Section 5A
Identification, Evaluation, and Selection of Water Management Strategies

5A.1.6 Agricultural Water Management Strategies

New firm water supplies cannot be developed for irrigated agriculture, because the cost of development far exceeds the value of the water in irrigated production. The assumption is made that the available groundwater resources are already fully exploited. Cloud seeding and brush control for water yield are the only potential new supplies of water for irrigated agriculture, but a firm yield cannot be assigned to these practices. Without any firm supply of water, agricultural producers will have to reduce the irrigation and confined livestock demands through a variety of conservation and other management practices.

5A.1.6.1 Water Conservation and Irrigation System Conversion

Water conservation is the most practical and feasible option, and increasing the efficiency of the irrigation systems is the strategy that offers the most practical and feasible solution with any certainty. To conserve water in irrigated agriculture, the assumption is made that the crop is fully irrigated, so that the water conserved remains in the aquifer or surface source and is available to meet other agricultural needs. The cost of water conservation per acft has to be within the production value range when it is used to meet a shortage. For example, a producer will not incur a conservation cost of $50/acft unless the production value of the water on another field with a shortage is less than $50/acft. The additional cost of delivery of the conserved irrigation water has to be taken into account. The producer will be most likely to adopt water conservation practices when a positive return will result, as with lower energy and labor costs. The tradeoff is with the higher cost of a more efficient irrigation system.

The efficiency of irrigation systems is dependent on the individual producer operation and on the inherent nature of the type of irrigation. The efficiency of irrigation is measured as the ratio of the water actually used by the crop to the total water delivered from the source. The major water losses are to deep percolation below the effective root zone of the crop (over-irrigation), water runoff from the field, and evaporation of the water to the atmosphere. As an extreme example, only 30 percent of the water applied from a high-pressure sprinkler on a very hot, very windy afternoon may ever reach the surface for infiltration. In general, gated pipe surface irrigation is 40 to 70 percent efficient, side roll sprinkler irrigation is 50 to 75 percent efficient, and a low-pressure center pivot with drop nozzles is about 90 percent efficient. The various forms of microirrigation (drip tape, microsprinklers, drip emitters, etc) are 90 to 95 percent efficient. Good management and ideal conditions will increase the efficiency.

Three scenarios were considered for an economic analysis of conversion of irrigation systems for water conservation. One scenario was conversion of a system that is 75 percent efficient to a system that is 90 percent efficient, such as conversion of a side roll system to an efficient center pivot or the renozzling of a center pivot with impact sprinkers to low-pressure drop nozzles. The second scenario was the conversion of a system that is 50 percent efficient to a system that is 75 percent efficient. This could be the conversion from a gated pipe to a side roll or adoption of cutback or surge irrigation with the gated pipe. The third scenario was the conversion of a 50 percent efficient system to a 90 percent efficient system.

Several assumptions were made for simplicity. A 25-year economic analysis period was selected, which is in the range for wells, pumps, pipelines, and the major equipment. Two interest rates were used—10 percent for conventional loan and 2 percent for a low-interest loan. Constant dollars (no inflation) were used. A linear series of annual values was used for the analysis. A capital recovery factor was calculated for the capital investment and operating (variable) costs for taxes, insurance, repair, and maintenance were calculated based on typical values. Water conservation results in lower energy costs for pumping and pressurization, and decreased labor is typically results from conversion of gated pipe and side roll irrigation to center pivot irrigation. Decreased energy and labor costs were taken into account.

For purposes of illustration, 130 acres were converted from one system to another in the scenarios. The cost of meeting the water shortage is expressed in dollars per acft of conserved water. Peanuts and cotton are the target crops for the analysis, although high-value horticultural crops and high-quality forage crops would also fit the scenarios. The crop requires 15-acre inches per acre to meet the yield objective. At 50 percent efficiency, 30 inches of water will be delivered from the source to the crop; at 75 percent efficiency, 20 inches of water will be delivered; and at 90 percent efficiency, 16.67 inches of water will be delivered. For a full season of irrigation, plus limited rainfall and carryover soil moisture reserve, the water conserved by conversion to more efficient irrigation is calculated. Conversion from 75 to 90 percent efficiency conserves 36.08 acft for the 130 acres, conversion from 50 to 75 percent conserves 108.33 acft, and conversion from 50 to 90 percent conserves 144.41 acft.

