Economic Impact of the Ability of Nebraska Agriculture to Irrigate
The Case of 2012

Prepared For: Nebraska Farm Bureau®

Prepared By: Decision Innovation Solutions™
Bridging Your Research Needs.

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Executive Summary

With the harsh 2012 growing season behind for Nebraska crop producers, sights are now on the prospects for 2013. An exceptional drought gripped much of the United States from mid-June to the end of the growing season. In many regards, the drought persists in many parts of the country. Without significant moisture accumulations prior to spring planting 2013, drought conditions may continue into next year's growing season.

Since the drought of 2012 became a cause of concern in mid-2012, there have been discussions regarding ways to limit the use of water for agricultural purposes. Many of these discussions will result in the introduction of various policy proposals and regulations at the state, watershed, and county levels. In an effort to provide context regarding the importance of the ability of Nebraska crop producers to irrigate their crops, the Nebraska Farm Bureau has retained the services of Decision Innovation Solutions to estimate the state level economic impact of crop producers' ability to irrigate.

Using methodology and assumptions outlined in this report, an estimated loss of **$7.1 billion** in direct economic activity would result from the inability of Nebraska's crop producers to irrigate their land in a predictable, well-defined manner. While $7.1 billion is in and of itself a very large figure (represents 8.8% of 2011 Nebraska GDP), the losses multiply when the backward linkages of this loss are considered. In fact, when all rounds of economic activity are considered, the estimated losses to the State of Nebraska would be the following:

- **31,221** fewer jobs
- **$11.0 billion** in lower Output
- **$5.5 billion** in lower Total Value-Added
- **$3.3 billion** in lower Labor Income

Impact Type	Employment	Labor Income	Total Value-Added	Output
Direct Effect	**-**	**($2,131,837,655)**	**($3,307,799,895)**	**($7,083,745,522)**
Indirect Effect	**(13,550)**	**($529,417,314)**	**($1,070,608,174)**	**($1,938,585,249)**
Induced Effect	**(17,672)**	**($643,189,735)**	**($1,150,415,492)**	**($1,947,118,568)**
Total Effect	**(31,221)**	**($3,304,444,704)**	**($5,528,823,562)**	**($10,969,449,338)**

As can be seen in the above results summary, the impact of the inability to irrigate Nebraska crop production is significant. Additionally, there are unintended consequences associated with limiting or preventing irrigation of Nebraska's crop land, many of which are not necessarily identified with this analysis. Due to the significant impact of the ability of Nebraska's farmers to irrigate their crops, extreme due diligence should be undertaken to understand all the implications and unintended consequences surrounding limiting agriculture's ability to irrigate, especially in a drought environment similar to that endured in 2012.

Background

With the 2012 growing season behind for Nebraska crop producers, sights are now on the prospects for 2013. An exceptional drought gripped much of the United States from mid-June to the end of the growing season. In many regards, the drought continues to persist in many parts of the country. Without significant moisture accumulations prior to spring planting 2013, drought conditions may continue throughout next year's growing season.

Because water is a limited resource, there is concern for its allocation, especially in times of drought. There are many distinct users of water who have unique needs for its use. When water is in short supply, these users' concerns come into sharp focus and can often become the topic of pointed debate regarding its use. The drought of 2012 is certainly not an exception to this reality.

Drought always brings to the forefront the competing uses of water in Nebraska--agriculture, domestic, industrial and stream flows for wildlife and environmental reasons. As a result, periods of drought lead to discussions of how to balance these competing uses for water. Often times, because agriculture is a large user, these discussions include the various ideas to regulate or restrict the use of water.

Since the drought of 2012 became a cause of concern in mid-2012, there have been discussions regarding ways to limit the use of water for agricultural purposes. Many of these discussions will result in the introduction of various regulations and policy proposals at the state, watershed, and county levels. In an effort to provide context regarding the importance of the ability of Nebraska crop producers to irrigate their crops, the Nebraska Farm Bureau has retained the services of Decision Innovation Solutions to estimate the state level economic impact of crop producers' ability to irrigate.

Drought of 2012

Beginning in early 2012, Nebraska's 2012 crop growing season looked promising. Due to an early spring and favorable planting conditions, crops were planted well ahead of historical averages. For example, in early May 2012, seventy-four percent of corn was planted, which was twenty-four percentage points ahead of the 2007-2011 average. As a result of the early planting and generally favorable emergence and early growing conditions, the crops showed early signs of strength. By the end of May, the corn crop was ninety-seven percent emerged, which was twenty-two percentage points ahead of the 2007-2011 average. Similar early season planting and growing conditions favored other key Nebraska crops, such as soybeans, wheat, and alfalfa.

While early growing conditions were certainly welcomed by Nebraska's crop producers, these favorable conditions soon gave way to a progressive deterioration of crop producing conditions. By the end of July, most of Nebraska was classified by the U.S. Drought Monitor (UNL) as an "Extreme Drought".

As the summer continued to progress, Nebraska, as well as a significant portion of the continental United States, continued to see conditions worsen. By the end of September, most of Nebraska was classified by the U.S. Drought Monitor (UNL) as an "Exceptional Drought". Figure 1 depicts the extent of the drought as of September 25, 2012.

