AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search
http://ageconsearch.umn.edu
aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

The Value of Water In Agriculture Land Markets: The Nebraska Case

By Chris L. Thompson and Bruce B. Johnson

Abstract

The true value of the water in agricultural production is determined by its perceived contribution to productive capacity. This analysis is concerned with determining an estimation of the value, or "worth," of the water from the 2010 Nebraska Farm Real Estate Survey. This survey allows the interpretation of the value of water from an aggregated expert panel of rural appraisers.

The analysis suggests that market participants exhibit a reduced willingness to pay for water rights and irrigation capabilities in uncertain conditions. It appears that participants in the Nebraska's agricultural land markets are risk averse regarding perceived future water conditions when purchasing land.

Introduction

Nebraska ranks first in the nation in total irrigated crop acres. However, in western Nebraska, like much of the arid western United States, the sustainability of groundwater is being questioned by irrigators and policy makers alike. The state is geographically situated over the most plentiful portion of the Ogallala aquifer; yet, many Nebraska irrigators are being required to reduce the amount of water consumed and/or forgo future irrigation development. Water is the life blood of Nebraska's agricultural-based economy. Without irrigation the state's agricultural economy would be significantly smaller. These water resources are cost-effective insurance for harnessing the productive potential of the cropland.

The last 30 years of intensive irrigation development in western Nebraska has led lawmakers to put regulations in place to prevent the over-appropriation of Nebraska's share of both surface and groundwater. Nebraska has regulated irrigation water to meet three main goals: 1) Surface water flows to meet endangered species requirements; 2) Surface water flows to meet interstate compact agreements; and 3) Long-term sustainability of Nebraska's portion of the Ogallala aquifer (*Neb. Rev. Stats.* §46-715).

Each of the three goals presents policy makers with a specific set of circumstances around which to mold effective policy. However, groundwater and surface water are known to be hydrologically linked, so none of the above goals can be treated as mutually exclusive. Nebraska's governance of water resources is a unique two-part governance structure made up of local Natural Resource Districts and State of Nebraska Department of Natural Resources control. Natural Resource Districts (NRDs) are multi-county areas, delineated on basin boundaries, and managed by an area board of directors. Board members are elected by the general population, but membership often tends to be weighted towards irrigators in the area. NRDs are charged with regulating groundwater following a correlative rights doctrine. The Nebraska Department of Natural Resources (NDNR) is in charge of surface water, which is administered following the appropriate doctrine of "first-in-time, first-in-right," and is responsible for interstate compliance and other state water obligations.

Chris L. Thompson and Bruce B. Johnson work at the University of Nebraska in the Department of Agriculture Economics in Lincoln, Nebraska.

Water policy in Nebraska has developed to the point where currently NRDs and the NDNR cooperate to develop water management plans which integrate ground and surface-water supplies and use. In the event that a projected surface water flow out of a NRD's basin is insufficient to justify additional surface water appropriations for irrigators, NDNR imposes a "fully" or "over" appropriated designation, and irrigation development from both ground and surface water ceases pending the completion of an integrated management plan. In the event of an over appropriated designation, irrigation consumptive use must be reduced to a specific level deemed sustainable over the long term. The areas in Nebraska which are fully and over appropriated are designated in Figure 1. The shaded areas are important to this study because these areas face regulations that may restrict future irrigation and adversely affect property values.

Regardless of the water policy goal, decreased consumptive use is often desired for many areas. Policy makers have considered using a number of regulations to achieve this goal, such as allocation, retirement of water rights, and efficiency incentives. With the goal of reducing consumptive use in the basin many NRD's are currently restricting, or have tentative plans in place to restrict, withdrawals of irrigation water. Reducing withdrawals impacts consumptive use and allows more water to "stay" in the basin for future uses or to reach the river to meet stream flow obligations.

