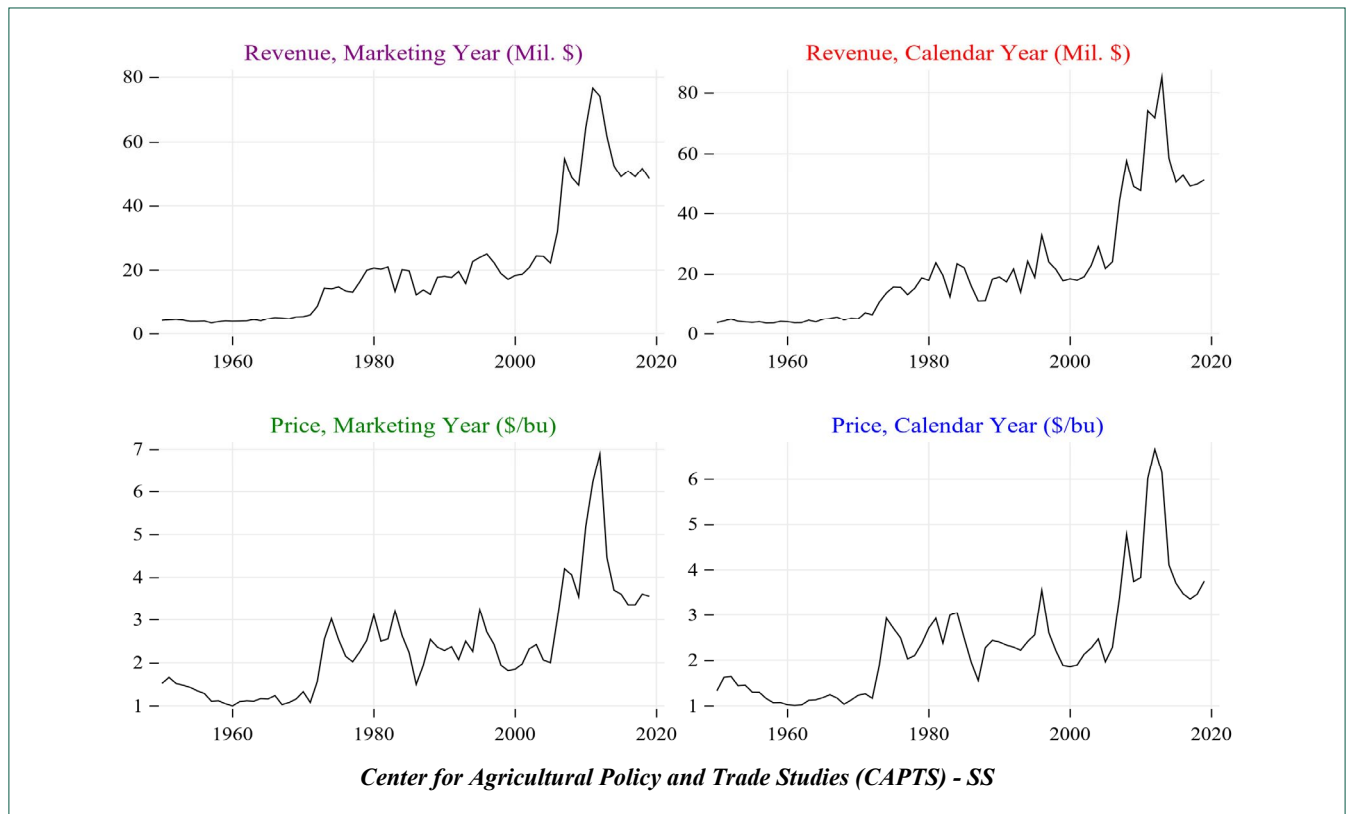


Table 8: U.S. Production Indicators, Annual Trends

Year	Revenue (Marketing) (\$)	Revenue (Calendar) (\$)	Marketing Year Price, MYP (\$/bu)	Calendar Year Price, CYP (\$/bu)
2000	18,342,844,350	18,433,732,318	1.85	1.86
2001	18,720,082,600	17,991,551,467	1.97	1.89
2002	20,802,945,840	19,106,728,633	2.32	2.13
2003	24,411,246,640	22,872,934,610	2.42	2.27
2004	24,319,496,860	29,100,757,165	2.06	2.47
2005	22,224,374,000	21,826,187,299	2.00	1.96
2006	32,014,613,920	24,019,736,376	3.04	2.28
2007	54,759,075,000	44,209,261,146	4.20	3.39
2008	48,895,404,180	57,566,510,340	4.06	4.78
2009	46,388,403,800	48,936,499,220	3.55	3.75
2010	64,363,209,400	47,599,368,342	5.18	3.83
2011	76,592,806,320	74,078,706,970	6.22	6.02
2012	74,102,714,790	71,763,478,148	6.89	6.67
2013	61,684,939,840	85,116,457,533	4.46	6.15
2014	52,603,980,400	58,468,613,350	3.70	4.11
2015	49,103,090,040	50,406,611,590	3.61	3.71
2016	50,897,407,680	52,689,925,510	3.36	3.48
2017	49,087,607,520	49,075,433,014	3.36	3.36
2018	51,768,732,090	49,737,179,815	3.61	3.47
2019	48,486,943,680	51,120,129,760	3.56	3.75

Figure 9: Top 5 States Planted Acreage, Annual Trends

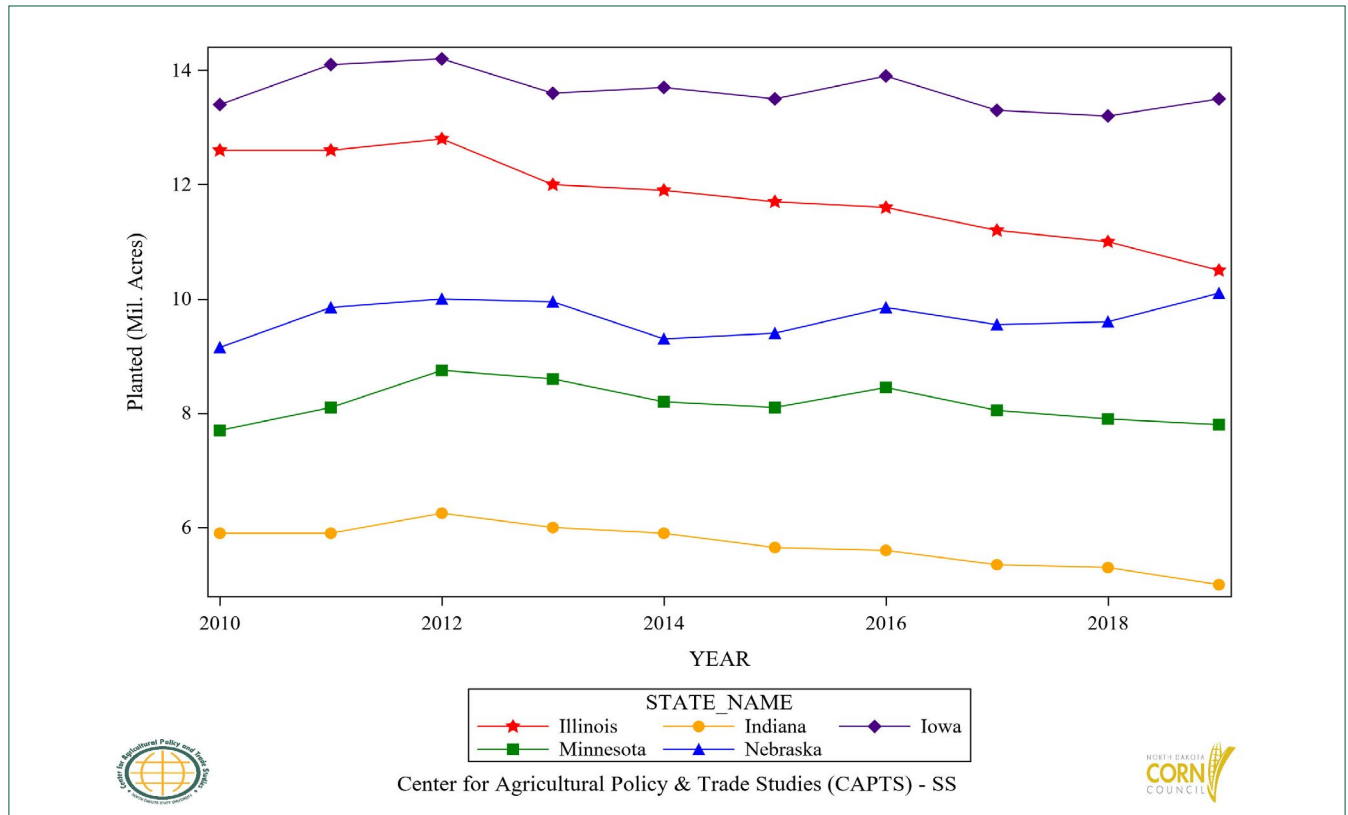


Table 9: Top 15 U.S. States Planted Acreage, Annual Trends

State	Planted (Acres)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Iowa	13,400,000	14,100,000	14,200,000	13,600,000	13,700,000	13,500,000	13,900,000	13,300,000	13,200,000	13,500,000
Illinois	12,600,000	12,600,000	12,800,000	12,000,000	11,900,000	11,700,000	11,600,000	11,200,000	11,000,000	10,500,000
Nebraska	9,150,000	9,850,000	10,000,000	9,950,000	9,300,000	9,400,000	9,850,000	9,550,000	9,600,000	10,100,000
Minnesota	7,700,000	8,100,000	8,750,000	8,600,000	8,200,000	8,100,000	8,450,000	8,050,000	7,900,000	7,800,000
Indiana	5,900,000	5,900,000	6,250,000	6,000,000	5,900,000	5,650,000	5,600,000	5,350,000	5,300,000	5,000,000
South Dakota	4,550,000	5,200,000	6,150,000	6,200,000	5,800,000	5,400,000	5,600,000	5,700,000	5,300,000	4,350,000
Kansas	4,850,000	4,900,000	4,700,000	4,300,000	4,050,000	4,150,000	5,100,000	5,500,000	5,450,000	6,400,000
Ohio	3,450,000	3,400,000	3,900,000	3,900,000	3,700,000	3,550,000	3,550,000	3,400,000	3,500,000	2,800,000
Wisconsin	3,900,000	4,150,000	4,350,000	4,100,000	4,000,000	4,000,000	4,050,000	3,900,000	3,900,000	3,800,000
Missouri	3,150,000	3,300,000	3,600,000	3,350,000	3,500,000	3,250,000	3,650,000	3,400,000	3,500,000	3,200,000
North Dakota	2,050,000	2,230,000	3,640,000	3,850,000	2,800,000	2,750,000	3,450,000	3,420,000	3,150,000	3,500,000
Michigan	2,400,000	2,500,000	2,700,000	2,600,000	2,550,000	2,350,000	2,400,000	2,250,000	2,250,000	2,000,000
Texas	2,300,000	2,050,000	1,850,000	2,350,000	2,250,000	2,300,000	2,900,000	2,450,000	2,200,000	2,500,000
Kentucky	1,340,000	1,380,000	1,650,000	1,530,000	1,520,000	1,400,000	1,500,000	1,320,000	1,330,000	1,550,000
Colorado	1,330,000	1,500,000	1,420,000	1,220,000	1,150,000	1,100,000	1,340,000	1,460,000	1,460,000	1,550,000
Pennsylvania	1,350,000	1,420,000	1,460,000	1,480,000	1,460,000	1,340,000	1,400,000	1,350,000	1,300,000	1,450,000
Tennessee	710,000	790,000	1,040,000	890,000	920,000	780,000	880,000	750,000	720,000	970,000
Arkansas	390,000	560,000	710,000	880,000	540,000	460,000	760,000	620,000	660,000	770,000
Mississippi	750,000	810,000	820,000	860,000	510,000	510,000	750,000	520,000	480,000	660,000
North Carolina	910,000	870,000	870,000	930,000	840,000	790,000	1,000,000	890,000	910,000	990,000
New York	1,050,000	1,100,000	1,170,000	1,200,000	1,140,000	1,080,000	1,100,000	1,000,000	1,070,000	1,020,000
Louisiana	510,000	580,000	540,000	680,000	400,000	400,000	620,000	500,000	460,000	570,000
Maryland	500,000	500,000	495,000	480,000	500,000	440,000	460,000	480,000	440,000	510,000
Georgia	295,000	345,000	345,000	510,000	350,000	330,000	410,000	290,000	325,000	395,000
Virginia	490,000	490,000	510,000	510,000	500,000	450,000	490,000	500,000	485,000	540,000
Oklahoma	370,000	380,000	360,000	370,000	320,000	310,000	400,000	350,000	310,000	370,000
Alabama	270,000	270,000	310,000	320,000	300,000	260,000	330,000	250,000	255,000	320,000
South Carolina	350,000	360,000	330,000	350,000	295,000	295,000	375,000	350,000	340,000	380,000
Delaware	180,000	190,000	185,000	180,000	175,000	170,000	170,000	180,000	170,000	185,000
Idaho	320,000	350,000	360,000	350,000	320,000	280,000	340,000	340,000	350,000	390,000
Washington	200,000	195,000	195,000	190,000	215,000	170,000	170,000	170,000	165,000	175,000
California	610,000	630,000	640,000	600,000	520,000	440,000	420,000	430,000	430,000	480,000
New Jersey	80,000	90,000	95,000	90,000	85,000	80,000	80,000	77,000	70,000	77,000
Wyoming	90,000	105,000	105,000	100,000	90,000	85,000	100,000	95,000	95,000	95,000
Oregon	70,000	83,000	85,000	80,000	80,000	65,000	80,000	85,000	75,000	85,000
New Mexico	140,000	130,000	125,000	120,000	125,000	125,000	120,000	125,000	135,000	150,000
Arizona	45,000	60,000	70,000	85,000	75,000	75,000	95,000	65,000	80,000	90,000
Florida	60,000	70,000	75,000	115,000	75,000	80,000	80,000	75,000	95,000	95,000
Montana	80,000	77,000	105,000	120,000	130,000	105,000	115,000	115,000	115,000	115,000
West Virginia	48,000	48,000	51,000	53,000	51,000	50,000	49,000	50,000	46,000	52,000
Utah	70,000	85,000	92,000	83,000	75,000	65,000	80,000	80,000	70,000	85,000

