

KEEPING UP WITH Research

Understanding the Perceptions of Producers Regarding the Ogallala Aquifer Use: A Survey Report

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Introduction

The Ogallala aquifer, spanning eight states in the Great Plains region, is a vital resource of groundwater for irrigated agriculture, and an important source of income and employment for rural communities in the region (Lauer et al., 2018). However, use of the Ogallala aquifer is not sustainable in many parts of the region, as withdrawals exceed recharge rates. Depletion of the aquifer is a serious risk to the communities that depend on irrigated agriculture.

The Ogallala aquifer had come under increased pressure due to rapid expansion of irrigated agriculture in the region. Given this increased stress, in 1985 Kromm and White asked the question, what do the residents of the Ogallala aquifer see as the problems and solutions surrounding groundwater use and agriculture in the region? Responses to the 1985 survey covering 14 counties showed that residents of the Ogallala aquifer were concerned about groundwater depletion, the cost of fuel for irrigation, and low crop prices. The solutions to these issues that residents favored were improved irrigation efficiency, conservation tillage, and encouraging water conservation laws.

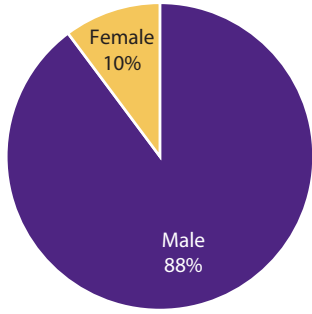
However, even given residents' clear concerns about groundwater depletion and continued research dedicated to agriculture and groundwater conservation in the region, since the time of this report (Kromm and White, 1985), many regions of the Ogallala aquifer have continued to be depleted (Lauer et al., 2018). This knowledge, paired with the continued regional dependency on irrigated agriculture, make groundwater use in the Ogallala aquifer more of a concern now than it was in 1985. The 1985 survey asked residents about the problems and solutions of groundwater use and agriculture in the Ogallala aquifer region. This survey asked producers in the Ogallala aquifer how they view their role in groundwater use, what they see as the consequences of groundwater depletion, and why they believe groundwater should be conserved. Producers were also asked about their worldviews and values. Together, these questions help provide an understanding of the cultural state of the Ogallala aquifer, especially as it pertains to groundwater use.

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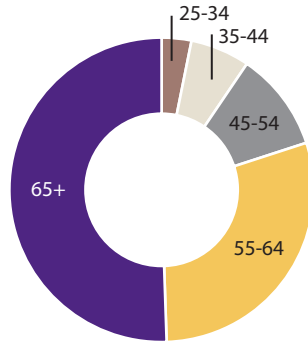
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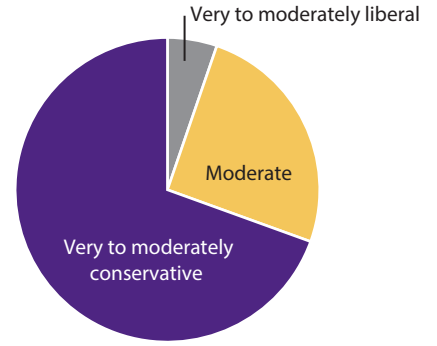
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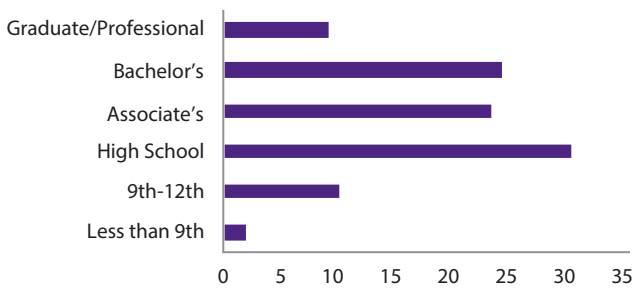
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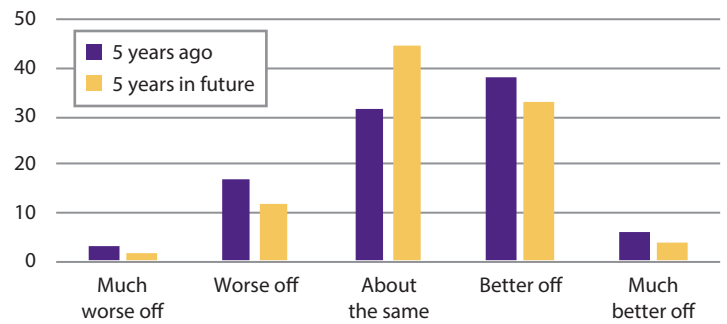
Political Orientation



