THE NEED TO INTEGRATE EQUIPMENT FOR CENTER PIVOT APPLICATION OF ANIMAL WASTES

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SUMMARY:
A discussion of why the integration of equipment for land application of animal wastes is important will be presented. Examples of projects will be discussed along with what worked, what did not work and why.

OBJECTIVE:
To help people involved with the land application of animal wastes have an appreciation for the need to apply an integrated approach to designing, specifying and purchasing equipment.

INTRODUCTION:
Land application of wastewater with center pivot equipment has been used for more than thirty years. Until the late 1970's the land application package was easy to select as the choices were limited to relatively high pressure impact sprinklers (50psi) or the Valley Slurry Shooter™ using high volume sprinklers (90psi). Since the early 1980's the equipment and techniques for irrigating with fresh water have changed dramatically to the point the pressures at the nozzle inlet may be as low as 6psi. Utilization of these packages requires close spacing of application devices and water relatively free of particles as the size of the orifices are small. In addition animal production units have changed in the number of animal units in single facilities, type of collection and storage and the amount of scrutiny from the public. Midwest Plan Service's MWPS-30 (MWPS, 1999) discusses general principles in sprinkler selection relating to fresh water application but does not attempt to quantify any procedure or specifically look at the integration of equipment for wastewater application. Other publications have provided general discussions with of components without offering information on integration - Livestock Waste Facilities Handbook (MWPS, 1993), Liquid Manure Application Systems Design Manual (NRAES, 1998) and Agricultural Waste Management Field Handbook (USDA, 1992). LaRue and Dorset began a discussion of a procedure to begin the integration process with *SELECTING SPRINKGER PACKAGES FOR ONLAND APPLICATION OF REUSE WATER (ASAE 1999)* and reported at the 2001 Central Plains Irrigation short course.

Irrigation Water Management Incentive

In fiscal year 2002, the SCC began a pilot project that provided monetary incentives to irrigators to implement an evapotranspiration (ET) based irrigation scheduling program. The intent of this program is to provide awareness and education to irrigators to encourage adoption of irrigation scheduling technologies such as KanSched. The SCC requires participants to receive appropriate training from KSU Research and Extension or the NRCS in order to gather, enter and process data required to implement a scheduling program. This program has been adopted for statewide eligibility for FY 2003.

WRCSP FUNDING

Funding Source

Funding for the Water Resources Cost-Share Program comes from the Kansas Water Plan Special Revenue fund, which is generated from an assortment of taxes and fees. This fund is a dedicated source of state funding with the intent of protecting, conserving and enhancing Kansas' natural resources.

FY 2003 Funding

The base allocation in the amount of $2,751,608 was divided among the 105 conservation districts in fiscal year 2003. This allocation addresses locally identified needs that may also be used to address water conservation. The 38 Kansas conservation districts eligible for enhanced irrigation efficiency allocations received a total of $451,000 to implement irrigation efficiency practices. The Rattlesnake Sub-basin is allocated $25,000 in irrigation efficiency targeted funding. An additional $213,871 is available on a competitive basis for Subsurface Drip (SDI) Irrigation demonstration projects.

Then becoming even more important in today's world we must take into account the issues and public perception of land application systems. Land application of wastes may be imposing in some locations, potentially dangerous conditions relative to environmental quality (Hegde 1997). We must insure any equipment being used for land application meets public scrutiny and local, state and federal regulations.

DISCUSSION:

Currently many land application systems are pieced together using what is available and adding equipment, which may not be applicable to a wastewater application. In particular, sprinkler packages are selected by customers and irrigation dealers based on personal experience and preference without regard to the rest of the system. The application for a permit to apply animal wastes is considered a nuisance and just enough is done to "get by". Generally little consideration is given to the overall needs or limitations of the system. The components of a system for the land application of wastewater are animal type, collection, storage, treatment, pumping, distribution, land application and management

An approach for the integration of equipment does not exist. Experience has taught, "if it worked the last time, it should work again" or "that is what my neighbor's doing" or "it works for my freshwater". We recommend looking at each waste water system from collection through application to make the best selection of equipment to provide an integrated package.

1) To begin the process, information must be collected far upstream of where we typically look - type of livestock, housing, collection, storage, treatment and pump suction position. Examples may be:

swine, farrowing, confinement, lagoon, floating suction
dairy, free-stall, scraper, lagoon, suction on the bottom

2) Next we need to consider the characteristics of the material being applied - estimated solids content, daily flows, organic material, inorganic materials, what the customer wants to pump - liquid or solids (dependent on permit and design parameters) and particle size

3) Lastly one of the areas most ignored - management issues such as goal or objectives for the system, permit requirements, operating and energy costs and interest in expansion.

Most of these items are not applicable or important to successful freshwater irrigation system.

