

A Historical Review of Mechanized Irrigation Performance for Wastewater Reuse Projects in Humid Regions

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Summary:

This paper will focus on some select mechanized irrigation wastewater reuse projects in humid regions which were proposed and were not developed, were installed but later abandoned and projects which have been operating for ten years or more successfully. An analysis will be presented of what leads to success and to failure of mechanized irrigation wastewater reuse projects both in the short and long run. From the analysis a list of parameters will be discussed which are considered critical to a project's performance. Municipal, industrial and agricultural projects will be included in the discussion.

Objective:

To discuss what leads to successful waste water reuse projects using mechanical move irrigation, solid set and treatment and discharge and identify critical parameters.

Introduction:

Land application of wastewater with center pivot and linear irrigation equipment has been used for more than thirty years. Since the early 1980's the equipment and techniques for irrigating with fresh water have changed dramatically and many of these changes have been incorporated into mechanized equipment used for land application (Gilley, 1983). While these changes have brought significant improvements, also in today's world we must take into account the issues and public perception of land application systems. Mechanized irrigation, due to their characteristics, are considered to have advantages with regards to applying waste water for reuse, particularly from a lagoon with large amounts of water to handle. Some of these characteristics include limited labor input required, application uniformity, ease in handling large quantities of effluent and particularly the ability to apply to actively growing crops with minimal negative impact to the crop. Pivots can also apply during periods of adverse climatic conditions preventing conventional waste handling mechanisms to be used. Some concerns have been expressed include "Land application of wastes may be imposing in some locations, potentially dangerous conditions relative to environmental quality". (Hegde 1997). Many projects choices are dictated by more than just the equipment being used also critically important is the project meets public scrutiny. Some land application projects are very successful for many years and others are abandoned after a relatively short time (Valmont Industries, 1988).

Discussion:

This paper will focus on some specific projects and their performance. A review of the original choices considered, concerns, project developed, challenges and benefits will be considered.

I. Municipal projects:

- 1) Project for three small towns in an area of rapidly expanding development. The project was hydraulically limited.
 - a. Choices considered were expanded waste treatment plant and discharge, solid set or center pivots
 - i. Area needed for land application - 92 acres
 - b. Concerns with using center pivot
 - i. Operator skill level
 - ii. Missed area in corners
 - iii. Maintenance
 - c. Project developed with center pivots in 1995
 - i. Project expanded in 2003 with center pivots
 - d. Major challenge
 - i. Harvest and removal of biomass
 - e. Major benefit
 - i. Considered environmentally positive

Project has consistently met and exceeded expectations due to the original design which had the correct area for the flows, the desire of operators to make the project a success and working with local farmer to harvest and remove the biomass. When it was time for expansion, no consideration was given to anything but using center pivots.

- 2) Project for a small town with rapid growth in housing. The project was hydraulically limited.
 - a. Choices considered were solid set or center pivots
 - i. Area needed for land application - 62 acres
 - b. Concerns with using center pivot
 - i. Maintenance
 - ii. Appearance of center pivots - too visible
 - c. Project developed with solid set in 1996
 - i. Project expanded in 2001 with solid set
 - d. Major challenge
 - i. Harvest and removal of biomass
 - ii. Breaking of heads during harvest
 - e. Major benefit
 - i. No discharge

In the initial phases the center pivots were ruled out early due to their 'appearance' according to the board. Board did not want something that was obvious and readily visible from the roads which went around all sides of the project. Center pivot capital cost and area met all requirements except was too visible. Only solid set was considered when the expansion phase was constructed.

- 3) Project of two small towns in area of rapid growth. The project was hydraulically limited.
 - a. Choices considered were expanded waste treatment plant with discharge, solid set or center pivots
 - i. Area needed for land application - 38 acres
 - b. Concerns with using center pivot
 - i. Operating costs
 - ii. Management of crop
 - c. Project expanded with additional changes to waste treatment plant in 2001
 - d. Major challenge
 - i. Cost of handling sludge
 - e. Major benefit
 - i. Unknown

During the design phase much concern was expressed about operating cost and crop management. The board did not appear interested in any solution other than treatment and discharge. Land application appeared more expensive due to the costs of land. Little consideration was given to operating cost and sludge handling.