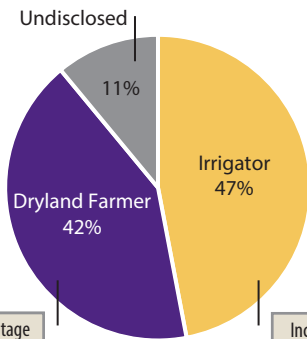
Education



Economic Status



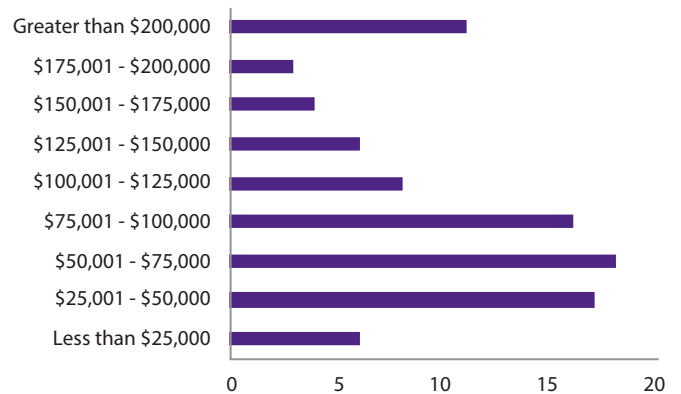
Irrigation Status and Related Income*



Income	Percentage
0%	8%
1-24%	19%
25-50%	17%
51-75%	11%
76-100%	37%

Income	Percentage
0%	50%
1-24%	13%
25-50%	11%
51-75%	7%
76-100%	12%

Income



*Related income refers to income derived from farming.

Figure 1. Responses from all producers for questions regarding irrigation status, political orientation, and other demographic factors.

The Survey and Respondents

Mailed surveys were sent to 8,000 producers in 227 counties overlying the Ogallala aquifer in the states of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, and Texas. Producers were identified as individuals who owned farmland within the study area, even if their home residence was outside of the study area. Producers were specifically targeted for this survey, as opposed to any resident of the Ogallala as was done for the survey conducted by Kromm and White, because producers are not only one of the heaviest users of groundwater in the region, but they will also be the most financially impacted by groundwater depletion given the significance of irrigated agriculture in the region. Survey responses were received from 1,226 producers from 206 counties.

Of the responses received, 47% of the producers use irrigation practices and 42% of the producers are using dryland practices, creating a nearly even split within the total population of responding producers (Figure 1). Nearly half (48%) of respondents were age 65 or older, and 88% of respondents were male. The highest achieved level of education was diverse among responding producers, but high school diploma (30%), associate’s degree (23%), and bachelor’s degree (24%) were the most common. For political orientation, respondents leaned heavily conservative (66%), with only 24% identifying as moderate and 5% as liberal.

Importance of Conserving Groundwater Today

One multi-part survey question inquired about why producers believed groundwater should be conserved (Figure 2). This question helped to better understand the producer’s personal norms as they relate to groundwater conservation. As a whole, producers were in the most agreement that groundwater

should be conserved so that future generations in the area could enjoy the benefits they have experienced, with greater than 80% of producers either agreeing or strongly agreeing. Further, producers were also in strong agreement (greater than 80% agreeing or strongly agreeing) that groundwater should be conserved so that their children or grandchildren, specifically, could enjoy the benefits they have experienced.

Producers also agreed (59%) that groundwater should be conserved today so that the water is available in the future if drought becomes more frequent. Further, they agreed (62%) that groundwater should be conserved today so that the economic security of their communities could be maintained via jobs and business opportunities. However, some questions revealed significant differences in the responses of irrigators and dryland farmers (Table 1). For example, 78% of irrigators agreed that groundwater should be conserved so that irrigated agriculture remains profitable on their farms in the future, while only 17% of dryland farmers agreed. Additionally, 74% of irrigators agreed that groundwater should be conserved so that irrigated agriculture remains profitable for other farms in their communities in the future, while only 36% of dryland farmers agreed.

Overall, responses to this survey question revealed that producers are united in their agreement that current conservation of groundwater is important, especially for the sake of future generations and their own families. However, it also demonstrated that irrigators are more interested in groundwater conservation so that irrigated agriculture can continue to be profitable, whereas dryland farmers, who by definition do not engage in any irrigated agriculture, are more concerned about conserving groundwater for the sake of their communities and potential future environmental conditions.

All producers' responses (n = 1226)

Groundwater should be conserved today so that...

