Water Currents

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DEAR READER:

With this issue on the economic implications of agricultural water conservation, **Water Currents** ends its third and final year of publication.

Past issues have presented water-related research by over seventy scientists with The Texas Agricultural Experiment Station in fourteen research centers throughout the state.

If you missed one or more issues, or would like to have extra copies on a particular topic, please let us know. Topics covered in the series include:

Drought preparedness
Drought-tolerant plants
Urban lawn water conservation
Stream quality
Aquaculture
Groundwater
Rice water management
Agricultural use of salt water
Water-based recreation
Irrigation efficiency
Soil moisture management
Economic issues

It is our sincere hope that **Water Currents** has given you a deeper appreciation for the depth and breadth and importance of water-related research conducted by dedicated, highly-trained agricultural scientists.

Publications from the Texas Water Resources Institute will be directed to more specific audiences in the future. We promise to keep you informed of their availability through our bimonthly newsletter, **Texas Water Resources.**

And for now, we wish to extend our thanks to those dear readers committed to the wise use and protection of our state's most valuable resource.

Sincerely,

Lou Ellen Ruesink
Editor

Water Currents reports quarterly on water research conducted by the Texas Water Resources Institute, Wayne R. Jordan, director, and The Texas Agricultural Experiment Station, Neville P. Clarke, director.

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Walking an Economic Tightrope

Texas farmers in general operate on an extremely narrow margin of profit - an economic tightrope, so to speak. They cannot afford to change methods or equipment simply because it is more modern, more efficient, or better for conserving a natural resource.

A farmer's primary concern when a new concept is presented by agricultural scientists is how much he can afford to spend on water-saving techniques or equipment.

For many years now, scientists with The Texas Agricultural Experiment Station (TAES) have studied methods to reduce water requirements of crops. They have also developed improved technologies and farming practices to increase water use efficiencies. Complementing this research, agricultural economists associated with TAES have evaluated such water conservation methods in dollars and cents terms.

Agricultural economists have developed sophisticated analyses and computer models to determine whether the cost of a new technique will pay in either the long or short haul. For no matter how much water a method can save, or how well it operates in the research field, if the agricultural economists cannot show that it will increase a farmer's profits or at least reduce the farmer's economic risks, it will not be seriously considered by the farmer.

Through the years, new water efficient ideas have been presented to farmers at annual field days at the thirty TAES research centers throughout the state. Area farmers and businessmen attending the demonstrations of research results, more often than not, ask the researchers tough economic questions about the new equipment and techniques. They ask, "Will the new equipment or concept increase yields or quality or reduce production expenditures enough to offset its costs?" Or, even more to the point, farmers ask, "Will it pay me to change from the way I am farming now?"

And even though many of the farmers' toughest water management questions remain unanswered, TAES research has given Texas farmers economically sound information on which to base many of their decisions.

Irrigators have no choice but to improve water use efficiency, according to the predictions by the Texas Department of Water Resources (TDWR). The state agency responsible for water planning in Texas also predicts that water used for irrigation demand will in fact be the only major water use not to increase substantially by the year 2030. Irrigated agriculture, by far the largest water user in the state, may actually decrease its use of water in the next decade or two.

Water use efficiency in irrigated production must be increased to the fullest extent possible, say TDWR experts. Their reasons cited include declining groundwater supplies, rising costs of pumping, and limited supplies of surface water.

The predictions emphasize the important decisions facing agricultural producers in the state. They must learn to optimally use the existing, but exhaustible, groundwater reserves and to reduce the costs of production. And they must, according to the TDWR, reduce water consumption while at the same time meeting growing market demands for food and fiber.

Water conservation methods listed by TDWR include more efficient irrigation application systems, soil moisture monitoring, use of drought tolerant varieties of crops, and appropriate farming practices to capture and retain rainfall in the soil profile.

TAES researchers in the Department of Agricultural Economics have also evaluated how the new water-saving methods will affect future agricultural water use and crop production in the state. Their research, including the following examples, can help Texas farmers better answer some of their tough economic questions.

