SURFACE IRRIGATION MANAGEMENT

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BACKGROUND

Furrow irrigation systems have been around for many years. Low initial investment costs and low operating costs makes them very attractive. However, low application efficiencies and poor application uniformity make furrow irrigation systems less desirable in regard to water quality and quantity issues.

It is physically impossible to uniformly apply water to both the upstream and downstream ends of the field with a furrow system since water is present for different time intervals at each end of the field. Water is in contact with the soil at the upstream end of the field for longer periods of time than at the downstream end. This is the primary cause of nonuniform application in furrow irrigation. A secondary cause is that some parts of the field may take in more water than others simply because soil conditions differ. However, to maximize uniformity, water should be applied for nearly the same amount of time at both ends of the field.

To accomplish this "ideal" uniformity, extremely high furrow velocities would be required. This would then lead to soil erosion and large amounts of runoff. To reduce erosion and runoff, extremely low furrow velocities would required, which would then lead to deep percolation at the top end of the field. A balance is needed in selecting the correct furrow velocity and proper set time to minimize deep percolation, furrow erosion and runoff. This balance should also meet the needs of the individual irrigation operation by nearly refilling the soil profile while leaving room for precipitation.

MANAGEMENT CHECKS

Much research has examined methods of improving furrow irrigation effectiveness. In the absence of new furrow irrigation technology, management practices can be improved and should be continued to be researched. There are several checks that can be made routinely to help diagnose system problems and arrive at an appropriate solution.

Average Depth of Application:

Measure and calculate the average depth of water applied during each application. This is the volume of water applied divided by the area covered. Knowing the average depth of application can help an irrigator know if he is applying too much water on a whole field basis.

Desirable Depth of Application:

Based on the depth of the active crop root zone and the available water capacity for the soil in question, calculate the maximum desirable depth of application as 50% of the available soil moisture. This is the target depletion level which will leave ample room for precipitation storage and yet will not unduly stress the crop.

Apply Water To Target Depletion:

Compare the average depth of application with the maximum desirable depth of application. If the average application greatly exceeds the storage available in the soil, excessive system losses are occurring, namely deep percolation and/or runoff.

Irrigation Schedule:

Evaluate the appropriateness of the frequency of irrigation by comparing the average depth of application and the evapotranspiration (ET) rate with an adjustment based on system efficiency. You can take the average depth of water applied times some reasonable efficiency such as 70% (an optimistic but attainable goal for furrow irrigators) and then divide by the average ET rate. This will tell you what your approximate interval between irrigations should be. For example, suppose you apply three inches of water and assume 70% efficiency. The net application would be 2.1 inches. If the crop water use (ET) is approximately 0.3 inches per day, then irrigation events should occur on an approximately seven day interval.

SYSTEM OR MANAGEMENT CHANGES

So -- what is the source of an over-application problem? Is the irrigator irrigating too often? Is the application amount for each irrigation too high? Both?

If the problem is that the irrigator is irrigating too frequently, a more appropriate irrigation scheduling method should be employed. Although there are many alternatives here, a reasonable first step is to become familiar with the concepts of the volume balance (checkbook) method. An understanding of, and accounting procedure based on, the soil moisture holding capacity, root zone expansion rates, ET rates, effective rainfall depths, and irrigation application amounts provide the basis for this technique. The checkbook method is particularly effective when backed up with periodic field checks using the appearance and feel technique.

The other alternate is that the application amount is too high during each irrigation event. This may be overcome with management procedures, equipment, or alterations to the general layout of the irrigation system. The first step in enhancing systems that over-apply is to determine if the excess water is contributing to high runoff volumes or deep percolation. This will help choose enhancement practices, since some target runoff losses, some deep percolation, and others will reduce both. Use the following practices if the amount applied per application is too high.

- Some Easy Things To Change:

  - Change to alternate (every-other) furrow irrigation rather than every furrow. This doesn't work on all soil types or systems, but on many systems alternate furrow irrigation can save up to 30% of the water used in every-furrow irrigation.

- Some Moderately Easy Or Relatively Inexpensive Things To Change:

  - Change furrow stream size and/or set time. Within an irrigation event, the only two easily changed items that affect the total volume of water pumped are the number of gates open (stream size) and the amount of time water runs from them (set time). These two items also dramatically influence the distribution of water down the length of the furrow. The set time and stream size for each irrigation would, ideally, be adjusted to accommodate the infiltration characteristics present at the time.

  - Use a timer to shut off the system for shorter set times. For example, if a farmer returns to the field every 12 hours, it is possible that he could use a timer to shut off the well after eight hours. Of course, he has to have excess capacity in his well to have the system shut down 1/3 of the time. Timer based shut-off units are available for both electric and fuel engines, but are much more expensive and cumbersome for fuel engines.

  - Use furrow packing to reduce infiltration. Furrow packing could be completed during a ditching operation and would cause the water to advance down the furrow at a higher rate, leading to more uniform application between the upstream and downstream ends of the field.

- Moderately Hard To Moderately Expensive Systems:

  - Replacing earth lined ditches or open canals with pipeline delivery systems and gated pipe will help reduce the percolation and evaporation losses that occur before water is even applied to a field. One drawback here is that a pumping unit may be required to pressurize the system.

  - Surged flow irrigation has a good chance of increasing the effectiveness of a furrow irrigation system, and may also make the system more manageable from a labor standpoint. Surge valves alternately water different areas of the field, perhaps causing surface sealing which can lead to more uniform application. Runoff management can also be accomplished with a well managed surge system.

- Runoff recovery is an obvious enhancement for systems that suffer from high runoff volumes due to steep slope, compacted soil, low infiltration rates, or short furrows. The cost effectiveness of the system will increase with the higher energy costs associated with a deeper well (greater distance to groundwater).

- Divide the field length in two if deep percolation is a problem due to long set times needed to advance water to the end of the field.

- Tillage practices have some impact on irrigation system performance. As tillage intensity is increased, infiltration rates decrease. Thus, for example, a field that generates far too much runoff may benefit from conversion from conventional tillage to a ridge tillage system.

- Improve land grading, especially in cases where short stretches of backslopes deter advance of water down the furrow.

• Items That Are Hard Or Expensive To Implement:

- Full automation. Although equipment is no longer commercially available today to fully automate surface irrigations, surge valves may be used to arrive at a partially controlled system.

- Conversion to center pivot. Center pivots are able to apply lower application amounts at higher efficiencies. However, the cost of investment, operating costs and field layouts must be considered.

- Although not fully proven in row crop situations, subsurface irrigation systems (buried drip tubing for example) may be worth looking into.

- Deficit irrigation supplies the crop with less water than the crop would like, and may reduce yields. This may be profitable in cases where water is very expensive. This may be required in cases where water availability is restricted.

CONCLUSIONS

Making changes in furrow irrigation systems may be relatively low cost or they may be expensive. Only the operator can determine what an acceptable level of deep percolation and runoff is for a particular field. However, just turning water on and letting it run for a standard length of time can be costing the producer and the environment. At a minimum, the producer should be using the volume balance (checkbook) method of irrigation scheduling. If water quality and or quantity are a concern, the producer should begin looking at the more expensive items to improve irrigation efficiency and uniformity.