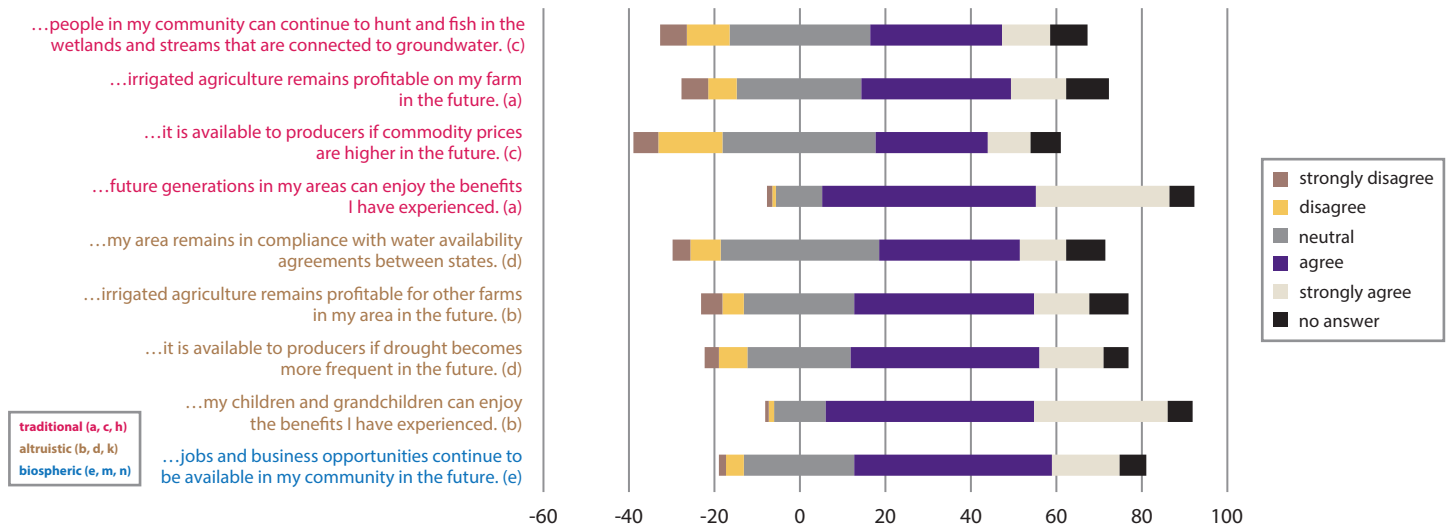


Figure 2. Responses from all producers for questions regarding groundwater conservation.

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Table 1. Responses from irrigators and dryland farmers regarding groundwater conservation

Questions: Groundwater should be conserved today so that...	Irrigators (n = 578)						Dryland (n = 513)					
	Response (%)						Response (%)					
	SD	D	N	A	SA	NA	SD	D	N	A	SA	NA
Q21a: ...future generations in my areas can enjoy the benefits I have experienced.	1	2	13	56	26	3	2	1	10	42	37	8
Q21b: ...my children and grandchildren can enjoy the benefits I have experienced.	1	2	12	56	26	3	2	1	11	43	36	8
Q21c: ...it is available to producers if commodity prices are higher in the future.	4	15	36	31	10	4	9	15	36	20	10	10
Q21d: ...it is available to producers if drought becomes more frequent in the future.	1	6	23	52	15	3	5	9	27	36	14	9
Q21e: ...jobs and business opportunities continue to be available in my community in the future.	1	4	25	51	16	3	3	4	28	40	16	9
Q22a: ...irrigated agriculture remains profitable on my farm in the future.	1	2	16	57	21	3	12	12	42	13	4	16
Q22b: ...irrigated agriculture remains profitable for other farms in my area in the future.	1	2	20	56	18	3	10	9	33	30	6	12
Q22c: ...people in my community can continue to hunt and fish in the wetlands and streams that are connected to groundwater.	7	14	37	30	7	4	4	8	31	32	14	11
Q22d: ...my area remains in compliance with water availability agreements between states.	5	10	36	35	11	4	2	4	39	32	11	13

SD = strongly disagree. D = disagree. N = neutral. A = agree. SA = strongly agree. NA = no answer.

Awareness of Consequences

Another multi-part question provided further insight into what producers viewed as the importance of groundwater itself and the consequences of its depletion. The previous set of questions asked why groundwater should be conserved *today*, focusing on issues producers saw as having immediate importance. This section reports the results from questions investigating producers' views on the importance of groundwater on a general level. Therefore, the results in this section reveal some of the reasons producers value groundwater, but these reasons are not necessarily related to the current conservation of groundwater.