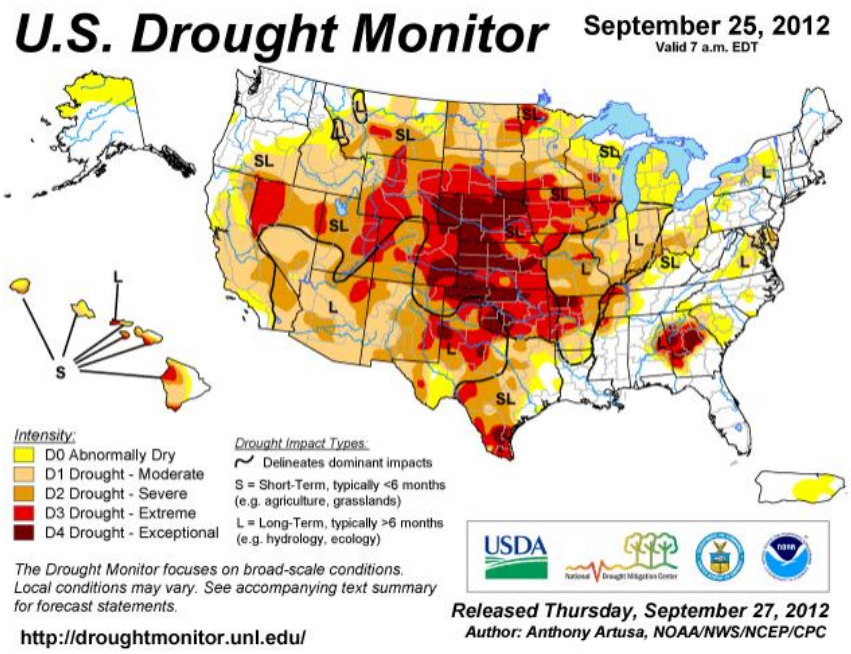

Figure 1, Drought Conditions Sept 25, 2012 (Source: Drought Monitor, UNL)

As the drought of 2012 worsened for Nebraska's crop producers, dryland acres began to show signs of stress. It became apparent that there would be yield losses associated with crops grown on these acres. Those crops under irrigations, however, were able to mitigate much of the yield losses persistently present on dryland acres. There have been periods of time throughout Nebraska's rich agricultural past where the value of irrigation is readily apparent. In most cases, the effects of abnormally dry weather have historically been alleviated through the ability of farmers to apply supplemental moisture to crops at critical growth phases.

Other times, in spite of the ability to irrigate crops in drought years, yield prospects diminish, albeit at a lower rate than those crops in dryland areas. These lower yields come from two broad sources: 1) the drought is extreme enough that continuous irrigation cannot overcome the effects of extreme heat and lack of moisture, and 2) pumping restrictions come into effect, either due to aquifer levels or restrictions on levels of electric power (for pumping) availability (i.e., high use of electricity for residential cooling purposes) during daytime hours.

The type of extreme drought which causes yield losses in irrigated acres was last experienced in Nebraska in 2002. Due to the extreme nature of that drought and the continued lack of moisture over the following winter, the effects of the 2002 drought continued throughout 2003. This was due to the fact that much of the subsoil moisture was not sufficiently replenished. Yields in much of Nebraska were diminished for both irrigated and dryland crops for both 2002 and 2003.

From all indications witnessed to date, the drought of 2012 has many of the same characteristics as the drought of 2002. While the coming winter moisture totals won't be known for 3-4 months, there is a considerable moisture deficit to make up if Nebraska is to avert a scenario similar to the persisting drought conditions endured in 2003.

Current State of Irrigation in Nebraska

Like many Midwestern, Plains, and Western states, Nebraska has considerable irrigation capabilities. According to the 2008 Farm and Ranch Irrigation Survey conducted by the USDA/National Agricultural Statistics Service (NASS), there were 8.4 million acres under all types of irrigation (pivot, linears, solid sets, wheel moves, travelers, and hand sets) in 2007. With this degree of irrigation, Nebraska has the highest level of acreage under irrigation for all states. The next closest state is California, where 7.3 million acres are under irrigation. Since the year 2007, the number of acres under irrigation of all types has likely increased, but at a decreasing rate. From a national perspective, in 2008, there were 54.9 million acres under irrigation, which was a 2.4 million increase since 2003.

A second set of data pertaining to the degree of irrigation to consider is from the Nebraska Department of Natural Resources. According to this data set, there are 86,593 irrigation wells permitted for irrigating up to 10.3 million acres. Depending on the pace at which irrigation has increased since the release of the 2008 Farm and Ranch Irrigation Survey, there is likely a degree of excess irrigation capacity in the state, meaning there are sufficient wells and pumping permits to adequately irrigate desired acreage. However, with new well drilling restrictions in some key watersheds in Nebraska, the ability of irrigators to keep ahead of irrigating demands will continue to diminish in the near term. Figures 2 and 3 show the degree of irrigation in Nebraska, both in terms of number of wells and the number of acres they are permitted to irrigate.

