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WATER MANAGEMENT STRATEGIES TO CONSERVE GROUNDWATER IN TEXAS' REGION A

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The Ogallala aquifer in the heavily irrigated, northern region of Texas continues to decline and has no appreciable rate of recharge. Under the water planning efforts in Texas, the regional water planning group identified a goal of limiting water use to an annual average of 1.25% of saturated thickness to preserve water availability for future generations. As a part of that effort, water management strategies that could be potentially implemented to reduce the rate of irrigation water use were identified and evaluated. The assessment of conservation strategies included the use of the ET network for irrigation scheduling, changes in crop variety, irrigation equipment improvements, changes in crop type, implementation of conservation tillage methods, precipitation enhancement, the conversion from irrigated to dryland farming, and brush control measures. While all of the strategies evaluated resulted in water savings, several have negative impacts on the economy of the region. If water savings are the principle objective, the strategies of changing crop variety and the use of conservation tillage should be potentially be dropped from consideration. The strategies of changing crop type and conversion of irrigated to dryland production generate the largest water savings, but had the largest negative impacts on the regional economy. The strategies of precipitation enhancement and irrigation scheduling were estimated to provide both a substantial water savings and have a positive impact on the regional economy. Regardless of the conservation strategy evaluated given the implementation level, the demand shortage could not be met with conservation alone in all areas.

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Abstract

The Ogallala aquifer in the heavily irrigated, northern region of Texas continues to decline and has no appreciable rate of recharge. Under the water planning efforts in Texas, the regional water planning group identified a goal of limiting water use to an annual average of 1.25% of saturated thickness to preserve water availability for future generations. As a part of that effort, water management strategies that could be potentially implemented to reduce the rate of irrigation water use were identified and evaluated. The assessment of conservation strategies included the use of the ET network for irrigation scheduling, changes in crop variety, irrigation equipment improvements, changes in crop type, implementation of conservation tillage methods, precipitation enhancement, the conversion from irrigated to dryland farming, and brush control measures. While all of the strategies evaluated resulted in water savings, several have negative impacts on the economy of the region. If water savings are the principle objective, the strategies of irrigation scheduling and the use of conservation tillage should be potentially be dropped from consideration. The strategies of changing crop type and change in crop variety generate the largest water savings, but had the largest negative impacts on the regional economy. The strategies of precipitation enhancement and irrigation scheduling were estimated to provide both a water savings and have a positive impact on the regional economy. Regardless of the conservation strategy evaluated given the implementation level, the demand shortage could not be met with conservation alone in all areas.

The shortfall in supply versus demand expectations in the northern Texas Panhandle as predicted with the use of the groundwater availability model (GAM) over the next 60 year period must be addressed in the near term if impacts to irrigated agriculture are to be gradual rather than dramatic and abrupt. The regional water team studied several conservation based strategies and assessed the feasibility of these strategies in lieu of heavy regulatory action by the state or the area groundwater districts. This assessment benefits area and state water leaders in their selection of strategies and their respective costs to the regional economy.

Introduction

The Texas legislature under Senate Bill 1, setup 16 regional groups to address water planning within their geographical areas. Region A consisted of 21 counties located in the northern plains of Texas. The Ogallala aquifer in the heavily irrigated, northern region of Texas continues to decline and has no appreciable rate of recharge. The Region A water planning group identified a goal of limiting water use to an annual average of 1.25% of saturated thickness to preserve water availability for future generations. In the Senate Bill 1 planning effort, the Region A Agricultural Demands and Projections Committee identified seven potential water management strategies for evaluation to reduce irrigation demand (Senate Bill 1 2001). These

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strategies included the use of the Evapotranspiration (ET) Network to schedule irrigation, changes in crop variety, irrigation equipment efficiency improvements, changes in crop type, implementation of conservation tillage methods, precipitation enhancement and conversion of irrigated land to dryland. Each of these strategies is presented in Table 1 with the assumed water savings and implementation schedule presented in Senate Bill 1.