Producers, both irrigators and dryland farmers, were united in their agreement that groundwater is important because it

provides drinking water to farms and communities, with 90% of producers agreeing or strongly agreeing (Figure 3). Groundwater was also viewed as important for the profitability of agricultural businesses in a producer's area, with 79% of producers in agreement. However, irrigating farmers were in much more agreement (91%) than dryland farmers (66%) regarding this issue (Table 2). Further, irrigators agreed that groundwater is important for their own agricultural production businesses (89% agreeing) and because it provides jobs in their communities (81%), while dryland farmers were in much less agreement on these issues with only 41% and 54% agreeing, respectively. Responses showed that the only statement that did not receive a majority of agreement from either group of producers was the statement that said groundwater was important for wetlands and streams where residents could hunt and fish.

All producers' responses (n = 1226)

Groundwater is important...

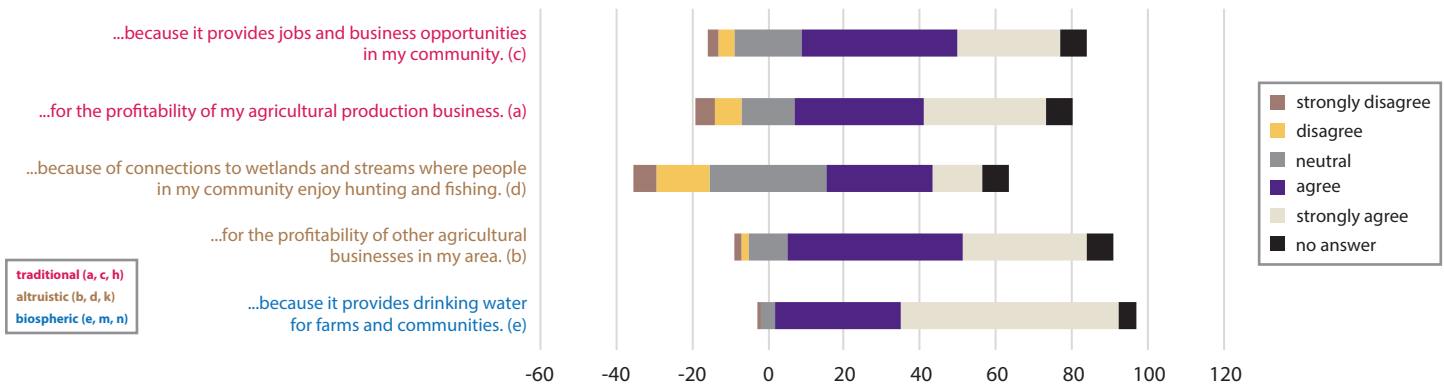


Figure 3. Responses from all producers for questions regarding awareness of consequences surrounding groundwater use and depletion.

Table 2. Responses from irrigators and dryland farmers regarding awareness of consequences surrounding groundwater use and depletion.

Questions: Groundwater is important...	Awareness of Consequences											
	Irrigators (n = 578)						Dryland (n = 513)					
	Response (%)						Response (%)					
	SD	D	N	A	SA	NA	SD	D	N	A	SA	NA
Q20a: ...for the profitability of my agricultural production business.	1	3	4	42	47	3	11	13	26	25	16	10
Q20b: ...for the profitability of other agricultural businesses in my area.	1	1	5	47	44	3	3	5	17	44	22	10
Q20c: ...because it provides jobs and business opportunities in my community.	2	2	12	46	35	3	5	7	25	37	17	10
Q20d: ...because of connections to wetlands and streams where people in my community enjoy hunting and fishing.	8	19	35	26	8	3	4	11	27	31	18	9
Q20e: ...because it provides drinking water for farms and communities.	1	0	4	36	58	2	1	0	4	31	56	8

SD = strongly disagree. D = disagree. N = neutral. A = agree. SA = strongly agree. NA = no answer.

Acknowledgment of Responsibility

Most survey questions investigated producers' views on the importance of groundwater conservation and of groundwater in general. However, there were two questions used to understand how producers viewed their role in groundwater use and depletion in the Ogallala region (Figure 4).

For the first statement (Q16h): "I feel personally responsible for groundwater depletion in my area," producers generally disagreed (58% disagreeing or strongly disagreeing), with some neutral (21%), and even less agreeing (10%). When observing responses from irrigators and dryland farmers separately, some difference is observed, but not as much as with previous survey questions reported in the two prior sections (Table 3). For this first statement (Q16h) regarding personal responsibility, 54% of irrigators disagreed, while 61% of dryland farmers disagreed, and 15% of irrigators agreed, while only 7% of dryland farmers agreed.