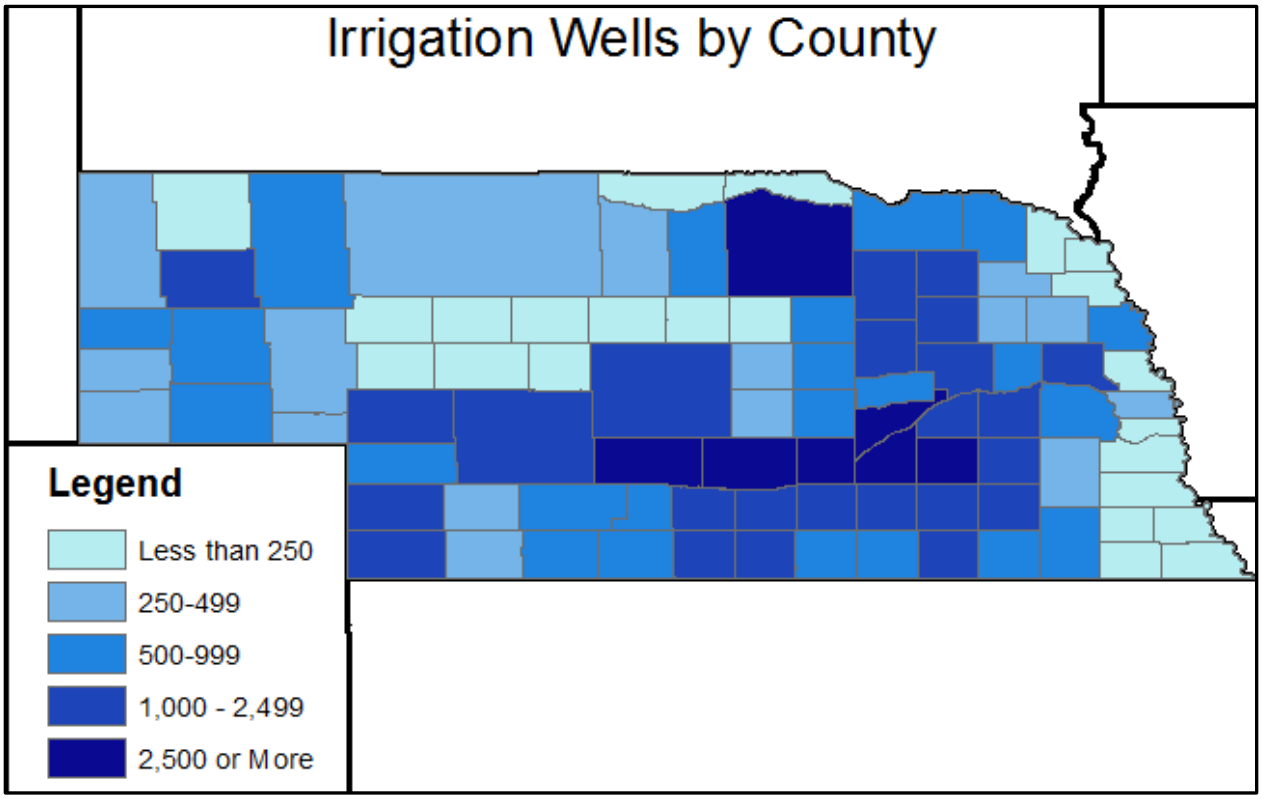

Figure 2, Irrigation Wells by County (Source: Nebraska Department of Natural Resources)

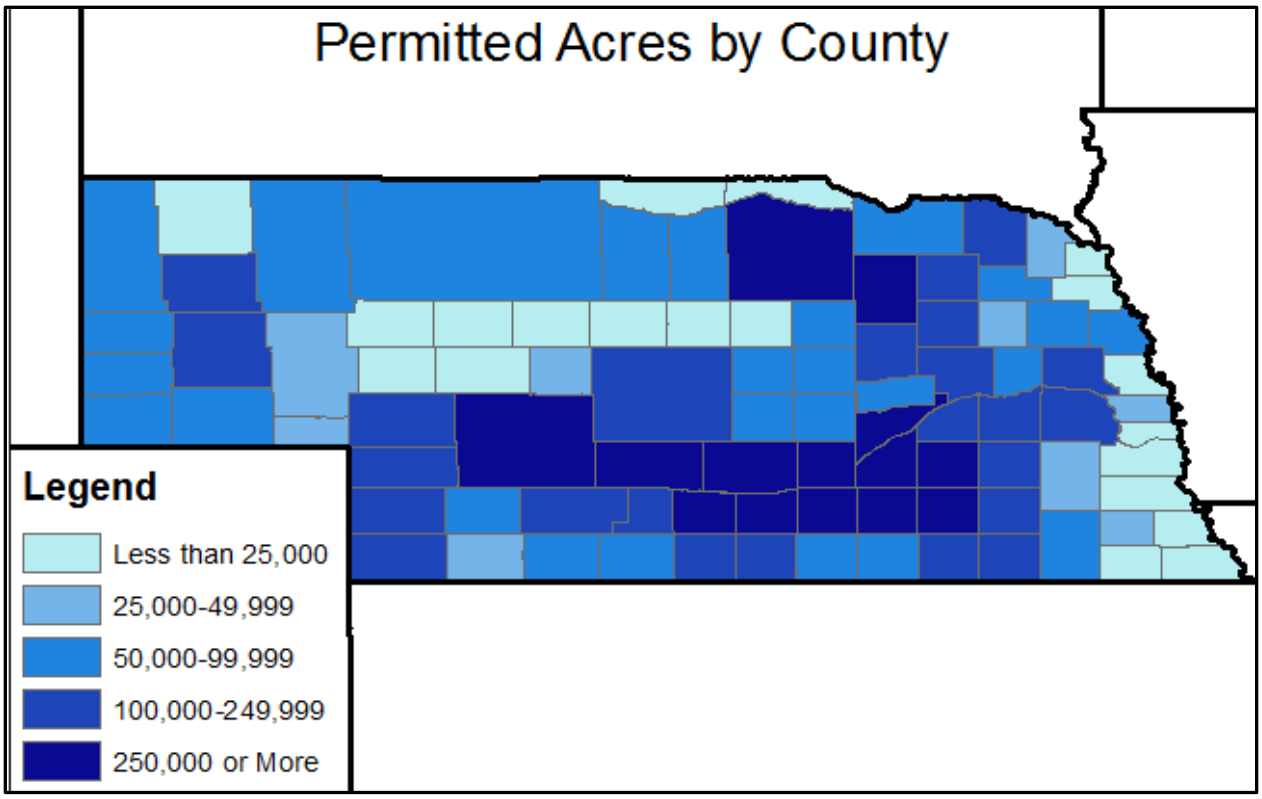

Figure 3, Permitted Acres by County (Source: Nebraska Department of Natural Resources)

In addition to the considerable use of irrigation in Nebraska, the state is also home to companies which manufacture, install, and maintain irrigation equipment such as Reinke Manufacturing, Valmont Industries, T-L Irrigation, and Lindsay Manufacturing, among others. While these and other irrigation companies located in Nebraska likely provide much of the necessary equipment for Nebraska agriculture, they also serve key customers both outside the State of Nebraska and the United States.