As long as irrigation is economically and legally feasible, farmers can adjust water applied to meet a specific yield goal which will, in turn, lead to an acceptable net return at the end of the growing season. However, as new regulations are put in place to limit the amount of water to be withdrawn each year per irrigated acre, it is quite possible that the market value of irrigated land may be affected because of uncertain future returns to water. The objective of this study is to analyze how the agriculture real estate market perceives the value of water as impacted by water policy.

Methodology

In Nebraska the most comprehensive source of current property values is the annual Nebraska Farm Real Estate Market Panel Survey. Conducted and analyzed by the University of Nebraska-Lincoln, Department of Agriculture Economics, this survey annually collects land value and rental data, land sales data, and other market characteristics. (Johnson et al., 2010). Nebraska is one of the few states that collect this type of information. Data has been reported for more than thirty years by a panel of experts within each of the eight Nebraska Statistical Reporting Districts. Average market data and market changes reported by panelists are thoroughly reported in Johnson et al. (2010); however, this analysis relies heavily on the raw data of the Nebraska Farm Real Estate Market Panel Survey to better understand the economic value of water.

For this analysis, data for the Northwest, Southwest, South, and Central Districts were used to analyze the economic value of water and irrigator perceptions of future water restrictions.[1] In 2010, surveys were sent to 13 professional appraisers in the Northwest, 20 professional appraisers in the Southwest, 15 professional appraisers in the South, and 18 professional appraisers in the Central Districts. The number responding were: Northwest - 9 (69%), Southwest - 11 (55%), South - 11 (73%), and Central - 12 (67%)[2]. The reporting districts are illustrated in Johnson et al.

The survey[3], administered by UNL, includes six parts. The first four parts are important in understanding the markets perceptions of water issues, while Parts 5 (actual farm sales data) and 6 (expectations of sale numbers) are beyond the scope of this project. Part 1 is a direct question that indicated the value of specific classifications of land, Part 2 is current cash rental values, and Part 3 consists of direct questions to indicate the impacts of water availability on land values.

Survey Results

Part 1of the survey is split into five parts (A,B,C,D, and E). Parts 1A and C are particularly useful in determining the economic value of water as derived from market prices. Part 1A's question is, "For the following types of farm or ranch real estate that are typical and which you are familiar with in your surrounding area, please report your estimated average values per acre as of February 1, 2010." Survey respondents were to indicate, in dollars per acre, the current value of dryland cropland with no irrigation potential, dryland cropland with irrigation potential, tillable grassland, non-tillable grassland, hay-land, gravity irrigated land, and center pivot irrigated land[4]. From this data set, we derived the value of water as being the value of dryland cropland with irrigation potential subtracted from the value of irrigated land. The survey derived values of water for each of the western cropping districts are reported in Table 1.

Part 1C extended Part 1A's question to include the quality of land, as denoted by Low Grade and High Grade. The question was, "Report the range in current average per acre values of those types of farm or ranch real estate with which you are familiar. For example, high grade

cropland would be Class I while low grade cropland would be Classes III & IV." The options for type of land are the same as Part 1A and the value of water for each grade of land is calculated similarly by subtracting the dryland cropland market values from the irrigated cropland market values. (Table 2.)

Part 2 of the survey collects current information about cash rental rates and corresponding market value. Part 2A collects information of low, high, and average cropland rental rates for dryland cropland, gravity irrigated cropland[7], center pivot irrigated cropland[8], dryland alfalfa, irrigated alfalfa, other hayland, and grazing pastureland. These yearly values were reported in dollars per acre[9].

The rental value of water (Table 3) is calculated by subtracting dryland cropland rents reported from irrigated cropland rents reported. This differential is the implied rent as perceived by the market for the water rights on the property. Similarly, the market value of water, also reported in Table 3, is the difference between market value of dryland cropland and irrigated cropland value as reported by survey respondents. Knowing the annual income reported in an area and the market value of the same type of property in the same area, calculating the capitalization rate will tell us about the time value of investment in the water right. The capitalization rates reported in Table 3 can be ordinally ranked to identify in which areas market participants require swifter realization of the value of water. We believe this is because in areas such as the Northwest and Southwest market participants are unsure of the future productive capacity of their water rights due to institutional uncertainties.