For the second statement (Q16i): "I should reduce or minimize my groundwater use," responses were more evenly distributed, with 35% of producers disagreeing, 34% neutral, and 20% agreeing. When studying responses of irrigators and dryland farmers separately, a small difference in responses is observed, with 33% of irrigators and 38% of dryland farmers disagreeing and 24% of irrigators agreeing compared to 14% of dryland farmers agreeing. Notably, for both statements, the highest percentage of non-response was observed among dryland farmers at 16% for Question 16h and 18% for Question 16i. This finding is not entirely surprising given that dry farmers may not feel a question of personal responsibility for groundwater depletion applies to them as they do not use groundwater for their farming operations. Further, the survey did not gather data on whether or not a current dryland farmer previously used irrigation on their farm.

When considering the findings of survey regarding personal norms, awareness of consequences, and responsibility as a

whole, we see producers, especially irrigators, understand the importance of groundwater for their communities and for their own agricultural production businesses, as well as the importance of conserving groundwater today for the sake of their own farming operations and their neighbors' operations. However, even though producers largely agreed on the importance of groundwater and groundwater conservation for the future of their own businesses and businesses in their communities, neither dryland farmers nor irrigators expressed a strong sense of personal responsibility for the depletion of groundwater or for reducing the use of groundwater. In short, although producers recognize the importance of groundwater for the future of farming in the Ogallala region and believe it should be conserved, they do not believe they are responsible for the depletion or conservation of this groundwater.

While these results may at first appear contradictory, they represent an example of the Tragedy of the Commons. This concept was first introduced by William Foster Lloyd in 1833 and later refined by Garrett Hardin in 1968. The Tragedy of the Commons refers to the situation that occurs when multiple individuals, sharing the same limited resource and acting in their own self-interest, ultimately deplete said resource even when it is in no one's best interest for this to happen. To provide an example of this, Lloyd (1833) described an open pasture where herdsmen bring their cattle to graze. Over time, a herdsman decides to maximize his own personal gain by increasing the number of cattle that he brings to graze in the pasture. As this trend continues and other herdsmen follow suit, the number of cattle grazing in the pasture exceeds the carrying capacity, the maximum number of cattle the pasture can support, and the natural resource is depleted. The survey results show that producers across the Ogallala recognize that it is in their best interests not to deplete the shared, limited resource of groundwater. However, on an individual level, the majority of producers do not feel personally responsible for preventing the depletion of the Ogallala and conserving water.

All producers' responses (n = 1226)

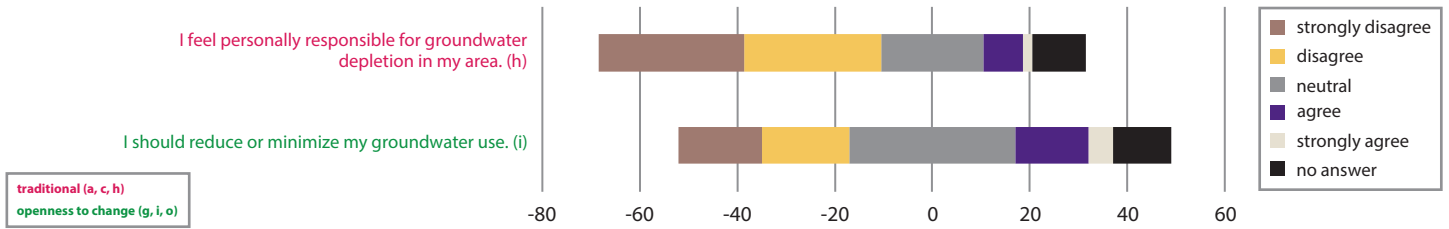


Figure 4. Responses from all producers for questions regarding the ascription of responsibility for groundwater depletion and conservation.

Table 3. Responses from irrigators and dryland farmers regarding the ascription of responsibility for groundwater depletion and conservation

Questions	Ascription of Responsibility											
	Irrigators (n = 578)						Dryland (n = 513)					
	Response (%)						Response (%)					
	SD	D	N	A	SA	NA	SD	D	N	A	SA	NA
Q16h: I feel personally responsible for groundwater depletion in my area.	24	30	26	12	3	5	36	25	16	5	2	16
Q16i: I should reduce or minimize my groundwater use.	12	21	38	20	4	6	23	15	29	9	5	18

SD = strongly disagree. D = disagree. N = neutral. A = agree. SA = strongly agree. NA = no answer.