Methodology & Assumptions

Considerable thought was given to first understand and then to quantify the intricacies regarding the ability of Nebraska crop producers to predictably irrigate their crops. Below is a description of the rationale for assumptions and the methodology utilized for estimating the ability of Nebraska crop producers to irrigate their crops.

Framing the Research Question

Framing the research question is really quite straightforward and is based on a few key assumptions:

1. Crop producers have advance notice as to whether they will have the ability to irrigate their crops.
2. For the purposes of this analysis, we are only looking at the decision making process for irrigated acres and crops that are typically grown on them. This is because a dryland crop producer plants for no irrigation (lower plant populations) regardless of anticipated growing conditions in the coming growing season.
3. If crop producers knew going into the planting season they would have the ability to irrigate, they would "plant for irrigation" (higher plant populations). Otherwise they would plant for no irrigation.

With the application of these three assumptions, the results of the scenario are determined from the comparison of two rational planting perspectives:

- A crop producer who plants their crop "for irrigation" suffers some yield loss from the drought. They harvest their crop and take advantage of elevated commodity prices and will likely have a very profitable year.
- A crop producer who plants their crop for no irrigation suffers significant yield loss from the drought. They harvest their crop and take advantage of elevated commodity prices and will likely have significant losses, especially if no crop insurance was purchased.

Once the above assumptions are applied, the ability to understand the respective estimated revenues is possible. The difference in the revenues from the two perspectives is then modeled for an estimation of economic impact to the State of Nebraska.

Planting for Irrigation

A farmer using irrigation will plant the maximum sustainable plant populations. The impact is most significant with corn and somewhat less for soybeans and other irrigated crops. The farmer can do so with the confidence that water will be available for the crops when needed.

A farmer on dry land cannot predict weather patterns so a plant population that is sustainable in a typical year is chosen. Consequently maximum potential yields are never realized even in very favorable growing conditions.

As a result, the use of irrigation holds statewide yields at a more stable level year to year. The following scenarios, while not specific in economic terms, illustrate the relative impact of variances in weather patterns from year to year.

1. **Better than average growing conditions** - The irrigated farm achieves maximum yields. The dry land farm achieves the best possible yield considering the plant population used, but could have produced a higher yield if a higher plant population was chosen. The result:
    - Overall yields are better than average
    - Farm incomes are better than expected
        - Margins are improved for the irrigated farm due to lower operating costs (reduced irrigation inputs)
        - Margins are improved for the dry land farm due to above average yields
        - Some downward pressure on crop prices due to all farms achieving better than average yields.
2. **Average growing conditions** - The irrigated farm achieves maximum yields. The dry land farm achieves an average yield due to the average plant population used. The result:
    - Overall yields are average or better
    - Farm incomes are average or better
    - Margins are at expected levels for the both irrigated farms and dry land farms
3. **Marginal growing conditions** - The irrigated farm achieves maximum yields. The dry land farm achieves a less than average yield due to the plant population at levels anticipating an average year. The result:
    - Overall yields are somewhat below average
    - Farm incomes are adversely impacted
        - Margins for irrigated operations are reduced by higher irrigation input costs
        - Margins for dry land operations are severely reduced due to reduced yields
4. **Drought conditions** - The irrigated farm achieves something less than maximum yields since irrigation by itself cannot completely offset other drought stressors such as extreme heat. The dry land farm achieves very poor yields due to plant populations at average levels. The result:
    - Overall yields are below average
    - Farm incomes are adversely impacted
        - Margins for irrigated operations are reduced by both lower yields and higher irrigation input costs
        - Margins for dry land operations (not covered by crop insurance) are negative.

Since the farmer using irrigation can plant for maximum potential yields every year with confidence the state can expect a more stable level of crop yields resulting in a relatively stable level of farm income. Stable farm incomes benefit communities and all of the businesses supporting agriculture.

Estimation of Irrigated & Dryland Acres

Major crop acreages and yields for each county grown in Nebraska were identified, using USDA/National Agricultural Statistics Service (NASS) data, to determine the direct effect that irrigation has on the Nebraska economy. Irrigated crops included corn for grain, corn for silage, soybeans, alfalfa, wheat, dry edible beans, and sugarbeets.

Estimation of Expected Yields, Acreage, and Prices

Once data were obtained regarding yields and acreages for the crops in question, we calculated time-series regression equations for each crop in every Nebraska county (where the irrigated crops were produced) using historical data from 1991 to 2011. These regression equations were used to estimate the irrigated and dryland crop yields, assuming normal precipitation, for 2012. Of note, all analysis of yields and acreage were done at county level and then rolled up to the state level for impact analysis. This was done to ensure variation in yields at the county level was captured. In the process of estimating 2012 county level yields for relevant crops, we double constrained the regression analysis by only considering counties which had a minimum threshold of data points in the 1991-2011 timeframe and had production in the recent past.

Because county specific data had not yet been published as of the writing of this study, crop acres were estimated for each county. In the process of estimating 2012 county level acreages for relevant crops, we double constrained the regression analysis by only considering counties which had a minimum threshold of data points in the 1991-2011 timeframe and had production in the recent past.

