Dairy Educational Materials

Tailwater Return Systems

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Introduction

Furrow and border strip (border) irrigation is often used for crops irrigated with manure water. Under good nutrient management, manure water is added to freshwater at controlled rates to attain the desired nutrient content matching plant nutrient requirements. Often, irrigation water accumulates or runs off the tail end of fields (tailwater) being furrow or border irrigated. Runoff water containing manure water should not leave the property. While the tailwater can be retained on the end of the field using soil berms, it is an excellent management practice to collect the tailwater and reuse it for irrigation.

Tailwater Runoff Collection and Reuse

Water running off the tail end of a field, as part of normal furrow or border strip irrigation practices, is referred to as tailwater. Tailwater is necessary, especially in furrow irrigation, to adequately irrigate the lower end of a field since sufficient infiltration time is required to allow the desired amount of water to infiltrate.

To maintain a good uniformity (evenness) of applied irrigation water across the field, it is recommended that the inflow rate to the border or furrows be kept high. This advances water across the field quickly and minimizes the infiltration time differences (and thus infiltrated water differences) between the top and bottom of the field. A high flow rate will tend to generate greater tailwater unless cutback irrigation (reducing the inflow rate when water reaches the end of the field) is practiced. Even with use of cutback irrigation, collection of the tailwater for reuse is a good management practice.

Dealing with Tailwater Where Manure Water is Applied

Tailwater can be collected and stored in a basin or lagoon (Fig.1) until it can be reused. Most often, a pump and a ditch / pipeline conveyance system is used to move the reused tailwater to where it will be applied. Such a system, well operated, maximizes irrigation efficiency and minimizes environmental impacts.

Advantages and Disadvantages of Tailwater Return Systems

The advantages of tailwater reuse include:

- Environmental impacts of tailwater leaving the property are minimized.
- Irrigation efficiency is improved since tailwater is beneficially reused as irrigation water.
- Water costs may be reduced by reusing tailwater. This may be especially important where water costs are high.
- Irrigation water management for flood systems which have no ready outlet for tailwater can be simplified since irrigations, especially those at night, do not need to be as closely monitored to prevent tailwater runoff.

- Tailwater collection systems remove standing water, which can result in crop loss and weed infestations, from the tail end of the field. Border strip-irrigated alfalfa and furrow-irrigated corn are examples of where this is commonly done.

Figure 1. Tailwater collection system.

The disadvantages of tailwater reuse include:

- There is a cost required for installation, maintenance, and operation of the tailwater return system. Land must be taken out of production for the pond and other tailwater recovery system components.
- Good management, requiring timely recycling of tailwater pond contents, is necessary to prevent groundwater pollution by nutrients or chemicals in the tailwater.

Tailwater Return System Design and Management

If a new tailwater return system is being planned, its management must be a key factor in the design. For an existing tailwater return system, its operation options will be constrained by the return system's capabilities. Factors such as the pond size and the return pump discharge rate will limit the ways in which the return system can be managed.

Recirculating tailwater back to the top of the irrigation set from which it came is often problematic. The tailwater would be applied to wet, low infiltration rate soil and it may add to irrigation non-uniformity by applying more water to the head of the field. A better strategy is to apply the tailwater to an unirrigated area. This may be another irrigation set on the same field or on another field.

Tailwater Pond

Most frequently, tailwater ponds are excavated to be below-ground ponds, allowing gravity flow to fill the pond. The major tailwater pond design decision is determining its size. A common rule-of-thumb is to expect tailwater volume to be 15-25% of the water applied to an irrigation set.

To determine the pond capacity, the operator must decide how often the pond will be emptied. After every irrigation set? After 2 sets? More? A small pond, such as that needing to be emptied after each irrigation set, may be difficult to manage since it must be monitored closely to make sure it does not overfill. Even with an automated pump system, a small pond may be problematic. The pond should never be so small that the tailwater pump is frequently cycling on and off.

Combining the estimated tailwater per set with the frequency of pond "pump-down" will determine the desired pond storage capacity. Seldom is it possible to pump the pond completely dry. It is usually not acceptable to have the pump intake at the bottom of the pond due to sediment accumulation so this should be accounted for.

The tailwater pond should be at least 5 feet in depth to control aquatic weed growth. Most ponds are deeper than this to attain the desired storage while minimizing the field area devoted to the pond.

The discharge to the tailwater pond should be designed to minimize bank erosion. A cantilevered pipe inlet (see Fig. 2) or some other form of protected inlet should be used.

Figure 2. Cantilevered pipe discharge into tailwater pond.

Removal of sediment and trash (weeds, crop residue, etc.) will be necessary. Equipment access to the pond should be taken into account. Steep pond wall slope (a 1:1 slope is usually the steepest acceptable) minimizes the area required for the pond and may reduce weed growth problems, but more gentle pond side slopes make access easier, may reduce erosion, and are often safer.