Worldviews and Values

The concept of the Tragedy of the Commons demonstrates how the survey results are not entirely unique but representative of a historic and long-term challenge. The following survey results investigating producers' worldviews and values provide cultural context to better understand why resolving the issues of groundwater depletion in the Ogallala may be particularly difficult. In this section, results from eight questions on worldviews (Figure 5) and 15 questions on values (Figure 6) are reported. The survey questions regarding worldviews provide insight into producers' relationship with nature. Together, the eight questions indicate if a producer leans more toward the view that humans have a right to dominate over nature or more toward the view that humans are equal with nature. The 15 survey questions regarding values were used to measure producers' alignment with five core values: traditional (a, c, h), altruistic (b, d, k), biospheric (e, m, n), self-enhancement (f, j, l), and openness to change (g, i, o). By learning producers' alignment with these core values, researchers can better understand which values are most important as guiding principles in a producer's life. Together, worldviews and values provide a necessary understanding of the cultural context that can influence producers' decisions regarding groundwater conservation.

Responses to the eight questions about worldviews did not elicit strong agreement or disagreement among producers as a whole or separately as irrigators and dryland farmers. For these questions, responses were more evenly distributed. Because of this, question responses that were close to a majority (>50% agreement or disagreement) are discussed. First, 52% of dryland farmers agreed that people are severely abusing the environment, compared to only 32% of irrigators (Table 4). Further, 48% of dryland farmers agreed that the earth has limited room and resources, while only 34% of irrigators agreed. Dryland farmers also agreed (47%) that plants and animals have as much right as people to exist, compared to

only 33% of irrigators. Irrigators were more likely to agree (49%) that the ecological crisis facing us has been greatly exaggerated when compared to dryland farmers (41%). Some questions also revealed shared disagreement among producers. Dryland farmers disagreed (51%) that nature can cope with the impacts of modern industry. Additionally, dryland farmers disagreed (49%) that people have the right to modify the natural environment to suit their needs. From the results of the worldviews questions, we observe less difference between irrigators and dryland farmers compared to results reported in previous sections, with responses more evenly distributed. However, generally, dryland farmers lean more towards an ecocentric worldview, where humans are more equal with nature, whereas irrigators lean more toward an anthropocentric view, where humans play a more dominant role over nature.

Results from the 15 values questions showed that producers, as a whole, strongly align with traditional values, with 87–91% of producers reporting traditional values as important or very important. Questions pertaining to traditional values include those of respecting elders, self-discipline, and family security. Producers also reported that biospheric (53–75%) and altruistic (59–79%) principles were important to them, but the results were not as united as for traditional values. Further, a larger percentage of dryland farmers reported biospheric and altruistic values as important when compared to irrigators (Table 5). Values of self-enhancement and openness to change were not reported to be of importance by most producers. The results of the survey question regarding values show that producers value the environment (biospheric values) and the well-being of humanity in general (altruistic values), as is in line with previously reported results that show producers believe groundwater should be conserved for the future of their communities. However, traditional values stand out as the most important values to producers. Thus, if water conservation approaches do not align with both biospheric and traditional values, they are likely to be unsuccessful.

All producers' responses (n = 1226)

