Chapter 9 Irrigation Water Management

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FL652.0904 Irrigation system evaluation procedures

(a) Field evaluation procedure

(1) Flow through subirrigation system

(i) Introduction

Successful operation of subirrigation systems requires that the water table is maintained at a uniform depth below the ground surface which can supply moisture to plants through capillary movement (upward flux). The water table is regulated by controlling the drainage to curtail removal of subsurface water and water is added to keep the water table high enough to provide adequate moisture to plants. A drainage system is essential to remove excess surface water and subsurface water so that the water table does not remain in the root zone for long enough period to cause crop damage.

Some important considerations which the irrigator normally can control:

- Irrigation water runoff.
- Loss of water in the delivery system.
- The depth to the water table (the range that the water table is allowed to fluctuate during the irrigation cycle).
- The uniformity of depth to water table (depends on uniformity of ground surface, spacing and length of irrigation furrows, size of irrigation stream).
- Adequacy of drainage system both surface and subsurface.

This section describes how to perform and evaluate both general and detailed evaluations of subirrigation systems. It is recommended that detailed evaluations be performed in order to gain knowledge and experience of how subirrigation systems perform under different management techniques, soil types, crops, etc., and when time and equipment is available. General field evaluations will normally be performed on systems where information is available on the system and/or where time and equipment is not available.

Information gathered should include both management factors as well as irrigation system factors. Management factors include whether or not water measurement devices are used (Md), method used to determine when to irrigate (S) (scheduling procedure), the skill of the irrigator in operating the system (I), the condition of the system (M) (maintenance), the ability of the system to provide irrigation water when needed (W), and the surface condition of the soil (Sc). System factors include the type of conveyance system used (F), the uniformity of application (U), the capacity of the delivery system (D), the elevation variation of the field being irrigated (L), and tailwater recovery systems (T). These factors are discussed in detail in "Farm Irrigation Rating Method (FIRM)", FL652.1501. The necessary data can be obtained by interviewing the irrigator and by making observations and measurements.

(ii) Field evaluation, general

General field evaluations often provide the necessary information for identifying and correcting problems of the system layout and of its operation.

Equipment Needed. The equipment needed for the evaluation:

- A soils auger for verifying soil type and installing water table wells (cased or uncased).
- A stop watch or watch with easily visible second hand for timing irrigation inflows and outflows.
- Measuring tape to measure water table depth and furrow spacing.
- Flow measurement equipment.
- Survey equipment for checking irrigation slope.

Field Procedure. Information to be gathered includes:

- Estimate water loss in the delivery system (if open ditches).

- Determine or verify soil type. Include areas where irrigator has observed abnormal conditions.
- Determine from irrigator and by observation, wet and dry locations in field. (Points that wilt early and areas where plant's response indicates wet areas).
- Choose typical locations (furrows) in fields to be evaluated. A minimum of three furrows shall be evaluated in a management zone. Locations shall include wet and dry points that contain a significant area (greater than 10 percent of the management zone).
- During the irrigation cycle record furrow inflow (gpm), length, slope, spacing, and depth.
- Observe the runoff (tailwater) in furrows or mains and record observations. Estimate the rate, length of time, and amount of tailwater loss.
- During the irrigation cycle, two water table depths shall be measured at each location evaluated. The water table depth will be recorded at points 1/4 and 3/4 along the furrow length midway between the furrows. The measurements should be taken when the irrigation stream is at least midway along the furrow. Measure the elevation difference between the water table and the bottom of the furrow. If the furrow spacing exceeds the recommended spacing in the Florida Drainage Guide an additional water table measurement shall be taken adjacent to the furrow at the point 1/4 along the furrow length.
- Observe drainage characteristics of the system. If inadequate, discuss with the irrigator.
- Check erosion throughout the system (furrows, drainage mains and laterals).
- Estimate total water available for irrigation.

Analysis of Field Data. This analysis is based on data taken as previously described.

- Analyze to determine if total water available is sufficient to meet the crop's peak consumptive use.
- Check variation in water table depth and water table response.

  When stabilized, the water table depth from the top of the bed should not vary more than 0.5 ft within a management zone.

  When the irrigation stream is pulsed and water table allowed to fluctuate, the system should have capacity to build the water table to the desired depth within twelve hours over the entire field. Briefer periods are desirable.
- If erosion is a problem, recommend methods or practices to control erosion.
- Estimate amount of water loss in the delivery system.
- Estimate tailwater loss and consider methods to reduce loss if it exceeds 10 percent of the total water pumped to the field or if it occurs for more than two hours.
- Analyze drainage problems. It is desirable to remove excess surface water in 24 hours or less on a two to five year frequency rainfall. The water table should drop to a 12-inch depth from the top of the bed within 24 to 48 hours after surface water removal.
- Run the DRAINMOD computer model for the site as installed when the furrow spacing exceeds the Florida Drainage Guide recommendations and the water table variation in the field at the beginning of the irrigation cycle exceeds 0.5 feet. Check the model output of predicted water table response. Compare this data with how well the system responded to irrigation and observed drainage.
- Using the FIRM computer program, rate the irrigation system.

