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Identifying Change in Agricultural Practices in Relation to Ethanol Plant Location

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IDENTIFYING CHANGE IN AGRICULTURAL PRACTICES IN RELATION TO ETHANOL PLANT LOCATION

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IDENTIFYING CHANGE IN AGRICULTURAL PRACTICES IN RELATION TO ETHANOL PLANT LOCATION

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This study was performed to identify changes in agricultural practices throughout Nebraska between 1997 and 2007, a period of large ethanol production growth. By identifying ethanol plant locations and using county level data for variables such as bushels of corn produced, fertilizer and chemical application, agricultural cropland, cattle population and Conservation Reserve Program enrollment, percent change was calculated, mapped and graphed. The results did not show any evidence of change that could be linked to the ethanol plant locations.

This study did not take into account advances in management practices or improvements in technology during the study time period. These changes increased ethanol production and reduced the inputs required thus reducing the impact of ethanol production on the environment.

Acknowledgements

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List of Acronyms

CAFE	Corporate Average Fuel Economy
CRP	Conservation Reserve Program
EWG	Environmental Working Group
FFV	Flexible Fuel Vehicle
GAO	U.S. Government Accountability Office
HHV	High Heating Values
LHV	Low Heating Values
MTBE	Methyl tert-butyl ether
OAPEC	Organization of Arab Petroleum Exporting Countries
RFA	Renewable Fuels Association
USDA	U.S. Department of Agriculture

Introduction

The purpose of this study is to determine if there is a relationship between changes in agricultural practices and locations of ethanol plants in Nebraska. Identifying changes in agricultural practices around ethanol plants could identify other factors to consider when choosing site locations for new plant development, and identify potential issues that could develop in the future as ethanol demand increases. I hypothesize that there will be an increase in agricultural production related aspects and a decrease in conservation reserve program enrollments closer to the ethanol plant sites selected.

The scope of this study includes all the counties of Nebraska for the years of 1997 and 2007. Counties of the state are organized according to distance from the selected ethanol plant location. The chosen variables to be evaluated are agricultural cropland measured in acres, fertilizer and chemical use measured in acres applied, corn production measured in bushels, Conservation Reserve Program (CRP) enrollment measured in both acres enrolled and operations, and cattle population. The variables were chosen to identify agricultural production change and conservation practice change during a time period of increased ethanol production. The corn production, agricultural cropland, and chemical and fertilizer application variables were selected to identify changes in agricultural activity. The CRP operations and acres enrolled were selected to identify changes in conservation practices. The cattle population variable was selected to show changes in the concentration of cattle around the ethanol plant selections due to the availability of the livestock feed created as a byproduct of ethanol production. I expect to see greater increase in production related activities closer the ethanol plant locations, with a corresponding decrease in CRP enrollment.

This study assumes that all other factors that affect agriculture and energy production remain the same throughout the research period. Factors such as drought, input cost, commodity prices, and transportation costs are not considered or accounted for. These factors and many more contribute to changes in agriculture and ethanol production. The scope of this paper focuses on the selected measurable changes from 1997 to 2007 in Nebraska.

Many issues have been raised both for and against biofuels in general. The issues include food price increases, environmental concerns, land use issues, green house gas emissions, social and economical impacts, energy balance, and governmental subsidies (Rosillo-Calle and Johnson 4). Corn based ethanol production has increased in the U.S. over the past decade, from 1630 million gallons in 2000 to 13230 million gallons in 2010 (Renewable Fuels Association). With this increase there has been a corresponding increase in demand for corn to enter ethanol production.

To meet the demand, corn production has increased, exports have been reduced, and other uses of corn have been reduced or replaced (Searchinger, Heimlich and Houghton 1238). Factors contributing to the increase in demand for ethanol include Crude oil price increases, federal mandates, and legislation (Wescott 7). The increase in corn production plays a large role in meeting the demand. Improved agricultural techniques and advances in technology provide steady increases to output, while changing land use can provide an increase in overall annual production. Land use changes include changing crops, changing crop rotation frequencies and farming sub-prime agricultural land.

With an increase of acres in production and the farming of sub-prime land, negative environmental impacts are increased. Soil erosion, nutrient loading on surface runoff, pesticide and herbicide pollution, nitrate contamination of ground water, and aquifer depletion are a few environmental impacts of the agricultural industry in general (Foley, Ramankutty and Brauman 5). With an increase in ethanol production and the corresponding increase in corn feedstock production these environmental impacts could be concentrated in areas surrounding ethanol plants. The ability to identify and reduce potential pollution hotspots will be beneficial to planners and developers to ensure a safe and productive environment.

Background

Corn ethanol production is achieved through the conversion of the starch in corn to glucose. This simple sugar is then fermented to produce carbon dioxide, distiller's grains and ethanol, after further distillation. Two main production methods are used in the U.S., wet milling and dry milling. During the wet milling process the corn kernel is soaked in a water and acid mix to aid in the mechanical separation of the kernel, producing germ, fiber, gluten and starches. The germ, fiber and gluten can then be used to produce corn oil, feed product and gluten meal. The starch is then processed in a similar way as in the dry mill process. During the dry mill process the whole kernel is ground into a meal and mixed with water. Enzymes and ammonia are added, and the mixture is heated to reduce contamination. After it is cooled, fermented, and distilled the ethanol is denatured and ready for blending. The remaining corn meal is processed to produce live stock feed. Wet milling allows for optional uses with the separated starch. Aside from fermentation to produce ethanol, both corn syrup and corn starch can be produced. As of 5 Oct 2011 two of the twenty-four operating ethanol plants in Nebraska used the wet mill process (Nebraska Ethanol Board)

Ethanol and ethanol blended fuels have been in use as a vehicle fuel since the development of Henry Ford's 1896 "Quadricycle" (Outlaw, Collins and Duffield 1). Over the years as petroleum prices and availability fluctuate, the demand for ethanol changes. Gasohol, a blend of ethanol and gasoline was marketed as "Agrol" during the 1930's and 1940's but ended in 1945 as gasoline became cheaper to produce (Scraggs 107). Ethanol didn't reappear until after the oil embargo of 1973.

The oil crisis of 1973 occurred when Arabic oil producing countries enacted an oil embargo against countries that supported Israel during the Fourth Arab-Israeli War, also known as the Yom Kipper War. In 1973 the Organization of Arab Petroleum Exporting Countries (OAPEC) embargoed oil shipments to the U.S. and the Netherlands, and cut production with additional monthly reductions of 5% until political demands were met (Licklider 217). This oil shortage prompted the U.S. to develop a plan to reduce dependency on foreign energy resources. On November 25th, 1973 President Nixon gave a speech outlining temporary energy conservation measures and emphasizing the need for U.S. energy independence. During his speech he stated,

> "What I have called Project Independence 1980 is a series of plans and goals set to insure that by the end of this decade, Americans will not have to rely on any source of energy beyond our own. As far as energy is concerned, this means we will hold our fate and our future in our hands alone. As we look to the future, we can do so, confident that the energy crisis will be resolved not only for our time but for all time. We will once again have plentiful supplies of energy which helped to build the greatest industrial nation and one of the highest standards of living in the world" (Nixon).

The oil embargo lasted until March 1974. During this time the U.S. government looked for ways to develop sustainable energy resources.

Many laws were enacted to assist the private sector with research and development. In 1974 the Solar Energy Research, Development, and Demonstration Act (Public Law 93-473) allowed for research and development projects financed by the U.S. to develop a commercially viable renewable fuel source. The Food and Agricultural Act of 1977 (Public Law 95-133) authorized the U.S. Department of Agriculture (USDA) to provide grants for research and to help finance pilot programs to develop alcohol from agricultural commodities. The National Energy Act of 1978 included the Energy Tax Act of 1978, (Public Law 95-618) which allowed the Federal tax free sale of blended fuels that contain at least 10% alcohol from January 1979 to September 1984. This tax exemption provided the equivalent of 40 cents per gallon of ethanol produced when blended at 10 % (Glozer 17). The Omnibus Reconciliation Act of 1980 (Public Law 96-499) placed a tariff on imported ethanol in order to protect the emerging domestic ethanol production industry.

The Crude Oil Windfall Profit Tax Act of 1980 (Public Law 96-233) also helped ethanol producers by establishing tax credits and exemptions to encourage investment in ethanol production (Glozer 19). These early legislative acts and policies helped establish ethanol production in the U.S., by providing funds for research, imposing tariffs, and offering tax credits and exemptions for the sale and production of fuel ethanol. Over the years additional bills have been passed in regards to the amount and rate of taxation.

The Energy Policy Conservation Act of 1975 (Public Law 94-163) established Corporate Average Fuel Economy (CAFE) standards aimed at increasing fuel economy in new vehicles being developed (NHTSA). Beginning in the late 1980's other regulation were developed that increased the demand for ethanol. In 1988 the Alternative Motor Fuels Act (Public Law 100-494) granted incentives to the automotive industry to develop Flexible Fuel Vehicles (FFV's). Vehicle manufactures were able to produce FFV's for a little more cost per vehicle, and increase the fleet mileage average, reducing penalties from the CAFE standards (Glozer 23).

Health and environmental impacts concern also plays a role in the demand for ethanol production. The 1990 Clean Air Act Amendments (Public Law 101-549) addressed issues with smog and carcinogenic emissions from vehicle exhaust. In order to reduce Carbon Monoxide emissions, an oxygenate additive was needed to reformulate gasoline so that it would burn more completely during the combustion process. Both MTBE (Methyl tert-butyl ether) and ethanol could have worked at this point in time, but issues with vehicle compatibility, cost, and logistics allowed MTBE to be the more viable option. MTBE has been used as an antiknock additive since 1979 to replace Tetraethyl Lead. It is produced from fossil fuels and blends well with gasoline.

MTBE started showing up in public water supplies and increased from 112 locations contaminated in 1996 to 637 in 2002 (Environmental Working Group). Multiple states enacted bans on MTBE and the government removed the oxygenate requirement from the Clean Air Act Amendments of 1990 (EPA). A nationwide minimum use mandate in the Energy Policy Act of 2005 (Public Law 101-140) and the phase out of MBTE increased the demand for ethanol well beyond original expectation. In 2007 the targeted minimum amount of renewable fuels blended into the nation's fuel was increased from 7.5 billion gallons by 2012 to 36 billion gallons by 2022. These minimum amounts include all renewable fuel sources, corn based ethanol use was set at 15 billion gallons by 2015 and the remaining amount from alternative ethanol production, cellulosic and other new processes by 2022. This minimum use goal has increased the importance of studying all aspects of ethanol production (GAO 6).

Special Interest Groups and Energy Security

The assistance that the ethanol industry has received from the federal government is substantial, the government has increased the market for ethanol and kept the price competitive with gasoline (Yucobucci 27).The amount of governmental subsidies for ethanol production is one of several issues within the debate about the cost and benefits of corn based ethanol production. Many corn ethanol based associations, special interest groups, and lobbies have been created to help influence and educate the public and government on ethanol related subjects. Senate Majority Leader Robert C. Byrd presented an essay titled "Lobbyists", which describes the history of lobbying and delivers an accurate portrayal of the role lobbyist and special interest groups fill in the legislative process.

> Today's lobbying is more diverse than ever before, with an organized lobby formed, seemingly, around virtually every aspect of American social and economic life. No longer do the lobbying groups come solely from Washington's great law firms and associations. Public relations companies, consulting groups, and specialized accounting, medical, and insurance firms have joined their ranks. All these, and others, engage in a multitude of activities, from raising money for election campaigns to conducting technical studies, with the ultimate goal of influencing the course of legislation and government policy (Byrd)

Many issues have been raised, both for and against, corn ethanol production in the United States. Special interest groups make claims both for and against the corn ethanol industry. Supporters claim benefits in the form of U.S. energy independence, reduction of greenhouse gas emissions, and helping rural economies. Opponents challenge these claims and raise issues concerning worldwide food availability and cost, net energy balance, land use change both local and worldwide, increased agricultural pollution, and soil/water degradation.

One major supporter of ethanol production is the Renewable Fuels Association (RFA). Organized in 1981 the RFA represents the U.S. ethanol industry as a national trade association, with producer members representing the majority of U.S. ethanol production. The listed objectives of this organization are as follows:

- Promote federal, state and local government policies, programs and initiatives that encourage expanded ethanol use.
- Provide technically accurate and timely information to auto manufacturers and technicians, the media, policy makers, marketers and refiners, and the general public.
- Participate in educational activities to increase public awareness regarding renewable fuels and the positive contribution they make to American energy independence, the economy and the environment.
- Provide RFA members with the information necessary for informed business decisions (Renewable Fuels Association).

The RFA represents a large portion of the ethanol production industry, transportation, supply, marketing, technology, and other industry related fields are also represented by this organization.

The Environmental Working Group (EWG) is a 501(c)(3) nonprofit organization that acts as an environmental information group. The stated environmental goal of this organization is "(t)o replace federal policies, including government subsidies that damage the environment and natural resources, with policies that invest in conservation and sustainable development" (Environmental Working Group). Also developed in 2002 was the Environmental Working Group Action Fund, which is a 501(c)(4) nonprofit organization that allows for more political lobbying and election campaign support than a 501(c)(3) organization.

The energy security debate has been an important issue in the development of ethanol. Glozer breaks the energy security debate into several different categories including import reduction, U.S. vulnerability to petroleum imports and domestic corn supply. He states that in order to measure import reduction the U.S. subsidy program would need to be removed, and the import reduction be calculated as if there were a competitive market in the U.S.. He analyzes the U.S. Energy Information Administration's 2008 Annual Energy Outlook (U.S. Energy Information Agency) and uses their finding to state that "On a net basis … U.S. petroleum imports are not reduced significantly." (Glozer 74) He also explains and provides data about historic oil supply, cost and distinct disruptions in the past. Glozer explains that due to current measures such as the Strategic Petroleum Reserve, the International Energy Agency, the geographical location of all U.S. oil importers and the fact that oil is traded on a world market, that the "… United States is well protected against any temporary severe interruption in world oil supplies…" (Glozer 80) He also raises the question about the reliability of the corn market in the U.S. by identifying weather incidents such as floods and droughts that have disrupted corn supplies, raising the costs of producing ethanol.

Ethanol Use in the U.S.

The RFA claimed in a letter written in July of 2011 to President Obama that, "(w)e are producing well over 13 billion gallons of ethanol each and every year, and displacing more than 445 million barrels of oil annually – a sum greater than annual oil imports from Saudi Arabia" (Renewable Fuels Association). Though the letter makes no mention of ethanol production providing energy security to the U.S., the sentiment is implied as energy security has been cited as a benefit by proponents of the ethanol industry. My research of the RFA claim produced a report prepared for the RFA in February of 2011, explaining the economic benefits of U.S. ethanol production (Urbachuk). To determine the validity of this claim the calculation was checked and determined to be accurate. The determined conversion calculation used is as follows: (Urbachuk 7)

Equation 1. Ethanol Gasoline Equivalent

$$(X)\left(\frac{1\ gallon\ gasoline}{EEE}\right)\left(\frac{42\ gallons\ crude\ oil}{PRG}\right)\left(\frac{1\ barrel}{42\ gallons}\right)$$

$$= Equivalent\ barrels\ of\ crude\ oil$$

X = Gallons of Ethanol

***EEE* = Energy Equivalent Value of Ethanol**

***PRG* = Production Rate of Gasoline**

The data from the EIA's U.S. Fuel Ethanol Overview puts ethanol production at 13,230,756 thousand gallons for 2010. The variable the RFA used in the calculation for the EEE is based on the lower energy value of ethanol, 76,300 Btu. Gasoline has an energy value of 116,000 Btu so:

Equation 2. Energy Equivalent of Ethanol

$$\left(\frac{116000\frac{Btu}{gallon}of\ gasoline}{76300\frac{Btu}{gallon}of\ ethanol}\right) = 1.52 = energy\ equvalent\ of\ ethanol$$

The constants used for the calculation were verified. There are High Heating Values (HHV) and Low Heating Values (LHV) differing in that the LHV accounts for heat loss due to the vaporization of water. The LHV is preferred when no energy is obtained from combustion exhaust. After checking current references it was determined that the correct heating value was used.