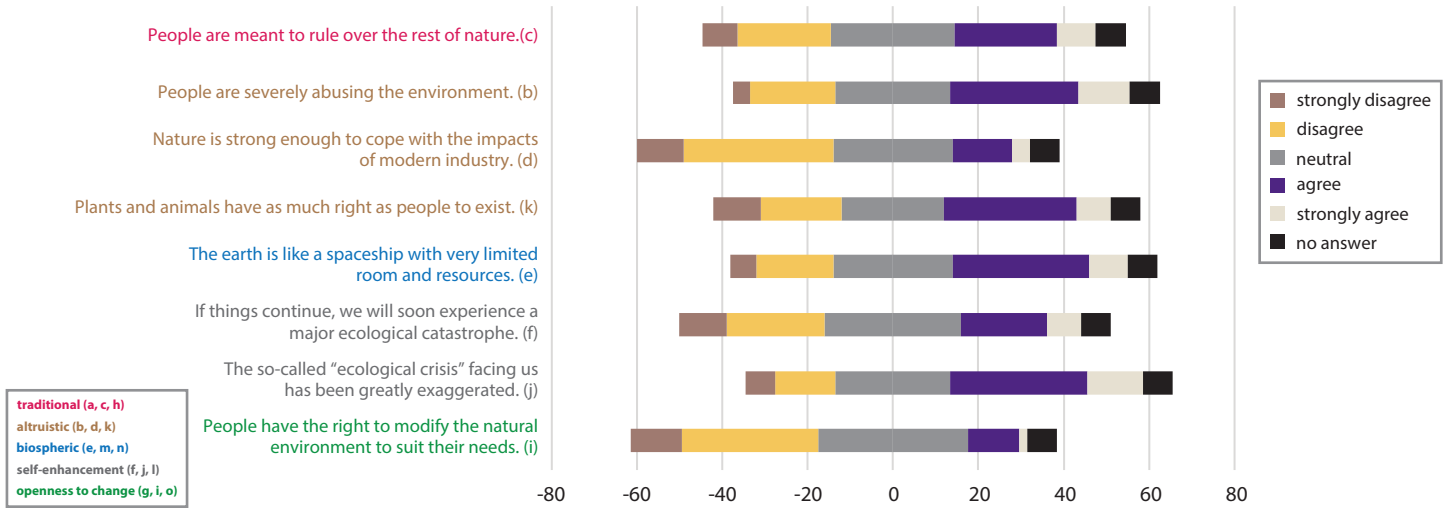


Figure 5. Responses from all producers for questions regarding their worldviews.

All producers' responses (n = 1226)

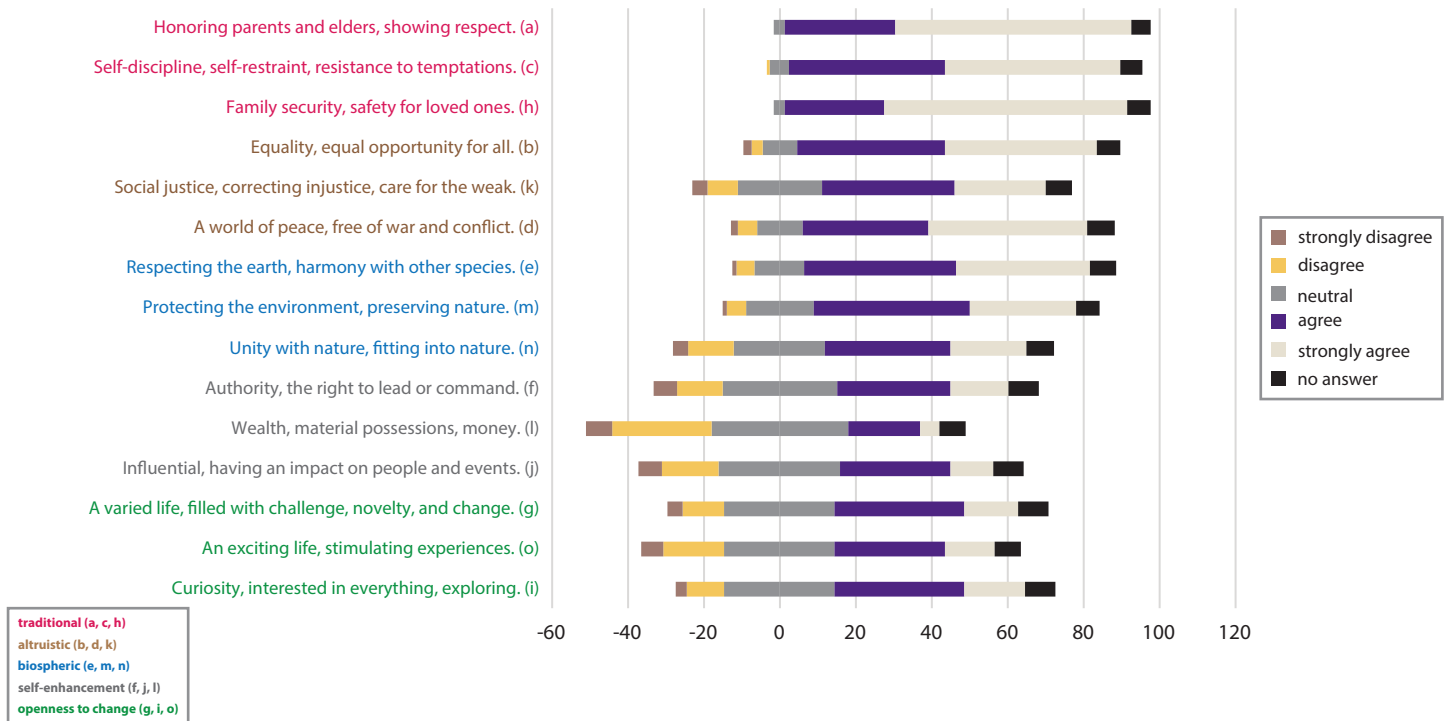


Figure 6. Responses from all producers for questions regarding their values.