Part 3 of the survey consists of questions directed specifically at understanding more directly the impact of water availability on market value. The first three questions are Yes/No questions that determine if there are current or proposed regulations affecting water availability. They ask if the appraiser's area is under development moratoriums, pumping restrictions, and if the restriction in place was a limitation on pumping quantity.

A development moratorium is an area deemed to be fully appropriated by the Nebraska DNR which dictates that no new water rights will be granted. Operationally, this means no new wells can be drilled and no new surface water acquisitions allowed. All (100 percent) of survey respondents in the Northwest reporting district reported they were in a development moratorium, 100 percent in the Central reporting district, 60 percent in the South reporting district, and 55 percent in the Southwest reporting district.

Pumping restrictions are a regulatory restriction on the amount of water a producer can pump. The first step of a restriction of this fashion is the amount of acres that can be irrigated. This means that landowners cannot develop more acres into irrigated acres. This regulation is geared at limiting the consumptive use of irrigation water in the basin. In the Northwest and Central reporting districts 100 percent of respondents indicated their area was under water restrictions.

Pumping limits are the most restrictive regulation in Nebraska and are a direct regulation that limits how many acre-inches of water a producer can apply to an acre during a specific period of time. In the Northwest, 17 percent of respondents indicated having pumping limits in their area. In the Southwest, 45 percent of respondents indicated having pumping limits and in the Central and South districts, the percentages were 17 percent and 47 percent respectively.

The Southwest reporting district is entirely covered by a development moratorium and there are both pumping restrictions and pumping limitations in place. Survey respondents indicating these conditions should have been at 100 percent. There were 11 respondents in the Southwest district; basically half indicated they were not in a water restricted area. This part of the survey clearly indicates that there is some misunderstanding between the survey respondents and the water resource policies of the Southwest reporting district.

In Part 3 of the 2010 Nebraska Farm Real Estate Survey, respondents were asked how market values would be affected by a 25 percent reduction in water availability and a 50 percent reduction in water availability. The wording of the question was, "Given the current situation on irrigation water availability in your area, what would you expect to be the impact on per-acre irrigated land values if there were...?" As expected these scenarios of reduced water availability did suggest sizable percentage reductions to associated land values (Table 4). However, in some geographical areas where irrigation cutbacks are new, the indicated perceived reductions may be larger than actual land value reductions.

In all reporting districts but the South, survey respondents reported that a 25 percent change in water avalibility would not decrease the value of the land by more than 25 percent. Additionally, all respondants reported less than a 41 percent change in land value with 50 percent change in water supply.

Comparative Analysis

Determining the economic value of water is sometimes confused with calculating the cost of water. The price of water can be defined as the price a user had to pay to get the water. In Nebraska, the price of water is often described as the pumping cost associated with attaining the water for use. This is an acceptable pricing method for crop budget analysis and other financial calculations; however, it should not be misconstrued as being the value of the water resource. The true value of the water is determined by its worth in contributing to productive capacity, and often the value of the water and the cost of the water are very different monetary values. This analysis is concerned with determining an estimation of the value, or "worth," of the water.

Two main methods of economically valuing irrigation water are the "Land Value Method" and the "Annual Residual Rent Method" (Young, 2005). The Land Value Method, an inductive valuation technique, is a simple method based on comparing land market transactions of irrigated and non-irrigated land. This method is most accurate when used in an area that relies on water for a stream of income flows, such as western Nebraska. Assuming all buyers and sellers are well informed about possible income flows and acting rationally, the Land Value Method is an excellent way to determine the value of water.