Table 1. Energy Equivalent Variable

	RFA Btu	HHV Btu	LHV Btu
Gasoline	116000	124340	116090
Ethanol	76300	84530	76,330
EEV	1.52	1.47	1.52

The estimate of 19.2 gallons could not be verified until after the analysis of the 2010 U.S. Refinery Percent Yield Data, yet in the report Urbachuk states that "According to EIA one 42 gallon barrel of crude oil produces 19.2 gallons of gasoline ” (Urbachuk 6). I could not find where this was stated and ended up calculating it from raw data. The 2010 U.S. Refinery Yield of Finished Motor Gasoline Percent equals 45.7 %. (U.S. Energy Information Agency)

Equation 3. Gasoline Production From Crude Oil

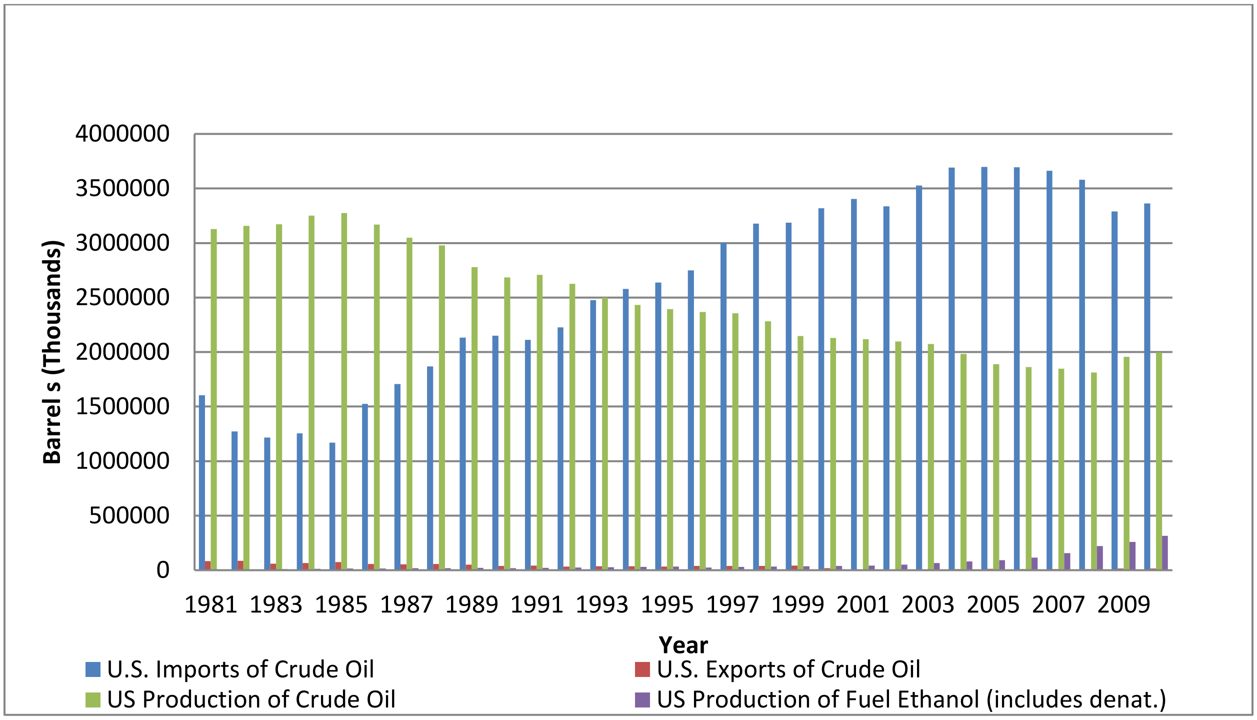
$$(.457)(42\ gallons\ of\ crude\ oil) = 19.194 \sim 19.2\ gallons\ of\ gasoline$$

Using the calculation, 1.52 gallons of ethanol to replace 1 gallon of gasoline and the estimate of 19.2 gallons of gasoline produced from each 42 gallon barrel of crude oil. Using significant figures changes this estimation to 450 million barrels of oil displaced as shown in Equation 4.

Equation 4. Ethanol / Crude Oil Equivalent

$$\left(13x10^{9}\ gallons\ ethanol\right)\left(\frac{1\ gallon\ gasoline}{1.52\ gallons\ ethanol}\right)\left(\frac{42\ gallons\ crude\ oil}{19.2\ gallons\ gasoline}\right)\left(\frac{1\ barrel}{42\ gallons}\right) = 4.5x10^{8} barrels\ of\ crude\ oil$$

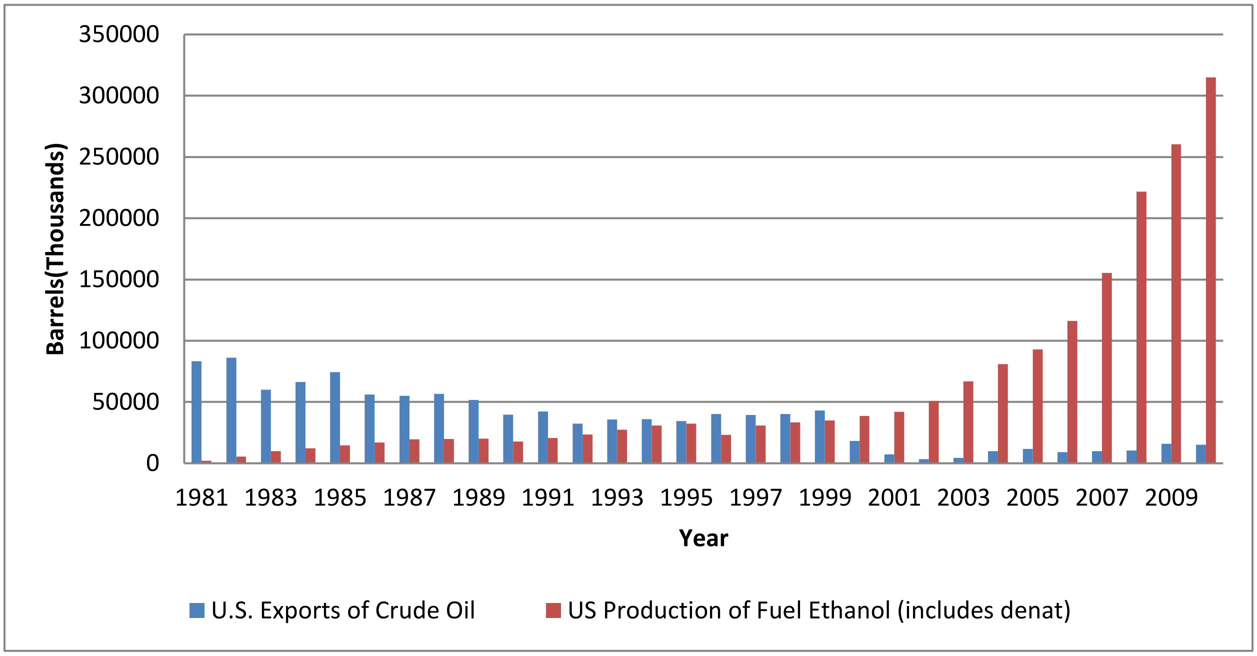
Figure 1. U.S. Crude Oil Export, Import, Production and Ethanol Production



Source: (U.S.Energy Information Agency)

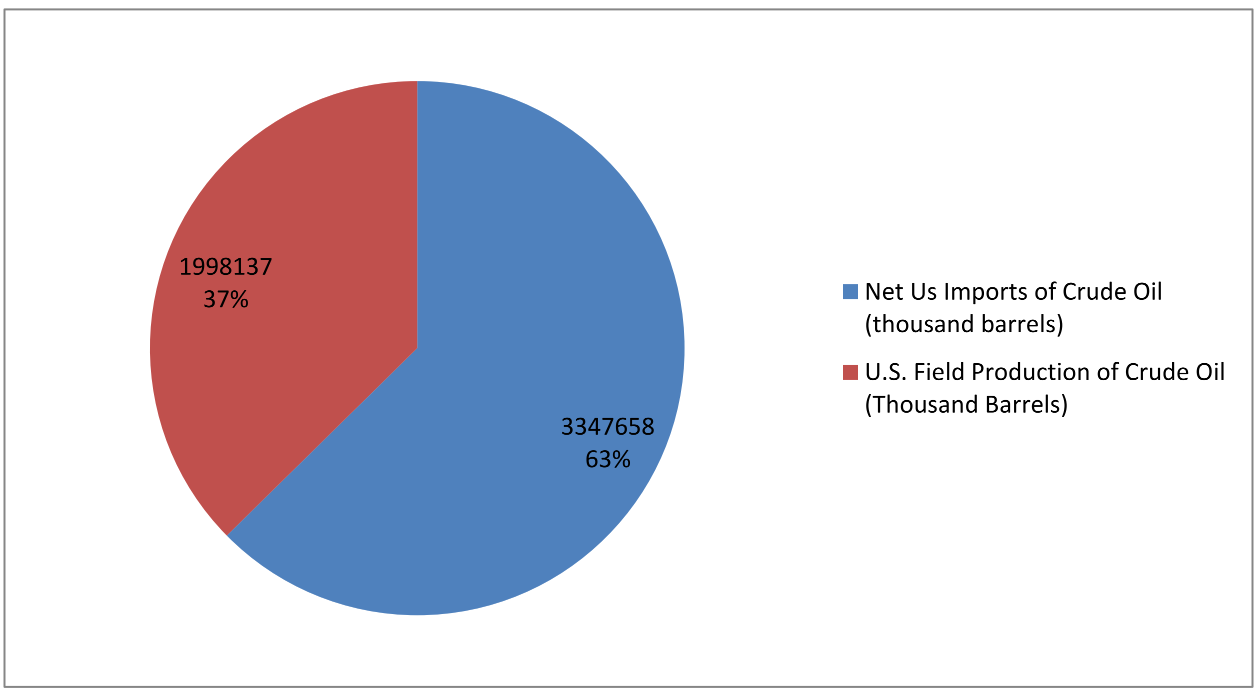
Figure 1 provides a visual comparison of import, export, and domestic production of crude oil along with U.S. production of fuel ethanol. Figure 2 (below) compares just U.S. export of crude oil and U.S. production of ethanol during the same time period but at a differ scale.

Figure 2. U.S. Crude Oil Exports and Ethanol Production



Source: U.S. Energy Information Agency

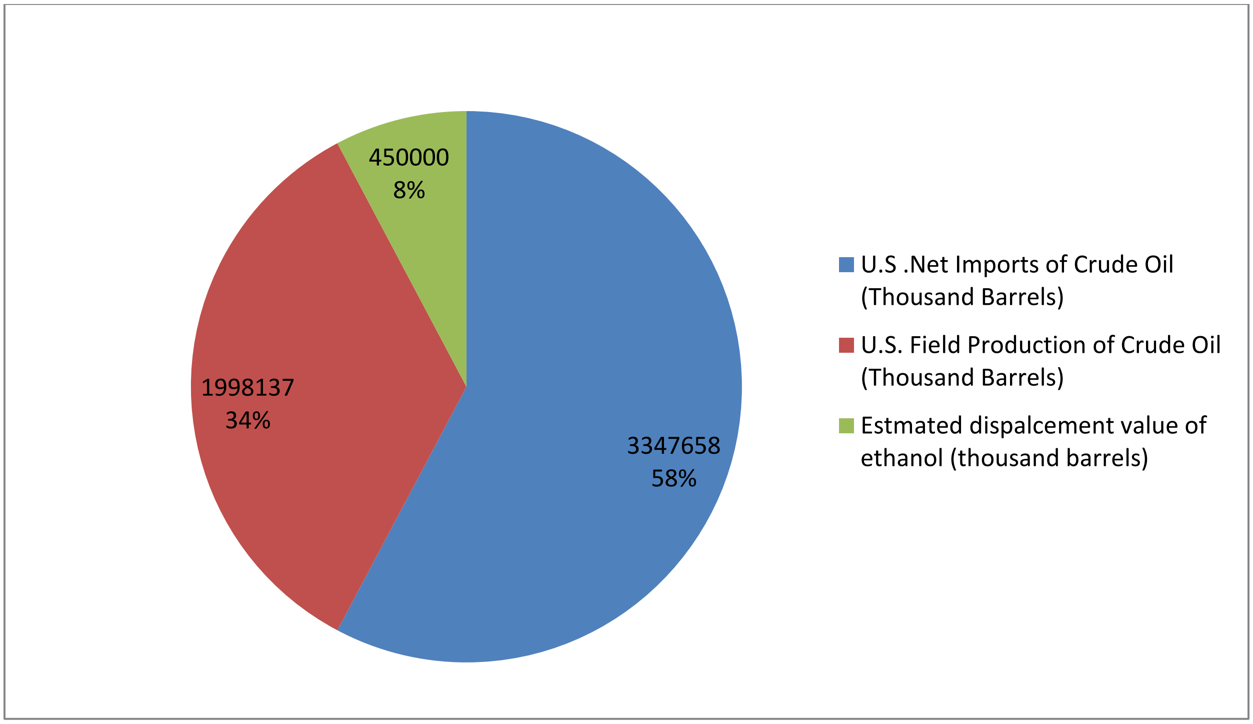
Figure 3. 2010 U.S. Net Import and Production of Crude Oil



Source: U.S. Energy Information Agency

Figure 3 (above) shows the U.S. production and import of crude oil. Figure 4 (below) shows U.S. production of crude oil and U.S. imports of crude oil with ethanol production displacing oil importation. This is what is claimed in the RFA's July 2007 letter to President Obama.

Figure 4. 2010 Ethanol Displacement of Crude Oil



Source for Data: U.S. Energy Information Agency and Renewable Fuels Association

Given a total crude input and the estimated ethanol contribution the percent increase in U.S. crude oil supply without displacement is as follows:

Equation 5. Percent Increase of Crude Oil with Displacement

$$\left(\frac{(final - begining\ )}{beginning}\right)(100) = percent\ change$$

$$\left(\frac{(450000)}{5345795}\right)(100) = 8.4\%\ \text{ gain}$$

The RFA claims that 13 billion gallons of ethanol was able to displace 450 million barrels of crude oil. This shows an 8.4% gain in U.S. crude supply. The previous calculation only accounts for crude oil net import and crude oil produced in the U.S. as seen in Figure 5 and Equation 4. I feel that the production of ethanol extended the amount of crude used and that it should be included, and not subtracted from the actual crude oil imports and production. No data was included for finished gasoline imports, or the gasoline denaturant used in finished fuel ethanol. Ethanol is considered by the report to be a direct replacement for gasoline. The comparison between crude oil use and ethanol is not as accurate as comparing net ethanol use in U.S. refineries and blenders to total gasoline production in the U.S..