Figure 10: Top 5 States Harvested Acreage, Annual Trends

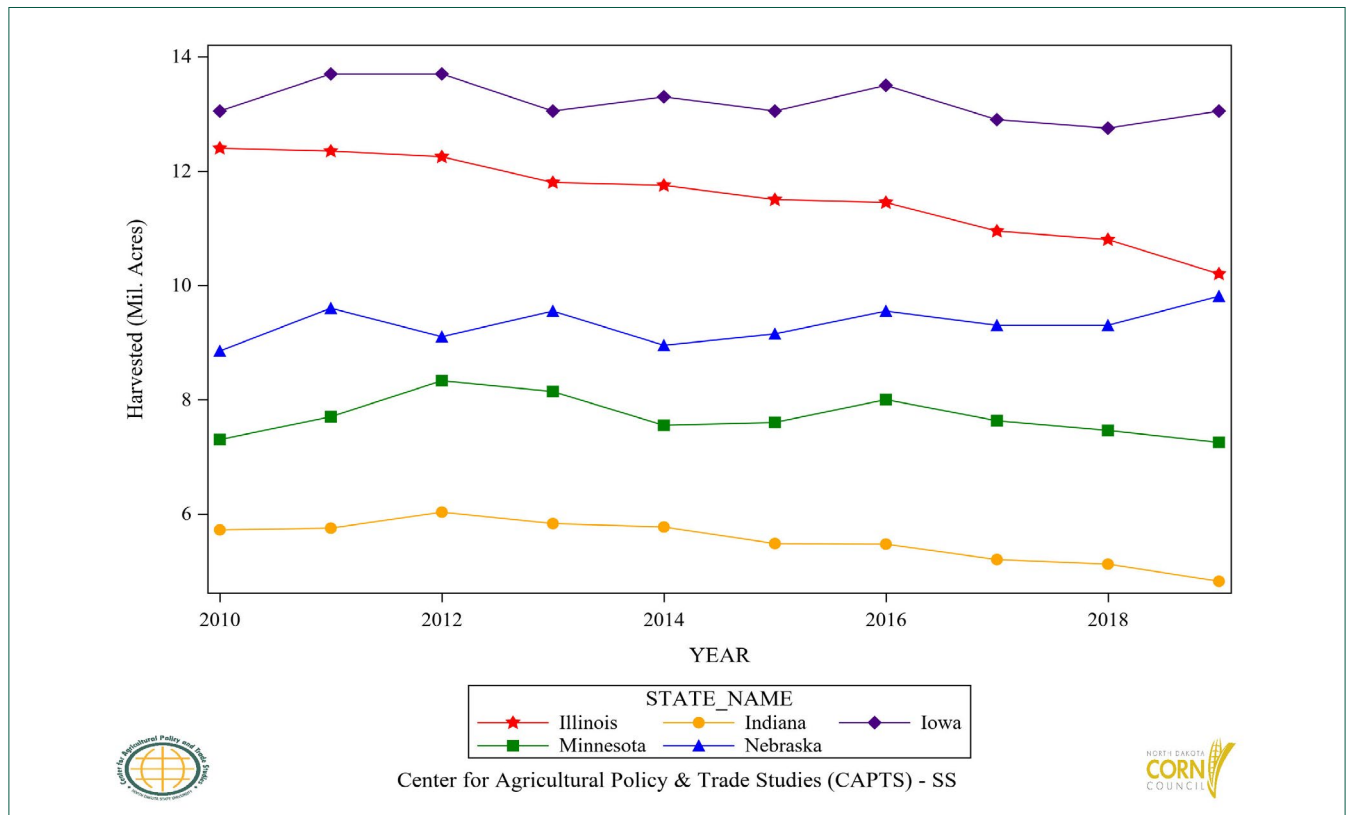


Table 10: Top 15 U.S. States Harvested Acreage, Annual Trends

State	Harvested (Acres)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Iowa	13,050,000	13,700,000	13,700,000	13,050,000	13,300,000	13,050,000	13,500,000	12,900,000	12,750,000	13,050,000
Illinois	12,400,000	12,350,000	12,250,000	11,800,000	11,750,000	11,500,000	11,450,000	10,950,000	10,800,000	10,200,000
Nebraska	8,850,000	9,600,000	9,100,000	9,550,000	8,950,000	9,150,000	9,550,000	9,300,000	9,300,000	9,810,000
Minnesota	7,300,000	7,700,000	8,330,000	8,140,000	7,550,000	7,600,000	8,000,000	7,630,000	7,460,000	7,250,000
Indiana	5,720,000	5,750,000	6,030,000	5,830,000	5,770,000	5,480,000	5,470,000	5,200,000	5,120,000	4,820,000
South Dakota	4,220,000	4,950,000	5,300,000	5,860,000	5,320,000	5,030,000	5,130,000	5,080,000	4,860,000	3,870,000
Kansas	4,650,000	4,200,000	3,950,000	4,000,000	3,800,000	3,920,000	4,920,000	5,200,000	4,980,000	6,020,000
Ohio	3,270,000	3,200,000	3,650,000	3,740,000	3,480,000	3,260,000	3,300,000	3,150,000	3,300,000	2,570,000
Wisconsin	3,100,000	3,320,000	3,300,000	3,030,000	3,110,000	3,000,000	3,220,000	2,930,000	3,170,000	2,670,000
Missouri	3,000,000	3,050,000	3,300,000	3,200,000	3,380,000	3,080,000	3,500,000	3,250,000	3,330,000	2,990,000
North Dakota	1,880,000	2,060,000	3,460,000	3,600,000	2,530,000	2,560,000	3,270,000	3,230,000	2,930,000	3,130,000
Michigan	2,100,000	2,190,000	2,380,000	2,230,000	2,210,000	2,070,000	2,040,000	1,890,000	1,890,000	1,610,000
Texas	2,080,000	1,470,000	1,550,000	1,950,000	1,990,000	1,970,000	2,550,000	2,240,000	1,750,000	2,150,000
Kentucky	1,230,000	1,300,000	1,530,000	1,430,000	1,430,000	1,310,000	1,400,000	1,220,000	1,220,000	1,450,000
Colorado	1,210,000	1,300,000	1,010,000	980,000	1,010,000	950,000	1,170,000	1,300,000	1,190,000	1,300,000
Pennsylvania	910,000	960,000	1,000,000	1,090,000	1,030,000	940,000	950,000	920,000	890,000	1,060,000
Tennessee	640,000	735,000	960,000	810,000	840,000	730,000	830,000	710,000	670,000	910,000
Arkansas	380,000	520,000	695,000	870,000	530,000	445,000	745,000	595,000	645,000	735,000
Mississippi	670,000	730,000	795,000	830,000	485,000	490,000	720,000	500,000	460,000	620,000
North Carolina	840,000	815,000	820,000	860,000	780,000	730,000	940,000	840,000	830,000	930,000
New York	590,000	620,000	680,000	690,000	680,000	590,000	570,000	485,000	615,000	545,000
Louisiana	500,000	570,000	530,000	670,000	390,000	390,000	550,000	490,000	450,000	545,000
Maryland	430,000	420,000	435,000	420,000	430,000	380,000	400,000	420,000	380,000	460,000
Georgia	245,000	270,000	310,000	465,000	310,000	285,000	340,000	245,000	285,000	350,000
Virginia	310,000	340,000	350,000	360,000	350,000	300,000	340,000	340,000	325,000	380,000
Oklahoma	340,000	190,000	295,000	310,000	290,000	280,000	350,000	305,000	270,000	330,000
Alabama	250,000	250,000	295,000	295,000	285,000	245,000	315,000	235,000	245,000	305,000
South Carolina	335,000	330,000	310,000	335,000	280,000	260,000	350,000	325,000	310,000	350,000
Delaware	173,000	182,000	178,000	174,000	168,000	164,000	164,000	171,000	166,000	180,000
Idaho	110,000	120,000	135,000	115,000	80,000	70,000	100,000	115,000	125,000	150,000
Washington	125,000	125,000	115,000	105,000	110,000	75,000	85,000	80,000	85,000	90,000
California	180,000	150,000	180,000	180,000	95,000	60,000	100,000	80,000	65,000	60,000
New Jersey	71,000	81,000	86,000	80,000	79,000	72,000	71,000	70,000	60,000	68,000
Wyoming	50,000	70,000	60,000	67,000	60,000	59,000	69,000	63,000	70,000	67,000
Oregon	38,000	51,000	52,000	36,000	39,000	30,000	39,000	44,000	40,000	49,000
New Mexico	66,000	45,000	43,000	38,000	48,000	40,000	41,000	43,000	35,000	48,000
Arizona	22,000	35,000	32,000	51,000	28,000	36,000	50,000	32,000	20,000	37,000
Florida	25,000	33,000	40,000	78,000	40,000	50,000	40,000	37,000	62,000	54,000
Montana	34,000	36,000	60,000	75,000	75,000	50,000	55,000	65,000	68,000	60,000
West Virginia	29,000	31,000	35,000	36,000	36,000	35,000	35,000	33,000	33,000	38,000
Utah	23,000	30,000	34,000	31,000	28,000	17,000	29,000	20,000	22,000	26,000

Figure 11: Top 5 U.S. States Production, Annual Trends

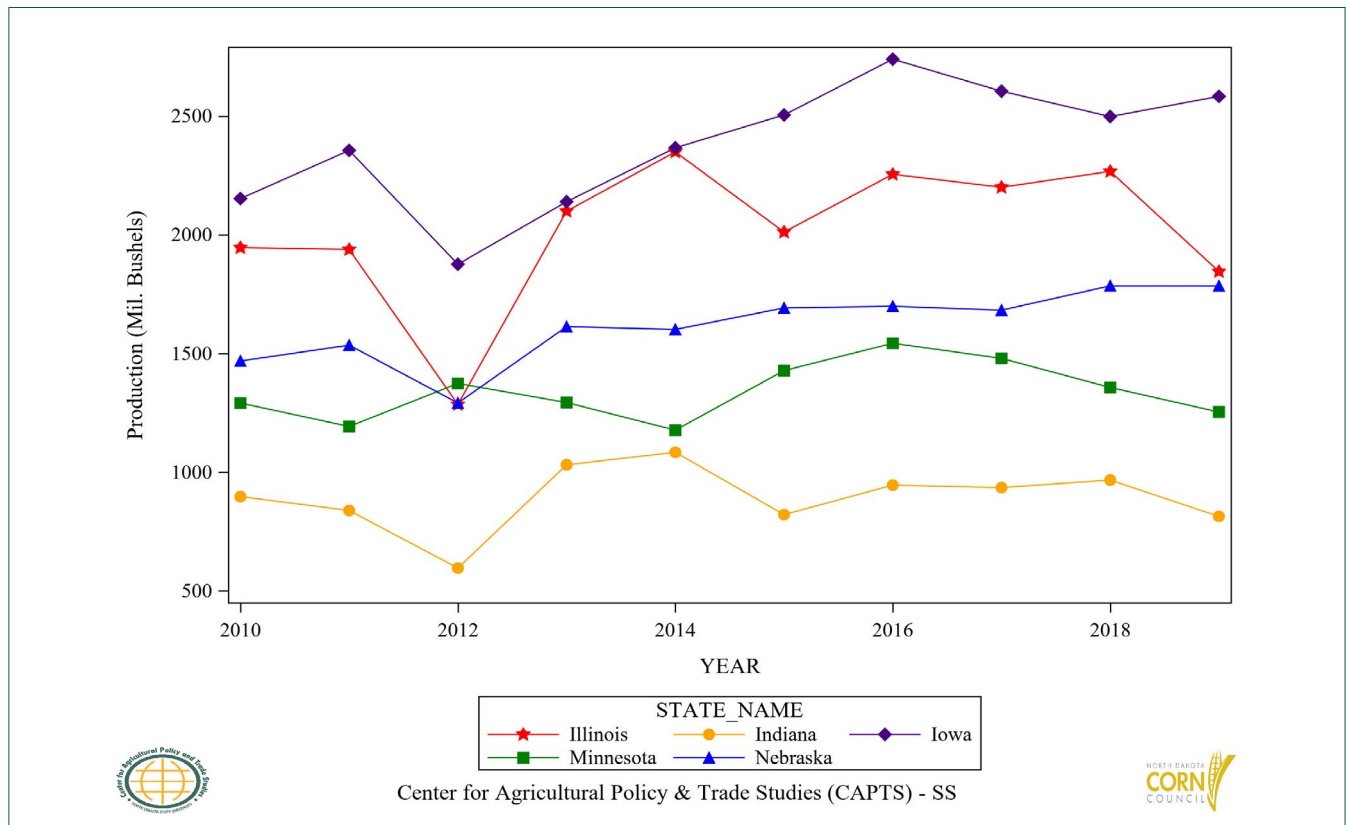


Table 11: Top 15 U.S. States Production, Annual Trends

State	Production (Bushels)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Iowa	2,153,250,000	2,356,400,000	1,876,900,000	2,140,200,000	2,367,400,000	2,505,600,000	2,740,500,000	2,605,800,000	2,499,000,000	2,583,900,000
Illinois	1,946,800,000	1,938,950,000	1,286,250,000	2,100,400,000	2,350,000,000	2,012,500,000	2,255,650,000	2,200,950,000	2,268,000,000	1,846,200,000
Nebraska	1,469,100,000	1,536,000,000	1,292,200,000	1,613,950,000	1,602,050,000	1,692,750,000	1,699,900,000	1,683,300,000	1,785,600,000	1,785,420,000
Minnesota	1,292,100,000	1,193,500,000	1,374,450,000	1,294,260,000	1,177,800,000	1,428,800,000	1,544,000,000	1,480,220,000	1,357,720,000	1,254,250,000
Indiana	898,040,000	839,500,000	596,970,000	1,031,910,000	1,084,760,000	822,000,000	946,310,000	936,000,000	967,680,000	814,580,000
South Dakota	569,700,000	653,400,000	535,300,000	802,820,000	787,360,000	799,770,000	825,930,000	736,600,000	777,600,000	557,280,000
Kansas	576,600,000	449,400,000	375,250,000	504,000,000	566,200,000	580,160,000	698,640,000	686,400,000	642,420,000	800,660,000
Ohio	523,200,000	489,600,000	438,000,000	650,760,000	612,480,000	498,780,000	524,700,000	557,550,000	617,100,000	421,480,000
Wisconsin	502,200,000	514,600,000	396,000,000	439,350,000	485,160,000	492,000,000	573,160,000	509,820,000	545,240,000	443,220,000
Missouri	369,000,000	347,700,000	247,500,000	435,200,000	628,680,000	437,360,000	570,500,000	552,500,000	466,200,000	463,450,000
North Dakota	248,160,000	216,300,000	422,120,000	396,000,000	313,720,000	327,680,000	516,660,000	448,970,000	448,290,000	410,030,000
Michigan	312,900,000	335,070,000	314,160,000	345,650,000	355,810,000	335,340,000	320,280,000	300,510,000	289,170,000	236,670,000
Texas	299,520,000	133,770,000	199,950,000	265,200,000	294,520,000	265,950,000	323,850,000	313,600,000	189,000,000	285,950,000
Kentucky	152,520,000	180,700,000	104,040,000	243,100,000	225,940,000	225,320,000	222,600,000	217,160,000	213,500,000	245,050,000
Colorado	182,710,000	172,900,000	134,330,000	128,380,000	147,460,000	134,900,000	160,290,000	185,900,000	154,700,000	159,900,000
Pennsylvania	116,480,000	106,560,000	131,000,000	159,140,000	158,620,000	138,180,000	122,550,000	148,120,000	124,600,000	162,180,000
Tennessee	74,880,000	96,285,000	81,600,000	126,360,000	141,120,000	116,800,000	125,330,000	121,410,000	112,560,000	161,070,000
Arkansas	57,000,000	73,320,000	123,710,000	161,820,000	99,110,000	80,545,000	127,395,000	108,885,000	116,745,000	128,625,000
Mississippi	91,120,000	93,440,000	131,175,000	146,080,000	89,725,000	85,750,000	119,520,000	94,500,000	85,100,000	107,880,000
North Carolina	76,440,000	68,460,000	95,940,000	122,120,000	102,960,000	82,490,000	121,260,000	119,280,000	93,790,000	103,230,000
New York	87,910,000	82,460,000	91,120,000	94,530,000	100,640,000	84,370,000	73,530,000	78,085,000	97,785,000	86,110,000
Louisiana	70,000,000	76,950,000	91,690,000	115,910,000	71,370,000	66,690,000	90,750,000	90,160,000	77,850,000	89,925,000
Maryland	45,580,000	45,780,000	53,070,000	66,360,000	75,250,000	62,320,000	60,800,000	72,240,000	55,480,000	74,060,000
Georgia	35,770,000	42,930,000	55,800,000	81,375,000	52,700,000	48,735,000	56,100,000	43,120,000	50,160,000	56,000,000
Virginia	20,770,000	40,120,000	36,050,000	55,440,000	50,750,000	48,300,000	50,320,000	47,600,000	47,450,000	54,720,000
Oklahoma	43,520,000	17,480,000	32,450,000	44,950,000	42,630,000	36,120,000	42,350,000	38,430,000	36,180,000	45,210,000
Alabama	28,750,000	28,500,000	28,910,000	43,365,000	45,315,000	36,015,000	37,800,000	39,245,000	38,220,000	44,835,000
South Carolina	28,140,000	21,450,000	37,820,000	43,215,000	32,760,000	24,180,000	44,450,000	44,200,000	39,370,000	37,100,000
Delaware	19,722,000	23,660,000	24,030,000	28,884,000	33,600,000	31,488,000	27,880,000	32,319,000	24,070,000	28,980,000
Idaho	20,900,000	22,680,000	26,325,000	20,815,000	16,000,000	14,490,000	18,800,000	23,345,000	26,625,000	30,750,000
Washington	25,625,000	28,125,000	24,725,000	22,575,000	23,650,000	16,125,000	19,975,000	18,000,000	18,700,000	21,330,000
California	34,560,000	27,150,000	32,400,000	34,380,000	15,675,000	9,420,000	18,500,000	13,360,000	11,245,000	10,080,000
New Jersey	8,094,000	9,963,000	10,148,000	11,120,000	12,403,000	10,584,000	10,295,000	11,690,000	8,460,000	10,540,000
Wyoming	6,150,000	9,100,000	8,520,000	8,509,000	8,280,000	9,381,000	10,143,000	9,765,000	11,480,000	8,241,000
Oregon	7,600,000	10,965,000	10,660,000	6,768,000	7,410,000	5,640,000	8,970,000	9,328,000	7,800,000	11,613,000
New Mexico	11,880,000	8,100,000	7,310,000	7,220,000	9,360,000	7,200,000	6,150,000	5,762,000	6,545,000	6,480,000
Arizona	4,620,000	6,230,000	6,240,000	9,027,000	5,880,000	7,560,000	10,750,000	6,240,000	4,400,000	8,547,000
Florida	2,725,000	3,432,000	4,600,000	10,374,000	5,400,000	7,050,000	5,800,000	5,957,000	9,734,000	8,694,000
Montana	4,590,000	4,572,000	6,240,000	8,625,000	7,500,000	5,500,000	5,500,000	4,550,000	5,780,000	5,700,000
West Virginia	2,610,000	3,534,000	4,480,000	5,292,000	5,364,000	5,180,000	5,075,000	5,016,000	5,016,000	6,270,000
Utah	4,094,000	4,920,000	5,678,000	5,270,000	4,480,000	2,941,000	5,075,000	3,520,000	4,004,000	3,718,000

