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Economically Optimum Agricultural Utilization of a Reclaimed Water Resource in the Texas Rolling Plains

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- Full Text

The U.S. Army Corps of Engineers (COE) has proposed a project that would reduce the flow from saline springs and seeps within the groundwater alluvium of the Red River Basin. While the amount of salts moving through the alluvium would be controlled by the project, total water quantity would not be appreciably affected. Presently, salinity levels in the basin are quite high, making irrigated agriculture an infeasible alternative. In areas affected by salinity, salts accumulate in the active root zone, thereby restricting the availability of soil moisture to the crop and reducing yield. To counteract the deleterious presence of the salts, extra irrigation water is applied to "leach" the salts below the active root zone thus maintaining the yield at some specified level.

Waters containing over 13,000 parts per million (ppm) salts have been sampled by the COE in the Pease River watershed (a subsector of the entire area to be impacted by the project). It is estimated that installation of the project would reduce this level to approximately 3000 ppm. Although 3000 ppm is not below the tolerance threshold of most plants, rainfall in the area is sufficient to act as a natural leaching agent.

The purpose of this study was to estimate the response of the agricultural sector to the project. A recursive linear program was designed in such a manner that the time path of producer adjustments to the reclaimed water source could be estimated. The Pease River watershed was chosen due to the sizable reduction in the salinity due to the proposed project, relative to other areas within the basin. By considering only a single watershed, the adoption process could be more closely studied. Two scenarios were considered in the analysis in an attempt to better understand the effects of the initial assumptions on the measure of project benefits. The first scenario applied guidelines established by the Water Resources Council (WRC). WRC guidelines required the use of OBERS SERIES E' yield projections, normalized prices, and an interest rate of 7.125 percent to discount future costs and benefits.

The second scenario applied in alternative criteria, which assumed no trend in yield, a three-year average of current prices, and a real interest rate of 2.5 percent.

Since probabilistic estimates indicating the improvement in water quality through time were unavailable from the COE, it was assumed that all improvement in water quality occurred linearly over time, with full water quality improvement in the tenth year. The adjustment process was then evaluated over a twenty year horizon. Several irrigation strategies were considered for each crop, thereby allowing the model to select an optimal leaching policy given the level of water quality for any point in time. The linear programming model maximized expected net returns from representative crop enterprises on the basis of a three-year moving average of past actual yields. This means expected yield in the linear programming model was slightly less than actual yield for any particular year. When all improvements in water quality had taken place and the model achieved steady state, the economically optimal allocation of the water resource had been determined.

Results from the study indicated that a policy of rapid adoption should be undertaken. In the initial year, a 40 percent leaching fraction was economically feasible on limited acreage. Dryland production then shifted quickly to irrigation as water quality improved. Water use also shifted, moving from a 40 percent to a 20 percent leaching fraction. By the ninth year of the analysis, all adjustment's had occurred and a 10 percent leaching fraction was economically optimal on all irrigated acreage. Due to its profitability and for relative salt tolerance, cotton was the only irrigated activity chosen by the model. An optimal cropping pattern of 55,121 acres of irrigated cotton, 14,437 acres of dryland cotton and 7,728 acres of native pasture was selected by the model under the first scenario. For the second, scenario, the optimal cropping pattern consisted of 55,703 acres of irrigated cotton and 25,583 acres of dryland alfalfa. The estimated net present value of benefits attributable to the project over the 20 year planning horizon was approximately $16 million and $30 million for the first and second scenarios, respectively.