Let us look at some examples to see if adequate consideration was given to the items in 1, 2 and 3 above.

Example 1 – Dairy, free stall, collection by scraping, two small lagoons – storage only, no water collected from rain, short of labor, energy cost not critical, has been using a traveling gun but labor is a problem, wants to use a towable center pivot.

Customer contacted irrigation dealer who contacted Valmont about what sprinkler package to use. Recommendation was made to use the Valley Slurry Manager™ with Nelson volume guns.

How did it work – within two hours of starting the pivot, the pivot pipeline was completely plugged and the customer was less than happy.

What went wrong?

1) customer was using a Cornell pump designed for solids handling and passing large chunks, ¾ inch and larger
2) pump suction was on the bottom of the lagoon
3) little agitation was done prior to beginning pumping
4) solids content was high for land application through irrigation equipment

What was done to correct?

1) customer switched to a Cornell slurry pump
2) pump inlet was set up off of the bottom
3) agitation was started 24 hours before pumping and moved to different positions around the lagoon
4) rainwater was diverted from the roofs of his buildings into the lagoons

How has it worked – fair – customer is satisfied.

Example 2 – Swine, farrowing, slatted floors, lagoon for 180 days of storage, short of labor, energy cost not critical, neighbors critical, has been using slurry wagons

Customer contacted irrigation dealer who contacted Valmont about what sprinkler package to use. Recommendation was made to use drops and a low pressure sprinkler package with Rotators on the first part of the pivot and fixed pad sprinklers on the outer end with wind and rain shutoff sensors.

How did it work? – fair but customer started moving pump between fields creating performance issues.

What went wrong?

1) No consideration was given to long-term customer needs
2) Annual use requirements were not adequately defined

What was done to correct?

1) Simplified the pump hookup to facilitate moving the pump

2) Specified another pump to better meet a broader range of conditions
3) Revised sprinkler package recommendation to meet a broader range of conditions.

How has it worked – ok – customer is satisfied and understands limitations of using the same pumping system everywhere

Example 3 – Swine, integrated system, slatted floors, lagoon for 180 days of storage, short of labor, energy cost not critical, neighbors critical, has been using slurry wagons

Customer was contacted by swine producer who sold him on the idea of the advantages of the wastewater – value as water, nitrogen and phosphorous source. Customer agreed and swine producer tied pipeline into the center pivot.

How did it work? – poor – plugged pressure regulators on the pivot sprinkler package

What went wrong?

1) Irrigator did not understand all of the ramifications of using waste water
2) Swine operator placed pump suction on the bottom of the lagoon

What was done to correct?

1) Irrigator changed his expectations – uniformity, first span
2) Sprinkler package was changed
    a. eliminate the use of pressure regulators
    b. wider spacing for water application devices in the first span allowing the use of larger orifices
3) pump suction was raised off of the bottom

How has it worked – ok – irrigator is satisfied and understands limitations when pumping wastewater

Example 4 – Dairy, free stall, flushing, lagoon for 20 days of storage, short of labor, energy cost not critical, limited neighbor issues, has been using slurry wagons, customer has irrigation well also

Customer contacted irrigation dealer who contacted Valmont about what sprinkler package to use. Recommendation was made to use the Valley Slurry Manager™ and Komet volume guns.

How did it work? – good for waste water but customer became unhappy when suffered yield loss during an abnormally dry year due to the lower distribution uniformity of the volume gun package for freshwater.

What went wrong?

1) Customer expectations
2) Did not adequately explain system limitations

What was done to correct?
1) Solutions offered were not accepted due to costs
2) Currently not resolved

How has it worked – ok – except when very dry

Example 5 – new installation, dairy, free stall, flushing, separator, two lagoons for 120 days of storage, short of labor, energy cost not critical, neighbors critical, plans to apply through center pivot

Dairyman contacted neighbor who irrigates. Irrigator contacted irrigation dealer who suggested a sprinkler package. Irrigator then contacted Valmont about what sprinkler package to use. Recommendation was made to drops and use Nelson Trashbusters.

How did it work? – not installed yet due to an impasse between the dairy and the irrigator. Dairy wants to send water primarily and handle separated solids by spreading in the fall, irrigator wants nitrogen and phosphorous besides the water and is concerned about problems with spreading solids.

What is going wrong?
1) Dairyman's expectations
2) Irrigator's expectations

How has it worked – ask me in another year!

SUMMARY:

This discussion has been to help develop an appreciation of the need to apply an integrated approach to the design and application of irrigation equipment for wastewater utilization. From the examples it is clear the problems, which may be experienced if an integrated approach is not utilized. In most of the examples the expectations were not met initially due to the lack of understanding of the total system. Livestock operators, irrigators, irrigation equipment dealers and manufacturers need to develop a greater appreciation for the total impact of all factors in a wastewater design including the animals, collection, storage, treatment, pumping, distribution, land application and management.