Figure 12: Top 5 U.S. States Yield, Annual Trends

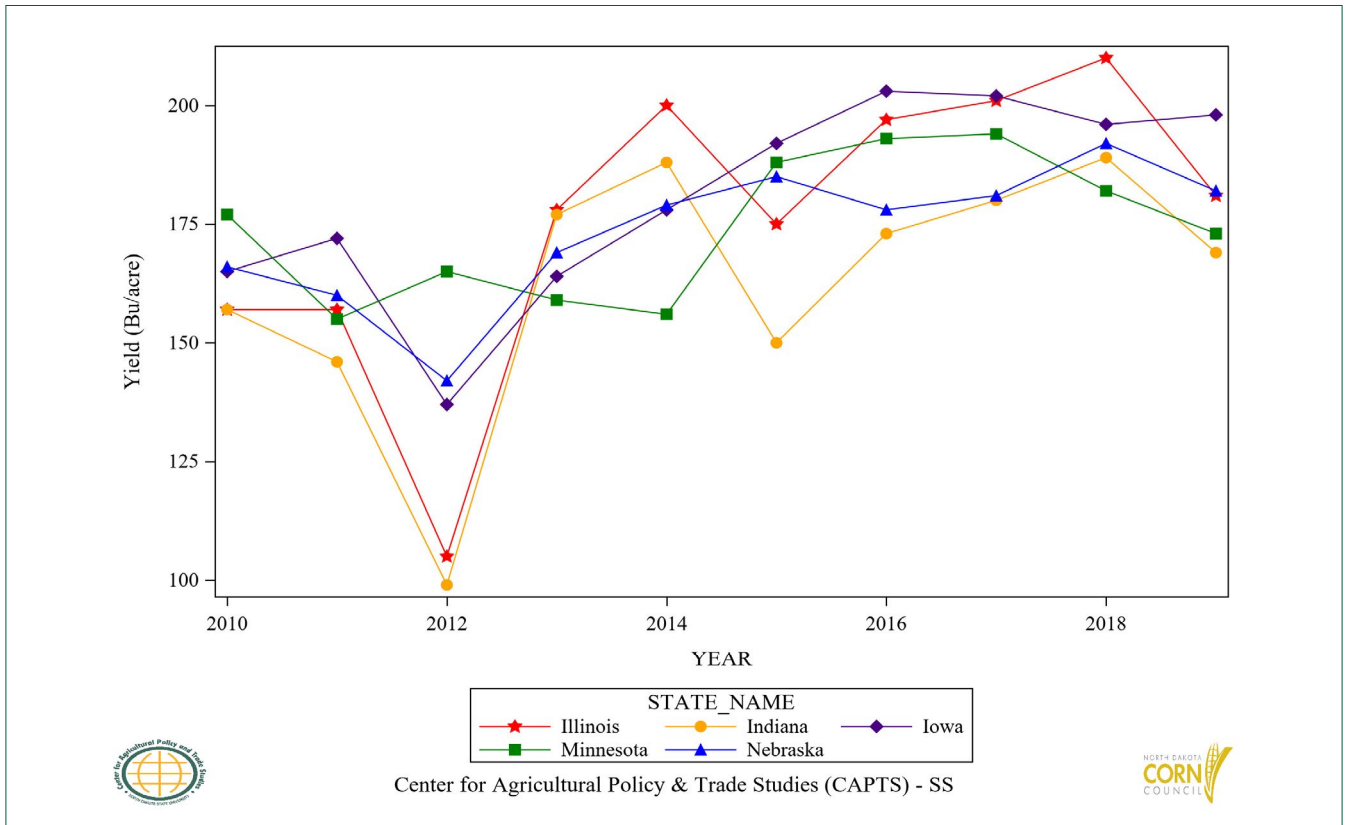


Table 12: Top 15 U.S. States Yield, Annual Trends

State	Yield (Bu/acre)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Iowa	165.00	172.00	137.00	164.00	178.00	192.00	203.00	202.00	196.00	198.00
Illinois	157.00	157.00	105.00	178.00	200.00	175.00	197.00	201.00	210.00	181.00
Nebraska	166.00	160.00	142.00	169.00	179.00	185.00	178.00	181.00	192.00	182.00
Minnesota	177.00	155.00	165.00	159.00	156.00	188.00	193.00	194.00	182.00	173.00
Indiana	157.00	146.00	99.00	177.00	188.00	150.00	173.00	180.00	189.00	169.00
South Dakota	135.00	132.00	101.00	137.00	148.00	159.00	161.00	145.00	160.00	144.00
Kansas	124.00	107.00	95.00	126.00	149.00	148.00	142.00	132.00	129.00	133.00
Ohio	160.00	153.00	120.00	174.00	176.00	153.00	159.00	177.00	187.00	164.00
Wisconsin	162.00	155.00	120.00	145.00	156.00	164.00	178.00	174.00	172.00	166.00
Missouri	123.00	114.00	75.00	136.00	186.00	142.00	163.00	170.00	140.00	155.00
North Dakota	132.00	105.00	122.00	110.00	124.00	128.00	158.00	139.00	153.00	131.00
Michigan	149.00	153.00	132.00	155.00	161.00	162.00	157.00	159.00	153.00	147.00
Texas	144.00	91.00	129.00	136.00	148.00	135.00	127.00	140.00	108.00	133.00
Kentucky	124.00	139.00	68.00	170.00	158.00	172.00	159.00	178.00	175.00	169.00
Colorado	151.00	133.00	133.00	131.00	146.00	142.00	137.00	143.00	130.00	123.00
Pennsylvania	128.00	111.00	131.00	146.00	154.00	147.00	129.00	161.00	140.00	153.00
Tennessee	117.00	131.00	85.00	156.00	168.00	160.00	151.00	171.00	168.00	177.00
Arkansas	150.00	141.00	178.00	186.00	187.00	181.00	171.00	183.00	181.00	175.00
Mississippi	136.00	128.00	165.00	176.00	185.00	175.00	166.00	189.00	185.00	174.00
North Carolina	91.00	84.00	117.00	142.00	132.00	113.00	129.00	142.00	113.00	111.00
New York	149.00	133.00	134.00	137.00	148.00	143.00	129.00	161.00	159.00	158.00
Louisiana	140.00	135.00	173.00	173.00	183.00	171.00	165.00	184.00	173.00	165.00
Maryland	106.00	109.00	122.00	158.00	175.00	164.00	152.00	172.00	146.00	161.00
Georgia	146.00	159.00	180.00	175.00	170.00	171.00	165.00	176.00	176.00	160.00
Virginia	67.00	118.00	103.00	154.00	145.00	161.00	148.00	140.00	146.00	144.00
Oklahoma	128.00	92.00	110.00	145.00	147.00	129.00	121.00	126.00	134.00	137.00
Alabama	115.00	114.00	98.00	147.00	159.00	147.00	120.00	167.00	156.00	147.00
South Carolina	84.00	65.00	122.00	129.00	117.00	93.00	127.00	136.00	127.00	106.00
Delaware	114.00	130.00	135.00	166.00	200.00	192.00	170.00	189.00	145.00	161.00
Idaho	190.00	189.00	195.00	181.00	200.00	207.00	188.00	203.00	213.00	205.00
Washington	205.00	225.00	215.00	215.00	215.00	215.00	235.00	225.00	220.00	237.00
California	192.00	181.00	180.00	191.00	165.00	157.00	185.00	167.00	173.00	168.00
New Jersey	114.00	123.00	118.00	139.00	157.00	147.00	145.00	167.00	141.00	155.00
Wyoming	123.00	130.00	142.00	127.00	138.00	159.00	147.00	155.00	164.00	123.00
Oregon	200.00	215.00	205.00	188.00	190.00	188.00	230.00	212.00	195.00	237.00
New Mexico	180.00	180.00	170.00	190.00	195.00	180.00	150.00	134.00	187.00	135.00
Arizona	210.00	178.00	195.00	177.00	210.00	210.00	215.00	195.00	220.00	231.00
Florida	109.00	104.00	115.00	133.00	135.00	141.00	145.00	161.00	157.00	161.00
Montana	135.00	127.00	104.00	115.00	100.00	110.00	100.00	70.00	85.00	95.00
West Virginia	90.00	114.00	128.00	147.00	149.00	148.00	145.00	152.00	152.00	165.00
Utah	178.00	164.00	167.00	170.00	160.00	173.00	175.00	176.00	182.00	143.00

Figure 13: Top 5 U.S. States Revenue (Calendar), Annual Trends

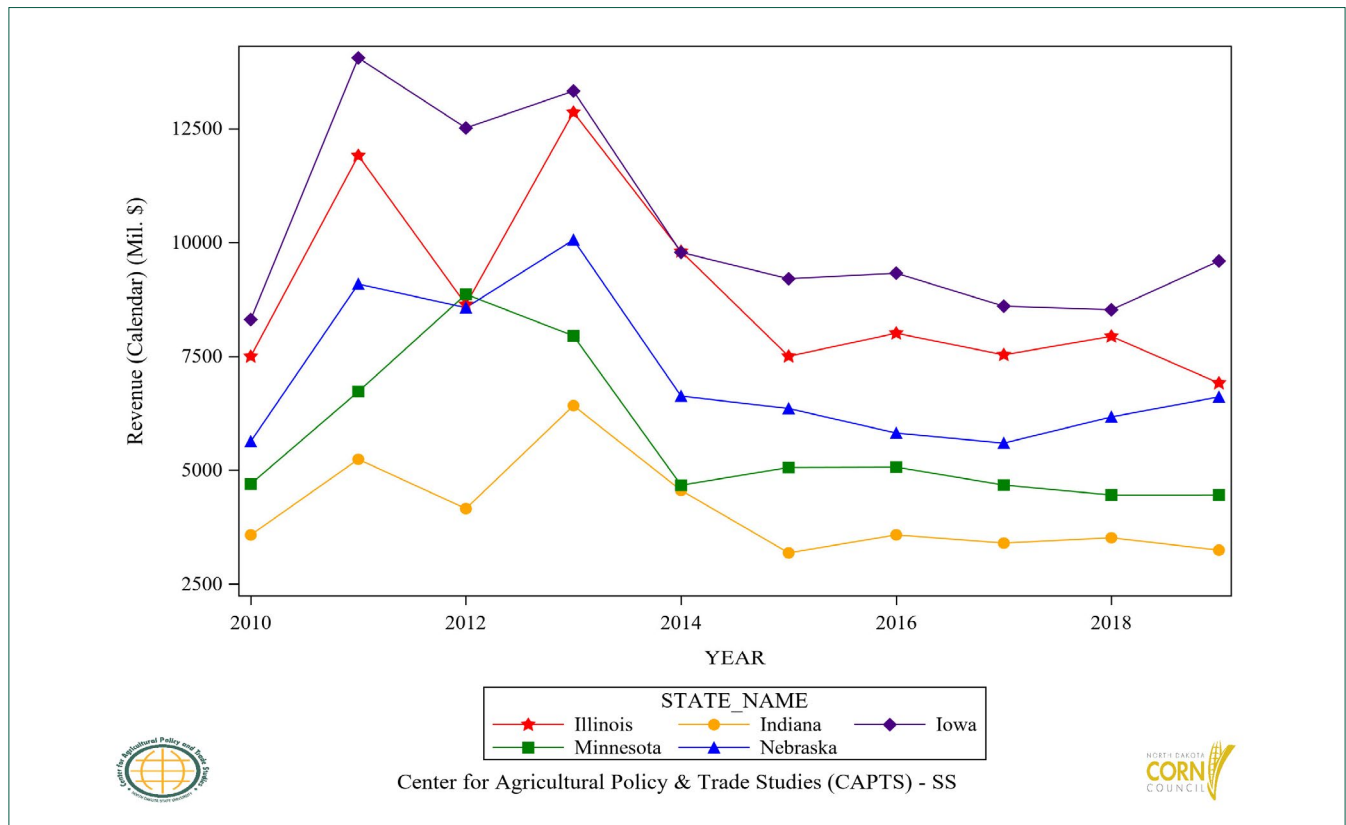


Table 13: Top 15 U.S. States Revenue (Calendar), Annual Trends

State	Revenue_CYP (\$)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Iowa	8,307,956,250	14,053,962,333	12,514,230,750	13,326,312,000	9,783,280,500	9,203,904,000	9,326,835,000	8,601,311,500	8,521,590,000	9,592,728,750
Illinois	7,498,424,667	11,908,384,583	8,638,240,625	12,857,948,667	9,805,375,000	7,501,593,750	8,007,557,500	7,532,751,375	7,939,890,000	6,912,480,500
Nebraska	5,630,325,750	9,088,000,000	8,568,362,833	10,058,943,375	6,627,146,833	6,354,865,625	5,815,074,583	5,594,167,000	6,169,248,000	6,609,029,700
Minnesota	4,696,783,500	6,725,372,500	8,862,911,750	7,949,992,050	4,670,958,500	5,059,142,667	5,066,893,333	4,673,794,650	4,454,453,033	4,455,723,125
Indiana	3,577,192,667	5,239,179,583	4,155,408,675	6,417,620,275	4,556,895,967	3,183,880,000	3,579,417,575	3,399,240,000	3,515,904,000	3,244,064,850
South Dakota	1,985,404,500	3,810,411,000	3,459,822,333	4,756,708,500	2,907,326,800	2,703,889,075	2,639,534,625	2,249,699,167	2,501,928,000	1,985,774,400
Kansas	2,207,417,000	2,845,451,000	2,535,439,167	3,110,520,000	2,368,131,500	2,224,430,133	2,401,575,000	2,263,404,000	2,250,076,050	2,966,445,300
Ohio	2,050,508,000	3,150,168,000	3,024,025,000	4,027,662,100	2,533,625,600	1,930,694,250	1,962,815,250	2,018,795,625	2,251,386,500	1,692,944,667
Wisconsin	1,877,391,000	3,112,472,333	2,572,350,000	2,693,581,625	2,006,540,900	1,776,530,000	1,934,415,000	1,688,353,900	1,857,450,933	1,613,320,800
Missouri	1,453,552,500	2,161,824,750	1,708,368,750	2,772,586,667	2,609,022,000	1,618,960,933	2,022,897,917	1,885,866,667	1,651,513,500	1,774,627,292
North Dakota	855,324,800	1,221,374,000	2,653,375,967	2,303,070,000	1,149,260,933	1,093,632,000	1,649,437,050	1,339,427,167	1,411,739,925	1,406,061,208
Michigan	1,207,011,750	2,084,135,400	2,101,730,400	2,056,041,417	1,431,838,742	1,227,623,850	1,144,200,300	1,042,018,425	1,031,373,000	929,126,975
Texas	1,227,033,600	853,675,550	1,398,816,875	1,661,920,000	1,375,899,267	1,131,617,250	1,258,427,125	1,168,682,667	744,660,000	1,226,010,625
Kentucky	621,264,800	1,126,965,667	703,657,200	1,509,651,000	985,098,400	894,520,400	846,807,500	804,396,833	805,250,833	977,953,708
Colorado	693,079,933	1,044,604,167	884,786,933	822,166,917	652,387,617	518,465,667	568,228,050	636,707,500	544,672,917	615,215,250
Pennsylvania	514,841,600	759,151,200	952,588,333	976,986,983	686,824,600	547,077,650	491,527,625	601,737,500	498,088,500	701,833,950
Tennessee	308,568,000	602,984,813	577,048,000	813,969,000	640,684,800	468,173,333	483,564,917	447,395,850	422,756,600	635,958,050
Arkansas	.	.	.	.	.	.	470,087,550	373,021,863	439,836,788	500,351,250
Mississippi	.	.	.	.	.	.	447,004,800	349,886,250	323,167,250	424,103,250
North Carolina	345,062,900	481,502,000	699,082,800	788,284,600	481,681,200	360,756,267	523,034,800	509,226,200	418,381,558	464,362,950
New York	.	.	.	.	.	.	286,767,000	301,733,454	403,118,663	367,689,700
Louisiana	.	.	.	.	.	.	335,775,000	329,534,800	295,894,875	357,002,250
Maryland	.	.	.	.	.	.	246,240,000	311,775,800	214,337,733	347,999,711
Georgia	.	.	.	.	.	.	217,668,000	187,572,000	218,697,600	243,110,000
Virginia	.	.	.	.	.	.	201,280,000	192,343,667	198,024,667	246,034,800
Oklahoma	.	.	.	.	.	.	143,566,500	135,818,025	136,971,450	180,990,700
Alabama	.	.	.	.	.	.	137,214,000	156,227,804	156,542,750	187,074,038
South Carolina	.	.	.	.	.	.	164,020,500	191,349,167	178,411,717	172,515,000
Delaware	.	.	.	.	.	.	114,029,200	129,922,380	98,927,700	124,614,000
Idaho	.	.	.	.	.	.	83,472,000	97,621,008	113,222,813	133,762,500
Washington	.	.	.	.	.	.	94,082,250	72,900,000	76,623,250	91,837,500
California	.	.	.	.	.	.	86,765,000	56,112,000	49,478,000	45,864,000
New Jersey	.	.	.	.	.	.	40,150,500	43,837,500	32,994,000	45,322,000
Wyoming	.	.	.	.	.	.	34,384,770	32,712,750	42,074,200	31,727,850
Oregon	.	.	.	.	.	.	38,122,500	35,259,840	32,214,000	51,677,850
New Mexico	.	.	.	.	.	.	24,169,500	22,471,800	28,143,500	28,512,000
Arizona	.	.	.	.	.	.	50,847,500	28,392,000	20,856,000	45,299,100
Florida	.	.	.	.	.	.	22,794,000	26,627,790	43,510,980	39,123,000
Montana	.	.	.	.	.	.	22,825,000	15,515,500	21,010,300	23,940,000
West Virginia	.	.	.	.	.	.	19,792,500	19,813,200	20,465,280	26,020,500
Utah	.	.	.	.	.	.	19,640,250	13,358,400	18,258,240	16,359,200