HIGH PLAINS STUDIES

Irrigation on the High Plains means higher yields of cotton, sorghum, wheat, and sunflowers. It also means the possibility of growing corn, soybeans and vegetables. Irrigation greatly reduces the risks faced by farmers dependent upon the sparse rainfall in this semi-arid region.

Irrigation water is by far the most expensive item in crop production on the High Plains. In recent years, irrigators have reached the point of asking not how much water they have available to them, but how long they can afford to pump the water from underground.

The High Plains, with eighty-nine percent of all the groundwater in Texas, has one of the most severe groundwater problems in the state. Pumpage far exceeds recharge of the region's groundwater source, the Ogallala Aquifer. This depletion means declining water levels and well yields in addition to rising pumping costs.

The impact of groundwater depletion on the High Plains spreads far beyond the farming community, according to resource economist Ronald Lacewell. Lacewell, a researcher for the Texas Agricultural Experiment Station and a professor in the Texas A&M Department of Agricultural Economics, expects the declining groundwater in the Ogallala to eventually affect the entire High Plains Region.

He and other TAES agricultural economists have conducted several studies to help farmers determine whether the increased yields and reduced risks of irrigation will offset the higher costs. They use a computer model which they have designed to estimate the role of new technology on future water use, farm and regional economics, and length of time farmers will be able to afford to pump from the aquifer.

Recently the researchers used the model to determine how the adoption of more efficient water use practices by farmers on the High Plains will impact irrigated and dryland acreages, the regional economy, and groundwater resources. The model takes into consideration the adoption of specific water-saving techniques, the availability and cost of water, types of crops, market prices of crops, cost of energy, and types of soil.

The researchers divided the High Plains into northern and southern subregions because cotton usually is not grown north of the Canadian River. The four major crops in the southern region - cotton, grain sorghum, sunflowers, and wheat - can all be grown either under irrigation or on dryland. Soybeans and corn, two popular crops in both regions, must have irrigation water to be produced successfully most years anywhere in the High Plains. Lacewell and research associates John Ellis and Duane Reneau projected the impact of new technology for a forty-year period between 1980 and 2020. They looked at water conservation technologies such as limited tillage and more efficient irrigation methods representative of the types of changes area farmers would be adopting in the next forty years. Current use of these technologies varies considerably in the region. Limited tillage is already widely used while the adoption of an irrigation system called Low Energy Precision Application (LEPA) is just under way.

According to Lacewell, there must be economic incentives for the adoption of advanced technologies. Net returns to land, management, and risk must be at least as great as those available under the conventional technology.

For the purposes of their study, the researchers defined limited tillage as crop residues left on the soil surface, chemical weed control, and no mold-board plowing.

The LEPA system of irrigation, developed by Bill Lyle, an agricultural engineer with the Texas Agricultural Experiment Station in Lubbock, is one of the most promising ways to reduce water use, according to TAES researchers. The LEPA system involves applying water through drop tubes and low pressure emitters attached to a sprinkler frame. Water is applied directly to the furrow as the frame moves through the field in either a linear or circular pattern. When combined with furrow diking - small dams formed across the furrow - LEPA has proven to be 92 percent efficient in distribution of water.

Improved furrow irrigation systems and techniques including tailwater recirculation pits and shorter row lengths were also considered.

Lacewell, Ellis, and Reneau compared the adoption of these advanced technologies in the High Plains with current conventional tillage and irrigation technology. They predict that if advanced technologies are not adopted to use water more efficiently, declining water supplies and increasing pumping costs will mean a decrease in crop output and net returns across the entire region.

One important finding from the research was the potential for greater profitability of dryland farming. By using the advanced technologies of limited tillage and furrow diking, High Plains dryland production will become increasingly more attractive. Because groundwater levels continue to decline and because pumping costs will continue to rise, Lacewell predicts a gradual adjustment from i irrigated to d dryland agriculture in the area. This has already occurred in many parts of the southern High Plains which initially had very limited groundwater.

The researcher also predicts, however, that the adoption of advanced technology will minimize the adverse effects of the eventual transition from irrigation to dryland production in the High Plains.

