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Rice Water Use and Costs in the Mississippi Delta

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Introduction

It has traditionally been held that the alluvial aquifer of the Mississippi Delta was fully rechargeable and therefore essentially inexhaustible. By the 1970's, this concept had begun to be questioned. Expanded acreage of rice and catfish, as well as the expanded use of irrigation for row crops, principally cotton and soybeans, had resulted in some observed declines in the alluvial aquifer water tables. In certain areas, the need to deepen wells became apparent.

Studies by the U.S. Army Corps of Engineers and the Mississippi Department of Environmental Quality in the early 1980's indicated that the aquifer was declining at an alarming rate. There appeared to be a great need for conservation and regulation of the aquifer for agricultural use. Discussion of these subjects, however, pointed out clearly that before rational regulations could be developed it would be necessary to quantify current uses.

When acreage and assumed quantities of water were considered, it appeared that rice production probably was the largest single agricultural user of water. The tremendous growth and expansion of the catfish industry in the Mississippi Delta was also suspected of having an impact on the declining aquifer. At that time, there were only rough estimates of acres of cotton, soybeans, and other crops being irrigated. Exact acreages of irrigated row crops also varied greatly from year to year. The number of irrigations also varied from year to year depending on rainfall, thus compounding problems. The problem of measuring the quantities of water used for row crop irrigation in the Mississippi Delta continues today.

Because it appeared that rice was the principal user of agricultural water, it was decided that rice would be the first crop to be studied to estimate actual water use. The first effort was to collect information about rice water use by mail survey of rice growers in the Mississippi Delta in 1987, from which 181 useful questionnaires were obtained. Surveys traditionally give very good data if the farmers know the answers to the questions included on the survey. The 1987 survey in general asked for data on one well irrigating rice in a particular year. This survey assumed that the farmer knew the gallons of water pumped per minute by these wells, hours the well operated throughout the production season, and fuel consumption. Using these data and formulas from the engineering handbook, rice water use was calculated to be approximately 76 acre-inches per year. This number, it was felt, was extremely high and, if accurate, raised some serious questions about the future of the rice industry in Mississippi.

As an outgrowth of this study, a massive effort to educate Mississippi rice growers was undertaken by the Mississippi Cooperative Extension Service. At the same time, it became obvious that two of the components used to calculate water use in the Mississippi Delta were in great error. The first of these was volume of water pumped per minute and, more importantly, the average hours of pumping required for a rice crop.

Existing data and increasing concern with the ground water supply for agriculture resulted in a study initiated by the Mississippi Agricultural and Forestry Experiment Station to look at the difference in water use between contoured and straight-levee rice fields. Usable data were collected from 22 straight-levee rice fields and 22 contoured fields. This confirmed that the survey data were in error. This study, however, could not be used to quantify average use because it was designed to measure differences in water use between contour and straight-levee fields. Also, the wells under study were not randomly selected to determine average water use. This study indicated a need to quantify rice water use in the Mississippi Delta. This work was initiated in the 1991 growing season.

Measurement Procedures

Wells studied were located from Tunica County to Sharkey County on a north-south line and into Humphreys and Leflore counties from the Mississippi River on an east-west line. The sample was drawn by Mississippi Agricultural Statistics Service from its list of rice producers. If a rice producer's name were drawn several years consecutively, wells were used on his farm only if they were different from the wells used the previous year.

An electronic flow meter and electronic totalizers were used to measure well flow and pumping hours. An attempt was made to measure flow rates of each well three times during the growing season to arrive at an average for the growing season. The timeframes for each of the three flow measurements were May-June, June-July, July-August. A totalizer records the actual operating time of a well. Two types of totalizers were used in the first year of the study. One type sensed vibration when the well was pumping water. The second type was activated by electric current flow if the well had an electric motor for power. This totalizer proved to be unreliable for some undetermined reason. Thus, vibration sensing totalizers were relied on for the last 3 years of the study.

A lubricant, usually hair gel, was required to improve the quality of connection between the sensor on the flow meter and well discharge pipe. Also, files and a cordless drill were used to remove excessive quantities of rust on the pipe where the sensors were placed. Totalizers were installed on the wells early enough to record all pumping time including early season flushing. Data on acres of rice irrigated, planting dates, and harvesting dates were obtained for each well in the study. An attempt was made to determine yields from these fields, but this proved to be a near impossible task because farmers do not keep individual field yields. In each year of the study, several rice producers refused to participate in the study.

Water Use Measurement Problems

The first electronic flow meter, an induction flow meter, used sensors on either side of the pipe to receive the turbulent signals and required an average of about 30 minutes for installation and sufficient averaging of readings to provide reliable data. In 1993 and 1994, a new updated electronic induction flow meter was obtained that permitted the installation and reading of the flow in approximately 15 minutes. This accounted for a significant increase in the number of wells in the study in the last 2 years. It was not possible to collect data on some wells. The principal reason for this was the failure of the electronic totalizers. The electronic totalizers suffered a great many failures because of condensation inside the sensing box. It was found that it was necessary to take the sensing box apart and heavily coat it with grease to improve durability and reliability.

It was also discovered that the AA batteries used in the totalizers had extremely variable battery life. Batteries in the totalizers were changed approximately every 25 to 30 days during 1992, 1993, and 1994. Data were not obtained from some wells because lightning strikes put them out of commission and forced farmers to use alternative water supplies. Pump or engine failure was also a problem. One well was lost when a car ran into it and destroyed the well head and diesel engine. Thus, any continuing effort to measure agricultural irrigation water use must take into account that 30 to 40 percent of the wells may not yield usable data.

