11-11-2018

Agricultural Production from the High Plains Aquifer Is Worth Over $3 billion per Year

Richard K. Perrin
University of Nebraska - Lincoln

Lilyan E. Fulginiti
University of Nebraska - Lincoln

Federico Garcia
University of the Republic, Uruguay

AGRICULTURAL ECONOMICS

November 14, 2018

agecon.unl.edu/cornhuskereconomics

Cornhusker Economics

Agricultural Production from the High Plains Aquifer Is Worth Over $3 billion per Year

Market Report	Year Ago	4 Wks Ago	11-9-18
Livestock and Products, Weekly Average			
Nebraska Slaughter Steers, 35-65% Choice, Live Weight.	*	*	114.00
Nebraska Feeder Steers, Med. & Large Frame, 550-600 lb.	179.94	183.35	169.61
Nebraska Feeder Steers, Med. & Large Frame 750-800 lb.	166.31	164.80	154.36
Choice Boxed Beef, 600-750 lb. Carcass.	212.59	202.68	217.37
Western Corn Belt Base Hog Price Carcass, Negotiated	59.91	NA	51.07
Pork Carcass Cutout, 185 lb. Carcass 51-52% Lean.	80.40	78.02	70.34
Slaughter Lambs, wooled and shorn, 135-165 lb. National.	136.55	137.49	135.43
National Carcass Lamb Cutout FOB.	393.31	376.01	380.23
Crops, Daily Spot Prices			
Wheat, No. 1, H.W. Imperial, bu.	3.26	4.69	4.43
Corn, No. 2, Yellow **Columbus**, bu.	3.09	3.40	3.40
Soybeans, No. 1, Yellow **Columbus**, bu.	8.73	7.67	7.79
Grain Sorghum, No.2, Yellow Dorchester, cwt.	5.49	5.41	5.48
Oats, No. 2, Heavy Minneapolis, Mn, bu.	3.06	3.32	3.18
Feed			
Alfalfa, Large Square Bales, Good to Premium, RFV 160-185 Northeast Nebraska, ton.	156.25		*
Alfalfa, Large Rounds, Good Platte Valley, ton.	80.00	102.50	110.00
Grass Hay, Large Rounds, Good Nebraska, ton.	82.50	87.50	87.50
Dried Distillers Grains, 10% Moisture Nebraska Average.	135.00	141.50	137.50
Wet Distillers Grains, 65-70% Moisture Nebraska Average.	42.00	48.75	49.00
*** No Market**			

Recent research (Garcia, Fulginiti and Perrin, 2018) has shown the that the extra agricultural production from irrigation across the High Plains Aquifer (HPA) was worth about $3.5 billion in 2007, $2 billion of which was produced in Nebraska. The aquifer water is valuable!

The HPA underlies an area that includes southern South Dakota, southeast Wyoming, eastern Colorado, Nebraska, western Kansas, eastern New Mexico, northwest Oklahoma, and northwest Texas (see Figure 1). This region has a semiarid climate that makes crop production highly dependent on irrigation. Given that irrigation has resulted in severe depletion in some areas of the HPA (Scanlon, et al. 2012), it is important for policy purposes to identify the overall value of this resource in agricultural production.

Analysis

The research analyzed crop production and weather information each year from 1960 to 2007 for each of the 205 counties overlying the HPA. The key parameter was the ratio of yields (total biomass per acre) on irrigated land compared to non-irrigated land (the "IR elasticity"). IR elasticity averaged about 50 percent over the whole period but had increased to about 60 percent by 2007.

Estimates of IR elasticity were obtained using a regression technique that related observed county dry matter yields to the share of irrigated county area, the rate of fertilizer and chemical applications, and weather variables. The latter consisted of growing season precipitation and four "degree day" variables measuring the amount of time over the season that the crop was exposed to various temperature ranges: -5 to 7.9° C, 8-14.9° C, 15-32.9° C and 33° C or over (the corresponding Fahrenheit breakpoints are 23°, 46°, 59°, and 91°).

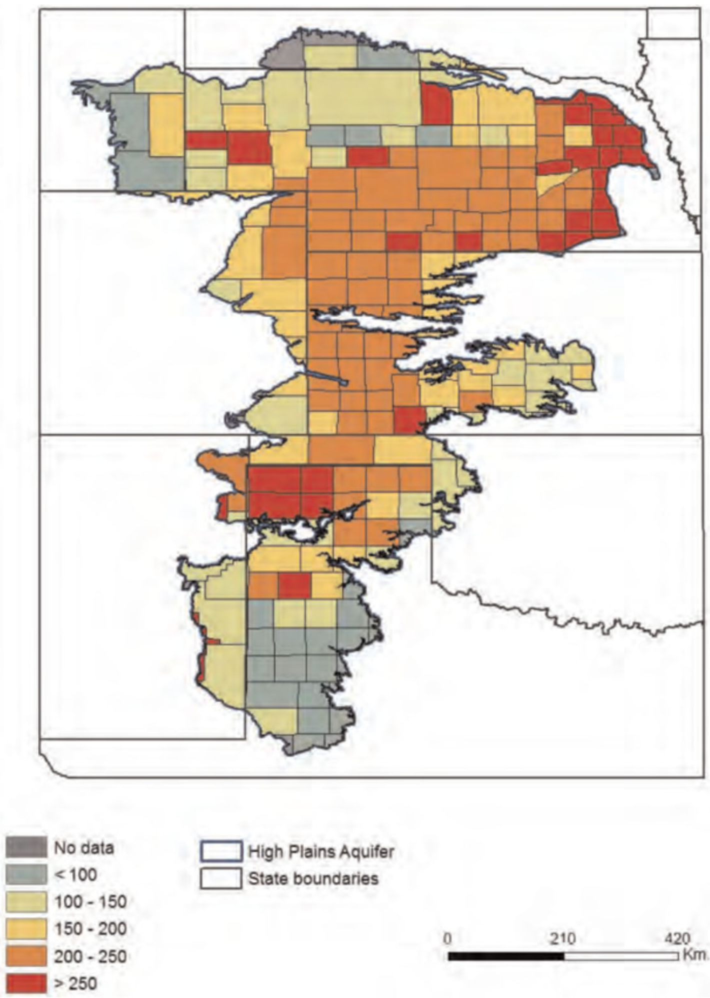

Figure 1. Estimated value of extra agricultural production due to irrigation over the High Plains Aquifer, 2007.