The second method of determining the value of water is a deductive method using a representative farm model. This method, based on crop growth production functions, determines the optimal cropping pattern for an average farm of the area and its associated future income stream using average crop prices and inputs. The residual income flow to the land, after all variable costs are paid, is the value of the land. By determining the cropping pattern of the representative farm with and with-out water available, one can interpret the value of the irrigation water resource (Thompson and Supalla, 2010).

The 2010 Nebraska Farm Real Estate Survey provides us with a "Land Value Method" of water valuation by going directly to the complex market of agricultural real estate. This survey allows the interpretation of the value of water from an aggregated expert panel[9] which probably reduces the subjective biases that may be present in some surveys. These survey data are experts' perceptions of the Nebraska farm real estate market.

However, these perceptions of market participants may not properly reflect the actual value of irrigation rights in western Nebraska. To better understand the value of irrigation water rights, the results of this survey are compared to with an "Annual Residual Rent" using calculated net returns from optimal cropping patterns and water use. Water Optimizer, an innovative single-year irrigation decision management tool, developed by the University of Nebraska-Lincoln Agriculture Economics Department, was used to determine average returns over variable costs under a variety of probable scenarios and geographic areas (wateroptimizer.unl.edu). This tool optimizes water applied and acres planted for various crops and cropping conditions, while taking into effect exogenous factors such as crop prices and input costs, to return a maximum net return for the tested scenario.

To compute the annual value of irrigation water, Water Optimizer was used to calculate the maximum dryland net return, and the irrigated cropping pattern which yielded the greatest net return when water is not limiting[10]. Water Optimizer's default values and county-specific crop growth functions allow for simple computation of the value of irrigation water within a certain geographic area[11]. As was done with data from the 2010 Nebraska Farm Real Estate Survey, dryland net returns were subtracted from optimal irrigated net returns. The remainder of the difference is considered to be the value of being able to irrigate. Water Cost calculations within Water Optimizer are variable costs per inch of irrigation water and thus the cost of obtaining the water is easily omitted. This allows direct comparison of calculated returns to water from Water Optimizer and the data collected in Part 1A of the 2010 Nebraska Farm Real Estate Survey which was reported in Table 3. The representative farm model, Water Optimizer allows for each situtation evaluated to be completely customized and the average of a range of results from probable scenarios are reported below. The Water Optimizer calculated value of water compared to the average survey derived rental value of water from Table 3, is reported in Table 5 below.

It is obvious by comparing the Average Market Survey Rental Value of Water and the Calculated Average Yearly Value of Water (Table 5) that there are some discrepancies between the values. More specifically, when comparing computed value to market perceived value, the latter is significantly lower. We suspect that perceptions of future risks and uncertainty by market participants may be the primary reason for this difference.

A market derived capitalization rate for the ability to irrigate reported in Table 3 can be interpreted as a measure of risk concerning irrigation. A high capitalization rate suggests that the investment in

irrigation capability is a relatively risky investment due in part to the prospect for future restrictions on water availability. Given that the capitalization rate is a measure of perceived risk, we can examine the types of risk that are in production agriculture. Potential landowners must consider both risk and uncertainty when valuing a piece of real estate. Weather risk, production risk, price risk, and institutional risk, are the major areas of risk. This risk is present across all type of agriculture production and should be interpreted in a very similar manner by the real estate market.

While the above risks are probable and monetarily measurable, uncertainty, as associated with institutional risk, is much more difficult to understand and mitigate. Uncertainty is simply not knowing what the future will be like, and not having any basis for decision making. Potential landowners must consider both risk and uncertainty when valuing a piece of real estate. To properly understand irrigators' perceptions of risk and uncertainty, the actual effects of future expectations of commodity price volatility, required changes in production practices, input price changes, and tax increases must be examined.

From an agronomic standpoint, irrigation is the best management method to manage risk. But, when the future availability of the water resource is uncertain, the perceived institutional risk to the land market participants can be great. In the 2010 Nebraska Farm Real Estate Survey the capitalization rates for dryland agriculture are much lower than the capitalization rates of irrigated cropland in the same geographic areas. In short, the perspective potential landowners who are in the market and valuing the water right appear to be taking into account this uncertainty and, thus, probably discounting the future right to irrigate.