  FIRM = E x FUDLT x Md SIMWSc

Recommendations. The analysis should indicate recommendations for improved management and/or system modifications. A review of the various management and system factors should be a starting point in making recommendations to the landowner. Additional items to review and address are as follows.

- Furrows should be spaced to allow no more than 0.5 ft variation in water table depth from furrow to mid-point during periods of peak consumptive use after the water table has stabilized. Variations in water table suggest need for irrigation land leveling, closer spacing on irrigation furrows, and/or closer spacing of water table control structures. Larger irrigation streams are needed when excessive time is required to raise the water table in the entire system to the desired depth.
- Normally the water table should be raised to the predetermined desirable level during each 24-hour period. Irrigation during the night is more efficient.
- Increased depths to the water table decreases the amount of water lost from evaporation from the soil surface. This increases irrigation efficiency but it is essential that the water table is within the zone that will supply adequate moisture to the root zone through upward flux.
- Water erosion can be controlled by structures at the ends of laterals, reducing the irrigation stream, structures in open ditches, and/or changing system layout to reduce slope in direction of irrigation.
- Wind erosion may be reduced by maintaining a water table depth during fallow periods at a level that will provide moisture to the ground surface.
- Prevent delivery system losses by using underground pipelines or an underground conduit system.
- Reduce tailwater losses by:
  - Installing water table control structures in outlet drainage ditches at 0.5 foot (or less) elevation intervals to maintain desired water table depths.
  - Allowing the water table to fluctuate within an allowable range. Stop irrigation when water is raised to desired depth. Start irrigation when water table drops to predetermined depth. This may be automated with electric motors and switches on water control structures or floats in observation wells.
  - Installing a tailwater recovery system.
  - Regulating irrigation streams to a continuous flow which minimizes tailwater losses. Water will normally recede up to the furrows during peak use period of the day (from noon to early afternoon, normally).
- Poor drainage suggests the enlargement of drainage ditches, increased capacity of structures, increased depth of irrigation laterals, and/or installation of subsurface drains. An underground conduit sub-irrigation system should normally be recommended when subsurface drains are needed.
- Cased observation wells properly located should always be recommended to allow the irrigator to observe the position of the water table at any time.

(iii) Field evaluation detailed

Detailed field evaluations provide more detailed data needed for recommending changes, for making economic comparisons, and for furnishing background data for design of systems operating under similar conditions.

Equipment Needed. The same equipment needed for general evaluation plus:

- Flow measuring devices such as small Parshall flumes, orifice plates, flow meters, large Parshall flumes, and/or calibrated containers. Devices must be capable of measuring head or recording velocity of flow.
- Equipment for determining soil moisture may be desirable.
- Stage recorders may be necessary.
- Cased observation wells.

Field Procedure. Information to be gathered includes the same as for general evaluation but may also include:

- Actual measurement of water loss in delivery system or portions of the

system.

- During the irrigation cycle, record hourly water table response, i.e., depth and time to raise in observation wells.
- Measure lateral (furrow) inflow and hourly outflow for 24 hours or one irrigation cycle when water is fluctuated.
- Measure tailwater losses from the management zone when possible or selected furrows for 24 hours or longer.
- In addition to survey data for general evaluations, survey to determine:

  - Elevations of water control structures.

  - Capacity of structures.

  - Capacity and adequacy of surface drainage system.

- Determine water flow into the system. Where possible measure pump discharges or water flow in open channels or use other data such as pump curves, meter readings, etc.
- Using the FIRM computer program, rate the irrigation system.

Analysis of Field Data. The analysis is essentially the same as for the general field evaluation; however, the use of more accurate data and possibly more data should result in a more precise analysis.

Recommendations. The recommendations should be the same as those suggested by the general field evaluation, but more information is available to make economic comparisons and background data will be available to make accurate design and system modifications.

(2) Sprinkler irrigation systems in mature citrus groves.

In evaluating sprinkler irrigation systems the uniformity of water application is an important factor. The procedure for determining sprinkler irrigation uniformity is discussed in NEH, Part 652, Chapter 9, 652.0904(g)(5). Uniformity of water application is normally determined using catch cans set on or near the ground surface. However, accurate catch can data for citrus and other large mature tree crops is impossible to obtain because the canopies will distort the water distribution. In these situations the uniformity of application will have to be estimated based on comparing data collected from systems with similar sprinkler sizes, spacings and operating pressures or simulated in the lab.