Prices used to determine harvest revenue were obtained from announced crop insurance prices. Because of the timing of this report, all harvest crop insurance prices have been announced and are shown in Table 1. In most cases, these harvest prices are elevated due to the effects of the drought. Due to the unavailability of data for corn silage, a multiple (7) of corn price was used as a proxy. Using this approach to placing value on corn silage is common in the dairy and other livestock industries.

Crop	Yield Unit	Harvest Price/Yield Unit
Corn	bu	$ 7.50
Corn Silage	ton	$ 52.50
Soybeans	bu	$ 15.39
Alfalfa	ton	$ 225.00
Grain Sorghum	bu	$ 7.31
Dry Beans	lb	$ 0.38
Sugarbeets	ton	$ 60.00
Wheat	bu	$ 8.70

Table 1, Harvest Crop Insurance Prices

2002-2003 Nebraska Drought as a Reference

Because actual yield estimates are not yet available for 2012, the impact of the 2012 drought on irrigated and dryland crops are not known with a high degree of certainty. To overcome this limitation, we use the 2002-2003 Nebraska drought as a reference. Recall that the drought which began in 2002 carried over into 2003 because of the lack of subsoil moisture replenishment during the 2002/03 winter and spring 2003. Because the drought persisted into 2003, we used both 2002 and 2003 to express the full impact of that particular drought.

In determining what the impact of the 2012 drought will have on relevant crops and acreages, we calculated a regression equation to determine the 10-year trend line yield estimate for the year 2002. Similar to calculating trend line yield estimates for 2012, we double constrained the regression analysis by only considering counties which had a minimum threshold of data points in the 10-yr time frame and had production in the recent past leading up to 2002.

Once expected yield for each county was calculated for the year 2002, a percent deviation from trend line was calculated for all counties and crops for both irrigated and dryland production. This percent deviation was then applied to 2012 yield expectations.

Estimation of Actual Harvest Revenue

To estimate what actual harvest revenue was for 2012, we use crop insurance harvest price announcements for the relevant crops. Crop budgets for each of the identified crops were obtained from The University of Nebraska Lincoln to determine the cost of production for both irrigated and dryland acres. In estimating harvest revenue for both irrigated and dryland production a few additional considerations were made. They are:

- Some irrigated crops would not normally be grown in a dryland environment (dry edible beans and sugarbeets). To address this issue, we assume irrigated dry edible beans would be planted to dryland wheat and irrigated sugarbeets would be planted to dryland soybeans.
- While all crops have the potential to receive crop insurance indemnities, those crops planted for no irrigation are more likely to receive crop insurance indemnities in a drought situation.
- For acreage which would likely receive crop insurance indemnities, these estimated indemnities were added back into crop revenue for comparison.
- To simplify the application of crop insurance indemnities, a weighted coverage level was calculated from 2012 data from the USDA/Risk Management Agency (RMA). These weighted average coverage levels were between 71% and 73%, which can be seen in Figure 5.

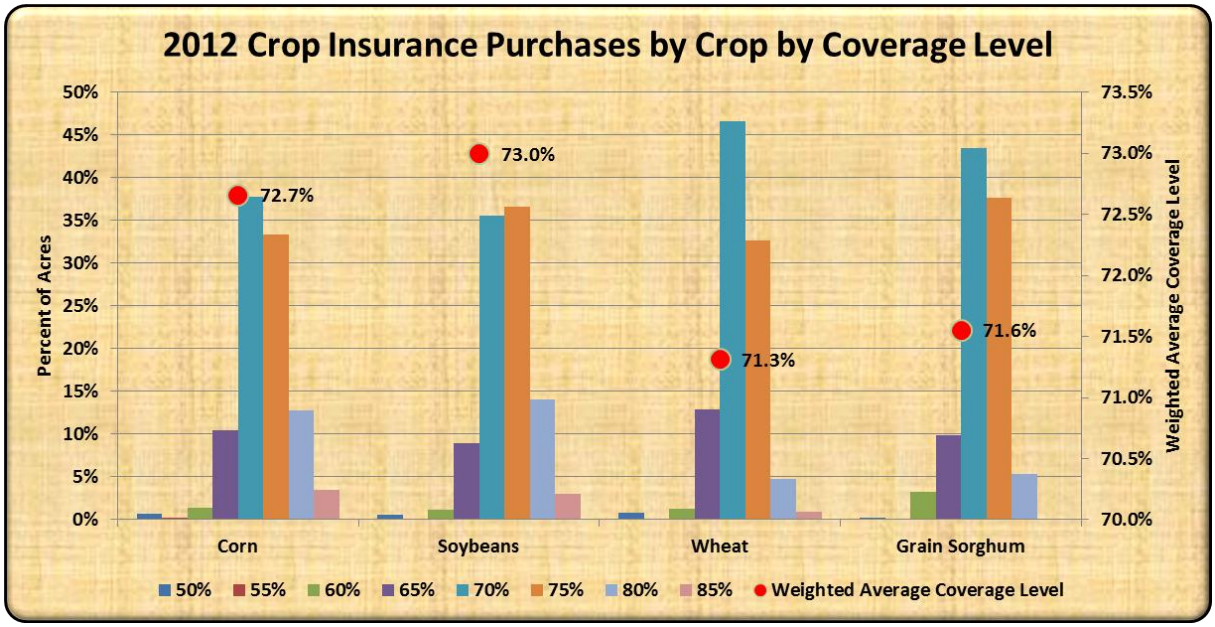

Figure 3, 2012 Nebraska Crop Insurance Purchases (Source: USDA/Risk Management Agency)