WINTER GARDEN AREA

In a similar study, Lacewell looked at the economic implications of new crops, furrow diking, and land clearing in the Winter Garden Region of Texas. This is another area of the state where groundwater use and pumping costs are major concerns. Groundwater levels in some areas of the Carrizo Aquifer, the major groundwater source in the region, have declined by as much as 200 feet over the past 40 years.

Irrigation is the major use of groundwater in the region. Total groundwater pumped for irrigation in the Winter Garden area is estimated at over 300,000 acre-feet per year while groundwater for all other uses is only about 24,000 acre-feet per year.

Even so, agriculture in the five-county area of Dimmit, Uvalde, Zavala, Frio, and LaSalle counties is limited by the lack of water. For instance, only 220,000 acres of the 1.65 million acres suitable for irrigation are currently irrigated. Although dryland production takes place on much of the cropland in the area, irrigation substantially enhances per acre yields.

Even with water limitations, the area is a major agricultural area in the state and is the U.S. Ieader in the number of acres of spinach. Currently over 30,000 acres of vegetables are harvested in the area. Other major agricultural crops in the area include corn, wheat, grain sorghum, and cotton.

Lacewell conducted the Winter Garden study in cooperation with three other TAES researchers: George Muncrief, Gerald Cornforth, and Joe Penal The researchers looked at water-saving cultural practices and their effects on farmer profit both for a one-year period and over a period of several years.

They concluded that between 1981 and 2001 furrow diking on dryland grain sorghum and on dryland cotton would be the most effective technique for reducing the dependence on groundwater. The study showed that furrow diking decreased groundwater pumpage and increased net returns by $6.7 million for the region. This figure is based on present cultivated acres and would be even higher if new land were cleared for cultivation.

These studies indicate that research and technology can provide answers to many of the difficult water questions facing Texas in the coming decades.

Economics of New Ways

Tillage systems which reduce the number of cultivation steps have been adopted by many Texas farmers. These reduced tillage systems - called no-till, low-till, reduced till, limited till, or conservation till - can, according to crop scientists, save soil moisture, fuel, labor, and machinery costs, as well as reduce wind and water erosion.

Wyatte Harman, an agricultural economist with the Texas Agricultural Experiment Station (TAES) research center in Amarillo, has studied the economics of reduced tillage methods compared to the conventional methods on the High Plains.

Farmers on the High Plains come out better economically, says Harman, with conservation tillage instead of conventional tillage methods. This is true, he found, for both irrigated and dryland sorghum production on the High Plains. The higher profit is largely due to the additional stored soil moisture resulting from conservation tillage practices. These practices also mean savings in fuel, labor, and depreciation costs. Herbicide costs, however, are greater than for conventional tillage.

Harman points out that since 1970 energy costs have increased fourfold. Costs of natural gas, the primary fuel for irrigation, has risen ten times while the cost of diesel fuel, the primary tractor fuel, has risen 300 percent during the same time period.

Producers can offset these increasing costs in some measure by shifting to crops requiring lower energy and water inputs, by substituting other inputs for the higher priced energy, by accepting reduced yields, and by adopting strategies such as conservation tillage.

Conservation tillage is one way farmers can reduce production costs without decreasing yields.

A most promising option to high energy costs, according to Harman, is a crop rotation of irrigated wheat, then no-till sorghum followed by a fallow period. The rotation system has been developed and tested by TAES scientist Allen Wiese at Amarillo, who worked in cooperation with Paul Unger, a USDA scientist stationed at Bushland.

The system involves planting sorghum in the stubble of a previous wheat crop after an 11-month idle period. The researchers have found that maintaining the stubble and not planting for almost a year results in an average of 2.2 inches more soil water stored at sorghum planting time than if the field had been conventionally tilled with a disc.

For irrigators, the additional stored water eliminates the need for a preplant irrigation in most years. For dryland producers, the extra soil moisture means an average 1,000 pound per acre increase.