Table 1. Estimated Water Savings and Implementation Schedules for Agricultural Water Conservation Strategies Proposed in Senate Bill 1, Region A

Water Management Strategy	Assumed Annual Regional Water Savings (in/ac)	Assumed Baseline Use Year 2000	Goal for Adoption 2010	Goal for Adoption 2020	Goal for Adoption 2030	Goal for Adoption 2040	Goal for Adoption 2050
Irrigation Scheduling	2	20%	70%	90%	90%	90%	90%
Change in Crop Variety	2	10%	40%	70%	70%	70%	70%
Irrigation Equipment Changes	3	55%	75%	95%	95%	95%	95%
Change in Crop Type	5	0%	20%	40%	40%	40%	40%
Conservation Tillage Methods	2	50%	60%	70%	70%	70%	70%
Precipitation Enhancement	1	0%	100%	100%	100%	100%	100%
Irrigated to Dryland Farming	12-14	0%	5%	10%	15%	15%	15%

In a subsequent planning effort, Senate Bill 2, Regional Planning groups were charged with refining and expanding planning efforts. The focus of this study conducted under Senate Bill 2 was to revisit the strategies in a more detailed analysis. An effort was made to fully describe and document each strategy, refine the potential water savings, identify the cost of implementation and the potential impacts to the region from implementing the strategy. This analysis will prove useful in evaluating the effectiveness of these strategies and provide information to assist in prioritizing the various strategies in the implementation process.

Based on the research conducted, some of the assumptions on potential water savings and strategy implementation schedules were altered before the proposed strategies were evaluated. A summary of the changes that were made to the various strategies is given in Table 2. For a more detailed discussion of the strategy documentation and associated changes consult Amosson et al. (2004).

Table 2. Changes to Senate Bill 1 Water Management Strategies.

Strategy	Change
Use of Irrigation Scheduling	Water savings were reduced to 1 in/ac. Implementation was reduced to 10% in 2000 and increased 7½% per decade until it was assumed to level off at 50% after 2050.
Change in Crop Variety	The water savings from converting from long season corn and sorghum varieties to short season was specifically identified at 4.1 in/ac and .65 in/ac respectively. The proposed implementation schedule for this strategy remained unchanged.
Irrigation Equipment Changes	In SB1, it was estimated in 2000 that 55% of the irrigation systems were efficient (LESA, LEPA and SDI). This was revised to 78.5%. The implementation schedule was altered to reflect the revised baseline. LEPA and SDI were projected to increase 2% and ½% every decade until the 95% level of efficient systems is reached. The calculated saving from this strategy was 6.3 inches per acre.
Change in Crop Type	Converting irrigated corn acreage to irrigated cotton, sorghum and soybean acreage equally as proposed in SB1 was again used and resulted in an estimated 8.3 inches per acre compared to the 5 inches per acre estimate in SB1. The proposed conversion of irrigated soybean and sorghum to irrigated wheat (SB1) was eliminated based on a lack of projected water savings. The proposed strategy implementation schedule remained the same.
Conservation Tillage Methods	Water savings from implementing conservation tillage was reduced from 2 to 1.75 inches per acre. The implementation schedule remained unchanged.
Precipitation Enhancement	Water savings estimates and implementation schedule remained unchanged from SB1.
Irrigated to Dryland Farming	The strategy of converting some of the marginally irrigated crops (wheat, sorghum and cotton) to dryland as proposed in SB1 remained unchanged. Estimated water saving per acre was 10-10.7 inches compared to 12-14 inches used in SB1.

Methodology

Water savings, implementation cost and change in gross crop receipts were estimated for each proposed water management strategy identified in the Senate Bill 1 planning effort. All strategies were evaluated over a 60-year planning horizon as identified in the Senate Bill 2 planning effort using Farm Service Agency (FSA) (2000) irrigated acreage for the region as the base. Water availability was assumed to remain constant in measuring the impacts of the various water conservation strategies.