Determination of Harvest Revenue

The methodology used to determine harvest revenue for both producers who plant for irrigation and producers who plant for no irrigation are below. Results from applying the above equations are shown in Table 2:

Producers who Plant for Irrigation

$$(((\text{Exp Irr Yld}_{2012}*(1+\text{Perc Deviation}_{2002\text{-}03}))*\text{Harvest Price}_{2012})+\text{Crop Ins Indem}_{2012}) * \text{Irrigated Acres}_{2012}$$

Producers who Plant for No Irrigation

$$(((\text{Exp Dry Yld}_{2012}*(1+\text{Perc Deviation}_{2002\text{-}03}))*\text{Harvest Price}_{2012})+\text{Crop Ins Indem}_{2012}) * \text{Irrigated Acres}_{2012}$$

	Irr_Yld_Drought_Rev	Dry_Yld_Drought_Rev	Difference
Corn	$ 7,747,405,434	$ 2,338,654,475	**$ 5,408,750,959**
Corn Silage	$ 93,027,028	$ 30,684,845	**$ 62,342,183**
Alfalfa	$ 440,727,171	$ 213,238,766	**$ 227,488,406**
Grain Sorghum	$ 9,524,564	$ 2,854,224	**$ 6,670,340**
Soybeans	$ 2,375,947,382	$ 1,125,211,058	**$ 1,250,736,324**
Wheat	$ 107,047,359	$ 48,168,354	**$ 58,879,005**
Dry Beans	$ 94,726,682	$ 25,848,234	**$ 68,878,448**
Total State Revenue	$ 10,868,405,621	$ 3,784,659,957	**$ 7,083,745,664**

Table 2, Estimated Harvest Revenue

Estimating Economic Impact

The term "Economic Impact Study" implies a change has taken place within a local economy. The change in a local economy typically comes from one of the following sources:

- Entrance/departure of a new business or industry
- Expansion/contraction of an existing business or industry

In the case of this project, we are dealing with the contraction of an existing industry; therefore, we would expect a negative economic impact from the change. The economic magnitude of these economic activities is largely related to the degree to which industries within the local area are able to supply needed inputs. To quantify the degree of impact from a particular project, we commonly use the following measures: output (sales), employment (jobs), labor income, and value added. The results section of this report show impacts in terms of these economic measures.

When estimating the total impact of a contraction in the relevant crop production sectors, we must understand the series of economic activities (impacts) which will no longer take place. When quantifying the economic impact of a contraction in the crop production, the lack of direct purchase of supplies and equipment are known as *direct effects*. The suppliers and vendors used during the production of commodities purchase their respective inputs to support the production of commodities; these are known as *indirect effects*. Those who work in the production of commodities, as part of the operations of those who support the production of commodities (suppliers and vendors) then use their additional income to make household purchases; these are known as *household, or induced effects*. Taken together, the sum of direct, indirect and induced effects are known as total effects and accounts for the total multiplier effect present from the production of commodities. The results section of this report will summarize direct, indirect, and induced effects.

When conducting economic impact analyses, an analyst following industry practice typically relies on primary sources of data, such as the project sponsor and others with first-hand knowledge of the project, and pertinent information obtained from independent sources. Additionally, an analyst typically makes use of any number of software packages to understand the linkages among industries present in the study area. These software packages rely heavily upon periodically reported government statistics and surveys and other secondary sources data. The purpose of these data sources is to identify and quantify the inputs a particular industry must obtain in order to produce its specific good(s) and/or service(s).

For the purposes of this analysis, we have utilized IMPLAN software, which is software designed to capture the total effects of a particular change in a local (State of Nebraska) economy. With the assumptions and methodology detailed in previous sections, it is now appropriate to report on the results of estimating the economic impact of Nebraska crop producers having the ability to irrigate their crops.

Results

The results of this analysis are reported in general terms. An extensive amount of results and supporting data are available for further understanding the implications of a change in Nebraska's economy of this magnitude. In the discipline of economic impact study, the results shown in this document are those results which are most commonly reported. These measures of impact are:

- **Output**
  - The most broad measure of economic activity – sometimes referred to as "sales"
- **Employment**
  - A measure of job positions without regard to whether they are full-time equivalents
- **Labor Income**
  - A measure of Employee Compensation (work for hire) and Proprietor Income (self-employed)
- **Total Value-Added**
  - A combination of Labor Income, Other Property Income, and Indirect Business Taxes, which represents the additional value a business adds to purchased inputs

Prior to reporting on the results of this analysis, a few points of additional clarification on the results of the economic impact estimates are appropriate:

- Impact figures for impact types are not additive and should be presented and analyzed independently.
- In terms of looking at various forms of economic activity measures:
  - **Output (Sales)** is the broadest measure of economic activity and includes all others (excluding employment) listed in tables in this document.
  - **Value Added** is a sub-component of output; value-added includes: Employee Compensation, Proprietor Income, Other Property Income, and Indirect Business taxes.
  - **Labor Income** is a sum of Employee Compensation (work for hire) and Proprietor Income (self-employed) and is a sub-component of value-added.

IMPLAN Model Assumptions and Inputs

All IMPLAN data come with base assumptions from software authors regarding the relationships among industries. In some cases, these base assumptions may need to be adjusted. For this analysis we utilized the 2009 IMPLAN data for the State of Nebraska. For the sectors impacted (crops), adjustments were made to reflect current levels of economic activity. While the adjustments did have an impact on the overall results of the study, they were in line with expectations.

With base model assumptions adjusted to current levels of economic activity, the model was loaded with data from Table 4, which were derived from data in Table 3. Background on how data in Table 3 were derived can be found in the Methodology & Assumptions section of this report. The total *direct* estimated impact of crop producers not being able to irrigate is **$7.1 billion**.