Harman compared the economics of this rotation system with conventional tillage practices for sorghum production typical of Texas High Plains practices. Conventionally tilled methods include controlling weeds by discing and sweeping following wheat harvest. Before sorghum is planted the next spring, the field is chiseled once and nitrogen fertilizer is knifed in. Another discing operation for weed control and smoothing prepares the field for herbicide application and listing to form furrows. Each of these operations requires fuel and can reduce soil moisture.

Weeds are controlled in no-till sorghum with chemicals applied to the wheat stubble throughout the 11-month idle period between wheat harvest and sorghum planting. The only tillage operation in no-till sorghum is the furrow- opening immediately before the first irrigation.

According to Harman's analysis, no-till practices reduce total irrigated sorghum production costs by $35 per acre. Total dryland no-till production costs remained somewhat higher than conventional tillage by about $4 per acre because of the high cost of chemical weed control.

According to his results, a producer on the High Plains, whether irrigating or producing dryland sorghum, would come out ahead economically by adopting no-till production methods. A yield increase of only 750 pounds per acre as a result of increased soil moisture storage resulted in increased returns to land and management of $67 per acre with irrigation and $29 per acre with dryland sorghum production.

These profits, says Harman, are a result of higher crop yields, reduced labor requirements, savings in irrigation and tillage energy costs, and reductions in machinery depreciation costs.

The Economics of Rice Water Management

As part of ongoing studies of water management in rice production, two agricultural economists with The Texas Agricultural Experiment Station (TAES), Ron Griffin and Greg Perry, surveyed rice producers after the 1982 growing season. Garry McCauley of the TAES research center in Beaumont assisted in the study.

These researchers explored various aspects of water demand and use in the Texas Rice Belt. Their findings are reported in a recent TAES publication, **Water Use and Management in the Texas Rice Belt Region.** Their investigation included how rice producers manage water delivered to their fields and what changes producers would make if water increased in price or became limited in availability.

At the time of the study, there was no available data for the amount of groundwater and surface water consumed in rice production. The researchers estimate that rice producers who rely heavily on groundwater pump an average of 3.8 acre-feet of water per acre of rice produced. This may be an overestimate, say Griffin and Perry, because respondents may have been optimistic in reporting their well and pump efficiency. On the basis of personal interviews with the management of sixteen major surface water suppliers, surface water deliveries to rice producers during recent years range from 2.6 to 7.4 acre-feet per acre with an average of 5.4 acre-feet.

The most common on-farm water losses, according to the researchers, are due to lateral losses, levee breakage and seepage, field leaching, and tailwater.

Rice producers were asked to estimate the percentage of water consumed by the rice crop and the percentage of water lost to these categories. The producers who responded, representing more than one-third of the rice acreage planted in 1982, replied that an average 57 percent of all water used in rice production is used for evapotranspiration - a combination of evaporation and transpiration of water by plants. In other words, they felt that just over half of the water applied to a rice field is consumed by the rice crop. Another sixteen percent of the water, they felt, is released from the field as tailwater. These estimates follow very closely those made for groundwater users by the Harris-Galveston Coastal Subsidence District.

Griffin and Perry also posed several questions on what changes the rice producers would make in production procedures if surface water or groundwater were limited or if water costs increased. Respondents to the survey said that they would reduce rice acreage, use water conservation practices, improve wells and pumps, and reuse tailwater if water became limited or more costly.

Primary data generated by the survey is being used to construct economic models to evaluate different water-saving methods in rice production. Using these models, researchers can evaluate water conservation practices such as land leveling, underground pipe, and sprinkler irrigation as alternatives to traditional rice production technologies.

Rice is a water intensive crop grown in an area of the state where competition for water grows more serious each year and where excessive groundwater withdrawal causes subsidence. For these reasons, the TAES researchers believe that rice farmers will become increasingly concerned about water conservation in the future.

According to Griffin and Perry, rice grown in Texas has the highest production costs of any rice grown in the U.S. High water costs contribute greatly to this situation. They feel that their study can help rice producers weigh the relative merits of water conservation as a way to decrease costs and increase farm profitability.