Computing Cost of Rice Water

Funding was obtained in 1993 from the Yazoo-Mississippi Delta Water Management District and the Mississippi Rice Promotion Board to determine the cost of rice water. The procedure used in this study was to make individual contacts with each of the growers included in the well study that year. Growers were contacted monthly to obtain fuel bills and maintenance costs as well as repair costs if such occurred. During these visits, farmers were asked to provide information on historical repair costs, particularly if pulling the well and repairing the well itself had been required. Ownership cost of the wells was obtained by contacting three of the principal drillers and installers of agricultural wells.

New cost for a well is used rather than the actual cost at the time of well installation. This would be consistent with economic theory in looking at interest and depreciation costs and calculating well replacement costs. There were principally three sizes of electric wells and two sizes of diesel wells. The first size in each category ranged up to 1,250 gallons per minute; the second size included all wells above 1,250 gallons per minute.

Four wells pumped in excess of 2,000 gallons per minute. These four wells were all more than 20 years old and indicated extremely poor pumping efficiency and very high energy costs. Because of the small number of these wells and the fact that well drillers indicate there is little demand for such wells, they are not included in this report. In addition to the conventional electric and diesel wells, seven submersible pump wells were observed. The variable costs reported in this study include energy, maintenance, and repair costs. Fixed costs include interest and depreciation (11% and 20-year life). The cost of rice water reported should reflect a high degree of accuracy because the amount of water actually pumped by each well was known.

Results

Water Use

For the purpose of analysis, the 4 years of data will be reported for contour-levee fields, straight-levee fields, and all rice fields. Appendix Tables 1 through 4 include each individual observation for each of the 4 years of the study and will indicate whether the field is contoured or straight levee, acres of rice watered by the well, flow (gallons per minute), and acre-inches of water per acre.

For the 4-year period of the study, 73 observations were made on contour-levee fields. The mean was 31.10 inches of water per acre and the standard deviation was 10.03 inches per acre. There were 84 observations made on straight- levee rice fields, with a mean of 28.93 inches per acre and a standard deviation of 10.64 inches per acre. When both types of rice fields were combined, the mean water use was 29.94 inches per acre and the standard deviation was 10.38 inches per acre.

Figure 1 represents the number of observations for one-half standard deviation for contour fields. Figure 2 provides the same information for straight-levee fields and Figure 3 the same information for all fields combined.

For the remainder of this report, the mean water use will be described as 30 acre-inches of water per acre. The contour fields reported that 61 of the 73 wells (84 percent) used 41.13 inches of water per acre of rice or less. Only 12 fields required higher water use. For the straight-levee rice fields, 62 wells (74% of all wells observed) used 39.57 inches of water per acre or less.

If all wells observed in the 4 years of the study are included, 120 of the 157 wells used 40.32 acre-inches per year or less. The high water use number for each of the levee situations was for the combined observations at one standard deviation above the mean. Going to 1.5 standard deviations, water use on contour-levee fields rose to 46.14 acre inches per year and 44.89 acre-inches per year on the straight-levee fields. When all wells are combined, an average maximum water use at 1.5 standard deviation was 45.51 acre-inches per year. When all wells are considered, 134 of the 157 wells included in the study used 45.51 acre-inches per year as previously reported. This would include 85 percent of all the wells in the study.

Rice Water Costs

As pointed out, to estimate cost of wells and water use, the same rice producers who were cooperating in the study in 1993 were contacted once a month and asked to keep records on fuel consumption and repairs and maintenance costs of those wells included in the water use study for the year. In addition, the three principal well contractors in the area were contacted to determine current costs of drilling, pumps and power units. From this information, variable and fixed costs for each well were calculated. By the end of the season the actual water pumped for each well was known, so it was possible to calculate precisely the cost of water used in rice production.

As indicated in the previous section, data on water use were collected from 57 wells in 1993. Water costs were broken down into two size categories--0 to 1,200 gallons per minute (13 wells), and 1,200 to 1,850 gallons per minute (37 wells). Data were also collected from seven submersible pumped wells. Not reported are the four wells pumping more than 2,000 gallons per minute.

Fuel consumption, maintenance costs, including labor (wage rate for labor was minimum wage plus perquisites), and repairs are included in the variable costs in Table 1. It is felt, as stated previously, that these are unusually accurate data on costs of rice water since it was possible to look at the total cost involved because the actual amount of water pumped by each well was known.

Summary

Rice water use data were obtained from a total of 157 wells over 4 years (1991-1994). Data were obtained from both contour and straight-levee fields. Average annual water use on contour-levee fields was 31.1 inches per acre. Average water use was 28.93 inches of water per acre annually on straight-levee rice fields. An average of all wells, both contour and straight-levee, indicated water use of 29.94 inches per acre annually. Data collected in 1993 on 57 wells were used to determine water costs. Three well sizes were found to comprise the bulk of the rice wells used in the Mississippi Delta. Total costs for electric wells ranged from $1.08 per inch for submersible pump wells to $1.54 per inch on 1,000-GPM wells. Costs for diesel-powered wells ranged from $1.37 for 1,400 GPM to $1.81 per inch for 1,000-GPM wells.

Conclusions

This study indicates that if and when these data need to be updated in the future, it should be assumed that approximately 20 percent of the wells in a study in any given year will yield no data for a variety of reasons. Twelve to 14 rice wells should be monitored annually to detect changes in water use.

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