Crop	Irr_Yld_Drought_Rev	Dry_Yld_Drought_Rev	Difference
Corn	**$ 7,747,405,434**	**$ 2,338,654,475**	**$ 5,408,750,959**
Corn Silage	**$ 93,027,028**	**$ 30,684,845**	**$ 62,342,183**
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Total State Revenue	**$ 10,868,405,621**	**$ 3,784,659,957**	**$ 7,083,745,664**

Table 3, Scenario Summary

Due to the aggregated nature of IMPLAN data (all sectors aggregated to 440), it is necessary to combine the "Difference" amounts in the Table 3 into sectors that are present in the IMPLAN model. In some cases, a simple aggregation of data can lead to erroneous results, but due to the similar nature of many of the crops, the structure of the IMPLAN data is sufficient to capture the impacts, at least from an estimation standpoint.

IMPLAN Sector Impacts	
Grain (Corn, Wheat, & Grain Sorghum)	**$ 5,474,300,304**
All Other Crop Production (Alfalfa & Corn Silage)	**$ 289,830,589**
Oilseeds (Soybeans & Dry Edible Beans)	**$ 1,319,614,771**
Total Impacts	**$ 7,083,745,664**

Table 4, IMPLAN Model Inputs

Total Impact Results

Using the model inputs contained in Table 4, the total impacts contained in Table 5 were generated with the customized state level IMPLAN model. As can be seen, the impact of the inability of Nebraska's crop farmers to irrigate is significant. After accounting for all rounds of economic activity (Direct, Indirect, and Induced), the estimated impact would result in **31,221** fewer jobs, **$3.3 billion** in lower Labor Income, **$5.5 billion** in lower Total Value-Added, and **$11.0 billion** in lower Output. These impact figures are a result of $7.1 billion in lower direct economic activity derived from higher crop sales being circulated in the state's economy.

Impact Type	Employment	Labor Income	Total Value-Added	Output
Direct Effect	**-**	**($2,131,837,655)**	**($3,307,799,895)**	**($7,083,745,522)**
Indirect Effect	**(13,550)**	**($529,417,314)**	**($1,070,608,174)**	**($1,938,585,249)**
Induced Effect	**(17,672)**	**($643,189,735)**	**($1,150,415,492)**	**($1,947,118,568)**
Total Effect	**(31,221)**	**($3,304,444,704)**	**($5,528,823,562)**	**($10,969,449,338)**

Table 5, Total Impact Results

Of note, the reason for zero direct employment effects is due to nuances associated with IMPLAN data and models, as well as the reality that if crop producers do not have the ability to irrigate their crops, the number of farmers will continue to remain at the same level, at least in the near term. In other words, these crop producers will continue to farm, but will instead raise their crops in a dryland environment.

Top 10 Impact Tables

For Table 6 and all subsequent impact tables (Tables 6-9), results for the top ten sectors impacted are shown. The two primary determinants which cause certain sectors to appear in these "Top 10" impact tables are: 1) the extent to which the directly impacted sectors (crop production) utilize certain sectors to produce their outputs, and 2) the degree to which those indirect sectors are present in the study area. With this in mind, many of the sectors which appear in Tables 6-9 make logical sense. For example, one would expect crop producers to utilize financial institutions and real estate services as they produce commodities for sale.

Nearly all sectors in the Nebraska economy are indirectly utilized in varying degrees to produce crops, but some are lesser impacted. Knowing that the agricultural community (i.e., crops and livestock) is quite interdependent, one would expect livestock to appear in the top portion of impacted sectors. As can be seen in Tables 6-9, there are no livestock sectors that make the "Top 10" lists. An explanation for this is that crop producers do not source any of their inputs directly from livestock producers. The sectors who supply inputs to crop producers do, however, source some of their inputs from livestock producers. A maker of leather gloves, for example, sources leather directly from the livestock sector, which are then sold to crop producers.

While there are some indirect and induced impacts from a reduced ability to irrigate crops evident in the livestock sectors, there are other impacts which are not necessarily quantified by this analysis. For example, in a drought year such as that experienced in 2012, feed availability (i.e., silage) becomes a

concern for livestock, particularly for cattle. Because Nebraska has significant production of cattle, a reduced availability of a crucial feedstuff such as silage has large implications for the ability of these cattle producers to provide adequate nutrition for their cattle. To the extent silage can be at least temporarily replaced with other feedstuffs, the impact of reduced irrigation would be mitigated. Also, due to geographical differences such as terrain and climate, some areas in Nebraska would be forced to endure a more harsh impact than other areas in the state.

In addition to the impacts shown in this analysis, the impact of higher commodity prices (as a result of lower commodity production) on the livestock sectors could be estimated. The IMPLAN modeling system we have utilized assumes constant prices and therefore does not account for the impact of higher prices on other sectors (livestock) within the model. In order to adequately estimate the impact of the inability of Nebraska crop producers (and potentially a limit on livestock producers to water their animals) to irrigate on the livestock industry, a separate model with unique assumptions would need to be specified and undertaken.

Output (Sales) Impacts

In terms of Output impacts, Table 6 details the top 10 sectors in the Nebraska economy will be impacted. The sum of all total Output impacts will sum to the $11.0 billion in Table 5. Results from all sectors are available upon request.