By comparing the capitalization rates of irrigated land and the capitalization rate of the water rights alone we can deduce that the water rights on a parcel of land are seen as very risky attributes in the *bundle of rights* associated with the land. The average capitalization rate for dryland cropland in each of the reporting districts are as follows: South - 4.5 percent, Central - 5.2 percent, Southwest - 5.6 percent, and Northwest - 6.0 percent according to the 2010 Nebraska Farm Real Estate Market Highlights (Johnson et al., 2010). When these capitalization rates are compared to capitalization rate of water, in Table 3, there are some differences. The capitalization rates for water rights are all higher than the capitalization rates for a property without the water included. These differences range from 1.41 to 2.3 percentage points. We suggest this difference may be a "Risk Premium" that the market has attributed to the institutional risk of not knowing the future fate of water rights in these areas.

Conclusion

Using the two methods of valuing irrigation water – the "Land Value Method' and the "Annual Residual Rent Method" – this analysis found considerable discrepancies in the value of water across western Nebraska. Uncertainty of the future, perhaps with regard to future institutional rules and regulations governing irrigation water availability, seem to be a major contributor to the discounting of water rights value.

This analysis also suggests that land market participants' perceived values of irrigation water may not reflect the true value of those water rights. Participants appear to be risk averse regarding future availability when purchasing land, exhibiting a reduced willingness to pay for water rights and irrigation capabilities in uncertain conditions. In turn, the market dynamic reflects lower values and higher capitalization rates associated with water. As reported, the annual average derived value of water from the responses of market participants ranged from $99-$118 per acre in 2010, considerably lower than the values derived from the residual rent approach using Water Optimizer which ranged from $231 to $252 per acre in 2010. Likewise, the capitalization rates derived from the market for land with irrigation capabilities were found to be 1.4 to 2.3 percentage points higher than for non-irrigated cropland in the same areas. In short, land market participants are guarded in their future expectations of water availability and, hence, associated future returns to irrigated land.

Uncertainty of any kind regarding future conditions will lead land market participants to act conservatively when bidding for land. In the case of water availability for irrigation, it appears the institutional uncertainty of future access is playing a significant role in today's agriculture land markets where irrigation is significant.

Endnotes

[1] Much of the area in the North reporting district is under an appropriation designation but is also comprised mainly of pasture land situated on the sandhills of Nebraska. While some row crop production is present, the market values in this district are heavily influenced by pasture land, and, consequently, were not included in this analysis.

[2] This statistical sample may be low by traditional standards, but only a small number of professional appraisers may work in the district.

[3] The survey and its results can be viewed at www.agecon.unl.edu/realestate

[4] The value of the center pivot, which is personal property, was not included in this value.

[5] The value of water is calculated by subtracting the value of Dryland Cropland (with irrigation potential) from value Irrigated Cropland.

[6] Rental rate assumes that the landowner owns the complete irrigation system.

[7] Rental rate assumes that the landowner owns the complete irrigation system.

[8] The values reported in Part 2, may be different than market values of cropland reported in Part 1. Both Parts 1 and 2 may have different numbers of responses and thus resulted in a slightly different average for each cropland value.

[9] This expert panel is comprised of professionals in the field of real estate appraisal, which may have a more objective view than land owners and farmers.

[10] Crop growth coefficients within Water Optimizer assume average rainfall. Each of the reporting districts are comprised of multiple counties and multiple Natural Resource Districts. To ensure an average value, Water Optimizer was run for each county in the cropping reporting districts.

[11] Water Optimizer was run using default values for prices, yields, maximum water requirements and input costs, for the counties in Nebraska within each reporting district.