In 2010 U.S. ethanol was exported, gasoline was used for a denaturant in all ethanol production and included in the total of ethanol production tally, and crude oil also provides additional products during refining as shown in Figure 6. Converting the Net annual input of ethanol to blenders and refineries to the gasoline equivalent, with comparison to an adjusted (finished fuel minus actual ethanol input plus adjusted fuel equivalent of ethanol) finished gasoline supply will provide a more accurate representation of ethanol benefits to the U.S. fuel supply.

Equation 6. Percent Increase of U.S. Fuel Supply Without Displacement

2010 Net Input to Refinery and Blenders of Fuel Ethanol = 285883 thousand barrels

2010 Net production of U.S. gasoline = 3306400 thousand barrels

Energy Equivalent of Ethanol = 1.52

$$\left(\frac{(Input\ of\ fuel\ ethanol)}{EEE}\right) = gasoline\ equivalent\ of\ ethanol$$

$$\left(\frac{(285883\text{ thousand barrels of ethanol})}{1.52}\right) = 188081\ thousand\ barrels\ gasoline\ equivalent\ of\ ethanol$$

$$(Net\ production\ of\ US\ gasoline - \ Net\ Input\ of\ Fuel\ Ethanol) = adjusted\ US\ production\ of\ gasoline$$

$$(3306400 - 285883) = 3020517\ thousand\ barrels\ of\ gasoline\ (adjusted)$$

$$(adjusted\ production\ of\ gasoline + gasoline\ equivalent\ of\ ethanol) = adjusted\ total\ production$$

$$(3020517 + 188081) = 3208598\ thousand\ barrels\ total\ (adjusted)$$

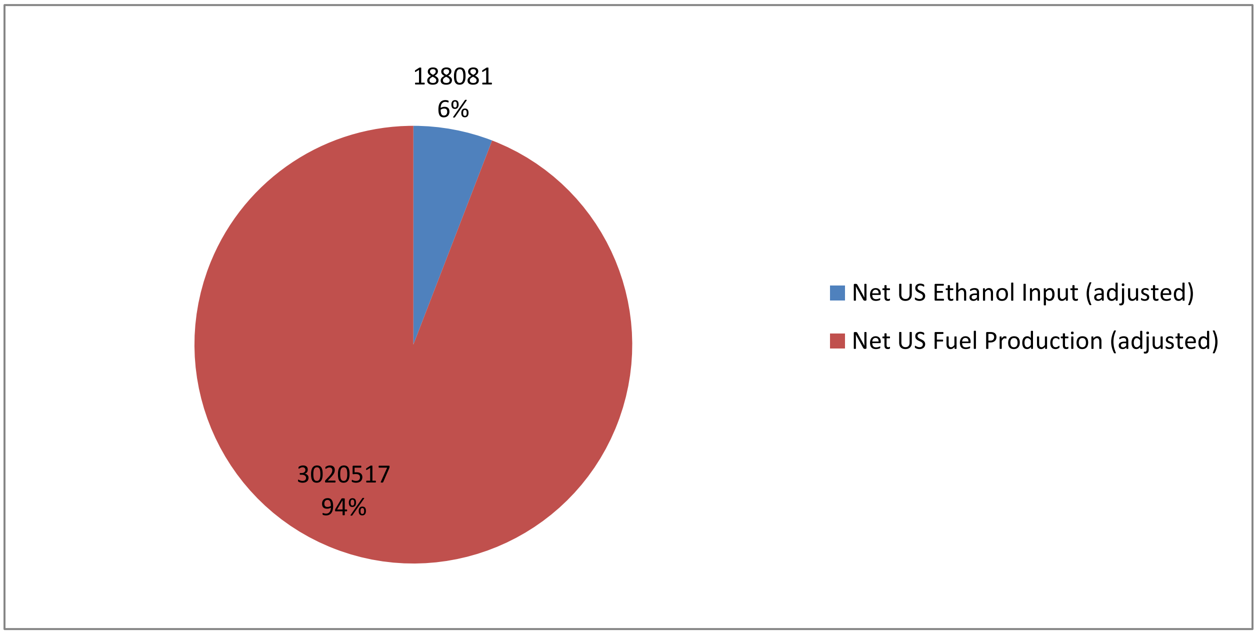
$$\left(\frac{(final - begining\ )}{beginning}\right)(100) = percent\ change$$

$$\left(\frac{(188081)}{3020517}\right)(100) = 6.2\%\ increase$$

Source for net inputs and net production: U.S. Energy Information Agency

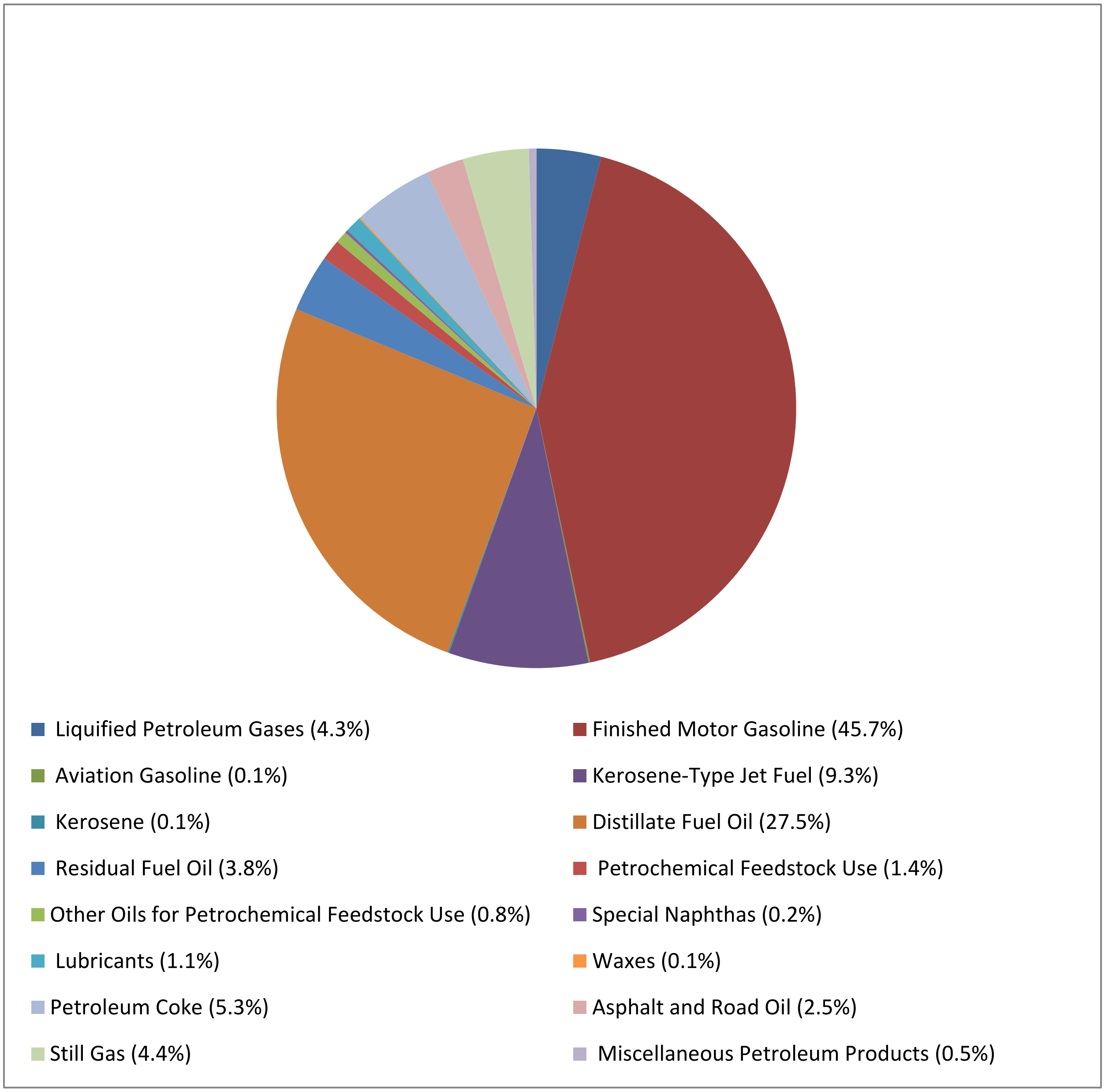
Figure 5 (below) shows a different comparison. Instead of comparing ethanol production to crude oil importation, now we are comparing an ethanol input that has been converted to its gasoline equivalent in volume to U.S. Fuel production that has the ethanol input removed as shown in Equation 6 (above).

Figure 5. 2010 Adjusted Fuel Production with Ethanol Input



Source for Data: U.S. Energy Information
Calculated from Equation 6

Comparison shows a decrease in percent when comparing total ethanol production to crude oil import and production (+8.4%) to net ethanol input to finished gasoline supplies (+6.2%). Saying that ethanol displaces crude oil could be misleading since refining crude oil also produces additional products not accounted for. Products such as diesel fuel, kerosene and jet fuel are also produced and consumed or exported as shown in Figure 6.



<u>Figure 6. 2010 U.S. Refinery Average Yield of Products from Crude Oil</u>

Source: (US Energy Information Agency)

Current Issues

Land use change encompasses a wide variety of issues. Issues such as resource consumption and degradation, global warming, and worldwide food availability are all related to changing land use, both direct and indirect. Concerns have been raised about increases in greenhouse gas emissions from land use change offsetting reductions obtained from the usage of biofuels, (Searchinger, Heimlich and Houghton 1238) and the amount of energy used in the production of corn ethanol. (Patzek, Anti and Campos 319) In August of 2009, the U.S. Government Accountability Office (GAO) produced a report titled "BioFuels: Potential Effects and Challenges of Required Increases in Production and Use" detailing the studies performed and potential impacts on a large variety of issue, from economics to environmental impacts. The report summarizes expert opinions on aspects of ethanol production, and identifies relationships between ethanol demand and issues. In summary the report states that:

- Increased corn ethanol production has had mixed effects on land use, crop selection, and livestock production.
- Growth in ethanol production has generally provided a boost to rural economies.
- Higher corn prices, driven in part by increased ethanol production, have been a factor in recent food price increases.
- The effects of expanded biofuels production on agriculture are uncertain but could be significant.
- Increased cultivation of corn ethanol could further stress water supplies.

- Increased corn cultivation is likely to impair water quality.
- Biofuels production can affect soil quality and productivity.
- Habitat and biodiversity may be compromised with increased biofuels feedstock cultivation.

Large discrepancies arose during the evaluation of how ethanol production affects greenhouse gas emission. Issues on how to account for agricultural input, energy input, co product energy value and indirect land use change significantly vary the results of the studies. The report recommends that the government develop a way to account for these variables in order to effectively determine all costs of increased biofuels production.

Materials and Methods

Data from the Nebraska Ethanol Board was used to identify the ethanol plants that were in operation as of 2005. After identification, the counties of Nebraska were divided, based upon their geographical relationship to counties containing the 2005 active ethanol plants. The county selection was performed using QGIS software, with 50 km and 120 km buffers created around towns nearest the ethanol plants, and county selection based upon distance from plant towns. The following categories were created:

1. Counties with active ethanol plants
2. Counties located within 50 km
3. Counties located within 120 km
4. Counties located past 120 km
5. All counties

County level data was obtained from the 1997 and 2007 Census of Agriculture, using the USDA NASS Quick stats ad hoc query tool. (USDA NASS) The data collected for all counties of Nebraska include the following sections:

1. Agricultural Cropland (Acres)
2. Fertilizer Totals including Lime and Soil Conditioners (Acres Applied)
3. Agricultural Land in Conservation and Wetlands Programs (Acres)
4. Agricultural Land in Conservation and Wetlands Programs (Number of Operations)
5. Corn for Grain Production, (Bushels)
6. Cattle, Cows, Inventory (Population)

Using Microsoft Excel the data was organized and 1997 to 2007 percent change calculated for each county. This data was then joined to the county data with the GIS program using a second party plug-in program created for use with the QGIS software. Maps were then created, representing each county's percent change. The results were also graphed using Microsoft Excel in each category of the six sections. The XY scatter graphs are arranged by percent change vs. county. The counties are organized in order of increasing distance selection, and arranged alphabetically within each section, with trend lines and slope labeled on the graph.

Results

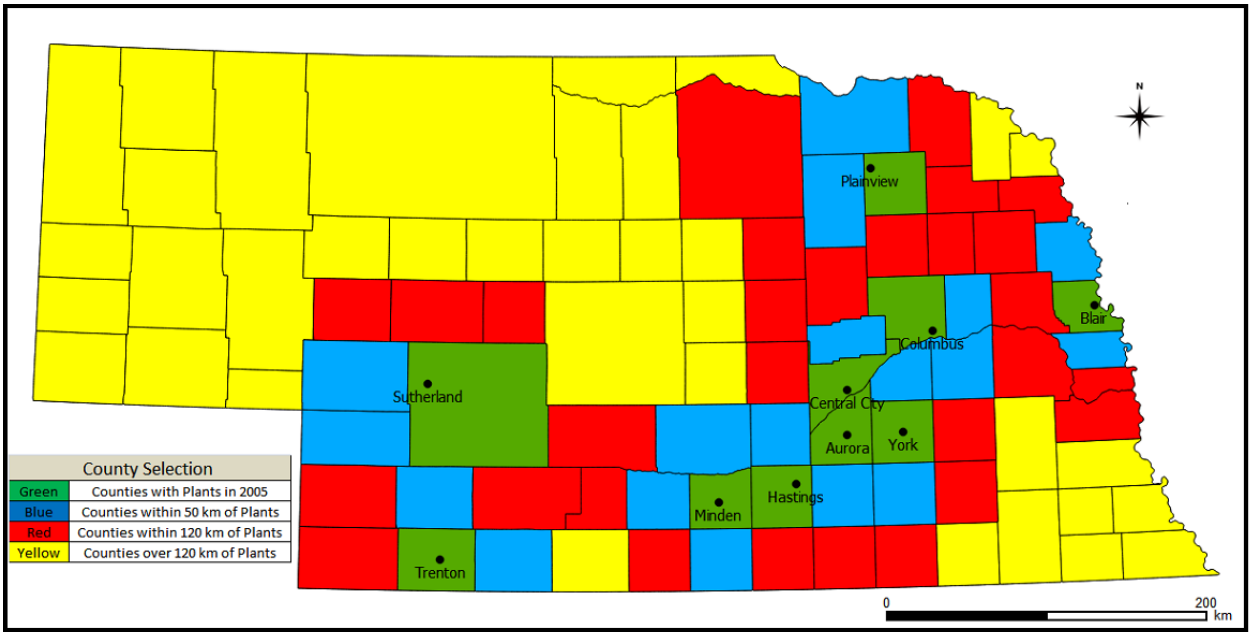
Table 2. Nebraska Ethanol Plant Selection Summary

City	County	Company	Year start of production	2005 Capacity (Million Gallons)
Sutherland	Lincoln	Midwest Renewable Energy, LLC	2004	28
Trenton	Hitchcock	Trenton Agri Products, LLC	null	30
Minden	Kearney	KAAPA Ethanol, LLC	null	40
Hastings	Adams	AGP	1995	52
Aurora	Hamilton	Aventine Renewable Energy INC	1995	40
Central City	Merrick	Platte Valley Fuel Ethanol LLC	2004	40
York	York	Abengoa Bioenergy	1994	55
Columbus	Platte	ADM	1992	80
Plainview	Piece	Husker Ag. LLC	2003	24
Blair	Washington	Cargill INC	2003	85

Source Data obtained from the Nebraska Ethanol Board

The county selection process identified ten ethanol plants operating in 2005, with annual ethanol production capabilities ranging from 24 to 85 million gallons annually. These plants had been in operation for 1 to 11 years prior to 2005. 18 counties were identified as being within 50 km of the 2005 ethanol plant selection. Lancaster and Furnas counties were excluded from this selection due to the small amount of area contained in the buffer. 29 counties were identified as being within 120 km, and an additional 36 counties as being over 120 km from the ethanol plant selection as seen below in Map 1 and above in Table 2.