Figure 14: Top 5 U.S. States Revenue (Marketing), Annual Trends

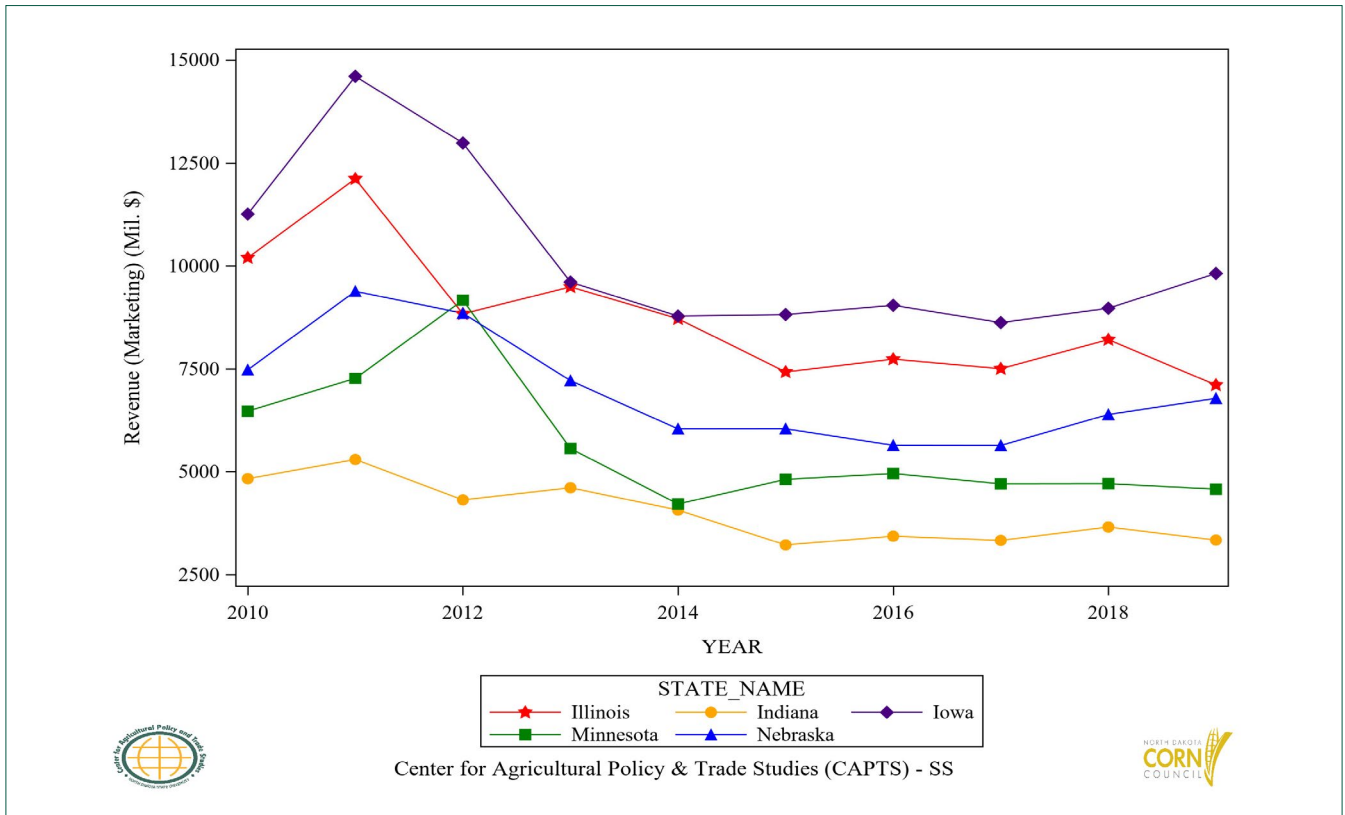


Table 14: Top 15 U.S. States Revenue (Marketing), Annual Trends

State	Yield (Bu/acre)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Iowa				9,609,498,000	8,783,054,000	8,819,712,000	9,043,650,000	8,625,198,000	8,971,410,000	9,818,820,000
Illinois			8,836,537,500	9,493,808,000	8,718,500,000	7,426,125,000	7,736,879,500	7,505,239,500	8,210,160,000	7,107,870,000
Nebraska	7,477,719,000	9,384,960,000	8,851,570,000	7,214,356,500	6,039,728,500	6,043,117,500	5,643,668,000	5,639,055,000	6,392,448,000	6,784,596,000
Minnesota	6,473,421,000	7,268,415,000	9,167,581,500	5,565,318,000	4,216,524,000	4,815,056,000	4,956,240,000	4,707,099,600	4,711,288,400	4,578,012,500
Indiana	4,831,455,200	5,297,245,000	4,316,093,100	4,612,637,700	4,067,850,000	3,222,240,000	3,435,105,300	3,332,160,000	3,657,830,400	3,339,778,000
South Dakota	2,899,773,000	3,940,002,000	3,597,216,000	3,251,421,000	2,629,782,400	2,639,241,000	2,552,123,700	2,276,094,000	2,628,288,000	2,061,936,000
Kansas	2,854,170,000	2,822,232,000	2,641,760,000	2,262,960,000	2,140,236,000	2,140,790,400	2,235,648,000	2,251,392,000	2,299,863,600	2,962,442,000
Ohio	2,851,440,000	3,153,024,000	3,105,420,000	2,869,851,600	2,315,174,400	1,940,254,200	1,894,167,000	2,012,755,500	2,307,954,000	1,770,216,000
Wisconsin	2,646,594,000	3,097,892,000	2,649,240,000	1,924,353,000	1,780,537,200	1,702,320,000	1,879,964,800	1,682,406,000	1,919,244,800	1,639,914,000
Missouri	1,974,150,000	2,225,280,000	1,816,650,000	1,988,864,000	2,225,527,200	1,613,858,400	1,939,700,000	1,884,025,000	1,715,616,000	1,807,455,000
North Dakota	1,243,281,600	1,256,703,000	2,726,895,200	1,548,360,000	1,047,824,800	1,074,790,400	1,555,146,600	1,364,868,800	1,488,322,800	1,455,606,500
Michigan	1,739,724,000	2,057,329,800	2,101,730,400	1,444,817,000	1,298,706,500	1,217,284,200	1,101,763,200	1,039,764,600	1,075,712,400	946,680,000
Texas	1,398,758,400	884,219,700	1,423,644,000	1,363,128,000	1,301,778,400	1,116,990,000	1,201,483,500	1,160,320,000	780,570,000	1,229,585,000
Kentucky	785,478,000	1,138,410,000	724,118,400	1,135,277,000	890,203,600	874,241,600	832,524,000	801,320,400	819,840,000	1,004,705,000
Colorado	909,895,800	1,063,335,000	921,503,800	591,831,800	582,467,000	497,781,000	548,191,800	626,483,000	572,390,000	631,605,000
Pennsylvania	712,857,600	751,248,000	944,510,000	711,355,800	618,618,000	548,574,600	495,102,000	573,224,400	525,812,000	713,592,000
Tennessee	354,931,200	631,629,600	594,048,000	615,373,200	537,667,200	457,856,000	458,707,800	431,005,500	423,225,600	636,226,500
Arkansas	259,350,000	459,716,400	842,465,100	828,518,400	409,324,300	331,039,950	470,087,550	396,341,400	443,631,000	501,637,500
Mississippi	398,194,400	582,131,200	910,354,500	737,704,000	380,434,000	343,857,500	447,004,800	347,760,000	323,380,000	431,520,000
North Carolina	395,959,200	481,958,400	717,631,200	605,715,200	431,402,400	356,356,800	493,528,200	505,747,200	411,738,100	459,373,500
New York	553,833,000	568,974,000	617,793,600	427,275,600	413,630,400	338,323,700	286,767,000	317,805,950	406,785,600	367,689,700
Louisiana	343,000,000	469,395,000	632,661,000	591,141,000	296,185,500	266,760,000	335,775,000	335,395,200	300,501,000	355,203,750
Maryland	275,759,000	306,726,000	387,411,000	321,182,400	285,197,500	241,801,600	246,240,000	290,404,800	228,022,800	318,458,000
Georgia	212,831,500	313,389,000	440,820,000	420,708,750	219,759,000	190,066,500	217,668,000	186,709,600	218,196,000	252,000,000
Virginia	115,065,800	263,989,600	263,165,000	266,112,000	197,925,000	195,615,000	201,280,000	188,496,000	192,647,000	227,088,000
Oklahoma	202,803,200	108,725,600	228,448,000	228,795,500	175,209,300	141,951,600	143,566,500	137,963,700	139,654,800	185,361,000
Alabama	145,762,500	180,120,000	207,573,800	204,249,150	169,931,250	134,696,100	137,214,000	158,549,800	157,084,200	188,307,000
South Carolina	154,488,600	141,570,000	283,650,000	201,814,050	127,764,000	98,170,800	164,020,500	194,480,000	177,165,000	172,515,000
Delaware	122,473,620	163,963,800	181,426,500	142,686,960	128,688,000	122,173,440	114,029,200	129,922,380	98,927,700	124,614,000
Idaho	110,143,000	157,852,800	186,907,500	102,201,650	66,560,000	68,247,900	83,472,000	98,282,450	117,682,500	138,375,000
Washington	155,800,000	174,937,500	165,410,250	119,421,750	115,885,000	69,337,500	94,082,250	72,900,000	76,857,000	88,519,500
California	175,564,800	174,031,500	216,432,000	183,245,400	75,396,750	41,353,800	86,765,000	56,112,000	49,478,000	45,864,000
New Jersey	48,968,700	67,748,400	75,095,200	51,819,200	47,131,400	40,748,400	40,150,500	43,837,500	32,994,000	45,322,000
Wyoming	32,656,500	56,420,000	60,066,000	34,716,720	31,464,000	32,270,640	34,384,770	32,712,750	42,361,200	31,727,850
Oregon	45,144,000	76,206,750	74,193,600	36,817,920	32,974,500	22,560,000	38,122,500	35,259,840	32,214,000	51,677,850
New Mexico	59,756,400	51,435,000	53,363,000	37,399,600	40,716,000	32,976,000	24,169,500	22,471,800	28,143,500	28,512,000
Arizona	26,796,000	42,239,400	48,921,600	53,169,030	31,516,800	37,648,800	50,847,500	28,392,000	21,824,000	45,299,100
Florida	12,807,500	22,822,800	34,500,000	46,786,740	19,710,000	26,790,000	22,794,000	26,627,790	43,510,980	39,123,000
Montana	27,540,000	29,580,840	44,990,400	36,828,750	28,275,000	22,055,000	22,825,000	15,515,500	21,906,200	23,940,000
West Virginia	15,007,500	22,971,000	32,256,000	24,872,400	20,651,400	20,461,000	19,792,500	19,813,200	20,465,280	26,020,500
Utah	23,540,500	34,292,400	43,096,020	28,826,900	18,502,400	13,763,880	19,640,250	13,939,200	17,257,240	16,359,200

Figure 15: Top 5 U.S. States Calendar Year Price, Annual Trends

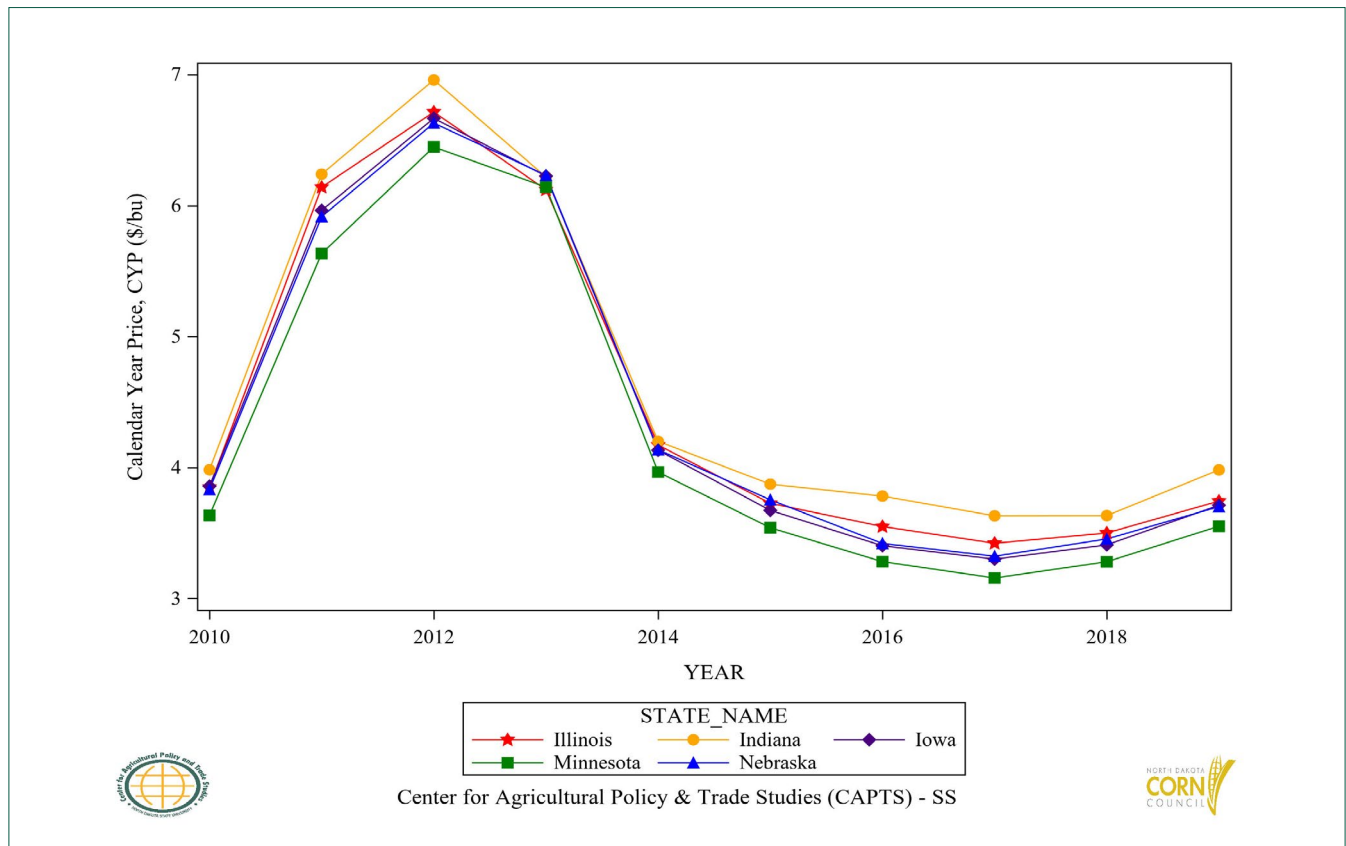


Table 15: Top 15 U.S. States Calendar Year Price, Annual Trends

State	Prices_CYP (\$/Bu)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Iowa	3.86	5.96	6.67	6.23	4.13	3.67	3.40	3.30	3.41	3.71
Illinois	3.85	6.14	6.72	6.12	4.17	3.73	3.55	3.42	3.50	3.74
Nebraska	3.83	5.92	6.63	6.23	4.14	3.75	3.42	3.32	3.46	3.70
Minnesota	3.64	5.64	6.45	6.14	3.97	3.54	3.28	3.16	3.28	3.55
Indiana	3.98	6.24	6.96	6.22	4.20	3.87	3.78	3.63	3.63	3.98
South Dakota	3.49	5.83	6.46	5.93	3.69	3.38	3.20	3.05	3.22	3.56
Kansas	3.83	6.33	6.76	6.17	4.18	3.83	3.44	3.30	3.50	3.71
Ohio	3.92	6.43	6.90	6.19	4.14	3.87	3.74	3.62	3.65	4.02
Wisconsin	3.74	6.05	6.50	6.13	4.14	3.61	3.38	3.31	3.41	3.64
Missouri	3.94	6.22	6.90	6.37	4.15	3.70	3.55	3.41	3.54	3.83
North Dakota	3.45	5.65	6.29	5.82	3.66	3.34	3.19	2.98	3.15	3.43
Michigan	3.86	6.22	6.69	5.95	4.02	3.66	3.57	3.47	3.57	3.93
Texas	4.10	6.38	7.00	6.27	4.67	4.26	3.89	3.73	3.94	4.29
Kentucky	4.07	6.24	6.76	6.21	4.36	3.97	3.80	3.70	3.77	3.99
Colorado	3.79	6.04	6.59	6.40	4.42	3.84	3.55	3.43	3.52	3.85
Pennsylvania	4.42	7.12	7.27	6.14	4.33	3.96	4.01	4.06	4.00	4.33
Tennessee	4.12	6.26	7.07	6.44	4.54	4.01	3.86	3.69	3.76	3.95
Arkansas	.	.	.	.	.	.	3.69	3.43	3.77	3.89
Mississippi	.	.	.	.	.	.	3.74	3.70	3.80	3.93
North Carolina	4.51	7.03	7.29	6.46	4.68	4.37	4.31	4.27	4.46	4.50
New York	.	.	.	.	.	.	3.90	3.86	4.12	4.27
Louisiana	.	.	.	.	.	.	3.70	3.66	3.80	3.97
Maryland	.	.	.	.	.	.	4.05	4.32	3.86	4.70
Georgia	.	.	.	.	.	.	3.88	4.35	4.36	4.34
Virginia	.	.	.	.	.	.	4.00	4.04	4.17	4.50
Oklahoma	.	.	.	.	.	.	3.39	3.53	3.79	4.00
Alabama	.	.	.	.	.	.	3.63	3.98	4.10	4.17
South Carolina	.	.	.	.	.	.	3.69	4.33	4.53	4.65
Delaware	.	.	.	.	.	.	4.09	4.02	4.11	4.30
Idaho	.	.	.	.	.	.	4.44	4.18	4.25	4.35
Washington	.	.	.	.	.	.	4.71	4.05	4.10	4.31
California	.	.	.	.	.	.	4.69	4.20	4.40	4.55
New Jersey	.	.	.	.	.	.	3.90	3.75	3.90	4.30
Wyoming	.	.	.	.	.	.	3.39	3.35	3.67	3.85
Oregon	.	.	.	.	.	.	4.25	3.78	4.13	4.45
New Mexico	.	.	.	.	.	.	3.93	3.90	4.30	4.40
Arizona	.	.	.	.	.	.	4.73	4.55	4.74	5.30
Florida	.	.	.	.	.	.	3.93	4.47	4.47	4.50
Montana	.	.	.	.	.	.	4.15	3.41	3.64	4.20
West Virginia	.	.	.	.	.	.	3.90	3.95	4.08	4.15
Utah	.	.	.	.	.	.	3.87	3.80	4.56	4.40