Implementation costs were defined as the direct costs associated with implementing a strategy whether these costs would be bourn by producers and/or the government. The change in gross crop receipts generated under the alternative strategies was estimated using five year averages for yields (Texas Agricultural Statistics Service 1998-2002) and prices (Master Marketer Educational System 1998-2002) in the region. All costs were evaluated in current dollars.

Results

Cumulative water savings, implementation cost and direct regional impacts as expressed by the change in gross crop receipts for each of the water conservation strategies are presented in Table 3. The change in crop type was estimated to generate the largest amount of water savings, 8.7 million ac-ft, which was 8.3% of the total irrigation water pumped over the 60-year planning horizon. Implementing this strategy was expected to cost 46.0 million dollars resulting in an average cost of $5.25 per ac-ft of water saved. However, achieving these water savings came at an additional cost. The move to lower productive crops resulted in a loss of 2.1 billion dollars in gross crop receipts or $235.85 per ac-ft of water saved over the planning horizon.

Table 3. Estimated Water Savings and Costs Associated with Proposed Water Conservation Strategies in Region A.

Water Management Strategy	Cumulative Water Savings (WS) ac-ft	WS/Total Irrigation Demand %	Implementation Cost (IC) $1,000	IC/WS $/ac-ft	Direct Regional Impact (DRI)[1] $1,000	DRI/WS $/ac-ft
Use of Irrigation Scheduling	2,065,469	1.96	8,100	$3.92	+	+
Change in Crop Variety	6,658,309	6.32	-	-	-1,548,584	-$232.58
Irrigation Equipment Changes	4,124,398	3.91	169,608	$41.12	-	-
Change in Crop Type	8,709,995	8.26	46,000	$5.25	-2,054,000	-$235.85
Conservation Tillage Methods	2,135,882	2.03	10,985	$5.14	-	-
Precipitation Enhancement	4,105,680	3.89	25,800	$6.28	+	+
Irrigated to Dryland Farming	5,157,272	4.89	39,000	$7.54	-406,000	-$78.72

[1]+indicates an anticipated positive impact that was not quantified.

The change to shorter season corn and sorghum varieties yielded the second largest water savings of 6.7 million ac-ft or 6.3% of the total pumped. However, changing crop variety led to a reduction in yields that resulted in a loss in gross cash receipts of 1.5 billion dollars or $232.58 per ac-ft of water saved.

Converting marginally irrigated land to dryland production yielded water savings of 5.2 million ac-ft or 4.9% of the total pumped. The estimated change in land values resulted in an implementation cost of 39 million dollars and a resultant cost of $7.54 per ac-ft of water saved. Loss in gross receipts was estimated to be 406 million dollars or $78.72 per ac-ft of water saved.

Additional conversion of non-efficient irrigation delivery systems in the region, such as, furrow and MESA to more efficient systems (LESA, LEPA or SDI) resulted in a savings of 4.1 million ac-ft (3.9% of total irrigation water pumped). Investment in these more efficient systems and reinvestment as they wore out resulted in an implementation cost of 170 million dollars. This translates into a cost of $41.12 per ac-ft of water saved, by far the most expensive of the strategies considered from an implementation cost standpoint. However, this strategy was not expected to have any adverse effects on gross receipts, thus having a neutral impact on the regional economy.

The precipitation enhancement strategy was projected to save 4.1 million ac-ft under the assumption that increased rainfall would result in an equal reduction in pumping. The estimated implementation cost associated with this strategy was 25.8 million dollars resulting in a cost of $6.28 per ac-ft of water saved. This strategy should yield a positive impact to gross receipts in the region since additional rainfall will occur not only on irrigated land but on dryland and pasture operations increasing their productivity. No estimate of these positive externalities is provided.

Increasing the level of conservation tillage practices yielded water savings of 2.1 million ac-ft or 2.0% of total irrigation water pumped. The cost of the increased conservation tillage given the implementation schedule was estimated at 11 million dollars resulting in the second lowest implementation cost per acre-foot of water saved ($5.14). Increasing conservation tillage acreage was assumed to have a neutral effect on gross crop receipts.