Map 1. County Selection



Source Data obtained from the Nebraska Energy Board

Table 3 summarizes the percent change and organizes it according to distance from the ethanol plant selections, the colors correspond to the county selection Map 1.

Table 3. Percent Change by Category and County Selection

	Agricultural Cropland (Acres)	Chemical and Fertilizer (Acres)	CRP Operation	CRP Acres	Corn Production (Bushels)	Cattle Population
State Average	-5.61	25.75	21.15	11.00	129.82	-4.12
State N	93.00	93.00	93.00	93.00	93.00	93.00
Standard Dev.	11.51	26.99	48.70	55.19	372.02	22.35
Minimum	-47.05	-13.03	-66.67	-76.74	-92.10	-73.81
Maximum	22.29	142.14	238.57	248.15	2697.86	76.17
Ethanol County Average	-5.39	15.15	27.53	27.55	106.59	-2.53
N	10.00	10.00	10.00	10.00	10.00	10.00
Standard Dev.	11.01	24.63	58.56	65.23	159.00	26.01
Minimum	-24.16	-7.26	-18.42	-34.91	-77.99	-38.61
Maximum	19.48	73.15	188.06	138.10	399.79	41.22
Counties within 50km Average	-6.84	20.18	29.21	4.32	53.05	-6.90
N	18.00	18.00	18.00	18.00	18.00	18.00
Standard Dev.	8.86	16.49	41.27	46.21	95.24	29.72
Minimum	-22.07	-2.84	-45.45	-68.48	-12.68	-73.81
Maximum	18.73	73.96	107.02	85.91	351.29	76.17
Counties within 120km Average	-5.76	26.85	32.87	20.77	241.57	-3.19
N	29.00	29.00	29.00	29.00	29.00	29.00
Standard Dev.	11.71	20.26	57.89	53.02	566.06	16.00
Minimum	-47.05	-9.74	-44.66	-59.77	-77.57	-25.46
Maximum	17.38	80.63	238.57	145.67	2697.86	41.51
Counties over 120km Average	-4.95	30.59	5.92	1.88	84.63	-3.93
N	36.00	36.00	36.00	36.00	36.00	36.00
Standard Dev.	12.96	35.00	38.02	55.81	284.46	22.35
Minimum	-29.92	-13.03	-66.67	-76.74	-92.10	-37.86
Maximum	22.29	142.14	72.73	248.15	1574.65	72.11
Eth. County	-5.39	15.15	27.53	27.55	106.59	-2.53
50	-6.84	20.18	29.21	4.32	53.05	-6.90
=120	-5.76	26.85	32.87	20.77	241.57	-3.19
+120	-4.95	30.59	5.92	1.88	84.63	-3.93
Pearson	0.37	1.00	-0.55	-0.54	0.32	0.02

<u>Figure 7. 1997 to 2007 Summary of Percent Change</u>

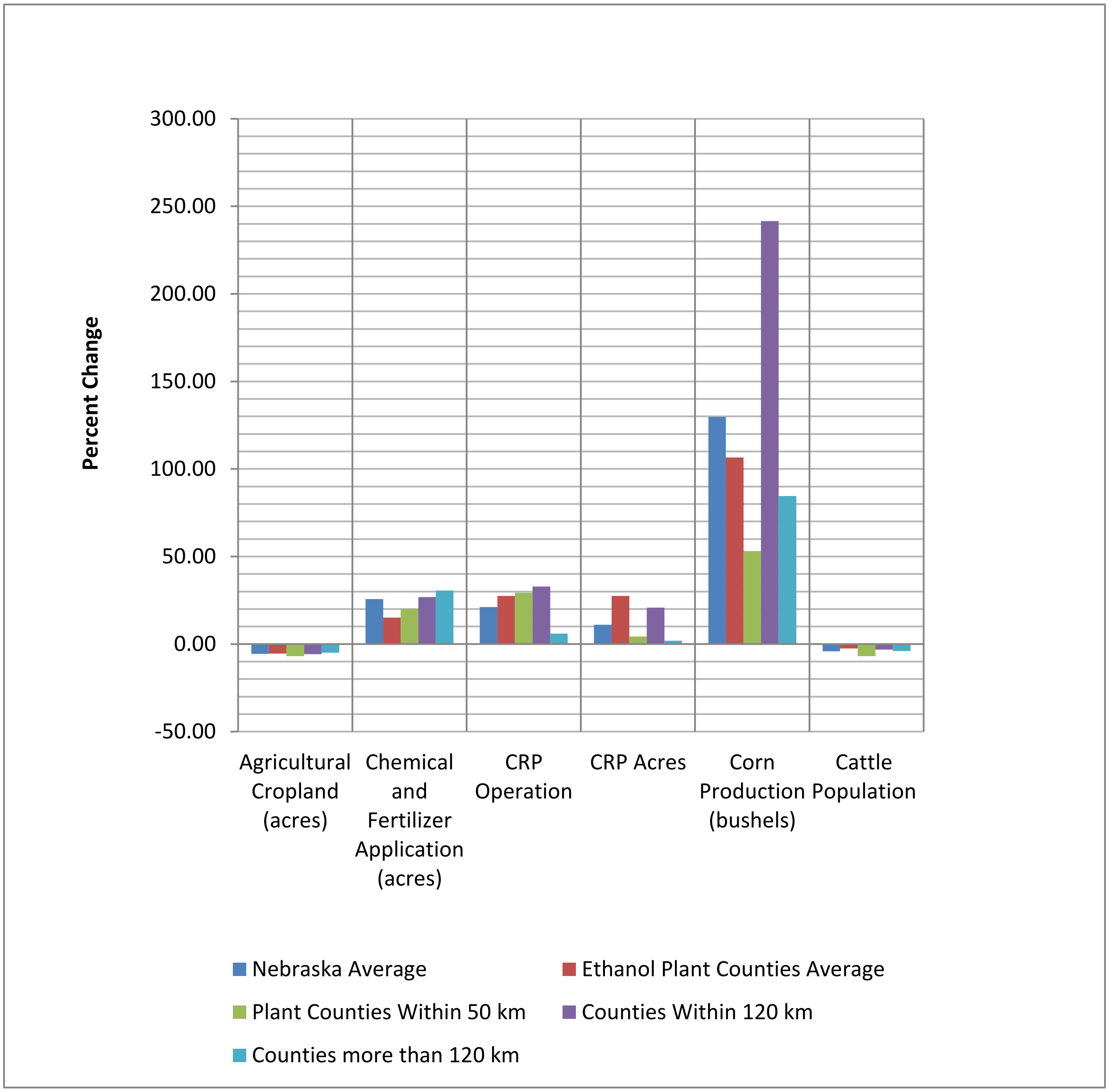
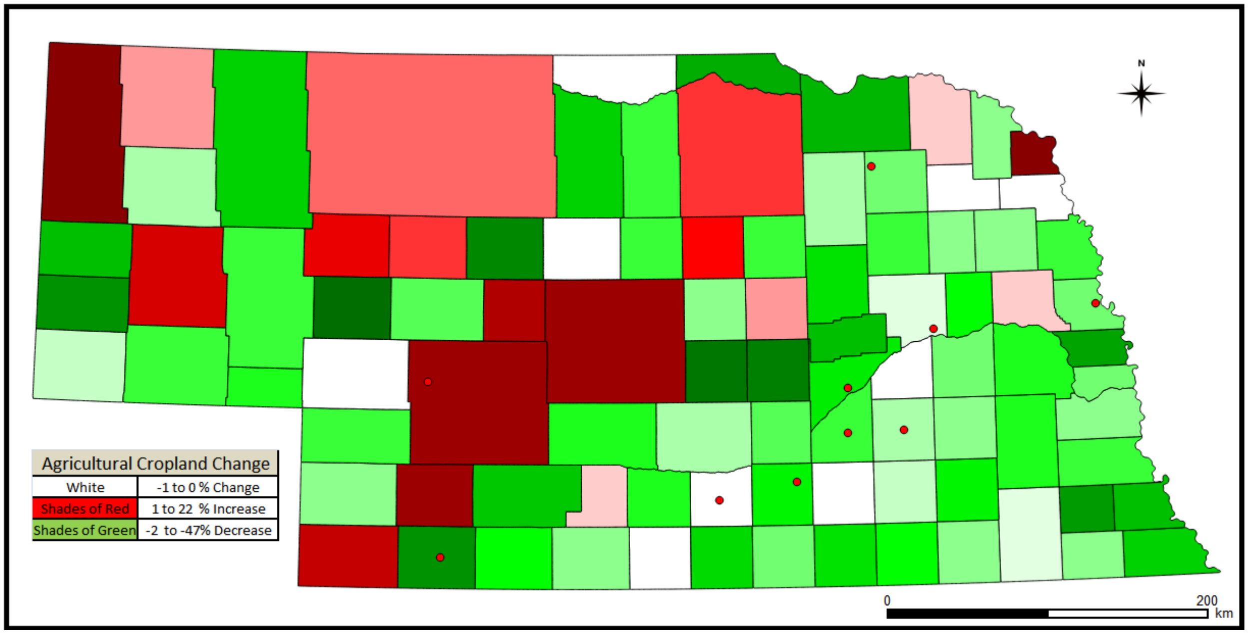


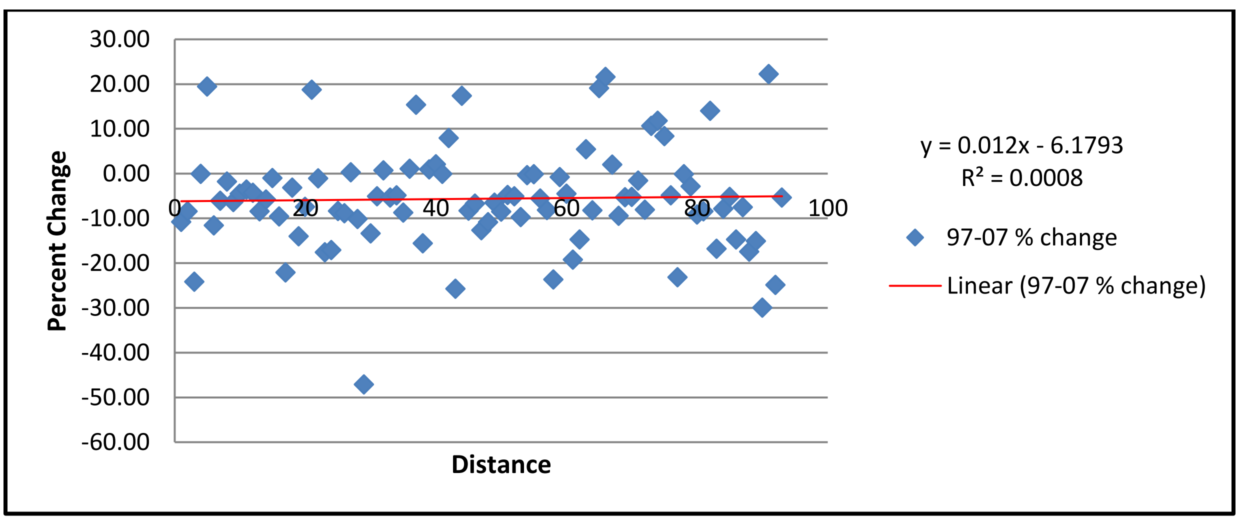
Table 7 summarizes the percent change and compares it to the state average while showing change according to distance. Notice the reduction in percent change in both the Agricultural Cropland and Cattle Population categories and the increase in change for the Chemical and Fertilizer Application.

Map 2. Agricultural Cropland Percent Change (Acres)

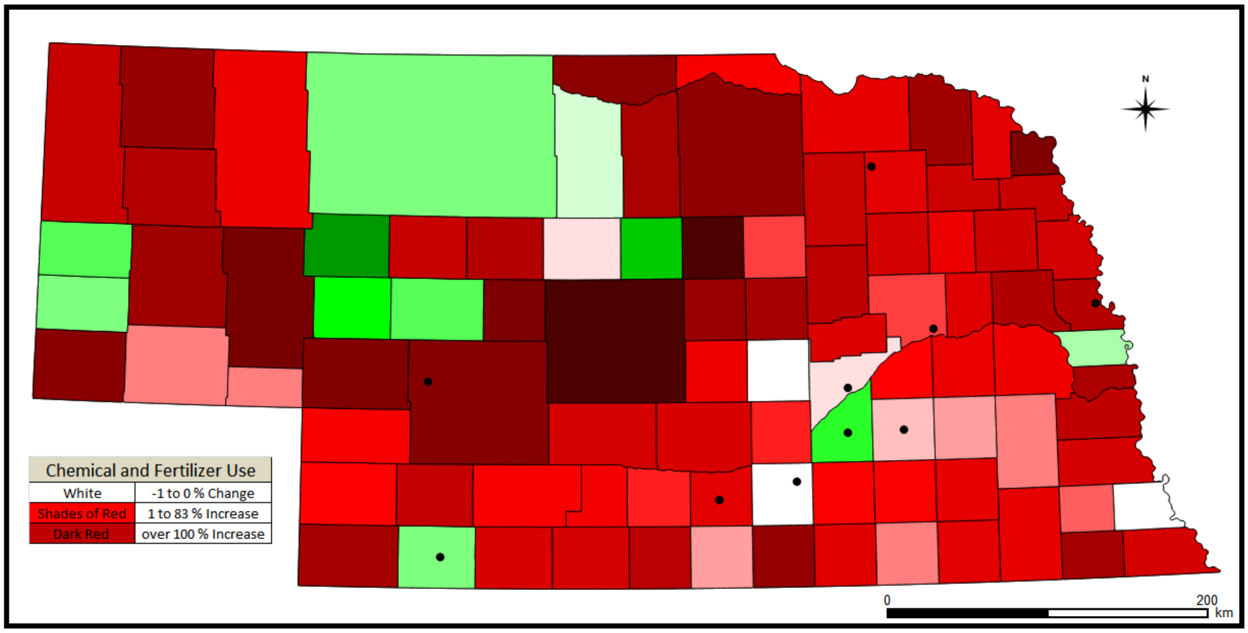


The statewide results showed consistent average decreases of acres in Agricultural Cropland across the state with limited correlation to distance.