Figure 16: Top 5 U.S. States Marketing Year Price, Annual Trends

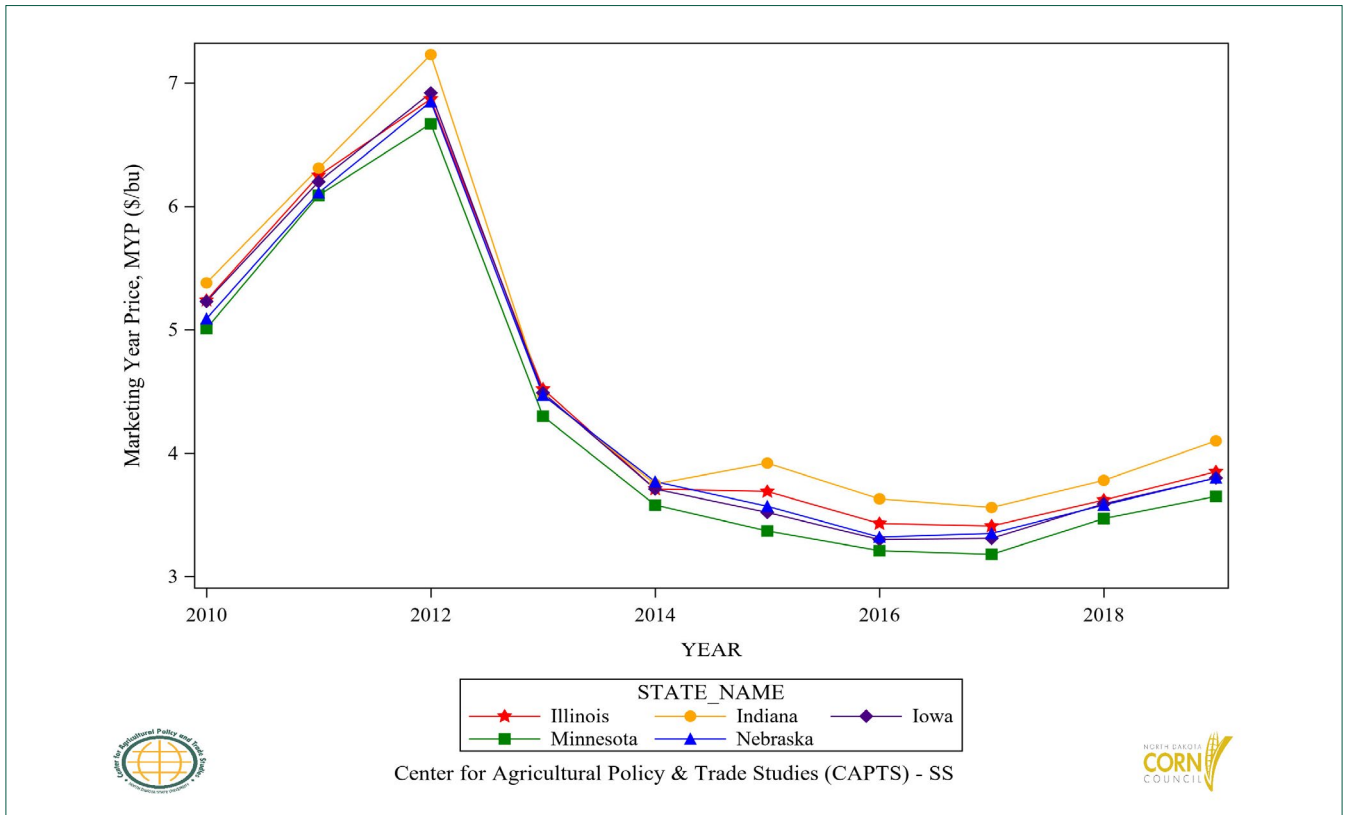


Table 16: Top 15 State Prices MYP, Annual Trends

State	Yield (Bu/acre)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Iowa	5.23	6.20	6.92	4.49	3.71	3.52	3.30	3.31	3.59	3.80
Illinois	5.24	6.25	6.87	4.52	3.71	3.69	3.43	3.41	3.62	3.85
Nebraska	5.09	6.11	6.85	4.47	3.77	3.57	3.32	3.35	3.58	3.80
Minnesota	5.01	6.09	6.67	4.30	3.58	3.37	3.21	3.18	3.47	3.65
Indiana	5.38	6.31	7.23	4.47	3.75	3.92	3.63	3.56	3.78	4.10
South Dakota	5.09	6.03	6.72	4.05	3.34	3.30	3.09	3.09	3.38	3.70
Kansas	4.95	6.28	7.04	4.49	3.78	3.69	3.20	3.28	3.58	3.70
Ohio	5.45	6.44	7.09	4.41	3.78	3.89	3.61	3.61	3.74	4.20
Wisconsin	5.27	6.02	6.69	4.38	3.67	3.46	3.28	3.30	3.52	3.70
Missouri	5.35	6.40	7.34	4.57	3.54	3.69	3.40	3.41	3.68	3.90
North Dakota	5.01	5.81	6.46	3.91	3.34	3.28	3.01	3.04	3.32	3.55
Michigan	5.56	6.14	6.69	4.18	3.65	3.63	3.44	3.46	3.72	4.00
Texas	4.67	6.61	7.12	5.14	4.42	4.20	3.71	3.70	4.13	4.30
Kentucky	5.15	6.30	6.96	4.67	3.94	3.88	3.74	3.69	3.84	4.10
Colorado	4.98	6.15	6.86	4.61	3.95	3.69	3.42	3.37	3.70	3.95
Pennsylvania	6.12	7.05	7.21	4.47	3.90	3.97	4.04	3.87	4.22	4.40
Tennessee	4.74	6.56	7.28	4.87	3.81	3.92	3.66	3.55	3.76	3.95
Arkansas	4.55	6.27	6.81	5.12	4.13	4.11	3.69	3.64	3.80	3.90
Mississippi	4.37	6.23	6.94	5.05	4.24	4.01	3.74	3.68	3.80	4.00
North Carolina	5.18	7.04	7.48	4.96	4.19	4.32	4.07	4.24	4.39	4.45
New York	6.30	6.90	6.78	4.52	4.11	4.01	3.90	4.07	4.16	4.27
Louisiana	4.90	6.10	6.90	5.10	4.15	4.00	3.70	3.72	3.86	3.95
Maryland	6.05	6.70	7.30	4.84	3.79	3.88	4.05	4.02	4.11	4.30
Georgia	5.95	7.30	7.90	5.17	4.17	3.90	3.88	4.33	4.35	4.50
Virginia	5.54	6.58	7.30	4.80	3.90	4.05	4.00	3.96	4.06	4.15
Oklahoma	4.66	6.22	7.04	5.09	4.11	3.93	3.39	3.59	3.86	4.10
Alabama	5.07	6.32	7.18	4.71	3.75	3.74	3.63	4.04	4.11	4.20
South Carolina	5.49	6.60	7.50	4.67	3.90	4.06	3.69	4.40	4.50	4.65
Delaware	6.21	6.93	7.55	4.94	3.83	3.88	4.09	4.02	4.11	4.30
Idaho	5.27	6.96	7.10	4.91	4.16	4.71	4.44	4.21	4.42	4.50
Washington	6.08	6.22	6.69	5.29	4.90	4.30	4.71	4.05	4.11	4.15
California	5.08	6.41	6.68	5.33	4.81	4.39	4.69	4.20	4.40	4.55
New Jersey	6.05	6.80	7.40	4.66	3.80	3.85	3.90	3.75	3.90	4.30
Wyoming	5.31	6.20	7.05	4.08	3.80	3.44	3.39	3.35	3.69	3.85
Oregon	5.94	6.95	6.96	5.44	4.45	4.00	4.25	3.78	4.13	4.45
New Mexico	5.03	6.35	7.30	5.18	4.35	4.58	3.93	3.90	4.30	4.40
Arizona	5.80	6.78	7.84	5.89	5.36	4.98	4.73	4.55	4.96	5.30
Florida	4.70	6.65	7.50	4.51	3.65	3.80	3.93	4.47	4.47	4.50
Montana	6.00	6.47	7.21	4.27	3.77	4.01	4.15	3.41	3.79	4.20
West Virginia	5.75	6.50	7.20	4.70	3.85	3.95	3.90	3.95	4.08	4.15
Utah	5.75	6.97	7.59	5.47	4.13	4.68	3.87	3.96	4.31	4.40



Section III

North Dakota Counties Trend and Risk

Figure 17: North Dakota Planted Acreage, Harvested Acreage, Production and Yield, Annual Trends

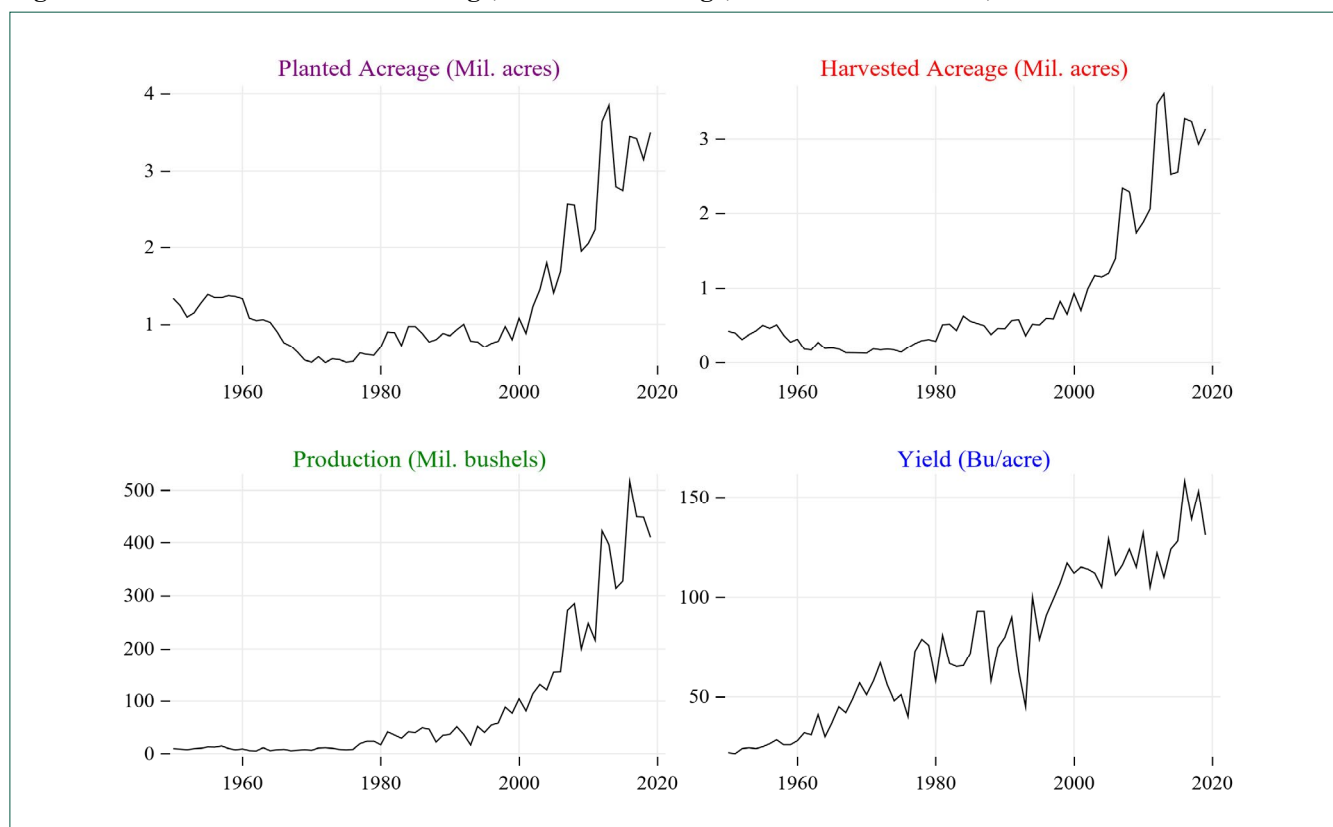


Table 17: North Dakota Production Indicators, Annual Trends

Year	Planted (Acres)	Harvested (Acres)	Production (Bushels)	Yield (Bu/acre)
2000	1,080,000	930,000	104,160,000	112
2001	880,000	705,000	81,075,000	115
2002	1,230,000	995,000	113,430,000	114
2003	1,450,000	1,170,000	131,040,000	112
2004	1,800,000	1,150,000	120,750,000	105
2005	1,410,000	1,200,000	154,800,000	129
2006	1,690,000	1,400,000	155,400,000	111
2007	2,560,000	2,350,000	272,600,000	116
2008	2,550,000	2,300,000	285,200,000	124
2009	1,950,000	1,740,000	200,100,000	115
2010	2,050,000	1,880,000	248,160,000	132
2011	2,230,000	2,060,000	216,300,000	105
2012	3,640,000	3,460,000	422,120,000	122
2013	3,850,000	3,600,000	396,000,000	110
2014	2,800,000	2,530,000	313,720,000	124
2015	2,750,000	2,560,000	327,680,000	128
2016	3,450,000	3,270,000	516,660,000	158
2017	3,420,000	3,230,000	448,970,000	139
2018	3,150,000	2,930,000	448,290,000	153
2019	3,500,000	3,130,000	410,030,000	131

Figure 18: North Dakota Revenue and Prices, Marketing and Calendar Year, Annual Trends

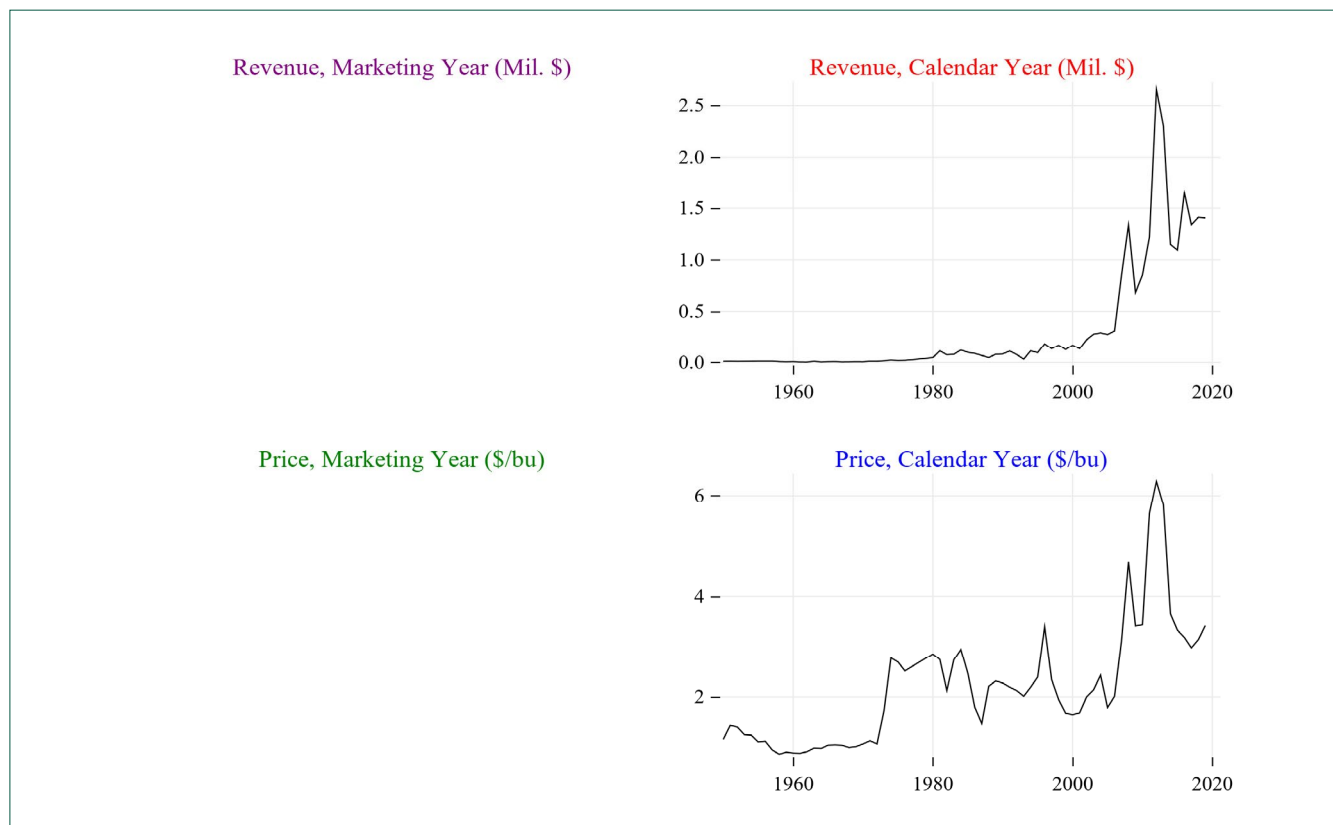


Table 18: North Dakota Production Indicators, Annual Trends

Year	Revenue (Marketing) (\$)	Revenue (Calendar) (\$)	Marketing Year Price, MYP (\$/bu)	Calendar Year Price, CYP (\$/bu)
2000	171,864,000	171,864,000	1.65	1.65
2001	151,610,250	136,611,375	1.87	1.69
2002	245,008,800	226,860,000	2.16	2.00
2003	310,564,800	280,534,800	2.37	2.14
2004	227,010,000	293,724,375	1.88	2.43
2005	278,640,000	277,479,000	1.80	1.79
2006	430,458,000	312,742,500	2.77	2.01
2007	1,106,756,000	850,966,333	4.06	3.12
2008	1,066,648,000	1,335,211,333	3.74	4.68
2009	636,318,000	684,342,000	3.18	3.42
2010	1,243,281,600	855,324,800	5.01	3.45
2011	1,256,703,000	1,221,374,000	5.81	5.65
2012	2,726,895,200	2,653,375,967	6.46	6.29
2013	1,548,360,000	2,303,070,000	3.91	5.82
2014	1,047,824,800	1,149,260,933	3.34	3.66
2015	1,074,790,400	1,093,632,000	3.28	3.34
2016	1,555,146,600	1,649,437,050	3.01	3.19
2017	1,364,868,800	1,339,427,167	3.04	2.98
2018	1,488,322,800	1,411,739,925	3.32	3.15
2019	1,455,606,500	1,406,061,208	3.55	3.43

Figure 19: Top 5 North Dakota Counties Planted Acreage, Annual Trends

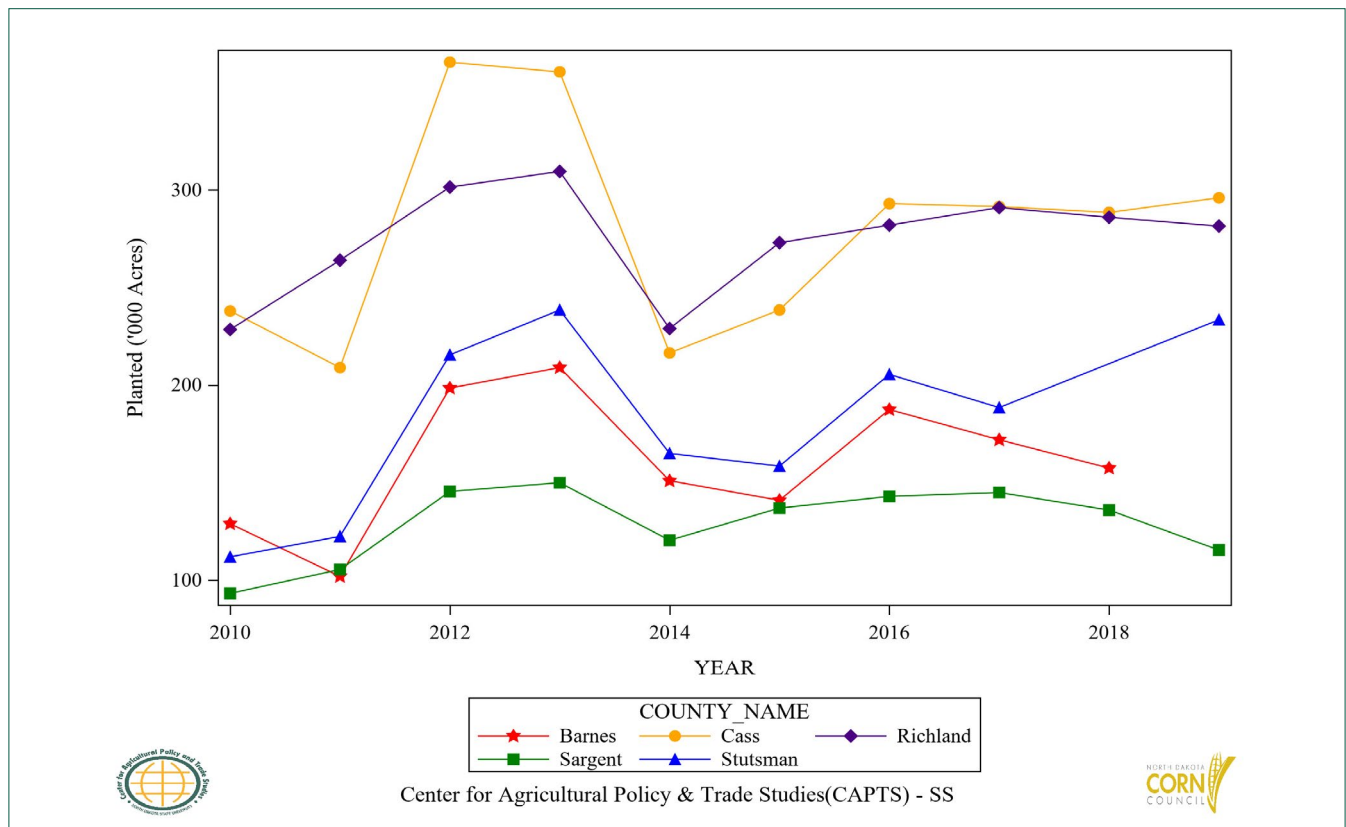


Table 19: Top 15 North Dakota Counties Planted Acreage, Annual Trends

State	Planted (Acres)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Richland	228,500	264,000	301,500	309,500	229,000	273,000	282,000	291,000	286,000	281,500
Cass	238,000	209,000	365,500	360,500	216,500	238,500	293,000	291,500	288,500	296,000
Stutsman	112,000	122,500	215,500	238,500	165,000	158,500	205,500	188,500	.	233,500
Sargent	93,300	105,500	145,500	150,000	120,500	137,000	143,000	145,000	136,000	115,500
Barnes	129,000	102,000	198,500	209,000	151,000	141,000	187,500	172,000	157,500	.
Dickey	112,000	152,000	196,000	204,000	152,000	160,000	178,500	159,000	.	.
LaMoure	125,500	140,000	184,000	202,000	.	157,500	176,500	162,000	.	139,500
Grand Forks	91,000	88,300	143,500	113,500	82,800	92,000	132,500	117,500	116,500	132,000
Traill	97,000	93,100	142,000	143,500	86,900	101,500	135,000	119,000	.	110,000
Ransom	67,000	74,400	117,500	131,000	.	103,500	115,500	110,500	107,000	.
Steele	76,700	68,500	112,500	115,000	.	66,200	91,800	81,700	78,700	91,400
Emmons	67,400	102,000	149,000	176,000	128,000	91,400	124,000	119,500	112,000	.
Wells	40,600	49,100	101,000	.	.	79,800	92,400	98,500	90,800	.
McLean	.	24,600	64,700	85,800	75,100	57,100	78,200	90,500	.	81,300
Ramsey	42,300	34,400	58,500	39,200	35,800	37,600	66,400	62,700	52,100	.