Table 1 illustrates how the estimated IR elasticity was converted into total value of production, summed across counties to state levels. First, observed yields at county level were multiplied by the IR elasticity estimate for the county to estimate the extra production due to irrigation. Next, that yield increment was multiplied by the average price for biomass in the county (the sum of all crop production in tons of total above-ground biomass produced, divided by total revenue from all crops). For this table, counties in each state were summed to obtain the total value by state for the year.

Findings

As Table 1 shows, Nebraska benefited most from water withdrawn for irrigation, with Kansas and Texas a distant second and third. Nebraska's estimated IR elasticity of 0.525 for 2007, applied against a yield of 4.856 tons of bone-dry biomass, implies that irrigation was responsible for an extra 2.55 tons per acre. At an average price of $103.50 per ton, this implies that the average acre irrigated across Nebraska realized $264 per acre of additional production, or about $2 billion given the 7.6 million acres irrigated.

Figure 1 illustrates the geographical distribution of county-level estimates of the value of extra production due to irrigation in 2007. The differences between counties are due in part to differences in estimated irrigation elasticity, in part to differences in yields on comparable non-irrigated land, and in part due to differences in the value of the extra biomass produced (the mix of crops differs considerably across the HPA).

Table 1 - Estimated annual average irrigation water value by state (3SLS+FE), 2007

State	Observed biomass yield	Average irrigation elasticity	Extra production from irrigation	Biomass price	Gross value per acre irrigated	Acres irrigated	Total gross value of irrigation water
	(metric tons per acre)	(IR)	(metric tons per acre)	($ per metric ton produced)	($/acre)	(million acres[a])	(million $)
Colorado	3.411	0.605	2.06	96.40	198.91	1.117	222
Kansas	3.284	0.625	2.05	99.30	203.82	2.426	494
Nebraska	4.856	0.525	2.55	103.50	263.87	7.602	2006
New Mexico	2.997	0.559	1.68	89.00	149.11	0.275	41
Oklahoma	2.773	0.700	1.94	100.10	194.28	0.132	26
South Dakota	1.907	0.726	1.38	104.80	145.11	0.005	1
Texas	2.333	0.598	1.39	105.00	146.47	2.898	424
Wyoming	2.888	0.438	1.26	93.60	118.39	0.212	25
HP Aquifer	3.682	0.577	2.12	101.70	216.07	14.667	3169

[a]Irrigated acres as reflected by USDA/NASS data for individual crops

The analysis also provided an estimate of the crop production damage caused by extreme temperatures – those above 33°C (91.4°F). For each county and year, the number of hours over the growing season that the crop was exposed to this high temperature was calculated. The result was divided by 24 to convert it to "degree days." Results indicated that each such degree day reduced yields by 3 percent. The average number of such degree days across the entire region and period was 2.7, indicating that on average, extremely high temperatures decreased crop yields by about 8 percent. In Nebraska, the average number of 33°C degree days was only 1.4, for a 4 percent loss, but in 2002, there were 2.8 such degree days, causing a loss of about 8 percent of all agricultural production (USDA surveys showed yields to be about 10 percent below trend that year).

Conclusions

The Great Plains states, especially Nebraska, depend heavily on the contributions of water from the HPA to augment agricultural production. Nebraska overlies 36 percent of the total HPA area and 69 percent of the total water volume (Young, et al., 2018). Water pumped for irrigation in Nebraska contributed about $2 billion worth of agricultural biomass in 2007. While water level changes have been fairly stable over the past ten years under most of Nebraska's portion of the HPA (Young, et al, 2018, p. 17), this study highlights the economic importance of continued aquifer monitoring and management efforts by various state agencies.

References

Garcia, F., Fulginiti, L.,& Perrin, R. (2018). What is the Use Value of Irrigation Water from the High Plains Aquifer? *American Journal of Agricultural Economics*, 0(0): 1–12; doi: 10.1093/ajae/aay062

Scanlon, B.R., Faunt, C.C., Longuevergne, L., Reedy, R.C., Alley, W.M., McGuire, V.L., & McMahon. P.B. (2012). Groundwater Depletion and Sustainability of Irrigation in the U.S. High Plains and Central Valley. Proceedings of the National Academy of Sciences of the United States of America 109 (24): 9320–25.

Young, A.R., Burbach, M.E., Howard, L.M., Waszgis, M.M., Lackey, S.O., & Joeckel, R.M. (2017). Nebraska Statewide Groundwater-Level Monitoring Report 2017. University of Nebraska–Lincoln, Conservation and Survey Division, Nebraska Water Survey Paper 85, 28 p.

Richard K Perrin
Roberts Professor
Department of Agricultural Economics
University of Nebraska-Lincoln
rperrin@unl.edu, 402-472-9818

Lilyan E Fulginiti
Frederick Professor
Department of Agricultural Economics
University of Nebraska-Lincoln
402-472-0561

Federico Garcia
Assistant Professor
University of the Republic, Uruguay