Figure 8. Agricultural Cropland State Average Percent Change

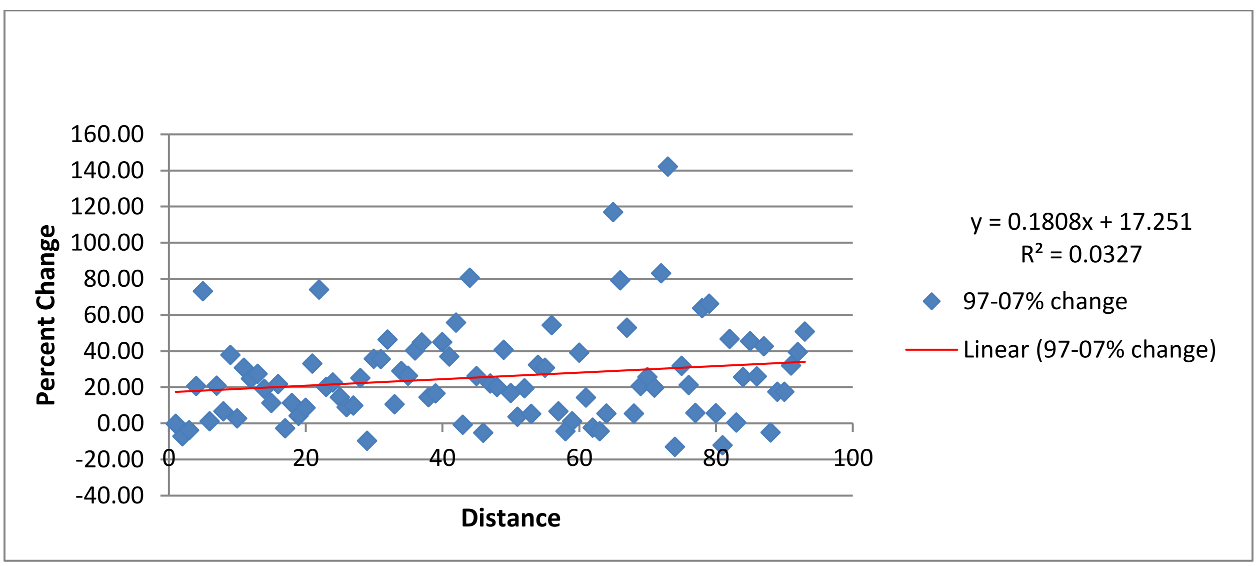


Map 3. Chemical and Fertilizer Use Percent Change (Acres)

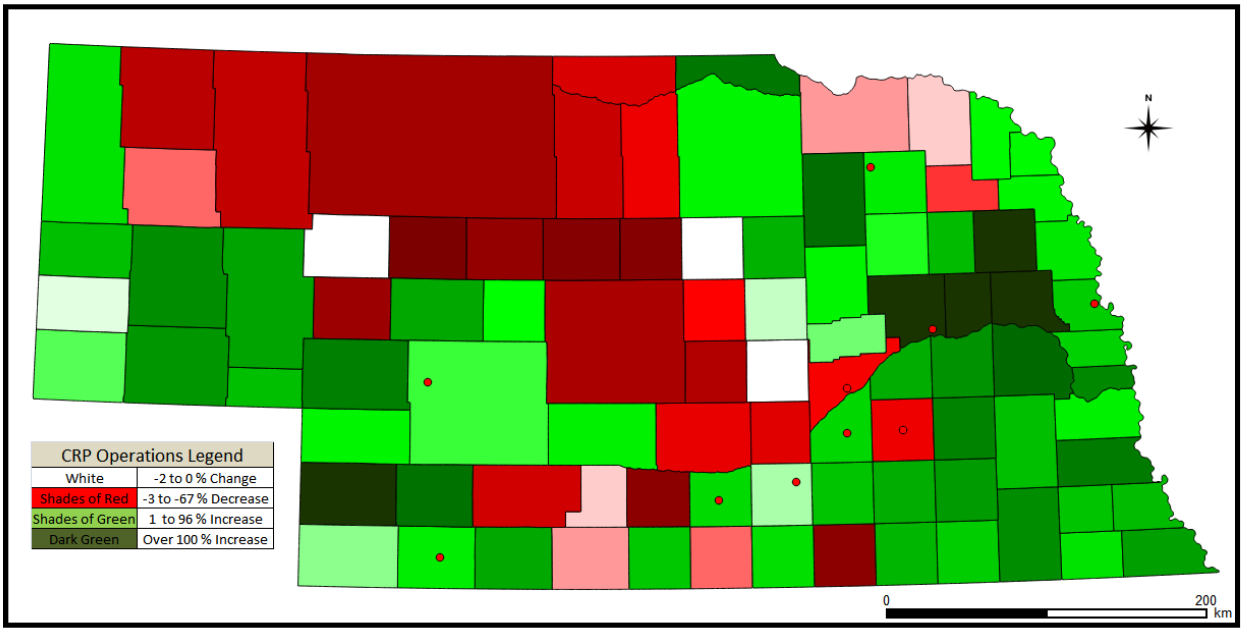


Chemical and fertilizer application of acres consistently increased as distance increased from the ethanol plant county selection.

Figure 9. Chemical and Fertilizer Use Percent Change (Acres)

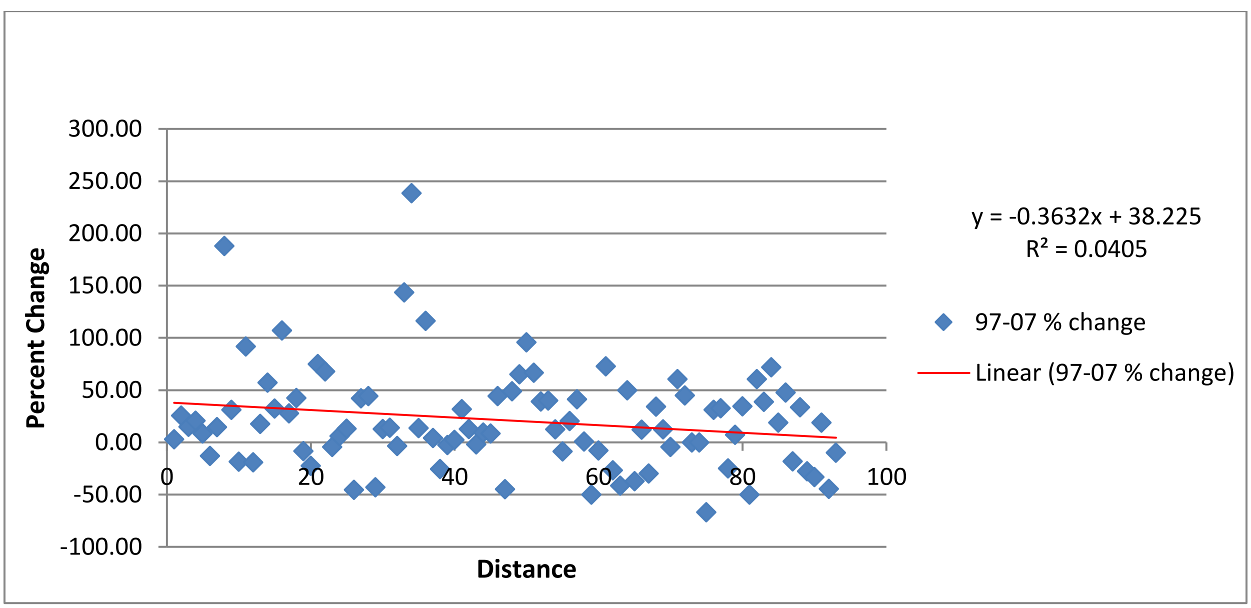


Map 4. CRP Operations Percent Change

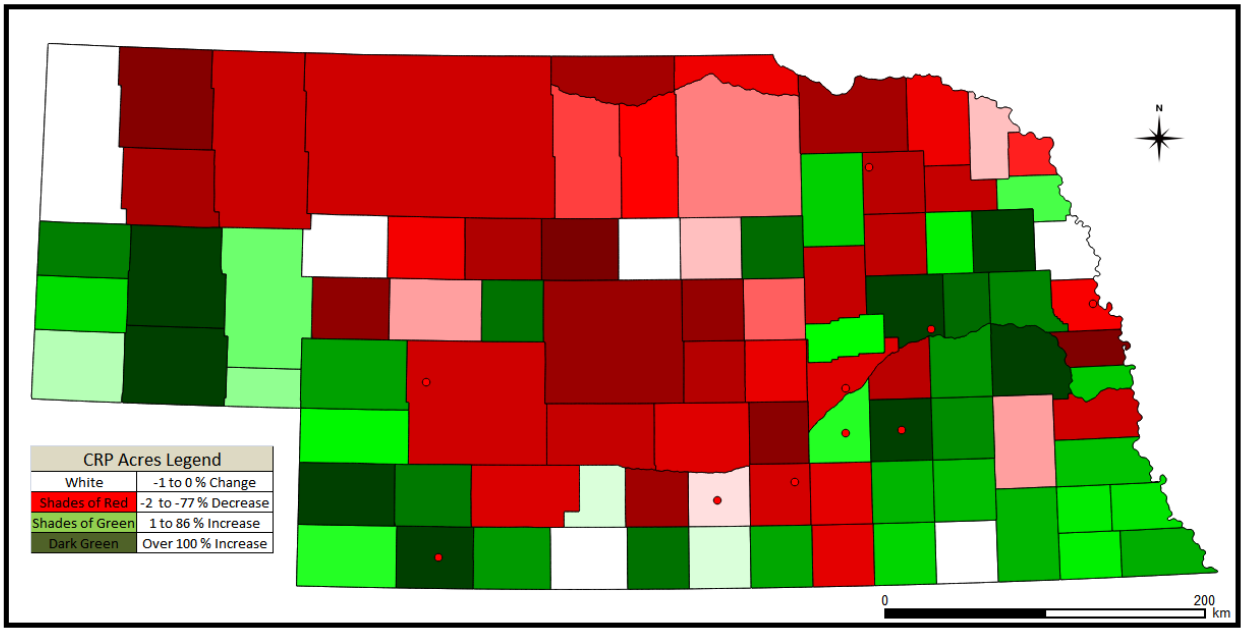


CRP operations increased consistently within the 120 km range but dropped significantly in the 120+ km range.

Figure 10. CRP Operations Percent Change

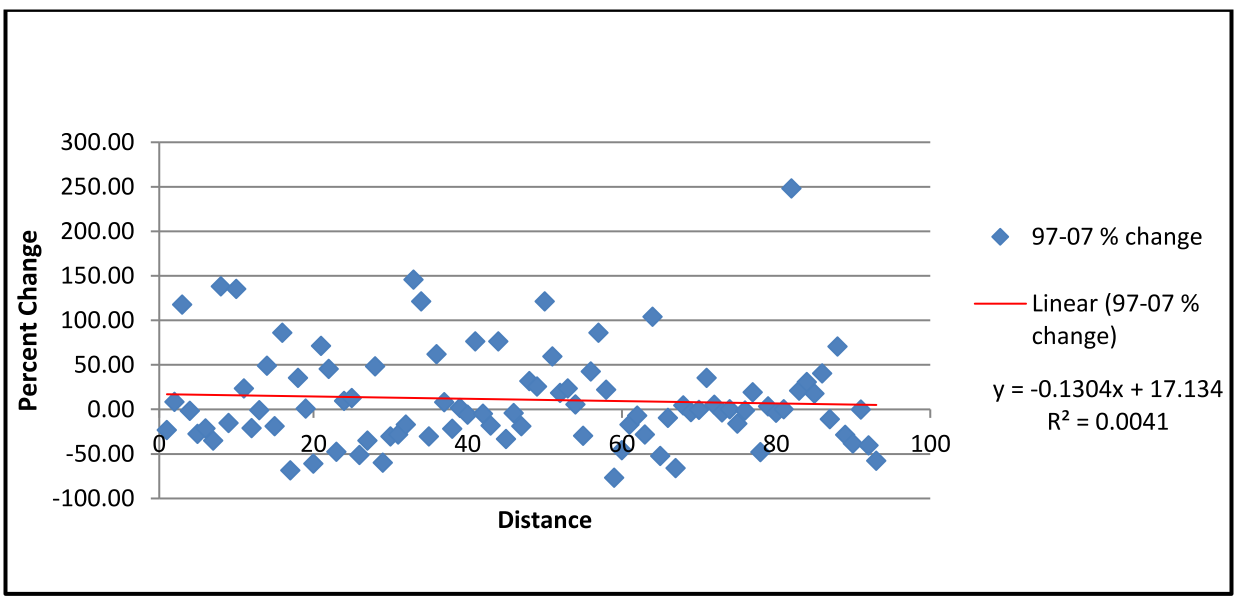


Map 5. CRP Acres Enrolled Percent Change

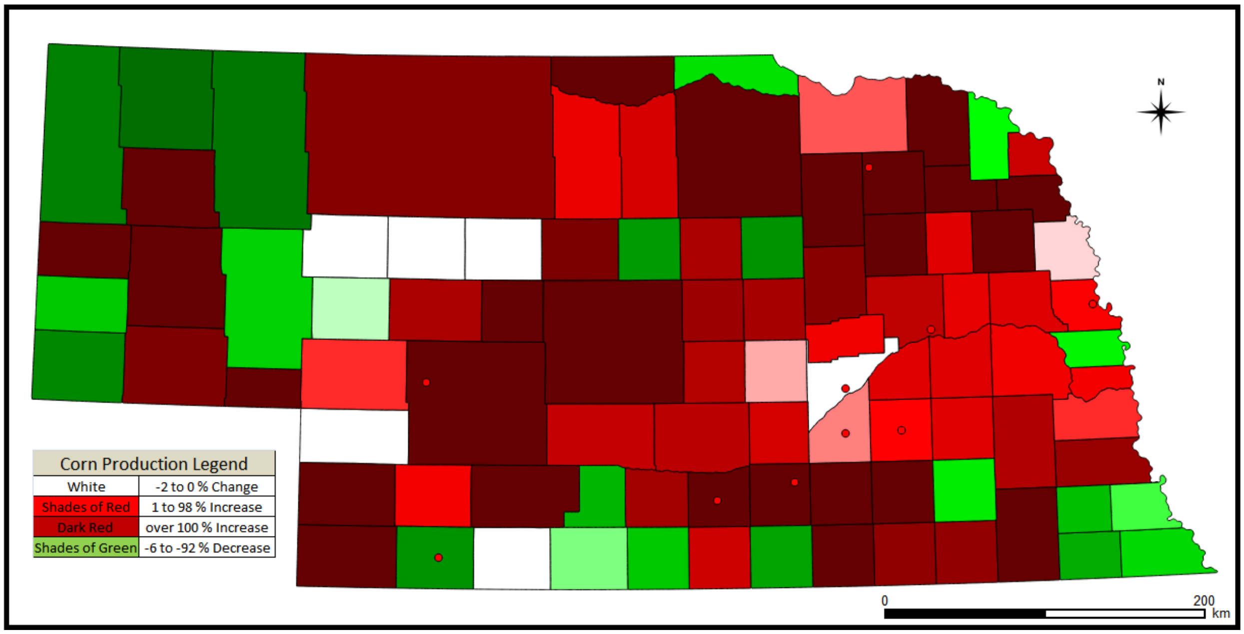


CRP acres increased in the ethanol plant county selection and the 120 km range, with minimal increases in the 50 km and 120+ ranges.