Figure 20: Top 5 North Dakota Counties Harvested Acreage, Annual Trends

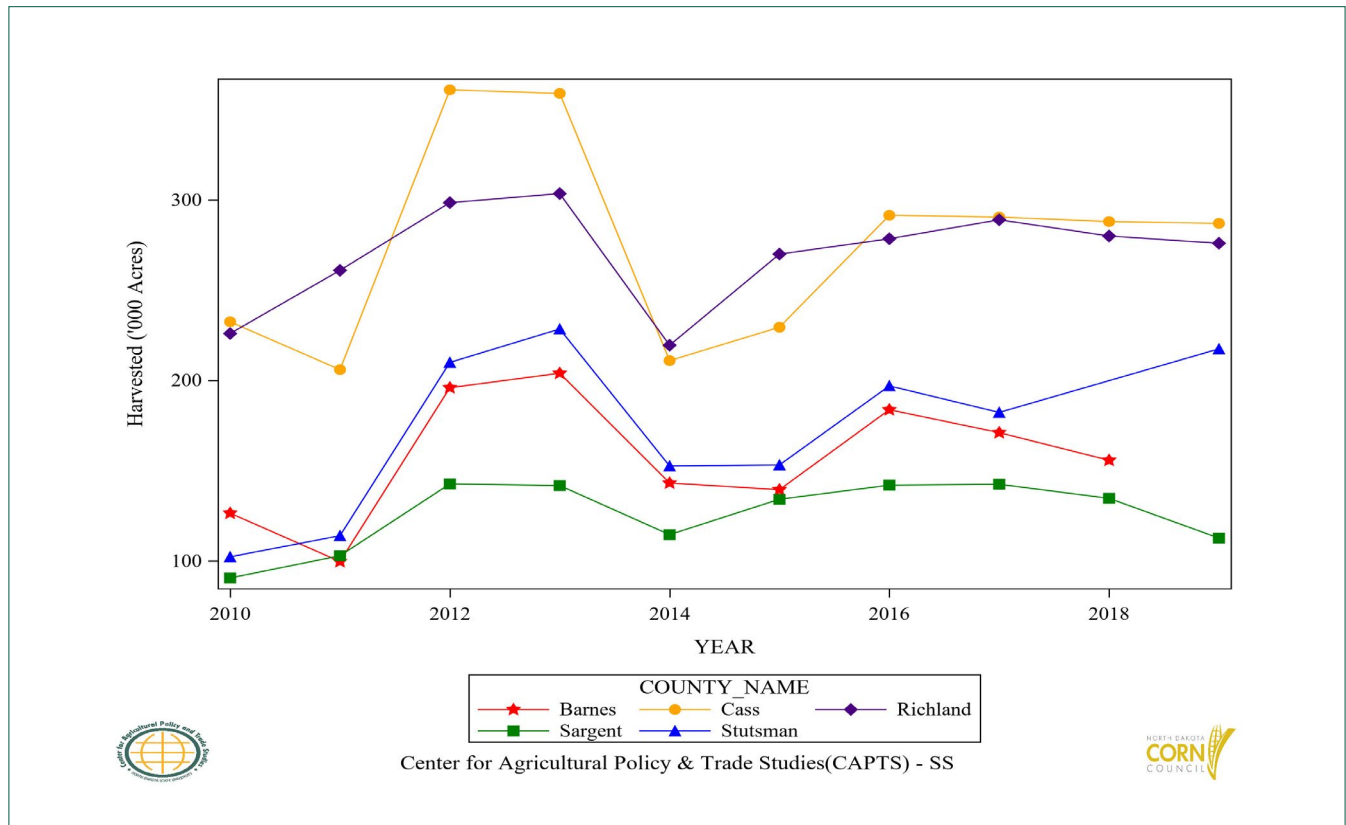


Table 20: Top 15 North Dakota Counties Harvested Acreage, Annual Trends

State	Harvested (Acres)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Richland	226,000	261,000	298,500	303,500	219,500	270,000	278,500	289,000	280,000	276,000
Cass	232,500	206,000	361,000	359,000	211,000	229,500	291,500	290,500	288,000	287,000
Stutsman	102,300	114,000	210,000	228,500	152,600	153,200	197,000	182,300	.	217,500
Sargent	90,600	102,900	142,700	141,800	114,600	134,200	142,000	142,500	134,700	112,700
Barnes	126,500	99,700	196,000	204,000	143,200	139,500	183,800	171,100	155,800	.
Dickey	107,500	149,900	193,100	199,000	144,900	156,000	176,200	157,200	.	.
LaMoure	121,500	136,000	180,700	198,700	.	152,600	173,400	159,500	.	128,800
Grand Forks	89,600	77,800	143,100	112,200	79,200	91,500	131,800	116,700	115,900	129,100
Traill	96,500	91,800	141,900	141,300	84,600	100,600	131,600	119,000	.	108,800
Ransom	64,300	69,700	113,000	123,600	.	98,100	110,300	107,500	98,000	.
Steele	75,700	67,500	112,100	113,800	.	65,000	91,200	81,700	78,000	85,300
Emmons	59,900	95,600	138,600	165,000	114,200	82,700	120,400	112,300	108,300	.
Wells	39,200	46,600	99,200	.	.	75,500	90,900	96,600	87,900	.
McLean	.	21,500	61,000	80,300	71,000	52,100	75,600	87,700	.	75,500
Ramsey	42,200	30,000	58,300	37,500	34,400	36,900	65,400	61,900	51,100	.

Figure 21: Top 5 North Dakota Counties Production, Annual Trends

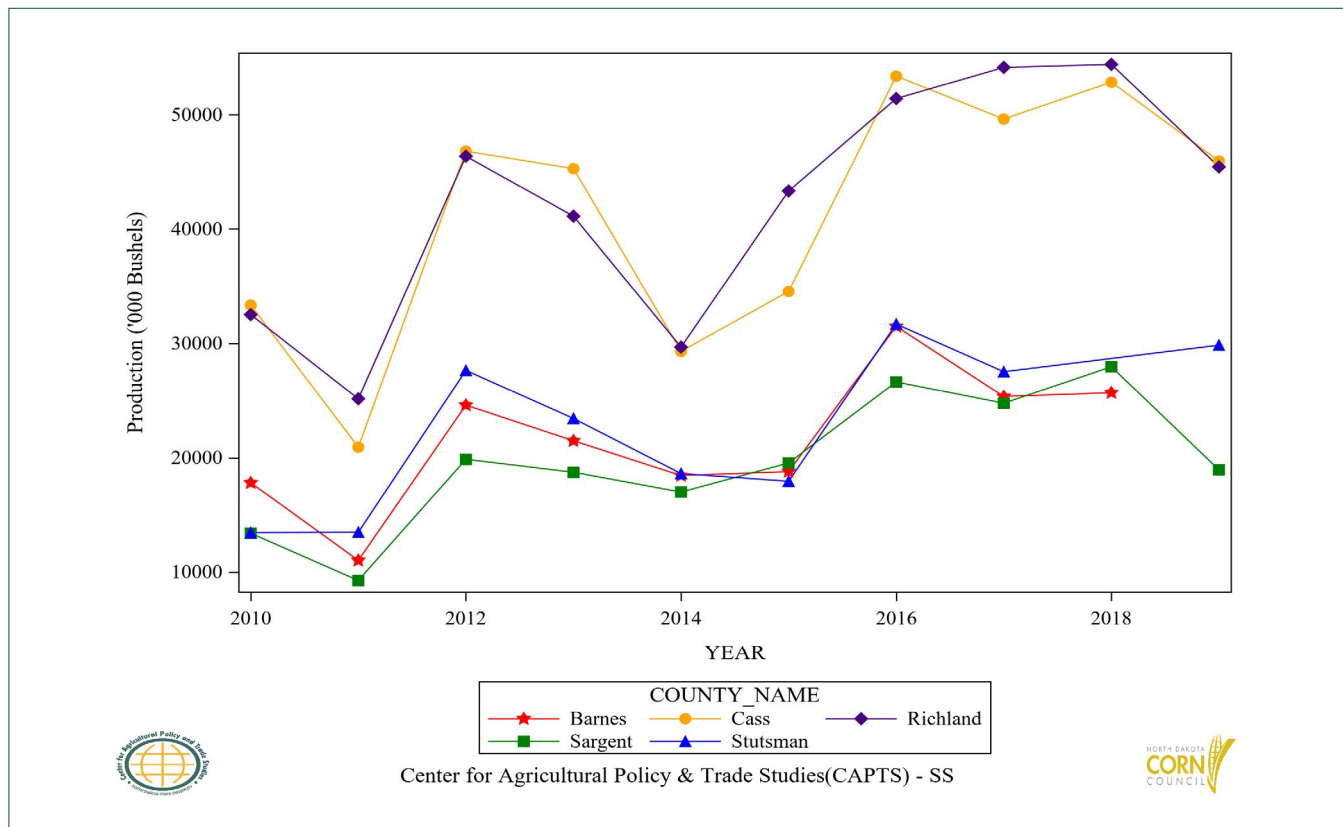


Table 21: Top 15 North Dakota Counties Production, Annual Trends

State	Production (Bushels)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Richland	32,515,000	25,160,000	46,375,000	41,123,000	29,680,000	43,331,000	51,408,000	54,143,000	54,406,000	45,445,000
Cass	33,341,000	20,930,000	46,815,000	45,290,000	29,312,000	34,545,000	53,379,000	49,619,000	52,848,000	45,951,000
Stutsman	13,453,000	13,485,000	27,643,000	23,439,000	18,626,000	17,952,000	31,689,000	27,528,000	.	29,850,000
Sargent	13,403,000	9,279,000	19,871,000	18,742,000	17,010,000	19,550,000	26,632,000	24,772,000	27,964,000	18,953,000
Barnes	17,818,000	11,029,000	24,604,000	21,491,000	18,455,000	18,799,000	31,490,000	25,363,000	25,691,000	.
Dickey	14,944,000	18,093,000	27,578,000	21,544,000	21,829,000	20,395,000	31,472,000	26,743,000	.	.
LaMoure	17,130,000	17,387,000	23,843,000	19,266,000	.	21,255,000	32,536,000	23,808,000	.	19,558,000
Grand Forks	11,950,000	7,895,000	19,055,000	13,610,000	9,989,000	12,743,000	19,204,000	16,518,000	18,823,000	20,537,000
Traill	14,123,000	9,922,000	17,947,000	17,167,000	10,418,000	14,996,000	20,838,000	19,750,000	.	15,945,000
Ransom	9,421,000	8,130,000	17,549,000	16,877,000	.	15,101,000	21,786,000	19,324,000	19,404,000	.
Steele	10,175,000	7,488,000	13,517,000	12,974,000	.	9,674,000	15,634,000	13,858,000	13,632,000	12,742,000
Emmons	5,956,000	10,505,000	11,923,000	14,692,000	11,252,000	8,682,000	18,025,000	12,480,000	11,913,000	.
Wells	4,874,000	4,885,000	13,006,000	.	.	7,870,000	12,905,000	14,112,000	11,471,000	.
McLean	.	2,309,000	6,013,000	9,561,000	8,404,000	5,603,000	10,233,000	8,970,000	.	10,479,000
Ramsey	4,502,000	3,120,000	7,906,000	4,276,000	3,824,000	4,355,000	8,779,000	7,800,000	6,643,000	.

Figure 22: Top 5 North Dakota Counties Yield, Annual Trends

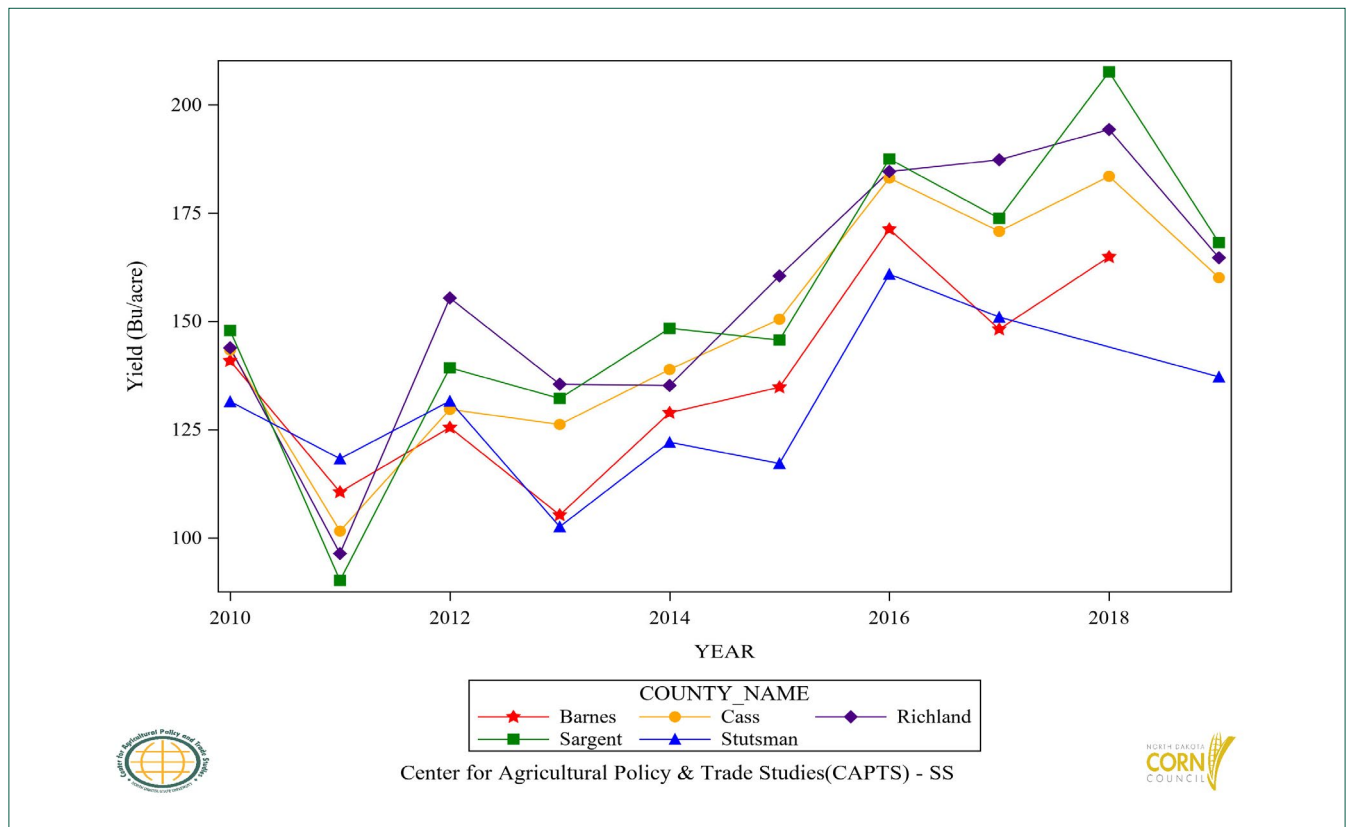


Table 22: Top 15 North Dakota Counties Yield, Annual Trends

State	Yield (Bu/acre)									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Richland	143.90	96.40	155.40	135.50	135.20	160.50	184.60	187.30	194.30	164.70
Cass	143.40	101.60	129.70	126.20	138.90	150.50	183.10	170.80	183.50	160.10
Stutsman	131.50	118.30	131.60	102.60	122.10	117.20	160.90	151.00	.	137.20
Sargent	147.90	90.20	139.30	132.20	148.40	145.70	187.50	173.80	207.60	168.20
Barnes	140.90	110.60	125.50	105.30	128.90	134.80	171.30	148.20	164.90	.
Dickey	139.00	120.70	142.80	108.30	150.60	130.70	178.60	170.10	.	.
LaMoure	141.00	127.80	131.90	97.00	.	139.30	187.60	149.30	.	151.80
Grand Forks	133.40	101.50	133.20	121.30	126.10	139.30	145.70	141.50	162.40	159.10
Traill	146.40	108.10	126.50	121.50	123.10	149.10	158.30	166.00	.	146.60
Ransom	146.50	116.60	155.30	136.50	.	153.90	197.50	179.80	198.00	.
Steele	134.40	110.90	120.60	114.00	.	148.80	171.40	169.60	174.80	149.40
Emmons	99.40	109.90	86.00	89.00	98.50	105.00	149.70	111.10	110.00	.
Wells	124.30	104.80	131.10	.	.	104.20	142.00	146.10	130.50	.
McLean	.	107.40	98.60	119.10	118.40	107.50	135.40	102.30	.	138.80
Ramsey	106.70	104.00	135.60	114.00	111.20	118.00	134.20	126.00	130.00	.