References

Johnson et al., *Nebraska Farm Real Estate Market Highlights (2009–2010)*. www.agecon.unl.edu/realestate.html

Johnson, B., Wilson, R. and S. Van Newkirk. "Nebraska Agricultural Land Markets Showing Strong Gains" *Cornhusker Economics*, March 16, 2011.

Thompson, C. and R. Supalla. "Understanding the Value of Water in Nebraska: Future Expectations and Considerations." *Cornhusker Economics*, December 15, 2010.

Young, Robert. "Determining the Economic Value of Water - Concepts and Methods." *Resources for the Future*, Washington D.C. 2005.

Table 1. Derived economic value of water per acre, 2010[1], U.S. dollars

Reporting District	Value of Water per Acre on Gravity Irrigated Cropland	Value of Water per Acre on Pivot Irrigated Cropland
South	$1,232.95	$1,539.77
Southwest	$1,053.75	$1,554.89
Central	$1,205.36	$1,407.86
Northwest	$958.33	$1,168.75
Value of Water = Irrigated Cropland Values minus Dryland Cropland Values		

Source: 2010 Nebraska Farm Real Estate Survey

[1] The value of water is calculated by subtracting the value of Dryland Cropland (with irrigation potential) from value Irrigated Cropland. Irrigation potential is determined by survey respondents in accordance to survey instructions.

Table 2. Derived value of water per acre by quality of land, 2010, U.S. dollars[2]

	Survey Calculated Value of Water per Acre			
Reporting District	Value of Water on Low Quality Gravity Irrigated Cropland	Value of Water on High Quality Gravity Irrigated Cropland	Value of Water on Low Quality Pivot Irrigated Cropland	Value of Water on High Quality Pivot Irrigated Cropland
South	$837.12	$1,413.26	$1,016.67	$1,833.71
Southwest	$877.98	$1,408.93	$1,060.83	$1,877.50
Central	$636.11	$1,825.00	$678.67	$2,287.50
Northwest	$559.52	$1,183.33	$841.67	$1,633.33
Average	$735.69	$1,470.69	$902.21	$1,921.09
Value of Water = Irrigated Cropland Values minus Dryland Cropland Values				

Source: 2010 Nebraska Farm Real Estate Survey

[2] The value of water is calculated by subtracting the value of Dryland Cropland (with irrigation potential) from value Irrigated Cropland.

Table 3. Derived rental value of water per acre, market value of water and capitalization rate of water, 2010, U.S. dollars

	Survey Calculated Value of Water per Acre					
Reporting District	Average Rental Value of Water* - Gravity Irrigated Cropland	Average Rental Value of Water* - Pivot Irrigated Cropland	Average Market Value of Water** - Gravity Irrigated Cropland	Average Market Value of Water** - Pivot Irrigated Cropland	Capitolization Rate of Water*** - Gravity Irrigted Land	Capitolization Rate of Water*** - Pivot Irrigted Land
South	$106.55	$130.00	$1,783.50	$2,201.00	5.97%	5.91%
Southwest	$93.70	$124.70	$1,458.33	$1,622.22	6.43%	7.69%
Central	$100.00	$115.09	$1,511.56	$1,681.00	6.62%	6.85%
Northwest	$85.17	$113.50	$1,022.02	$1,366.67	8.33%	8.30%

*Rental Value of Water = Irrigated Rental Rate minus Dryland Rental Rate

**Market Value of Water = Irrigated Cropland Market Value minus Dryland Cropland Market Value

***Capitolization Rate of Water = Rental Rate of Water divided by Market Value of Water

Source: 2010 Nebraska Farm Real Estate Survey

Table 4. Market perceived percentage reductions in land value under 25 percent and 50 percent reductions in water availability, 2010, U.S. dollars