Figure 11. CRP Acres Enrolled Percent Change

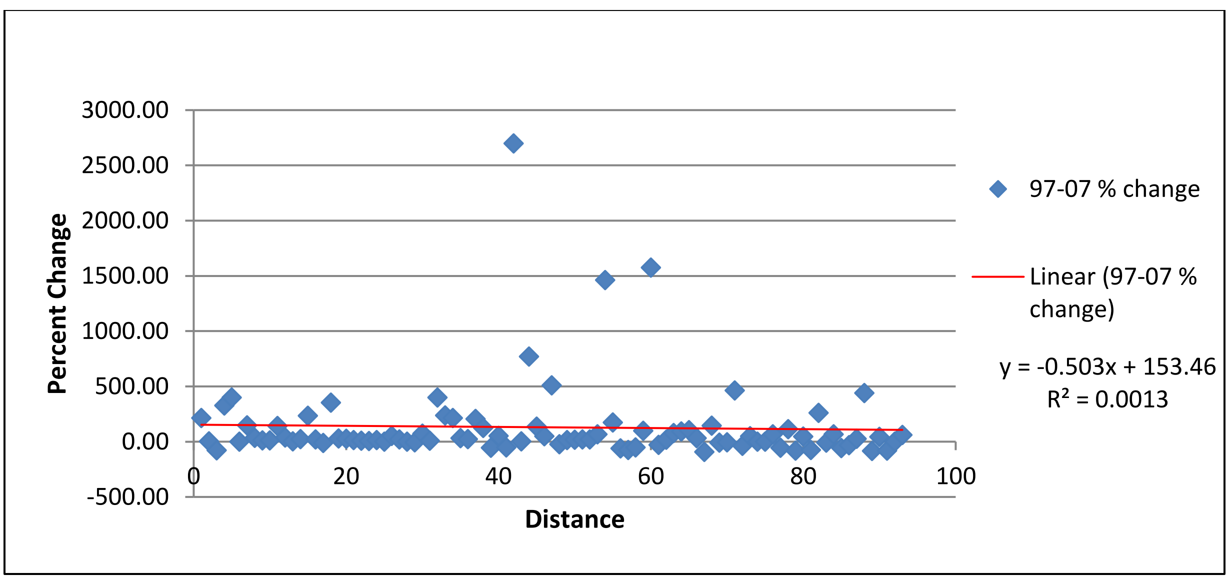


Map 6. Corn Production Percent Change

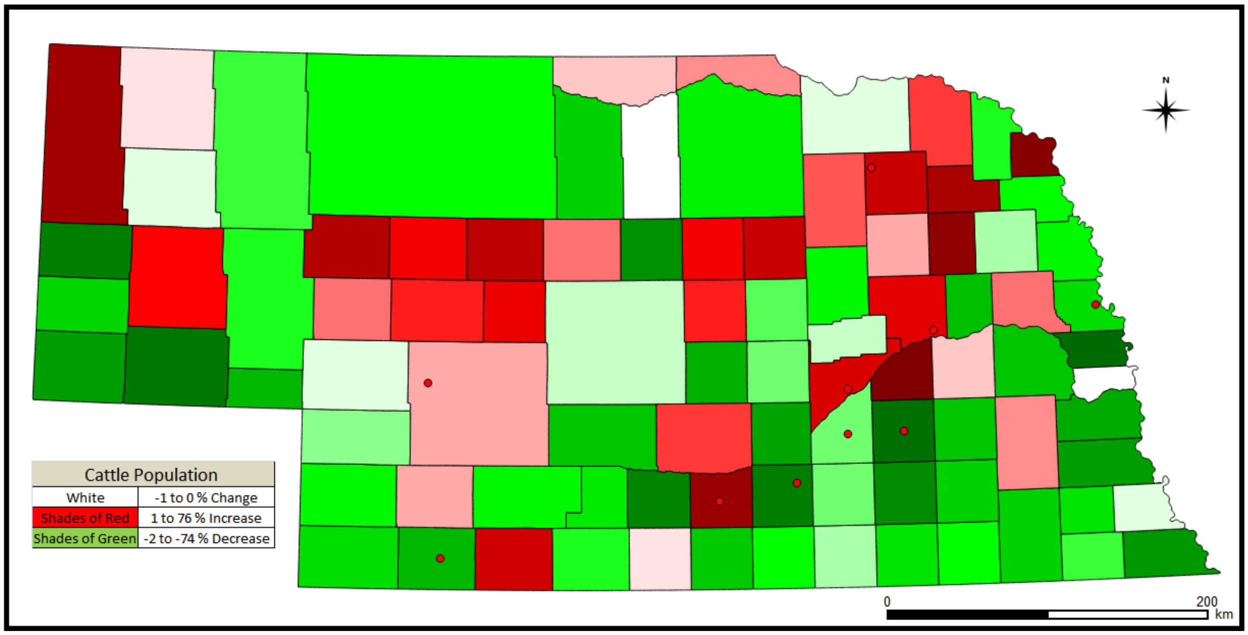


Corn production in bushels increased statewide with the greatest percent increase in the 120 km range,

Figure 12. Corn Production Percent Change

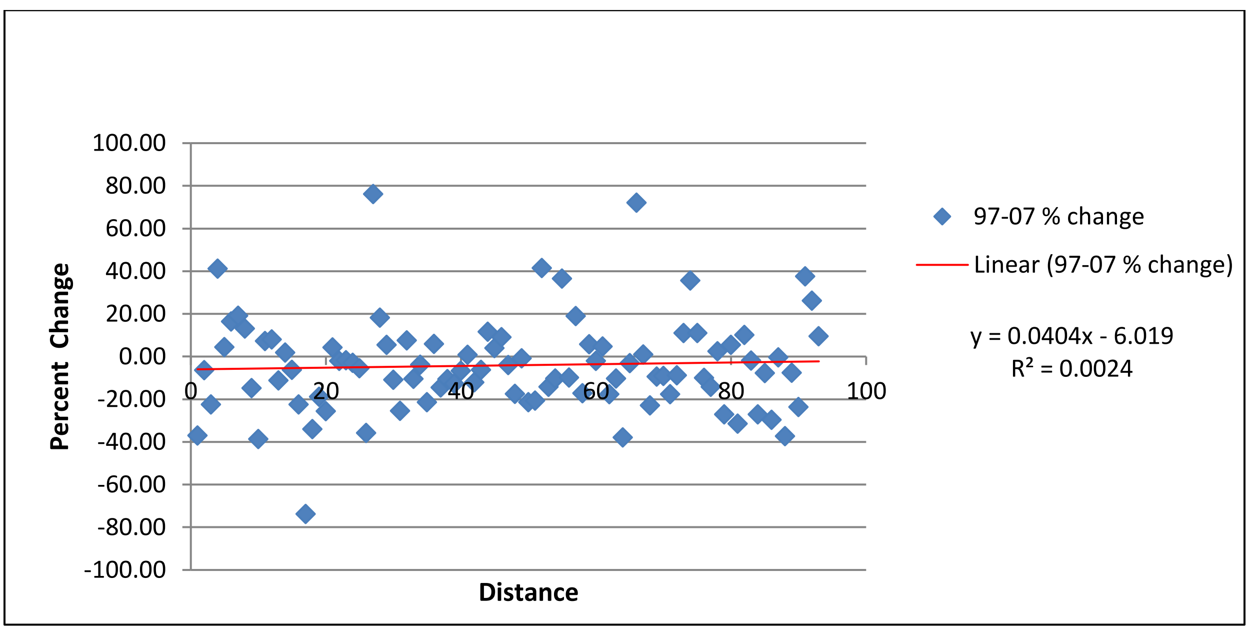


Map 7. Cattle Population Percent Change



Cattle population showed consistent decreases across the state and at all distances

Figure 13. Cattle Population Percent Change



Discussion

The expected result for the Agricultural Cropland variable is that there would be larger increases in agricultural acres closer to the ethanol plant selection than the state average and the additional county selections. Figure 7 and Figure 8 both show statewide average decreases consistently across all county selections. Map 2 shows decreases of 2 to 47 % around the ethanol plant sites and increases of 1 to 22 % to the North and West areas of the State. The results of both the averages and graphical representation do not show an increase or a trend consistent with the expected results. Figure 8 also supports the results showing consistent decrease with minimal slope.

The expected results for the Chemical and Fertilizer Acres Applied variable is that there would be a greater increase closer to the ethanol plants than the state and other county selections. The Figure 7 and Figure 9 results show a consistent increase of acres as distance increased from the ethanol plant sites. The Map 3 results show statewide increases from 1 to 100+ %, with minimal decreases ranging from 2 to 13%. The majority of the increase is closer to the ethanol plant sites than the counties with decreases. The Figure 7 and Figure 9 trend identified is opposite from what was expected and does not support the initial expectations.

The expected results for the CRP Operations variable is that there would be a greater decrease closer to the ethanol plant county selection than the state average and other county selections. The Figure 7 and Figure 10 results show an increase in CRP operations in all counties within 120 km. The state average is lower than the plant sites, and the 120+ km selection shows a significant reduction in gains. Map 4 results show decreases farther away from the plant county selections. The results do not support the initial expectations.

The expected results for the CRP acres enrolled variable is that there would be a greater decrease closer to the ethanol county plant selection. Figure 7 and Figure 11 show the largest increase in acres is located in the ethanol plant county selection. Map 5 results shows both increases and decreases in all counties and no spatial pattern. The results do not support the initial expectation.

The expected result for the corn production variable is that there would be an increase in areas closer to the ethanol plant county selection. The Figure 7 show increases in all selections and the state average with a minimal relation to distance. Map 6 also shows a large majority of the corn production increases in the vicinity of the ethanol plant county selections. Figure 12 shows a slight decrease in production as the distance from the plant county selection increases. The results do support the initial expectations.

The expected result for the cattle population variable is that there would be an increase in the cattle population nearer the plant county selections. Figure 7 and Figure 13 show state wide decreases with the largest decreases in the counties within 50 km of the ethanol plant county selections. Map 7 supports this information with the majority of the decrease in the vicinity of the plant county sites. The results do not support the initial expectations.

The strongest relationship identified was the percent increase in acres of chemical and fertilizer application. The data show a statewide increase with a correlation between distance and percent increase, the results were opposite of what was expected but mimicked the type of relationship that was expected for other categories.

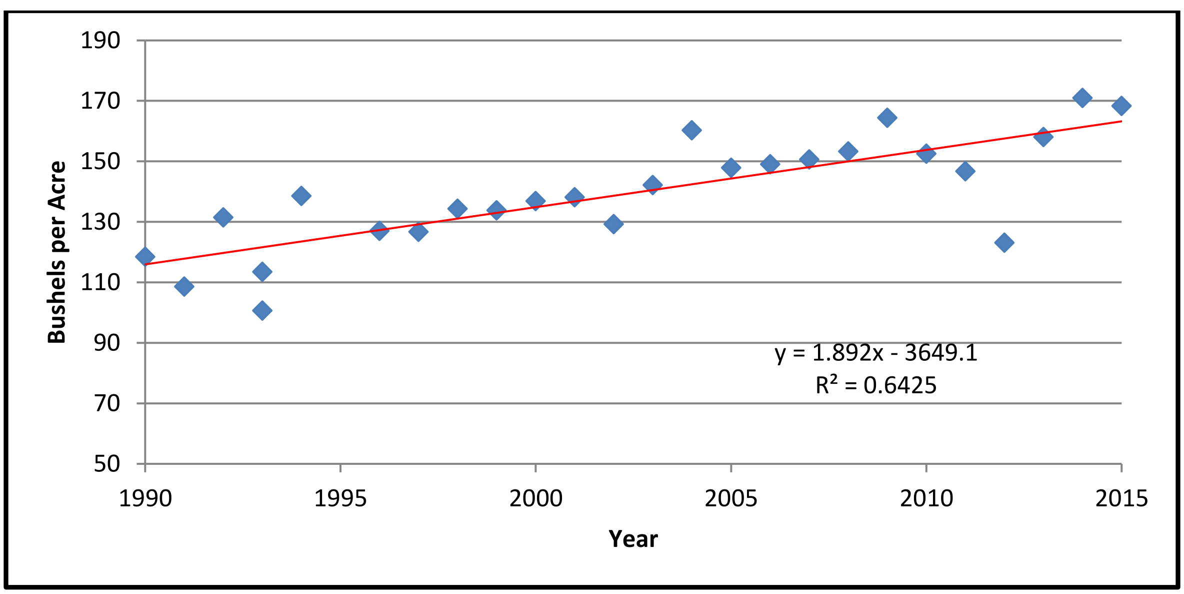
Conclusion

This study was performed to determine if ethanol plant locations affected changes in agricultural practices in Nebraska from 1997 to 2007. Agricultural county level data was collected for the state of Nebraska. The percent change for all variables was calculated, mapped and graphed as a function of distance from the ethanol plant locations. Agricultural Cropland and Cattle Population both showed a minimal decrease at all distances and reflected the state average. The number of CRP operations increase as distance increases up to 120 kilometers and then falls well below the state average for the counties located more than 120 kilometers away from the ethanol plant selection. CRP Acres Enrolled and Corn Production variables show no noticeable relation to distance. The Chemical and Fertilizer Application variable showed the strongest relationship to distance with a steady increase in acres applied as distance increased, showing that there might be a relationship to ethanol plant location. Expected results were that application would be greater closer to the ethanol plant county selections.

The majority of this project was completed in late 2011. Since then, agricultural data has been updated, new and current studies have been performed and new information has been published. The initial expectation of this project was based upon the fact that during the 1997 to 2007 time frame ethanol production increased from 267,785,000 gallons to 1,282,500,000 gallons (Nebraska Ethanol Board). With this 379 percent increase in ethanol production the expected results would be noticeable on map and chart graphics. After reviewing the results and current literature, several key reasons have been identified that explain why the hypothesis is not proven. One main component that was not accounted for is the use of the co product of ethanol production, dried distillers grain with solubles, as a feed stock for cattle. The use of this feed product reduces the amount of land needed for cattle feed production. In 2011 when accounting for the amount of feedstock used reduced the amount of land needed for ethanol production from 40.5 percent to 25 percent (Mumm, Goldsmith and Rausch 1). This factor would need to be addressed in future studies to accurately identify the amount of corn production and agricultural cropland change over time that might be attributed to ethanol production.

Annual crop yield increases due to the use of better crop management technologies, the continued development hybrids, and genetic variations, also affected the result of this study Yields increased over time with an average increase of 1.8 percent per year (Elgi 79). Current trends in the U.S. show an increase in average corn yield from 118 bushels per acre in 1990 to 168 bushel per acre in 2015 as seen below in Figure 14 (United States Department of Agriculture).

Figure 14.U.S. Average Yield for Corn (Bushels per Acres) From 1990 to 2015



Source (United States Department of Agriculture)

The use of the Conservation Reserve Program enrollment variables as a environmental impact measure is also misleading. This program is entirely voluntary and has a national cap placed on acres enrolled. National CRP enrollment peaked in 2007 with 36.8 million acres enrolled. National caps placed on enrollment reduce the cap to 24 million acres by 2018. Enrollment periods generally last for 10 or 15 years with large penalties for removing land from the program early (Stubbs 9). Controlling factors such as these do not allow for fluctuation on annual basis, creating problems when measuring change over time. Perhaps a better measure would be wildlife population counts or occurrences of specific compounds related to agricultural production in local water supplies.