■
Section IV

Variance Decomposition and Sources of Variation

Figure 23: State Level Variance Decomposition, Planted Acreage Trends

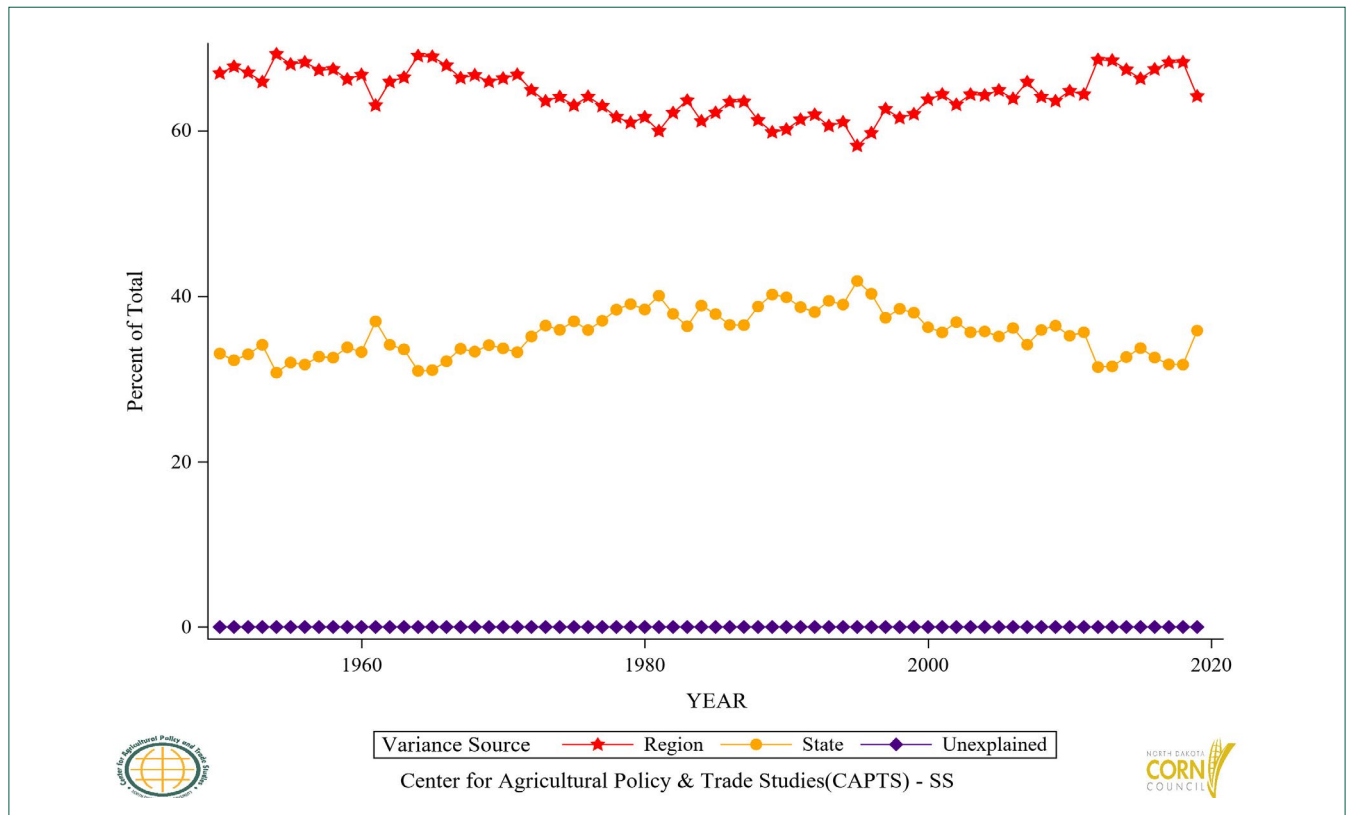


Figure 24: State Level Variance Decomposition, Harvested Acreage Trends

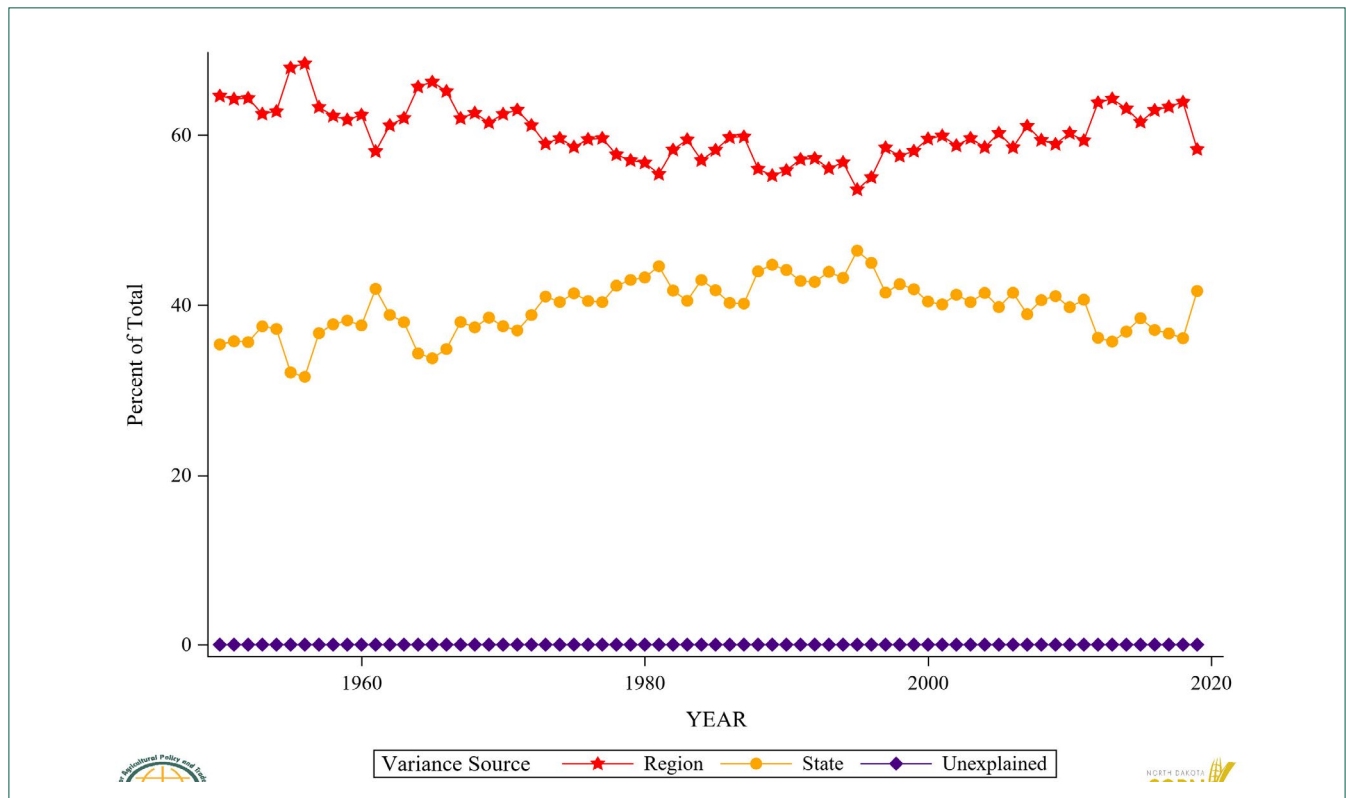


Figure 25: State Level Variance Decomposition, Production Trends

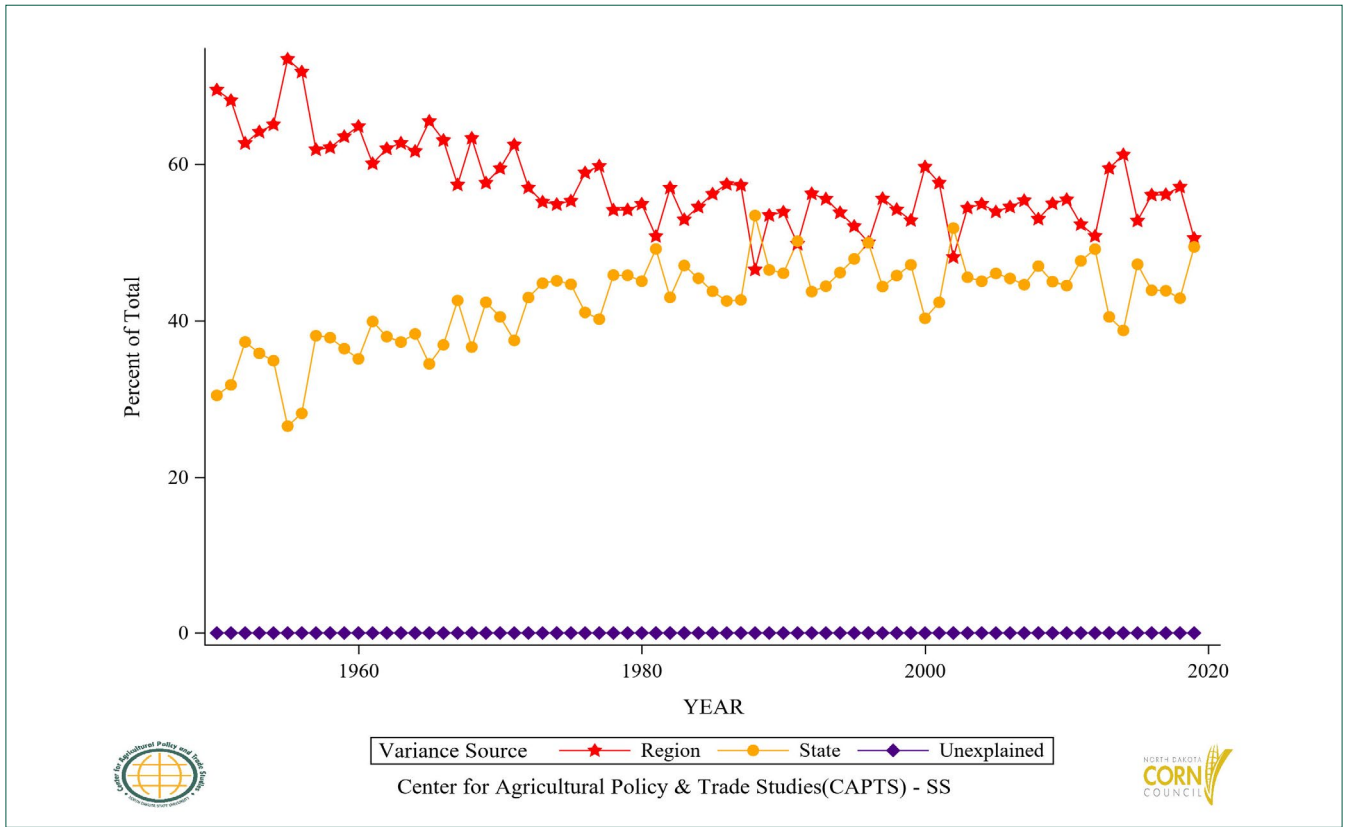


Figure 26: State Level Variance Decomposition, Yields Trends

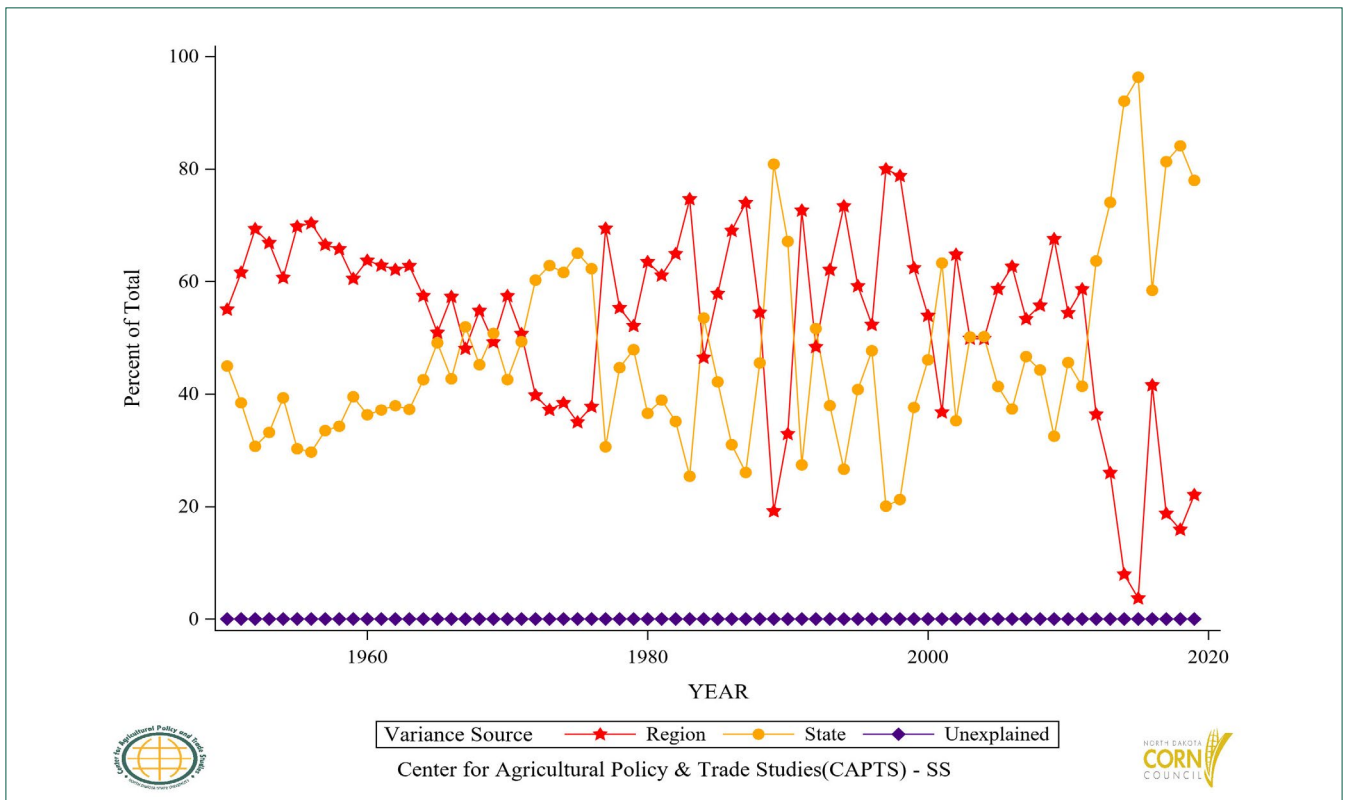


Figure 27: State Level Variance Decomposition, Revenue Trends

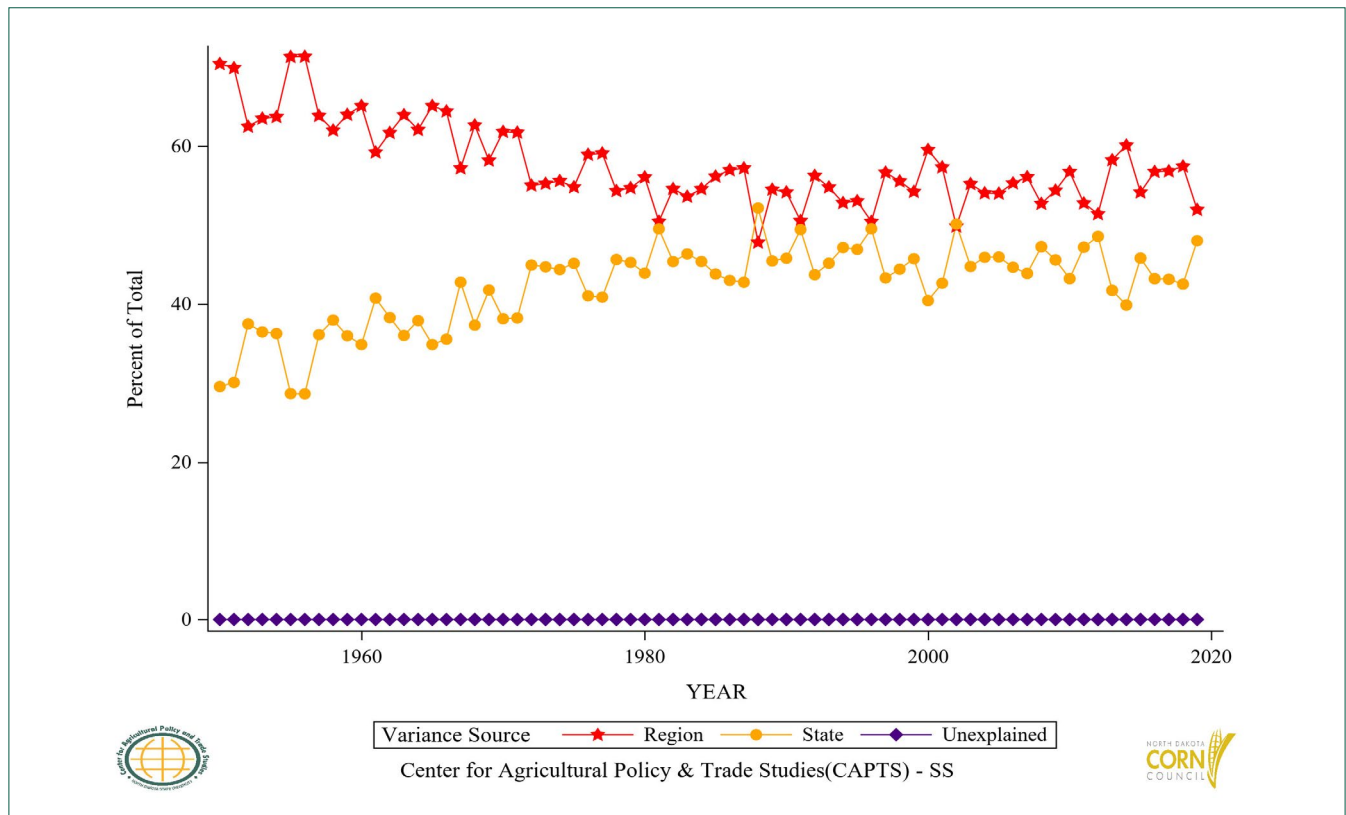