Increased use of the ET network to improve the efficiency of irrigation scheduling was estimated to save 2.1 million ac-ft or approximately 2.0% of total water pumped. Implementation costs were estimated at 8.1 million dollars resulting in the lowest cost per ac-ft of water saved, $3.92. It should be noted that the water savings assumed a 1 in/ac savings which may or may not be accurate for the region. Results of a very limited, previous survey of ET network users indicated that just as many producers increased pumping from use of the ET (increased irrigated acreage) as decreased water usage. A study of the California network yielded a significant increase in returns from a combination of water savings and yield increases, but the amount of water savings achieved was omitted from the study report.

Summary and Conclusions

The purpose of this study was to provide more substantial documentation of the agricultural water conservation strategies proposed in the Senate Bill 1 planning effort including refining estimates of water savings and implementation costs. In addition, the potential direct effect to the region's economy was evaluated via the anticipated change in gross crop receipts. Additional regional impacts derived from the indirect and induced effects caused by the change in crop receipts were not evaluated. The impact of each strategy was evaluated using the revised Region A Senate Bill 2 parameters of a 60-year planning horizon and an irrigated acreage base constructed from Farm Service Agency (FSA) data.

Prioritizing the seven strategies will depend on how policy makers want to weigh the various decision variables, i.e., water savings, implementation costs and regional impacts. The two strategies that yield the largest water savings, changing crop type and change in crop variety, are projected to generate a significant negative impact to the regional economy, -$235.85 and -$232.58 per ac-ft of water saved, respectively. The third leading water saving strategy, conversion to dryland, yields significant water savings, yet still has a negative impact to the regional economy of -$78.72 per ac-ft of water saved. Changing to more efficient irrigation systems comes with the highest estimated implementation cost of $41.12 per ac-ft of water saved. Conservation tillage is a proven water management strategy that is already widely adopted in the region, however, further adoption would result in significant water savings at the second lowest implementation cost per acre-foot. Precipitation enhancement and irrigation scheduling appear to provide the potential of significant water savings while positively impacting the regional economy. However, of all the strategies considered, less documentation of the effectiveness of these two strategies exists.

It is recommended that water conservation strategies selected by the water planning group should go through a more thorough analysis prior to implementation. These analyses should include a more detailed documentation of the selected strategies; a county level assessment of the water savings impacts; and a complete cost analysis of the strategy or strategies including required government expenditures and producer bourn costs. Completing these analyses will allow for development of an implementation plan of action that could maximize water savings given available funding for a specific strategy or combination of strategies on a county and regional basis.

Finally, it would be remiss not to provide the warning that the associated water savings with these strategies are "potential" water savings. In the absence of water use constraints, most if not all the strategies considered will simply increase gross receipts. In fact, the improved water use efficiencies generated from some of these strategies may actually increase the depletion rate of the Ogallala Aquifer.

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References

Amosson, S., L. Almas, F. Bretz, D. Gaskins, B. Guerrero, D. Jones, T. Marek, L. New, and N. Simpson. 2004. Water Management Strategies for Reducing Irrigation Demands in Region A. Prepared for Agricultural Sub-Committee Panhandle Water Planning Group. Texas A&M University Agricultural Research and Extension Center, Amarillo, TX. 61 pp.

Farm Service Agency. 2000. Irrigated Crop Acres by County. Personal Communication. United States Department of Agriculture, Texas Farm Service Agency, College Station, TX.

Senate Bill 1. 2001. Regional Water Plan – Panhandle Water Planning Area. Prepared for the Panhandle Water Planning Group through a contract with the Panhandle Regional Planning Commission, Amarillo, Texas. Vol. 1. p. 5-33

Texas Agricultural Statistics Service. 1998 – 2002. Texas Agricultural Statistics Annual Bulletin. Compiled by the United States Department of Agriculture, National Agricultural Statistics Service, Texas Field Office, Austin, TX. Bulletins 257-261.

Master Marketer Educational System. 1998-2002. Crop Prices. Texas A&M University System, Texas Cooperative Extension. Available at http://mastermarketer.tamu.edu.