Improvements in all aspects of ethanol production over time increase production efficiency, reducing the amount of inputs needed to produce the equal amount of product at a previous time. Improvements have been made and are continually being developed (Gallagher, Yee and Baumes 1)   Not accounting for the development of better management practices and technological advancement when conducting a study of change over a time period reduces the accuracy of the results. Future studies need to account for these and other variables in order to provide accurate information.

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APPENDIX A

County Data

Source for base data (USDA NASS)

County	Agricultural Cropland (Acre)			
	1997	2007	97-07 Change	97-07 % Change
ADAMS	297,365	265,408	-31957	-10.75
ANTELOPE	382,639	369,071	-13568	-3.55
ARTHUR	58,541	30,999	-27542	-47.05
BANNER	221,807	169,408	-52399	-23.62
BLAINE	43,557	43,211	-346	-0.79
BOONE	326,340	282,746	-43594	-13.36
BOX BUTTE	402,326	384,396	-17930	-4.46
BOYD	111,731	90,271	-21460	-19.21
BROWN	134,609	114,848	-19761	-14.68
BUFFALO	388,198	371,615	-16583	-4.27
BURT	269,230	246,588	-22642	-8.41
BUTLER	313,677	295,608	-18069	-5.76
CASS	259,921	246,870	-13051	-5.02
CEDAR	363,300	365,996	2696	0.74
CHASE	327,045	309,580	-17465	-5.34
CHERRY	393,288	414,749	21461	5.46
CHEYENNE	605,496	556,005	-49491	-8.17
CLAY	294,372	291,501	-2871	-0.98
COLFAX	207,462	187,650	-19812	-9.55
CUMING	320,605	305,090	-15515	-4.84
CUSTER	482,022	574,106	92084	19.10
DAKOTA	121,478	147,766	26288	21.64
DAWES	198,912	202,946	4034	2.03
DAWSON	362,113	330,690	-31423	-8.68
DEUEL	255,832	231,828	-24004	-9.38
DIXON	199,278	188,725	-10553	-5.30
DODGE	301,641	305,051	3410	1.13
DOUGLAS	93,496	72,859	-20637	-22.07
DUNDY	220,327	254,230	33903	15.39
FILLMORE	333,433	322,967	-10466	-3.14
FRANKLIN	191,833	165,034	-26799	-13.97
FRONTIER	224,892	189,835	-35057	-15.59
FURNAS	291,568	276,450	-15118	-5.19
GAGE	419,826	413,217	-6609	-1.57
GARDEN	204,480	187,960	-16520	-8.08
GARFIELD	70,551	78,080	7529	10.67
GOSPER	129,149	130,355	1206	0.93

GRANT	40,507	45,299	4792	11.83
GREELEY	124,947	127,554	2607	2.09
HALL	266,782	247,081	-19701	-7.38
HAMILTON	318,516	291,752	-26764	-8.40
HARLAN	224,536	224,467	-69	-0.03
HAYES	177,086	210,258	33172	18.73
HITCHCOCK	253,935	192,582	-61353	-24.16
HOLT	618,373	667,581	49208	7.96
HOOKER	20,349	22,059	1710	8.40
HOWARD	212,378	157,759	-54619	-25.72
JEFFERSON	244,445	232,700	-11745	-4.80
JOHNSON	148,352	113,982	-34370	-23.17
KEARNEY	272,208	272,177	-31	-0.01
KEITH	263,004	260,184	-2820	-1.07
KEYA PAHA	101,514	101,405	-109	-0.11
KIMBALL	356,033	346,020	-10013	-2.81
KNOX	331,836	273,593	-58243	-17.55
LANCASTER	356,202	323,610	-32592	-9.15
LINCOLN	441,087	527,021	85934	19.48
LOGAN	59,602	69,963	10361	17.38
LOUP	38,517	35,265	-3252	-8.44
MADISON	281,257	257,990	-23267	-8.27
MCPHERSON	37,353	34,854	-2499	-6.69
MERRICK	225,634	199,641	-25993	-11.52
MORRILL	233,491	266,348	32857	14.07
NANCE	166,578	138,178	-28400	-17.05
NEMAHA	203,587	169,508	-34079	-16.74
NUCKOLLS	234,927	205,197	-29730	-12.65
OTOE	280,327	258,398	-21929	-7.82
PAWNEE	147,010	139,385	-7625	-5.19
PERKINS	485,080	444,497	-40583	-8.37
PHELPS	308,988	281,690	-27298	-8.83
PIERCE	263,104	247,215	-15889	-6.04
PLATTE	361,523	355,259	-6264	-1.73
POLK	227,906	228,592	686	0.30
RED WILLOW	274,953	247,135	-27818	-10.12
RICHARDSON	245,111	209,034	-36077	-14.72
ROCK	167,188	154,635	-12553	-7.51
SALINE	271,355	241,911	-29444	-10.85
SARPY	92,725	86,719	-6006	-6.48

SAUNDERS	393,365	359,915	-33450	-8.50
SCOTTS BLUFF	233,392	192,776	-40616	-17.40
SEWARD	286,098	272,420	-13678	-4.78
SHERIDAN	336,713	285,985	-50728	-15.07
SHERMAN	179,159	125,561	-53598	-29.92
SIOUX	97,774	119,572	21798	22.29
STANTON	187,346	177,938	-9408	-5.02
THAYER	294,776	266,148	-28628	-9.71
THOMAS	13,547	10,180	-3367	-24.85
THURSTON	173,766	173,210	-556	-0.32
VALLEY	156,234	147,845	-8389	-5.37
WASHINGTON	200,840	188,129	-12711	-6.33
WAYNE	238,573	238,313	-260	-0.11
WEBSTER	188,497	177,974	-10523	-5.58
WHEELER	123,168	113,156	-10012	-8.13
YORK	329,487	314,696	-14791	-4.49

County	Application of Fertilizer and Chemical Total (Acre)			
	1997	**2007**	**97-07 Change**	**97-07 % Change**
ADAMS	234,102	233,406	-696	-0.30
ANTELOPE	243,749	318,504	74755	30.67
ARTHUR	10,412	9,398	-1014	-9.74
BANNER	62,339	59,660	-2679	-4.30
BLAINE	13,892	14,035	143	1.03
BOONE	182,243	247,234	64991	35.66
BOX BUTTE	183,030	254,407	71377	39.00
BOYD	45,327	51,808	6481	14.30
BROWN	65,904	64,260	-1644	-2.49
BUFFALO	251,461	313,389	61928	24.63
BURT	150,465	191,527	41062	27.29
BUTLER	175,175	208,509	33334	19.03
CASS	136,616	185,017	48401	35.43
CEDAR	206,591	302,353	95762	46.35
CHASE	227,746	251,545	23799	10.45
CHERRY	76,625	73,308	-3317	-4.33
CHEYENNE	255,186	268,971	13785	5.40
CLAY	237,517	264,243	26726	11.25
COLFAX	118,350	143,964	25614	21.64
CUMING	188,313	242,714	54401	28.89
CUSTER	218,372	473,729	255357	116.94
DAKOTA	70,473	126,288	55815	79.20
DAWES	41,241	63,039	21798	52.86
DAWSON	219,116	276,625	57509	26.25
DEUEL	123,117	129,836	6719	5.46
DIXON	121,609	146,782	25173	20.70
DODGE	164,106	230,101	65995	40.21
DOUGLAS	54,994	53,432	-1562	-2.84
DUNDY	128,953	186,580	57627	44.69
FILLMORE	246,734	274,247	27513	11.15
FRANKLIN	124,168	129,340	5172	4.17
FRONTIER	141,494	161,884	20390	14.41
FURNAS	175,149	219,838	44689	25.51
GAGE	262,800	314,831	52031	19.80
GARDEN	73,398	134,329	60931	83.01
GARFIELD	13,625	32,991	19366	142.14
GOSPER	106,475	124,028	17553	16.49

GRANT	6,518	5,669	-849	-13.03
GREELEY	63,884	92,549	28665	44.87
HALL	198,651	215,744	17093	8.60
HAMILTON	267,399	247,989	-19410	-7.26
HARLAN	144,864	198,395	53531	36.95
HAYES	114,540	152,326	37786	32.99
HITCHCOCK	140,674	135,344	-5330	-3.79
HOLT	245,889	383,074	137185	55.79
HOOKER	3,430	4,523	1093	31.87
HOWARD	124,429	123,417	-1012	-0.81
JEFFERSON	151,456	183,433	31977	21.11
JOHNSON	64,058	67,670	3612	5.64
KEARNEY	199,667	240,996	41329	20.70
KEITH	111,510	193,987	82477	73.96
KEYA PAHA	18,732	30,653	11921	63.64
KIMBALL	78,735	130,794	52059	66.12
KNOX	163,374	196,235	32861	20.11
LANCASTER	203,146	214,282	11136	5.48
LINCOLN	264,865	458,621	193756	73.15
LOGAN	22,903	41,370	18467	80.63
LOUP	16,358	14,357	-2001	-12.23
MADISON	168,353	212,287	43934	26.10
MCPHERSON	8,891	8,417	-474	-5.33
MERRICK	172,901	174,860	1959	1.13
MORRILL	106,311	155,858	49547	46.61
NANCE	93,336	114,359	21023	22.52
NEMAHA	115,547	115,979	432	0.37
NUCKOLLS	150,483	183,630	33147	22.03
OTOE	149,883	188,242	38359	25.59
PAWNEE	59,264	86,195	26931	45.44
PERKINS	273,349	312,680	39331	14.39
PHELPS	225,585	245,575	19990	8.86
PIERCE	165,889	200,303	34414	20.75
PLATTE	276,749	295,020	18271	6.60
POLK	161,960	177,819	15859	9.79
RED WILLOW	154,072	192,552	38480	24.98
RICHARDSON	119,602	150,603	31001	25.92
ROCK	42,288	60,337	18049	42.68
SALINE	154,073	184,900	30827	20.01
SARPY	46,009	64,724	18715	40.68
SAUNDERS	204,355	238,418	34063	16.67

SCOTTS BLUFF	138,716	131,645	-7071	-5.10
SEWARD	194,222	201,144	6922	3.56
SHERIDAN	82,696	97,165	14469	17.50
SHERMAN	75,778	88,936	13158	17.36
SIOUX	34,007	44,873	10866	31.95
STANTON	114,114	136,193	22079	19.35
THAYER	218,956	230,367	11411	5.21
THOMAS	6,020	8,392	2372	39.40
THURSTON	108,113	143,091	34978	32.35
VALLEY	77,564	116,919	39355	50.74
WASHINGTON	96,834	133,371	36537	37.73
WAYNE	156,604	204,620	48016	30.66
WEBSTER	94,846	146,275	51429	54.22
WHEELER	46,414	49,499	3085	6.65
YORK	253,780	260,761	6981	2.75

County	CRP Operation Per County			
	1997	2007	97-07 Change	97-07 % Change
ADAMS	64	66	2	3.13
ANTELOPE	122	234	112	91.80
ARTHUR	7	4	-3	-42.86
BANNER	132	133	1	0.76
BLAINE	14	7	-7	-50.00
BOONE	124	140	16	12.90
BOX BUTTE	157	145	-12	-7.64
BOYD	44	76	32	72.73
BROWN	45	33	-12	-26.67
BUFFALO	127	103	-24	-18.90
BURT	142	167	25	17.61
BUTLER	187	294	107	57.22
CASS	93	106	13	13.98
CEDAR	233	225	-8	-3.43
CHASE	62	151	89	143.55
CHERRY	65	38	-27	-41.54
CHEYENNE	202	303	101	50.00
CLAY	43	57	14	32.56
COLFAX	57	118	61	107.02
CUMING	70	237	167	238.57
CUSTER	154	97	-57	-37.01
DAKOTA	98	110	12	12.24
DAWES	145	102	-43	-29.66
DAWSON	58	66	8	13.79
DEUEL	67	90	23	34.33
DIXON	233	262	29	12.45
DODGE	74	160	86	116.22
DOUGLAS	36	46	10	27.78
DUNDY	95	99	4	4.21
FILLMORE	33	47	14	42.42
FRANKLIN	96	88	-8	-8.33
FRONTIER	43	32	-11	-25.58
FURNAS	158	151	-7	-4.43
GAGE	404	649	245	60.64
GARDEN	60	87	27	45.00
GARFIELD	21	21	0	0.00
GOSPER	39	38	-1	-2.56

GRANT	1	-	#VALUE!	#VALUE!
GREELEY	85	87	2	2.35
HALL	40	31	-9	-22.50
HAMILTON	35	44	9	25.71
HARLAN	60	79	19	31.67
HAYES	80	140	60	75.00
HITCHCOCK	81	93	12	14.81
HOLT	142	160	18	12.68
HOOKER	12	4	-8	-66.67
HOWARD	111	109	-2	-1.80
JEFFERSON	189	248	59	31.22
JOHNSON	257	341	84	32.68
KEARNEY	29	35	6	20.69
KEITH	84	141	57	67.86
KEYA PAHA	20	15	-5	-25.00
KIMBALL	216	232	16	7.41
KNOX	281	269	-12	-4.27
LANCASTER	421	566	145	34.44
LINCOLN	142	154	12	8.45
LOGAN	21	23	2	9.52
LOUP	12	6	-6	-50.00
MADISON	140	152	12	8.57
MCPHERSON	9	13	4	44.44
MERRICK	39	34	-5	-12.82
MORRILL	99	159	60	60.61
NANCE	99	105	6	6.06
NEMAHA	129	179	50	38.76
NUCKOLLS	103	57	-46	-44.66
OTOE	179	308	129	72.07
PAWNEE	247	294	47	19.03
PERKINS	189	214	25	13.23
PHELPS	44	24	-20	-45.45
PIERCE	151	173	22	14.57
PLATTE	67	193	126	188.06
POLK	26	37	11	42.31
RED WILLOW	54	78	24	44.44
RICHARDSON	260	384	124	47.69
ROCK	55	45	-10	-18.18
SALINE	174	259	85	48.85
SARPY	43	71	28	65.12
SAUNDERS	162	317	155	95.68

SCOTTS BLUFF	104	139	35	33.65
SEWARD	168	280	112	66.67
SHERIDAN	213	154	-59	-27.70
SHERMAN	115	77	-38	-33.04
SIOUX	42	50	8	19.05
STANTON	191	266	75	39.27
THAYER	112	157	45	40.18
THOMAS	9	5	-4	-44.44
THURSTON	119	134	15	12.61
VALLEY	72	65	-7	-9.72
WASHINGTON	106	139	33	31.13
WAYNE	174	159	-15	-8.62
WEBSTER	132	159	27	20.45
WHEELER	29	41	12	41.38
YORK	38	31	-7	-18.42