Three levels of cost for conversion of irrigation systems were selected: \$300/acre, \$500/acre, and \$700/acre. The actual costs for a field will depend on proximity to water supply, existence or absence of pipelines, field layout, "farmability," and other factors. Taxes and insurance were calculated at 2 percent and repair and maintenance were calculated at 5 percent. The water was available at no cost. The annual cost of labor saved was estimated at \$6545 for conversion to a center pivot from gated pipe or side roll system. The energy cost was calculated as \$2.00 per acre-inch, based on typical values for pressure requirements, flow requirements, and electricity cost. Other costs were neglected.

The results of the cost analysis are shown in Table 4-81. As shown in the table, at conventional financing, the economically feasible options are limited. The options are for a low investment cost (\$300/acre) or conversion to a 90 percent efficient irrigation system. With low interest financing, the options are more economically feasible, and include all three low investment cost scenarios and conversion of 50 percent efficient irrigation systems to 70 or 90 percent efficient systems, although an increased cost of production will be incurred by the producer.

For planning purposes, the amount of water conserved will be 0.23 acft/acre for conversion of a system that is 75 percent efficient to one that is 90 percent efficient; 0.83 for conversion from 50 percent efficient to 75 percent efficient, and 1.11 for conversion from 50 percent efficient to 90 percent efficient.

Table 5A.1-3.
Cost/Value of Irrigation Water Conservation from Increasing the Efficiency of Irrigation Systems (130 acre system)

Investment Cost (dollars/acre)	Water Conserved (acft)	Cost	
		10% finance ($/acft)	2% finance ($/acft)
300	30.48	10.65	20.65
	108.33	-40.86	33.98
	144.41	20.66	40.65
500	30.48	-119.18	-53.94
	108.33	-84.1	-40.6
	144.41	-11.77	-33.94
700	30.48	-249.02	-27.83
	108.33	-127.35	-14.27
	144.41	-44.21	-7.83

5A.1.6.2 Strategies for Meeting Irrigation Shortages

As stated previously, there are no new economically feasible water supply options for irrigated and confined animal production. Shortages must be met through agricultural management strategies detailed in the following section. Following are general water conservation strategies for irrigation.

- Plant crops that require less water and/or decrease yield objective. The cost is variable, depending on current markets. Irrigated wheat requires irrigation in winter and spring, but may have very little economic return unless wheat is used for stocker pasture in fall and mid-winter. Sorghum requires less water than cotton, but the economic return is typically much less. Peanuts require water over a 120 to 150 day growing period, but the economic return is significant. Silage corn may requires only one or two irrigations and is harvested in early July, but requires a nearby market and a compatible irrigation system. Plant populations may be decreased to make maximum use of rainfall during the growing season, but the anticipated economic benefit is usually less. An economic analysis of these strategies is very region specific, and probably specific to individual agricultural producers.
- Convert to more efficient irrigation systems for delivery and application efficiency (up to $1000/acre to convert from gated pipe to center pivot; $500/acre to convert side roll to center pivot; about $1000/acre to install drip irrigation;
- Use soil moisture and potential evapotranspiration irrigation scheduling (cost of about $3.50/acre, but significant technology transfer will be required)

- Convert to dryland production or reduce the number and amount of irrigation (deficit irrigation). Water production functions (relationship between yield and water applied) are poorly known and are not generally used for major crops in Brazos G. With water production functions, producers select the optimum timing and amount of irrigation water to apply to achieve the maximum yield for a unit of water. In general terms, this strategy allows moisture stress, but the stress is managed to have the least impact on the final yield or quality. Incorporation of deficit irrigation strategies based on plant and soil measurements will require additional research and technology transfer for each crop in each cropping region.
- Develop new crops and crop varieties. Plants that are able to perform with less water are essential. Possibilities include earlier maturing crops, crops with a higher ratio of yield to non-yield components (harvest index), crops that can be planted earlier in the growing season to take advantage of stored soil moisture and spring rains, crops with improved rooting characteristics, new crops for an area, and varieties that simply perform better than similar varieties under dry conditions. Significant research and technology transfer will be required on a regional basis.
- Use cultural practices that suppress evaporation. Mulches are effective in reducing evaporation from the soil surface. Plastic mulches may be used in vegetable production and dust mulches formed with cultivation are used extensively in row crop production.
- Increase infiltration. Off-season cultural practices that increase infiltration (i.e., reduce runoff) of winter precipitation are very effective. For many crops, half of the total water requirements may be available from a full soil moisture profile in the upper meter or so of root zone.