Figure 28: State Level Variance Decomposition, Price Trends

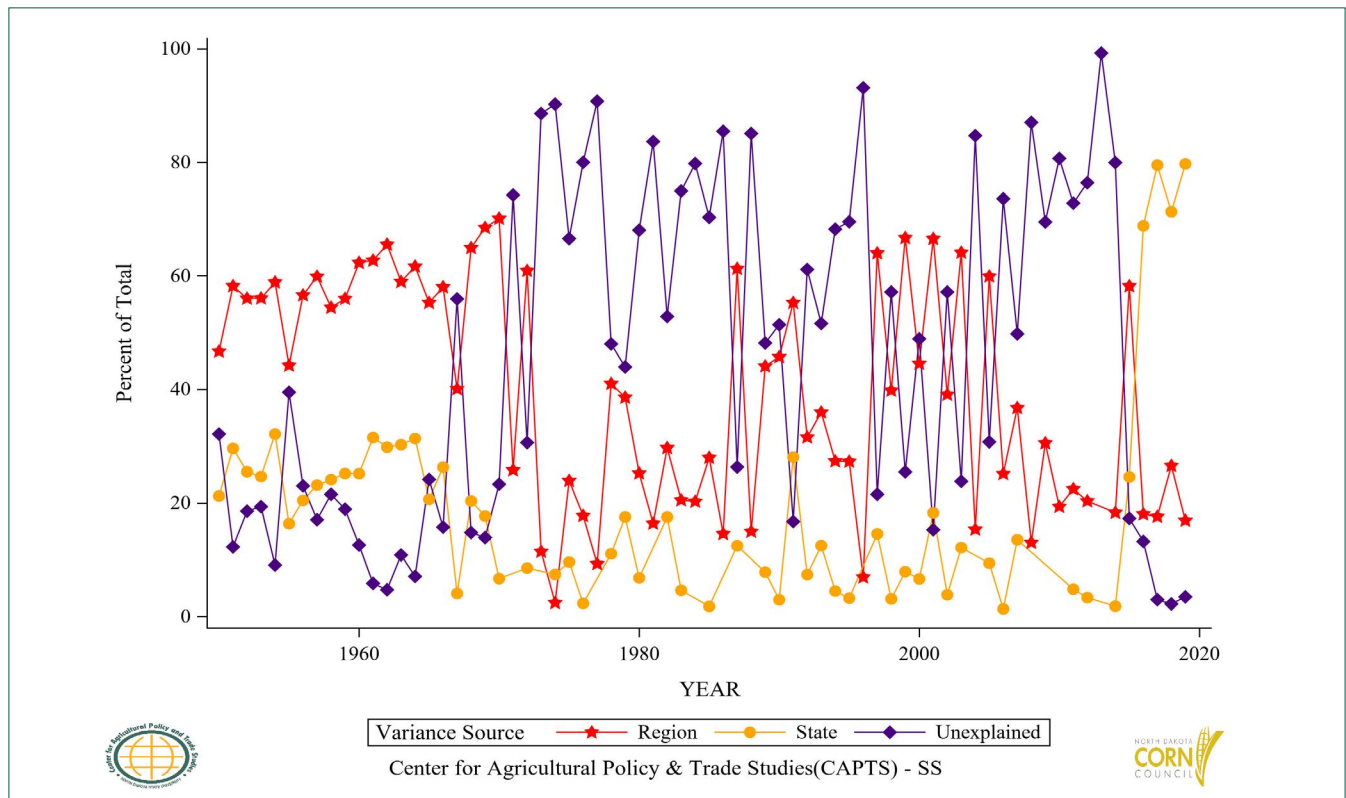


Figure 29: County Level Variance Decomposition, Planted Acreage Trends

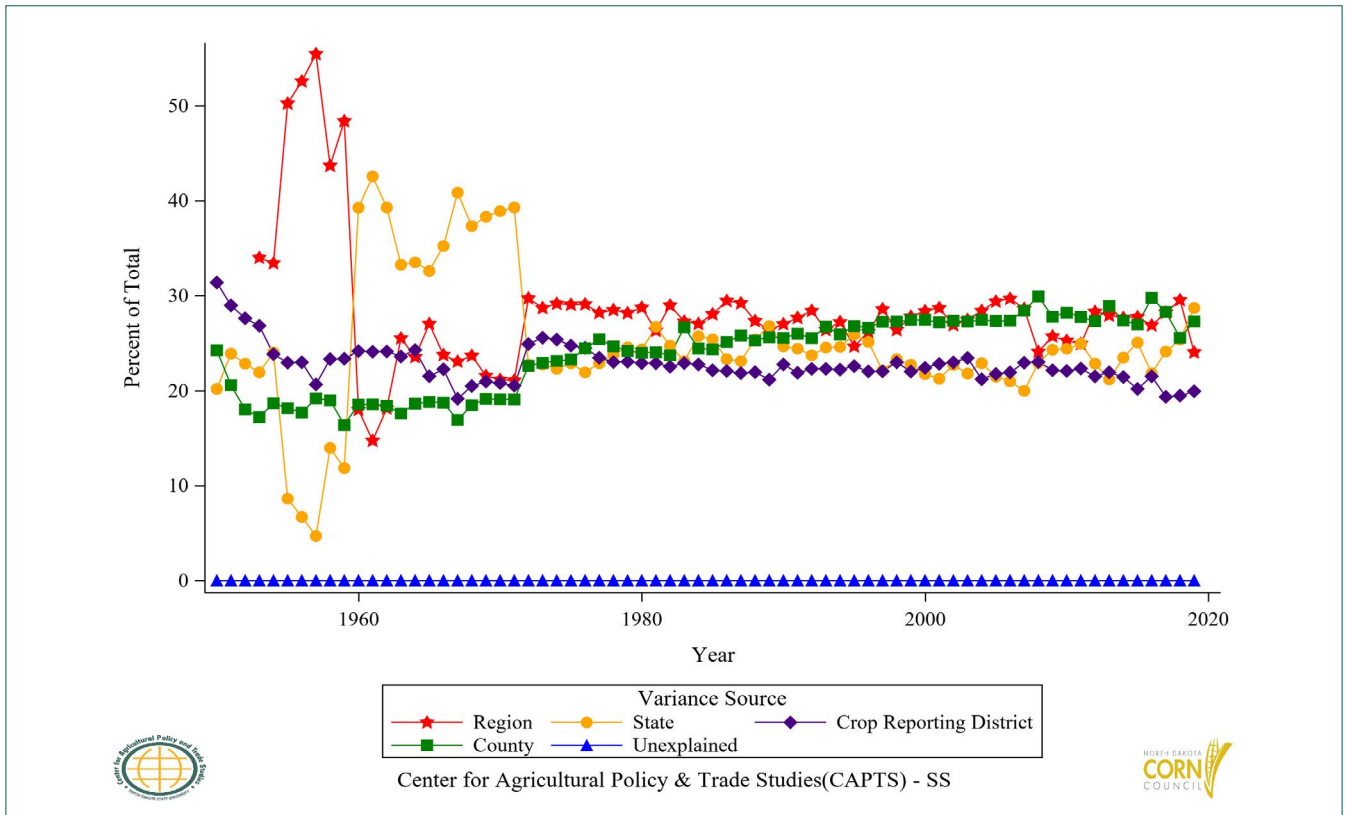


Figure 30: County Level Variance Decomposition, Harvested Acreage Trends

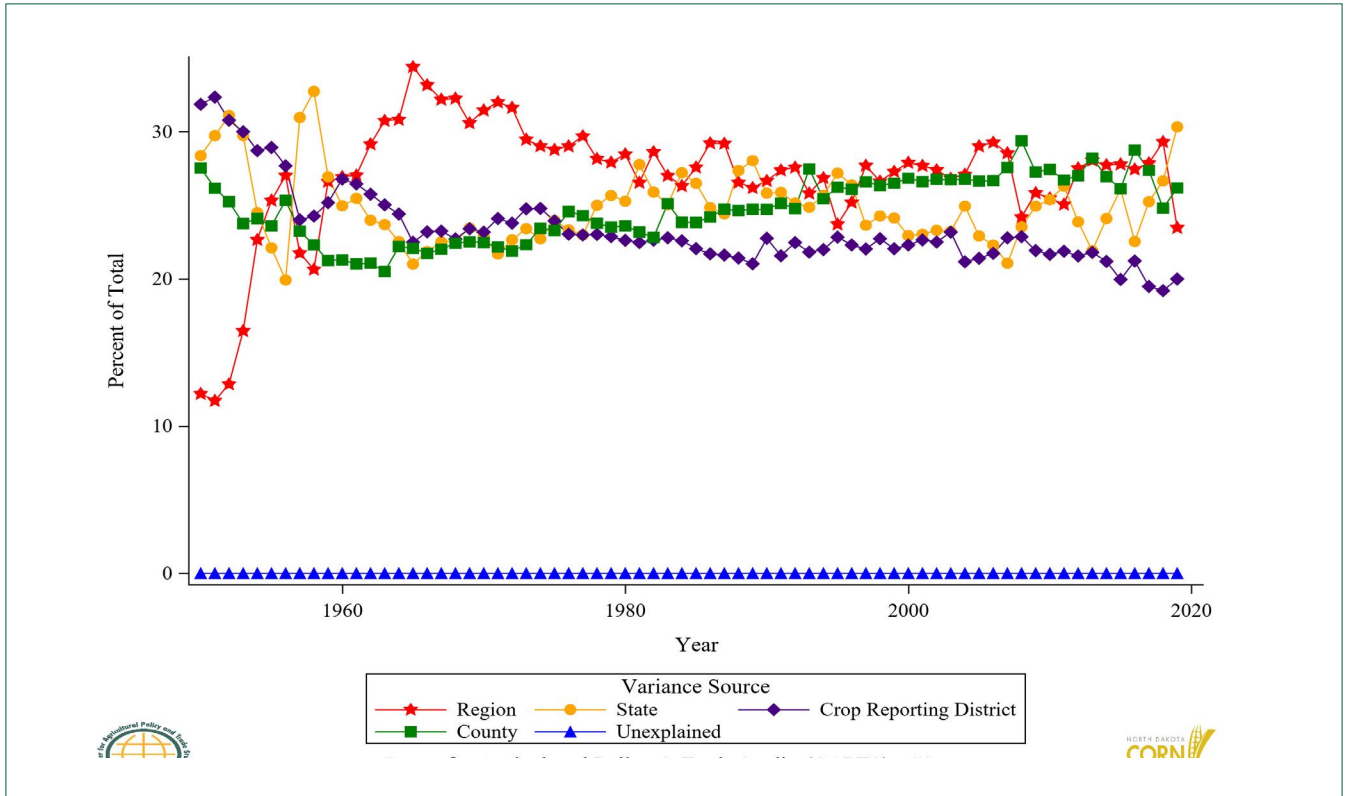


Figure 31: County Level Variance Decomposition, Production Trends

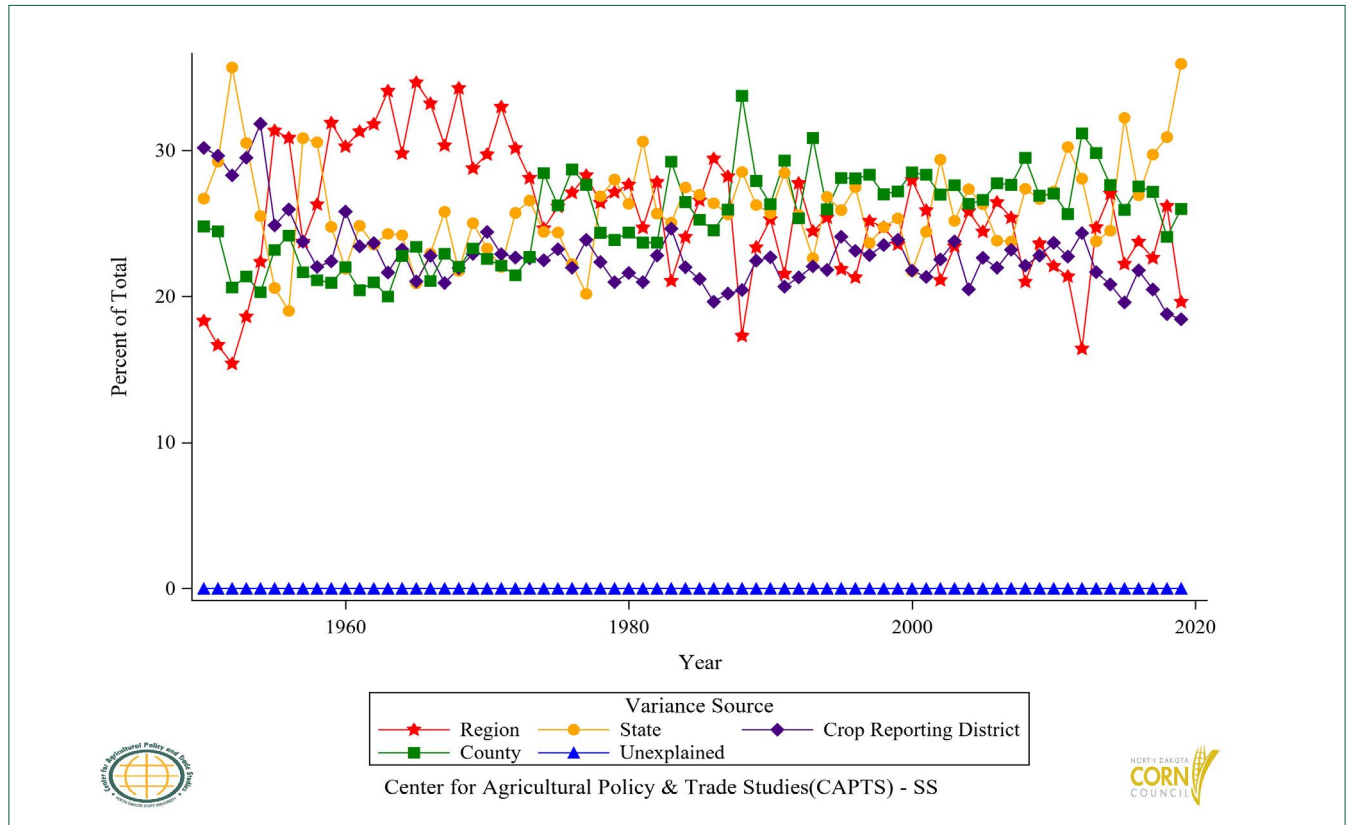
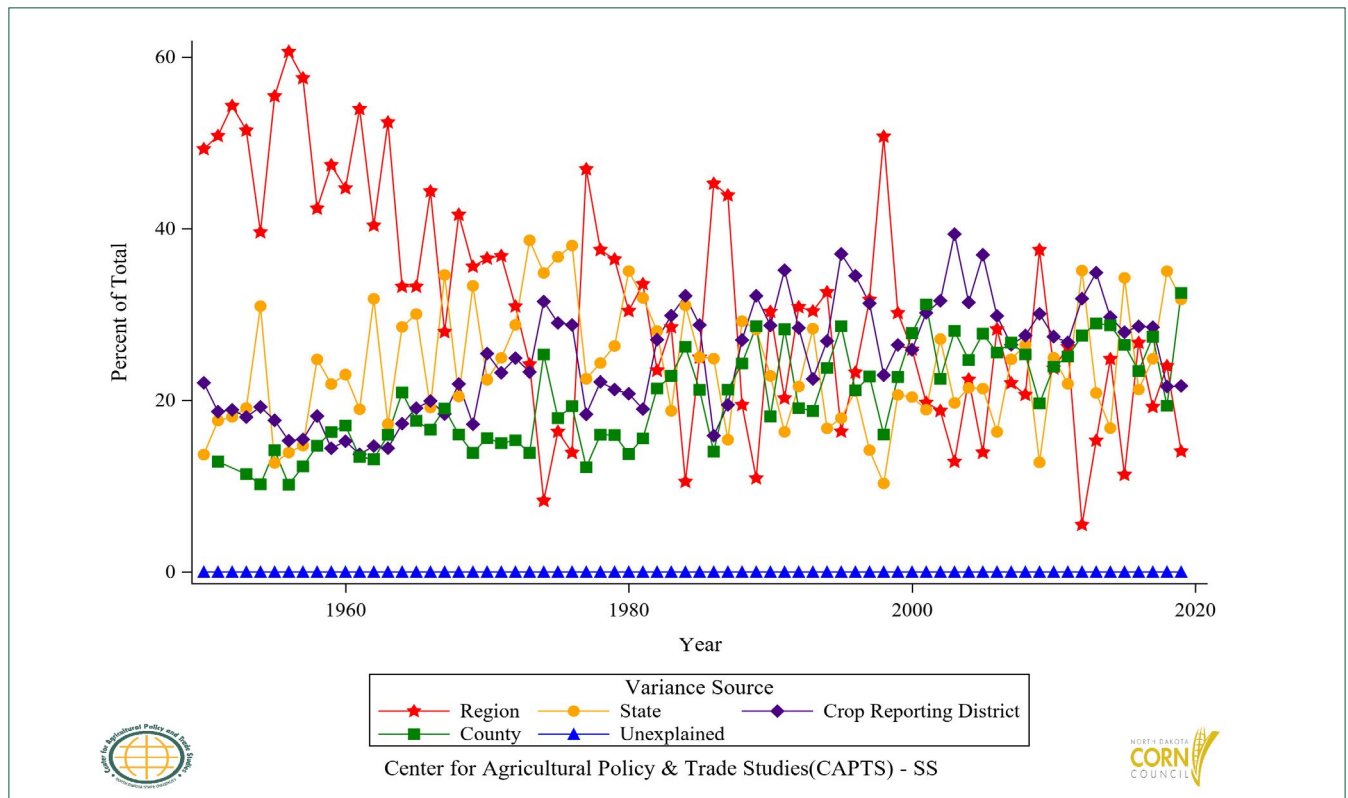


Figure 32: County Level Variance Decomposition, Yield Trends



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