Consideration should be taken in choosing the width of the tailwater pond. Two important considerations are: (1) that the pond may need to be cleaned of sediment using machinery located on the pond embankments, and (2) mosquito larva control may be required.

If the tailwater pond is not lined, it has been shown that the seepage from tailwater ponds can be a conduit for movement of water-soluble chemicals to shallow groundwater, but ensuring that the tailwater pond is emptied after the last irrigation and remaining tailwater is not simply allowed to infiltrate from the pond will minimize the movement of the water-soluble chemicals to the groundwater. It is therefore an important tailwater management practice to empty the tailwater pond after the last irrigation set. The tailwater should be applied back to a field, not left in the pond to infiltrate.

Return Flow Pump

The tailwater return flow pump removes water from the tailwater pond and moves it to the discharge point where it will be reused for irrigation. This may be to the head of the field from which the tailwater was generated or to another field. Selecting a high flow rate pump allows the pond to be emptied more quickly, often desirable when additional pond capacity is needed. If the return pump is large enough, it may allow tailwater to be used as the sole irrigation source for the period the pond is being emptied. The major disadvantage of a large capacity pump is its cost. It will also require a larger return flow pipeline, an additional cost. If the tailwater is used to supplement the irrigation supply, a high return flow rate may need to be accounted for by setting additional siphons or opening more valves. Selection of a lower capacity pump will be less costly and the required return flow pipeline will be smaller and less costly. It will take longer to empty the pond using the smaller capacity pump.

Final pump selection will be based on the desired tailwater return flow rate and pressure. The pump should be selected to have a high efficiency under the planned operating conditions. Since the pond level will be changing, the pump operating conditions (flow rate and pressure) will also change. Selecting a pump with high efficiency, across the range of expected operating conditions, is desirable.

As a rule-of-thumb, the tailwater pump discharge rate can be set at 20 – 25% of the irrigation flow rate.

The tailwater return pump is frequently automated to operate when the pond has reached a pre-set height and then shuts off when the pond has been pumped down to a desired level. Automation can help ensure that the pond does not overfill. Even when automated, the tailwater return system can always be operated manually. Some operators will choose manual operation, especially if additional siphons must be started or valves opened to accommodate the additional flow rate.

A screen should be installed at the return flow pump intake to protect the pump from trash and debris. This is often a vertical screen on a concrete sump (Fig. 3) or a screen surrounding a pipe intake.

There should be a control valve (e.g. butterfly or gate valve) downstream of the pump to allow control of the tailwater return flow rate (Fig. 4). There should also be appropriately-placed air and vacuum relief valves, or open vents, to protect the return flow pipeline (Fig. 4).

The tailwater return system should have a check valve installed downstream of the pump (Fig. 4). This is especially important if the return system is connected to the irrigation system and irrigation water could move to the tailwater pond. The check valve also keeps the return flow pipeline full, protecting from excessive power loads and pressure surges associated with an empty pipeline at pump start-up.

Tailwater Return Pipeline

The design of the tailwater return pipeline depends primarily on the return flow pump discharge rate. The choice of pipe size is a balancing of cost vs. pressure loss. Greater pressure loss due to smaller pipe means increased energy costs to pump the tailwater. Saving money on the initial pipe cost by selecting smaller pipe may cost more in long-term operating costs. Tailwater pipelines should be sized to maintain flow velocities in the pipe between 2.5 and 5.0 feet per second.

PVC pipe is the most common choice for return flow pipelines. The PVC pipe Class should be selected to match the expected pressure requirements. Typical tailwater return systems are designed with Class 100 or 80 PIP rated pipelines. The exposed section of pipe at the tailwater pump should be steel pipe.

The discharge point for the return flow pipeline varies depending on the irrigation system design. It may be a standpipe connected to the irrigation system, a supply ditch, or some other point.

Figure 3. Trash screen on a concrete sump intake box.

Figure 4. Control (butterfly) valve, air-vacuum relief valve, and check valve located downstream of tailwater return pump.

Power Unit

Most commonly, either an electric motor or a diesel engine will be the power unit for the return flow pump. Electric motors (Fig. 4), the most commonly used, have the advantage of being easily automated, available on-demand, and their maintenance costs are low. They also have a low pollution impact, important in areas where air quality regulations are a factor.

Diesel engines can also be used as the power unit for the pump. Their selection is usually based on cost. Diesel fuel prices, engine maintenance costs, and air quality regulations are weighed against electric energy costs, meter and service charges, and other electric motor expenses. Most diesel engine-driven pumps are operated on a manual start and shutdown basis. Automated diesel starting / shutdown systems are available but add to the overall cost.

References:

USDA, Natural Resources Conservation Service. 2006. National Conservation Practice Standard, Irrigation System, Tailwater Recovery. Standard 447-1.

Westland Water District. 2001. Water Management Handbook, Tailwater Reuse Systems.