Top 10 Sectors Impacted - Output (Millions)				
Sector	Direct	Indirect	Induced	Total
Grain farming	($5,474.3)	($86.3)	($2.4)	($5,563.1)
Oilseed farming	($1,319.6)	($25.2)	($0.8)	($1,345.6)
Real estate establishments	$0.0	($402.2)	($58.9)	($461.1)
Monetary authorities and depository credit intermediation activities	$0.0	($249.7)	($69.8)	($319.5)
All other crop farming	($289.8)	($3.6)	($0.1)	($293.5)
Wholesale trade businesses	$0.0	($205.3)	($79.8)	($285.1)
Offices of physicians, dentists, and other health practitioners	$0.0	($0.0)	($131.4)	($131.4)
Food services and drinking places	$0.0	($13.7)	($112.2)	($125.9)
Non-depository credit intermediation and related activities	$0.0	($58.4)	($62.8)	($121.1)
Private hospitals	$0.0	($0.0)	($121.1)	($121.1)

Table 6, Output (Sales) Impacts

Employment Impacts

In terms of employment impacts, Table 7 details the top 10 sectors in the Nebraska economy will be impacted. The sum of all total employment impacts (exclusive of direct crop production) will sum to the 31,221 in Table 5. Results from all sectors are available upon request.

Top 10 Sectors Impacted - Employment				
Sector	Direct	Indirect	Induced	Total
Real estate establishments	-	(4,136)	(606)	(4,742)
Food services and drinking places	-	(256)	(2,102)	(2,358)
Wholesale trade businesses	-	(1,238)	(481)	(1,720)
Support activities for agriculture and forestry	-	(1,397)	(2)	(1,399)
Monetary authorities and depository credit intermediation activities	-	(992)	(277)	(1,269)
Offices of physicians, dentists, and other health practitioners	-	-	(966)	(966)
Private hospitals	-	-	(875)	(875)
Transport by truck	-	(635)	(143)	(778)
Retail Stores - Food and beverage	-	(27)	(694)	(721)
Nursing and residential care facilities	-	-	(706)	(706)

Table 7, Employment Impacts

Total Value-Added Impacts

In terms of Total Value-Added impacts, Table 8 details the top 10 sectors in the Nebraska economy that will be impacted. The sum of all total Output impacts will sum to the $5.5 billion in Table 5. Results from all sectors are available upon request.

Top 10 Sectors Impacted - Total Value-Added (Millions)				
Sector	Direct	Indirect	Induced	Total
Grain farming	($2,651.2)	($41.8)	($1.2)	($2,694.2)
Oilseed farming	($566.8)	($10.8)	($0.3)	($578.0)
Real estate establishments	$0.0	($291.4)	($42.7)	($334.1)
Wholesale trade businesses	$0.0	($149.6)	($58.1)	($207.7)
Monetary authorities and depository credit intermediation activities	$0.0	($126.0)	($35.2)	($161.2)
All other crop farming	($89.7)	($1.1)	($0.0)	($90.9)
Offices of physicians, dentists, and other health practitioners	$0.0	($0.0)	($78.2)	($78.2)
Insurance carriers	$0.0	($9.4)	($61.9)	($71.3)
Food services and drinking places	$0.0	($6.5)	($53.0)	($59.5)
Private hospitals	$0.0	($0.0)	($55.7)	($55.7)

Table 6, Value-Added Impacts

Labor Income Impacts

In terms of Labor Income impacts, Table 9 details the top 10 sectors in the Nebraska economy that will be impacted. The sum of all total Output impacts will sum to the $3.3 billion in Table 5. Results from all sectors are available upon request.

Top 10 Sectors Impacted - Labor Income (Millions)				
Sector	Direct	Indirect	Induced	Total
Grain farming	($1,673.2)	($26.4)	($0.7)	($1,700.4)
Oilseed farming	($352.2)	($6.7)	($0.2)	($359.1)
Wholesale trade businesses	$0.0	($86.6)	($33.7)	($120.3)
All other crop farming	($106.4)	($1.3)	($0.0)	($107.8)
Monetary authorities and depository credit intermediation activities	$0.0	($60.4)	($16.9)	($77.3)
Offices of physicians, dentists, and other health practitioners	$0.0	($0.0)	($73.4)	($73.4)
Private hospitals	$0.0	($0.0)	($52.2)	($52.2)
Real estate establishments	$0.0	($40.0)	($5.9)	($45.8)
Food services and drinking places	$0.0	($4.5)	($37.2)	($41.7)
Support activities for agriculture and forestry	$0.0	($39.4)	($0.1)	($39.5)

Table 7, Labor Income Impacts

Conclusion

The results of this economic impact study show that the impact of the inability to irrigate Nebraska crop production to be significant, especially in terms of Output, Employment, Total Value-Added, and Labor Income. The economic impact to the State of Nebraska's economy would result in an estimated loss of:

- **$11.0** Billion in Output
- **31,221** Jobs
- **$5.5 Billion** in Total Value-Added
- **$3.3 Billion** in Labor Income

Beyond the quantifiable impacts reported in this study, there are many unintended consequences associated with limiting or preventing irrigation of Nebraska's crop land. Some of these impacts, such as those related to the production of livestock, have been briefly mentioned. However, many of the unintended consequences are not necessarily identified with this analysis. Due to the significant impact of the ability of Nebraska's farmers to irrigate their crops, extreme due diligence should be undertaken to understand all the implications and unintended consequences surrounding limiting agriculture's ability to irrigate, especially in a drought environment similar to that endured in 2012.

This project summary has been intended to inform stakeholders of Nebraska's water resources of the estimated impact of crop producer's ability to irrigate. In addition to the material presented in this document, other, more detailed data are available upon request. If additional data are desired and/or questions arise regarding methodology, feel free to contact the primary author of this research study, Spencer Parkinson (Decision Innovation Solutions), at either (515) 864-6077 or spence@decision-innovation.com.