Overview

Irrigation is a major user of ground and surface water in the United States accounting for 80% of the Nation’s consumptive water use and over 90% in many Western States (Windham). Rice requires constant water throughout the growing season to successfully develop. With increased aquifer exploitation the water table has declined. This has forced farmers to drill deeper and cerate additional wells to adequately irrigate their crops. This causes our water resources to be depleted even further. However, a recent emphasis has been placed on tail-water recovery systems, where crop irrigation water is collected and then reused.

What is Tail-Water Recovery?

Excess water (or tail-water) collects at the lowest point a rice field. At this point, the water may infiltrate into the soil or flow as surface drainage away from the field. Tail-Water Recovery involves constructing a large pit or ditch (Figure 1) down gradient from the rice field which captures and stores runoff water. Tail-water recovery systems require equipment of some kind to transport the tail-water from the storage pit to the point of reentry into the agricultural fields. This may involve installing a re-lift and pipeline (Figures 1 & 2) to return the water to the upper portion of the farm.

Water Quantity

The Arkansas Off-Stream Reservoir Analysis (ARORA) reveals the years 2000 and 2010 had similar precipitation data. Mathematical tests were run for these two years. Differences in water consumption before and after the installation of the Tail-Water recovery system were realized.
1) Year 2000: Traditional Well = 1,356 hrs. 2) Year 2010: Traditional Well = 1,008 hrs. Well pump = 1,200 gallons/minute

1) 1,200 X 60,480 = 72,576,000 gallons
2) 1,200 X 81,360 = 97,632,000 gallons

Gallons saved = 97,632,000gals X 72,576,000gals
25,056,000gals saved (450 acre farm)
25,056,000gals/acre = 55,680gals/acre! saved!

Crop Yields

Data show little change in rice quality. Conversely, preceding studies indicate that cold water hinders rice growth. Root dry weight and plant height decrease significantly compared to warmer temperature treatments (Infinger).

Water Temperature: 73°F to 50°F

Advantages:

1. Minimizes environmental impacts of irrigation water leaving the property.
2. Conserves irrigation water supplies, especially in areas where groundwater supplies are decreasing.
3. Reduces farming costs, which may be especially important where water costs are high.
4. Removes standing water, which can result in crop loss and weed and mosquito infestations.
5. Water is warmer.

Drawbacks:

1. High cost of purchase, construction, and operation of tail-water recovery system.
2. Requires land set aside for tail-water storage which could otherwise be used for rice production (pond or drainage canal).
3. Oil and gas are the source of energy to keep pumps operating.
4. Maintenance required.

Economic/Financial Costs

Yield and Expense data were obtained for ten farming seasons. R² values were calculated for “Total Profit” and “Water Expenses” to see if there was a statistical trend between the two categories. Total Profit = Crop Yield – Water Expenses + Additional Expenses

Final Total Profit = \( \frac{\text{Crop Yields} \times \text{Water Quantity}}{\text{Expenses}} \)

Environmental/Ecosystem Health

TWR’s capture runoff water as it is leaving the field. They produce an additional benefit by reducing the amount of runoff sediment, nutrients, and pesticides that leave a farm. This is especially important, as sedimentation is the number one problem affecting surface waters in Eastern Arkansas (Czarnocki, Hays and Terry). Aquatic Life: TWR’s can prevent algal buildup by capturing fertilizer that could run into water bodies. Excessive decomposition of dead algae can result in hypoxic conditions (Lower Dissolved Oxygen) eventually killing all aquatic life and desirable fish species.

Discussion and Conclusion

Preliminary results show that with limited (and decreasing) water availability in the Alluvial Aquifer (Eastern Arkansas), tail-water recovery systems can decrease water consumption and lower farming costs. In addition, these systems might provide an additional benefit by controlling the amount of sediment, nutrient and pesticides that leaves the farm. The crop yield shows little change, which suggests the water quality from the Tail-Water Recovery System was appropriate to grow and successfully harvest rice.

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