II. Industrial projects:

- 4) Project for poultry processor. The project was nutrient limited.
 - a. Choices considered were expanded solid set or center pivots
 - i. Area needed for land application - 185 acres
 - b. Concerns with using center pivot
 - i. Operator skill level
 - ii. Maintenance
 - c. Project developed with center pivots in 1998
 - i. Project expanded in 2002 with center pivots
 - d. Major challenge
 - i. Wheel tracks
 - e. Major benefit
 - i. Revenue from crop production

Time was spent with the plant management to help them understand land application and using center pivots. They were taken to visit other sites with center pivots. Early on a farmer was identified who wanted to use the water and this has helped generate a revenue stream for the operation of the project.

- 5) Project for power plant. The project was hydraulically limited.
 - a. Choices considered were treatment and discharge or center pivots
 - i. Area needed for land application - 275 acres
 - b. Concerns with using center pivot
 - i. Capital investment
 - ii. Maintenance
 - c. Project developed with treatment and discharge 2003
 - d. Major challenge
 - i. Cost of disposal of precipitates
 - e. Major benefit
 - i. Low capital investment

In the design phase were not able to overcome management's concern about the cost of land for the project. They were sold on technology for treatment without significant consideration of the operating cost to dispose of the precipitates. Comments were made after the project was installed indicating the operating costs were far exceeding their expectations.

- 6) Project for meat packer. The project was hydraulically limited with the potential for salinity projects.
 - a. Choices considered were treatment and discharge or center pivots
 - i. Area needed for land application - 148 acres
 - b. Concerns with using center pivot
 - i. Maintenance
 - ii. Operation
 - c. Project developed center pivots 1991
 - i. Project abandoned and converted to treatment and discharge 1998
 - d. Major challenge
 - i. Odor issues
 - ii. Biomass production
 - e. Major benefit
 - i. None identified

The initial design was undersized given the volume of water and climatic conditions. No consideration was given to management of the land and too many decisions were left to the farmer in the beginning. By the time the project was abandoned, less than 25% of the area had an active crop and there were significant odor problems.

III. Agricultural projects:

- 7) Project for farrowing operation. Project was hydraulically limited.
 - a. Choices considered were direct injection or center pivots
 - i. Area needed for land application - 125 acres
 - b. Concerns with using center pivot
 - i. Maintenance
 - c. Project developed with center pivots in 2001
 - i. Project expanded in 2003 with center pivots
 - d. Major challenge
 - i. Crop management
 - e. Major benefit
 - i. Crop production
 - ii. Ability to apply during growing season

Due to previous problems with being able to get into the fields, center pivots were considered the preferred solution. A farmer was identified early on and the design was developed to meet the hog and farm operations.

- 8) Project for integrated hog production. Project was nutriently limited.
 - a. Choices considered were direct injection or center pivots
 - i. Area needed for land application - 195 acres
 - b. Concerns with using center pivot
 - i. Odor
 - ii. Maintenance
 - c. Project developed with direct injection during 2000
 - d. Major challenge
 - i. Inability to apply during growing season

The hog operation was convinced center pivots would have the potential for too many odor issues. They did not want to consider some of the advanced design sprinkler packages available. Their vision was limited to impact sprinklers on top of the pipe. In addition little effort was put into identifying a crop producer who might be interested in participating with a center pivot.

Conclusions:

Land application using mechanical move irrigation equipment has proven very beneficial to many reuse projects and can be cost effective over the life of the project. One of the keys to successful projects is an integrated approach to the design combining hardware, agronomic principles and management together with the existing wastewater treatment plant.

An analysis of the projects above would indicate the key parameters to be:

- Land application system should fit with the existing management and/or treatment processes.
- Sufficient land must be available for the expected nutrient and hydraulic load with some allowance for the future.
- Early identification of a potential farmer
- Design must be sensitive to the local concerns about odor, impact on visual landscape other possible concerns.
- Projects must be reviewed periodically to ensure operation is meeting the design basis.
- Continuing education must be kept up for consulting engineering firm's personnel so they understand the equipment, the concepts and agronomics of a land application water reuse system.

References:

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