Table 4. Responses from irrigators and dryland farmers regarding their worldviews

Questions	Worldviews											
	Irrigators (n = 578)						Dryland (n = 513)					
	Response (%)						Response (%)					
	SD	D	N	A	SA	NA	SD	D	N	A	SA	NA
Q30b: People are severely abusing the environment.	6	24	30	26	6	7	3	16	23	34	18	6
Q30c: People are meant to rule over the rest of nature.	6	21	32	24	10	7	12	22	27	24	9	7
Q30d: Nature is strong enough to cope with the impacts of modern industry.	8	36	30	15	4	7	15	36	26	14	4	6
Q30e: The earth is like a spaceship with very limited room and resources.	7	21	30	28	6	8	4	15	26	36	12	6
Q30f: If things continue, we will soon experience a major ecological catastrophe.	14	27	32	16	3	7	8	19	31	25	12	6
Q30i: People have the right to modify the natural environment to suit their needs.	8	32	37	14	2	7	15	34	32	10	2	6
Q30j: The so-called “ecological crisis” facing us has been greatly exaggerated.	5	11	27	35	14	7	9	15	28	29	12	6
Q30k: Plants and animals have as much right as people to exist.	13	22	26	29	4	7	9	17	22	34	13	6

SD = strongly disagree. D = disagree. N = neutral. A = agree. SA = strongly agree. NA = no answer.

Table 5. Responses from irrigators and dryland farmers regarding their values

Questions	Values											
	Irrigators (n = 578)						Dryland (n = 513)					
	Response (%)						Response (%)					
	NI	SI	MI	I	VI	NA	NI	SI	MI	I	VI	NA
Q29a: Honoring parents and elders, showing respect.	0	0	3	31	60	6	0	1	4	26	65	5
Q29b: Equality, equal opportunity for all.	3	4	10	40	36	7	1	3	9	38	45	5
Q29c: Self-discipline, self-restraint, resistance to temptations.	0	1	6	44	42	7	0	1	5	38	50	5
Q29d: A world of peace, free of war and conflict.	2	6	13	35	36	7	1	3	11	32	47	6
Q29e: Respecting the earth, harmony with other species.	1	6	14	43	28	7	1	4	13	34	41	6
Q29f: Authority, the right to lead or command.	6	12	31	31	12	9	5	11	30	28	18	7
Q29g: A varied life, filled with challenge, novelty, and change.	3	11	33	32	11	9	4	11	26	35	17	8
Q29h: Family security, safety for loved ones.	1	0	3	27	61	7	0	0	4	24	67	5
Q29i: Curiosity, interested in everything, exploring.	4	10	30	32	14	8	2	10	28	34	19	7
Q29j: Influential, having an impact on people and events.	6	15	33	29	10	8	5	15	32	29	12	7
Q29k: Social justice, correcting injustice, care for the weak.	5	9	24	33	20	8	3	7	21	36	27	5
Q29l: Wealth, material possessions, money.	6	26	37	20	4	8	6	27	35	20	6	6
Q29m: Protecting the environment, preserving nature.	1	5	23	43	20	7	1	4	15	39	36	5
Q29n: Unity with nature, fitting into nature.	6	12	29	33	13	8	3	11	21	34	26	5
Q29o: An exciting life, stimulating experiences.	5	18	29	31	9	8	6	14	31	27	16	6

NI = not important. SI = somewhat important. MI = moderately important. I = important. VI = very important. NA = no answer.

Conclusion

This report has detailed the results of a survey of producers from 206 counties across the Ogallala aquifer. While a previous survey conducted by Kromm and White (1985) of 14 counties in the Ogallala investigated perceptions of potential policy solutions for groundwater management among residents, this survey focused exclusively on producers. The survey examined producers' perceptions of groundwater, its conservation, their perceived role in its use, and their more general worldviews and values associated with conservation. Together, these results describe a paradox. The results showed that producers view groundwater as important for their own agricultural businesses and their communities. Further, producers clearly believe groundwater should be conserved for the use of future generations and in case of drought in the future. However, the majority of producers do not feel personally responsible for groundwater depletion and do not believe they need to minimize or reduce their groundwater use or they are already doing all they can to conserve groundwater. This paradox is an example of the Tragedy of the Commons, as producers view groundwater as a shared resource that they do

not want to be depleted, but they also believe they should not, or cannot, reduce their use of the resource. Moving ahead, a focus on producers' values may be important for resolving this instance of a Tragedy of the Commons. The results show that traditional values are important factors motivating producers' decision-making. Thus, for producers to engage in groundwater conservation behavior, solutions should align more with traditional values.

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