Please remember to always observe and follow all applicable local, state and federal regulations and apply good environmental stewardship.

REFERENCES:

Gilley, James R, 1983, *Suitability of Reduced Pressure Center Pivots*, Journal of Irrigation and Drainage Engineering, Vol 110, No. 1,

Hardemann, T.L., Mickelson, S.K., Baker, J.L., Kanwar, R.S., Lorimor, J.C., Melvin, S.W., 1997 *Effects of Rate, Method, and Timing of Swine Manure Application on Groundwater Quality*, 1997 International Summer Mtg. of ASAE, Paper 97-2145, Minneapolis Minnesota, ASAE 2950 Niles Road, St Joseph, Mi 49085 USA

Hegde, Poornima and Kanwar, R.S., 1997 *Impact of Manure Application on Groundwater Quality*, 1997 International Summer Mtg. of ASAE, Paper 97-2144, Minneapolis Minnesota, ASAE 2950 Niles Road, St Joseph, Mi 49085 USA

Kifco / Ag-Rain, Havana, Illinois

LaRue and Dorsett, 1999, *Selecting Sprinkler Packages for Onland Application of Reuse Water,* 1997 International Summer Mtg. of ASAE, Paper 99-2018, Chicago, Illinois, ASAE 2950 Niles Road, St Joseph, Mi 49085 USA

LaRue and Howard, 1998, The Use of Center Pivots to Minimize Environmental Impact of Land Applied Swine Manure, 1998 International Summer Mtg. of ASAE, Paper 98-2113, Orlando, Florida, ASAE 2950 Niles Road, St Joseph, Mi 49085 USA

LaRue and Howard, 1998, Modification and Testing of Commercial Center Pivots to Apply Dairy Waste Slurries and Meet EQIP Program Requirements, 1998 International Summer Mtg. of ASAE, Paper 98-2100, Orlando, Florida, ASAE 2950 Niles Road, St Joseph, Mi 49085 USA

Midwest Plan Service, *Sprinkler Irrigation Systems,* MWPS-30, 1st edition, 1999, Ames Iowa

Midwest Plan Service, *Livestock Waste Facilities Handbook*, MWPS-18, 3rd edition, 1993, Ames Iowa

Northeast Regional Agricultural Engineering Service, *Liquid Manure Application Systems Design Manual*, NRAES-89, 1998, Ithaca, New York

United States Department of Agriculture, *Agricultural Waste Management Field Handbook,* Part 651, 1992, Washington DC

Valmont Industries Inc., *Livestock Waste Management through Center Pivots,* Wastewater Intelligence volume 1, AD10182 1988

Utilizing Swine Effluent on Sprinkler-Irrigated Corn

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ABSTRACT

The expansion of large swine production facilities in Colorado prompted a need to evaluate the impact of swine effluent applied on irrigated corn grown on sandy soil. The objectives of this study were to: evaluate the use of swine effluent as a nutrient source for irrigated corn production, evaluate irrigated corn response grown on sandy soils to different application rates, determine NH_3 loss during sprinkler application and the 72 hour period following application, and evaluate N movement through the soil profile under swine effluent and commercial-N fertilizer for irrigated conditions. The 5-year study was initiated in 1995 on a 14.5-ha sprinkler-irrigated field planted to grain corn. In 1999, the field experiment was expanded to two other facilities, both having one-stage lagoons to evaluate ammonia volatilization from single stage lagoon effluent. Both swine effluent and commercial-N fertilizer treatments were applied at four N rates labeled, control, low, agronomic, and high. All treatments were replicated three times in a randomized complete block design. Approximately 90% of the total nitrogen from the 2-stage lagoon effluent was in ammoniacal form, and the total dry matter content of the effluent was only 0.1-0.2% by volume. Corn yields increased with the increase of both swine effluent and commercial-N fertilizer rates. In contrast to the swine effluent treatments, significant soil-N buildup was observed at the 1.5 to 3.0 m depths for the commercial-N fertilizer treatments. Higher total N and P plant removal for the swine effluent treatments resulted in little N accumulation below the root zone. As the swine effluent application rate increased, the plant N and P removal and recovery rate increased. Ammonia loss during application ranged from 8 to 27% of the total NH_4-N in the effluent due to drift and volatilization, with an average loss of 17%. The range of estimated N loss from the soil within 72 hours of application varied from 24 to 56%, with an average loss of 42% of the NH_4-N in the applied effluent. The total N loss from both the sprinkler application and the soil ranged from 33 to 73% of the applied NH_4-N, with an average loss of approximately 60%. Effluent N concentration did not significantly impact the percent of N lost, while air temperature and wind speed were significant variables in the percent of N lost.