CRP Acre Per County

County	1997	2007	97-07 Change	97-07 % Change
ADAMS	3,901	2,995	-906	-23.22
ANTELOPE	13,797	17,055	3258	23.61
ARTHUR	1,581	636	-945	-59.77
BANNER	50,414	61,535	11121	22.06
BLAINE	2,562	596	-1966	-76.74
BOONE	19,002	13,259	-5743	-30.22
BOX BUTTE	35,997	19,526	-16471	-45.76
BOYD	3,019	2,506	-513	-16.99
BROWN	6,528	6,072	-456	-6.99
BUFFALO	12,396	9,787	-2609	-21.05
BURT	18,444	18,308	-136	-0.74
BUTLER	13,724	20,446	6722	48.98
CASS	5,605	4,013	-1592	-28.40
CEDAR	20,519	17,039	-3480	-16.96
CHASE	10,168	24,980	14812	145.67
CHERRY	13,442	9,637	-3805	-28.31
CHEYENNE	37,946	77,425	39479	104.04
CLAY	2,810	2,281	-529	-18.83
COLFAX	2,952	5,488	2536	85.91
CUMING	3,075	6,801	3726	121.17
CUSTER	15,112	7,199	-7913	-52.36
DAKOTA	14,918	13,512	-1406	-9.42
DAWES	31,855	10,884	-20971	-65.83
DAWSON	7,105	4,954	-2151	-30.27
DEUEL	12,014	12,553	539	4.49
DIXON	36,504	35,443	-1061	-2.91
DODGE	2,345	3,795	1450	61.83
DOUGLAS	3,249	1,024	-2225	-68.48
DUNDY	17,849	19,297	1448	8.11
FILLMORE	2,389	3,237	848	35.50
FRANKLIN	8,406	8,466	60	0.71
FRONTIER	4,955	3,868	-1087	-21.94
FURNAS	18,333	18,210	-123	-0.67
GAGE	42,211	57,205	14994	35.52
GARDEN	11,124	11,710	586	5.27
GARFIELD	8,725	8,437	-288	-3.30
GOSPER	2,872	2,913	41	1.43

GRANT	(D)	-	#VALUE!	#VALUE!
GREELEY	9,030	8,477	-553	-6.12
HALL	3,668	1,431	-2237	-60.99
HAMILTON	1,739	1,885	146	8.40
HARLAN	3,728	6,579	2851	76.48
HAYES	15,367	26,322	10955	71.29
HITCHCOCK	7,527	16,391	8864	117.76
HOLT	26,453	25,165	-1288	-4.87
HOOKER	788	662	-126	-15.99
HOWARD	7,797	6,372	-1425	-18.28
JEFFERSON	16,316	16,124	-192	-1.18
JOHNSON	29,394	35,024	5630	19.15
KEARNEY	2,025	1,990	-35	-1.73
KEITH	12,336	17,921	5585	45.27
KEYA PAHA	3,017	1,572	-1445	-47.90
KIMBALL	97,721	101,129	3408	3.49
KNOX	32,053	16,797	-15256	-47.60
LANCASTER	35,254	33,880	-1374	-3.90
LINCOLN	20,840	15,110	-5730	-27.50
LOGAN	3,843	6,774	2931	76.27
LOUP	(D)	225	#VALUE!	#VALUE!
MADISON	13,947	9,319	-4628	-33.18
MCPHERSON	3,035	2,910	-125	-4.12
MERRICK	4,220	3,319	-901	-21.35
MORRILL	12,632	43,978	31346	248.15
NANCE	11,423	12,511	1088	9.52
NEMAHA	9,960	12,050	2090	20.98
NUCKOLLS	4,714	3,828	-886	-18.80
OTOE	14,158	18,514	4356	30.77
PAWNEE	31,998	37,677	5679	17.75
PERKINS	37,658	42,429	4771	12.67
PHELPS	2,909	1,423	-1486	-51.08
PIERCE	14,619	9,516	-5103	-34.91
PLATTE	5,150	12,262	7112	138.10
POLK	1,957	1,268	-689	-35.21
RED WILLOW	5,425	8,043	2618	48.26
RICHARDSON	22,818	32,020	9202	40.33
ROCK	19,908	17,718	-2190	-11.00
SALINE	10,711	14,118	3407	31.81
SARPY	1,983	2,489	506	25.52
SAUNDERS	10,739	23,759	13020	121.24

SCOTTS BLUFF	14,538	24,783	10245	70.47
SEWARD	10,950	17,470	6520	59.54
SHERIDAN	40,853	29,116	-11737	-28.73
SHERMAN	10,627	6,567	-4060	-38.20
SIOUX	10,938	10,902	-36	-0.33
STANTON	20,544	24,306	3762	18.31
THAYER	7,649	9,436	1787	23.36
THOMAS	862	513	-349	-40.49
THURSTON	15,042	15,886	844	5.61
VALLEY	6,555	2,764	-3791	-57.83
WASHINGTON	6,930	5,864	-1066	-15.38
WAYNE	17,481	12,288	-5193	-29.71
WEBSTER	12,053	17,195	5142	42.66
WHEELER	13,517	25,131	11614	85.92
YORK	919	2,163	1244	135.36

Corn Grain Production (Bushels)

County	1997	2007	97-07 Change	97-07 % Change
ADAMS	9,287,075	29,216,429	19929354	214.59
ANTELOPE	14,047,600	33,681,365	19633765	139.77
ARTHUR	685,110	647,177	-37933	-5.54
BANNER	2,286,476	1,058,789	-1227687	-53.69
BLAINE	554,933	1,099,122	544189	98.06
BOONE	14,109,562	24,218,367	10108805	71.65
BOX BUTTE	553,071	9,262,019	8708948	1574.65
BOYD	2,720,692	1,916,124	-804568	-29.57
BROWN	6,255,486	7,263,606	1008120	16.12
BUFFALO	29,073,512	39,678,545	10605033	36.48
BURT	17,045,683	17,223,629	177946	1.04
BUTLER	19,346,185	23,701,372	4355187	22.51
CASS	12,453,547	13,409,464	955917	7.68
CEDAR	5,500,011	27,363,811	21863800	397.52
CHASE	8,616,455	28,889,720	20273265	235.29
CHERRY	1,996,680	3,541,706	1545026	77.38
CHEYENNE	1,950,654	3,720,124	1769470	90.71
CLAY	9,141,987	30,505,523	21363536	233.69
COLFAX	12,650,079	14,951,874	2301795	18.20
CUMING	7,770,640	24,275,354	16504714	212.40
CUSTER	26,046,903	53,150,533	27103630	104.06
DAKOTA	9,519,390	12,386,579	2867189	30.12
DAWES	2,607,945	206,089	-2401856	-92.10
DAWSON	29,617,916	38,955,824	9337908	31.53
DEUEL	875,646	2,142,417	1266771	144.67
DIXON	13,258,457	11,943,825	-1314632	-9.92
DODGE	20,160,162	24,805,570	4645408	23.04
DOUGLAS	5,931,493	5,179,212	-752281	-12.68
DUNDY	4,914,011	14,902,437	9988426	203.26
FILLMORE	7,444,586	33,596,466	26151880	351.29
FRANKLIN	9,124,691	11,808,633	2683942	29.41
FRONTIER	4,657,807	10,366,795	5708988	122.57
FURNAS	12,388,879	11,499,174	-889705	-7.18
GAGE	3,009,080	16,916,418	13907338	462.18
GARDEN	7,318,937	4,456,628	-2862309	-39.11
GARFIELD	1,664,565	2,479,509	814944	48.96
GOSPER	29,005,523	12,844,838	-16160685	-55.72

GREELEY	7,387,196	11,110,558	3723362	50.40
HALL	27,870,219	34,740,013	6869794	24.65
HAMILTON	36,783,261	37,808,660	1025399	2.79
HARLAN	35,034,765	16,140,099	-18894666	-53.93
HAYES	9,052,877	10,191,916	1139039	12.58
HITCHCOCK	25,632,034	5,641,635	-19990399	-77.99
HOLT	1,530,288	42,815,391	41285103	2697.86
HOOKER	2,443,053	-	#VALUE!	#VALUE!
HOWARD	13,769,513	14,091,344	321831	2.34
JEFFERSON	7,601,058	12,602,052	5000994	65.79
JOHNSON	8,717,152	3,912,638	-4804514	-55.12
KEARNEY	7,009,986	29,878,524	22868538	326.23
KEITH	16,108,600	17,371,447	1262847	7.84
KEYA PAHA	834,466	1,763,815	929349	111.37
KIMBALL	10,794,663	2,058,217	-8736446	-80.93
KNOX	14,350,316	14,926,366	576050	4.01
LANCASTER	10,043,691	14,606,756	4563065	45.43
LINCOLN	9,974,824	49,853,525	39878701	399.79
LOGAN	392,744	3,409,989	3017245	768.25
LOUP	3,554,102	800,204	-2753898	-77.49
MADISON	7,896,157	18,463,194	10567037	133.83
MCPHERSON	127,225	190,080	62855	49.40
MERRICK	21,192,630	20,788,302	-404328	-1.91
MORRILL	3,434,481	12,393,925	8959444	260.87
NANCE	10,090,191	11,573,475	1483284	14.70
NEMAHA	10,670,836	9,800,050	-870786	-8.16
NUCKOLLS	2,020,330	12,317,486	10297156	509.68
OTOE	7,686,002	12,678,006	4992004	64.95
PAWNEE	11,134,633	4,499,185	-6635448	-59.59
PERKINS		22,874,370	22874370	#DIV/0!
PHELPS	23,516,662	35,626,477	12109815	51.49
PIERCE	7,711,655	18,974,691	11263036	146.05
PLATTE	24,449,075	32,826,889	8377814	34.27
POLK	19,244,791	23,063,338	3818547	19.84
RED WILLOW		11,809,270	11809270	#DIV/0!
RICHARDSON	16,762,648	11,371,032	-5391616	-32.16
ROCK	3,817,012	4,749,808	932796	24.44
SALINE	22,815,282	17,122,028	-5693254	-24.95
SARPY	5,161,125	5,822,268	661143	12.81
SAUNDERS	19,928,353	22,967,933	3039580	15.25
SCOTTS	1,932,631	10,412,660	8480029	438.78

BLUFF				
SEWARD	17,934,889	21,454,274	3519385	19.62
SHERIDAN	27,189,356	3,774,224	-23415132	-86.12
SHERMAN	8,126,642	11,496,170	3369528	41.46
SIOUX	13,100,433	2,384,919	-10715514	-81.80
STANTON	10,189,391	12,207,043	2017652	19.80
THAYER	11,901,355	19,825,588	7924233	66.58
THOMAS	22,549,094	(D)	#VALUE!	#VALUE!
THURSTON	722,883	11,296,058	10573175	1462.64
VALLEY	8,461,314	13,511,529	5050215	59.69
WASHINGTON	10,128,267	11,297,236	1168969	11.54
WAYNE	6,571,317	17,911,518	11340201	172.57
WEBSTER	27,737,128	10,316,054	-17421074	-62.81
WHEELER	19,481,108	4,369,828	-15111280	-77.57
YORK	35,521,210	39,260,315	3739105	10.53

County	Cattle Population			
	1997	2007	97-07 Change	97-07 % Change
ADAMS	10678	6721	-3957	-37.06
ANTELOPE	26095	27990	1895	7.26
ARTHUR	20240	21359	1119	5.53
BANNER	12161	10065	-2096	-17.24
BLAINE	22927	24246	1319	5.75
BOONE	23165	20634	-2531	-10.93
BOX BUTTE	16068	15738	-330	-2.05
BOYD	23737	24864	1127	4.75
BROWN	34143	28105	-6038	-17.68
BUFFALO	38957	42059	3102	7.96
BURT	6400	5685	-715	-11.17
BUTLER	12659	12889	230	1.82
CASS	7486	5580	-1906	-25.46
CEDAR	27855	29977	2122	7.62
CHASE	18593	16637	-1956	-10.52
CHERRY	166494	149414	-17080	-10.26
CHEYENNE	13907	8642	-5265	-37.86
CLAY	15150	14210	-940	-6.20
COLFAX	9436	7322	-2114	-22.40
CUMING	13681	13152	-529	-3.87
CUSTER	100744	97675	-3069	-3.05
DAKOTA	4033	6941	2908	72.11
DAWES	30351	30633	282	0.93
DAWSON	40037	31472	-8565	-21.39
DEUEL	3609	2785	-824	-22.83
DIXON	12044	10909	-1135	-9.42
DODGE	6489	6869	380	5.86
DOUGLAS	5414	1418	-3996	-73.81
DUNDY	21186	18104	-3082	-14.55
FILLMORE	6909	4562	-2347	-33.97
FRANKLIN	19353	15711	-3642	-18.82
FRONTIER	30457	27221	-3236	-10.62
FURNAS	18703	16990	-1713	-9.16
GAGE	18207	15004	-3203	-17.59
GARDEN	37007	33738	-3269	-8.83
GARFIELD	17644	19578	1934	10.96
GOSPER	13734	11990	-1744	-12.70

GRANT	18549	25169	6620	35.69
GREELEY	21182	19755	-1427	-6.74
HALL	14793	11008	-3785	-25.59
HAMILTON	8078	7561	-517	-6.40
HARLAN	15051	15174	123	0.82
HAYES	17770	18535	765	4.31
HITCHCOCK	13014	10083	-2931	-22.52
HOLT	115083	101114	-13969	-12.14
HOOKER	14359	15941	1582	11.02
HOWARD	22135	20755	-1380	-6.23
JEFFERSON	13125	11817	-1308	-9.97
JOHNSON	10040	8617	-1423	-14.17
KEARNEY	9837	13892	4055	41.22
KEITH	22331	21865	-466	-2.09
KEYA PAHA	29208	29907	699	2.39
KIMBALL	10158	7410	-2748	-27.05
KNOX	43426	42667	-759	-1.75
LANCASTER	13597	14341	744	5.47
LINCOLN	73676	76919	3243	4.40
LOGAN	16604	18536	1932	11.64
LOUP	19906	13653	-6253	-31.41
MADISON	15717	16342	625	3.98
MCPHERSON	20018	21827	1809	9.04
MERRICK	13979	16275	2296	16.42
MORRILL	35692	39291	3599	10.08
NANCE	15362	14920	-442	-2.88
NEMAHA	8190	8038	-152	-1.86
NUCKOLLS	15614	14987	-627	-4.02
OTOE	11803	8600	-3203	-27.14
PAWNEE	12037	11112	-925	-7.68
PERKINS	10163	9605	-558	-5.49
PHELPS	14507	9321	-5186	-35.75
PIERCE	16047	19104	3057	19.05
PLATTE	15771	17827	2056	13.04
POLK	10432	18378	7946	76.17
RED WILLOW	14756	17439	2683	18.18
RICHARDSON	11331	7975	-3356	-29.62
ROCK	36536	36407	-129	-0.35
SALINE	9022	7437	-1585	-17.57
SARPY	1784	1769	-15	-0.84
SAUNDERS	13038	10239	-2799	-21.47

SCOTTS BLUFF	24554	15403	-9151	-37.27
SEWARD	11373	9029	-2344	-20.61
SHERIDAN	66265	61204	-5061	-7.64
SHERMAN	27104	20672	-6432	-23.73
SIOUX	30275	41645	11370	37.56
STANTON	11224	15883	4659	41.51
THAYER	13250	11369	-1881	-14.20
THOMAS	13861	17497	3636	26.23
THURSTON	5815	5218	-597	-10.27
VALLEY	24270	26572	2302	9.48
WASHINGTON	6746	5747	-999	-14.81
WAYNE	14555	19879	5324	36.58
WEBSTER	18262	16467	-1795	-9.83
WHEELER	19128	22751	3623	18.94
YORK	10450	6415	-4035	-38.61