Permanent 25% Change in Water Availability				
Reporting District	**South**	**Southwest**	**Central**	**Northwest**
	Reported Range of the Resulting Reduction in Market Value			
Gravity Irrigated Land	16% - 28%	10% - 22%	13% - 20%	12% - 24%
Pivot Irrigated Land	15% - 26%	9% - 20%	11% - 19%	7% - 20%
Permanent 50% Change in Water Availability				
Reporting District	**South**	**Southwest**	**Central**	**Northwest**
	Reported Range of the Resulting Reduction in Market Value			
Gravity Irrigated Land	30% - 39%	23% - 41%	22% - 31%	19% - 36%
Pivot Irrigated Land	25% - 28%	21% - 39%	20% - 29%	14% - 30%

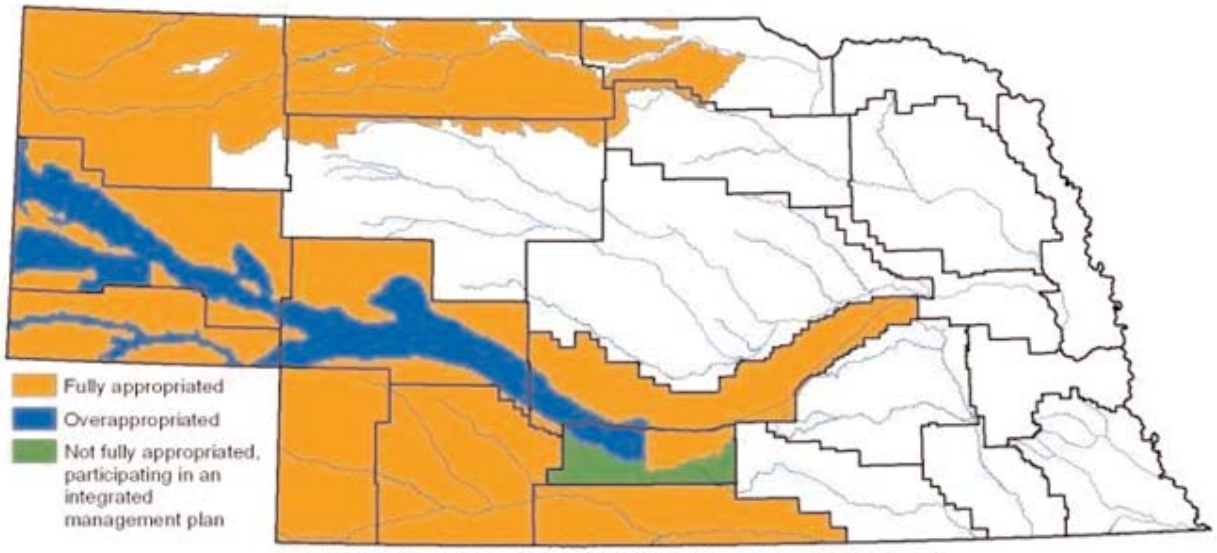
Source: 2010 Nebraska Farm Real Estate Survey

Table 5. A range of the calculated economic value of water rights per acre, per year in four Nebraska crop reporting districts, 2010, U.S. dollars

Permanent 25% Change in Water Availability				
Reporting District	**South**	**Southwest**	**Central**	**Northwest**
	Reported Range of the Resulting Reduction in Market Value			
Gravity Irrigated Land	16% - 28%	10% - 22%	13% - 20%	12% - 24%
Pivot Irrigated Land	15% - 26%	9% - 20%	11% - 19%	7% - 20%
Permanent 50% Change in Water Availability				
Reporting District	**South**	**Southwest**	**Central**	**Northwest**
	Reported Range of the Resulting Reduction in Market Value			
Gravity Irrigated Land	30% - 39%	23% - 41%	22% - 31%	19% - 36%
Pivot Irrigated Land	25% - 28%	21% - 39%	20% - 29%	14% - 30%

Source: 2010 Nebraska Farm Real Estate Survey

Figure 1. Fully and over appropriated areas of Nebraska, July 2008



Source: Nebraska Department of Natural Resources (dnr.ne.gov).