SUBSURFACE AND DRIP IRRIGATION

This chapter is intended to give broad information on two irrigation methods, subsurface and drip, which have limited scope for use in North Dakota. The intent is to provide enough information so that SCS field personnel are aware of the methods and their advantages and limitations.

Subsurface Irrigation

In subsurface irrigation, water is applied beneath the ground surface to create an artificial or perched water table over some natural barrier that restricts deep percolation. Moisture then reaches the plant roots through capillary movement.

Subsurface irrigation may also be referred to as "controlled drainage". In naturally high water table soils, the drainage system is operated to lower the water table incrementally so the development of the root system is not limited because of the lack of air. Water may also be introduced into the drainage system to keep the water table at the proper height so crops can receive their water needs from it.

The subirrigation method is suited to soils having reasonable uniform texture and permeable enough for water to move rapidly both horizontally and vertically within and for some distance below the crop's root zone. The soil profile must also contain a barrier against excessive losses through deep percolation, either a nearly impermeable layer in the substratum or a naturally high water table on which a perched or artificial water table can be maintained throughout the growing season. Topography must be smooth and nearly level or the slopes very gentle and uniform. The subirrigation method is suited to irrigating vegetables, most field crops, small grains, pasture grasses, and most forage crops.

This method can be used for soils having a low water-holding capacity and a high intake rate where surface methods are impractical. The water level can be maintained at optimum depths for crop needs at different growth stages. Water loss by evaporation from the soil can be held to a minimum. Weed seeds are not carried over the surface by irrigation water.

The subirrigation distribution system can also be used as the drainage system. Labor requirements are less than for any other irrigation method. Labor is required only for regulating stream flow into the system, adjusting water-level control structures, and operating the pump installation if pumping is required.

Since this method requires an unusual combination of natural conditions, it can be used in only a few areas. Water having a high salt content cannot be used. In some arid areas soils become saline unless adequately drained. Choice of crops is limited in some areas. Deep-rooted crops such as deciduous orchard trees and citrus trees generally cannot be subirrigated.

A disadvantage of subirrigation is that it is not adapted for pre-emergence irrigation or shallow rooted crops due to the difficulty in obtaining uniform depth to a shallow water table.

Drip Irrigation

Drip irrigation is also known as trickle irrigation. The Soil Conservation Service in its Engineering Standard, Irrigation, Drip, defines an irrigation system as:

> A planned irrigation system where all necessary facilities have been installed for the efficient application of water directly to the root zone of plants by means of applicators (orifices, emitters, porous tubing, perforated pipe, etc.) operated under low pressure. The applicators may be placed on or below the surface of the ground.

A well designed drip system is capable of attaining high field application efficiencies. However, the SCS limits the assumed efficiency to 90 percent for design purposes.

A properly designed drip irrigation system includes the following components: (See Figure 7.1)

1. Water source

2. Pump and power unit

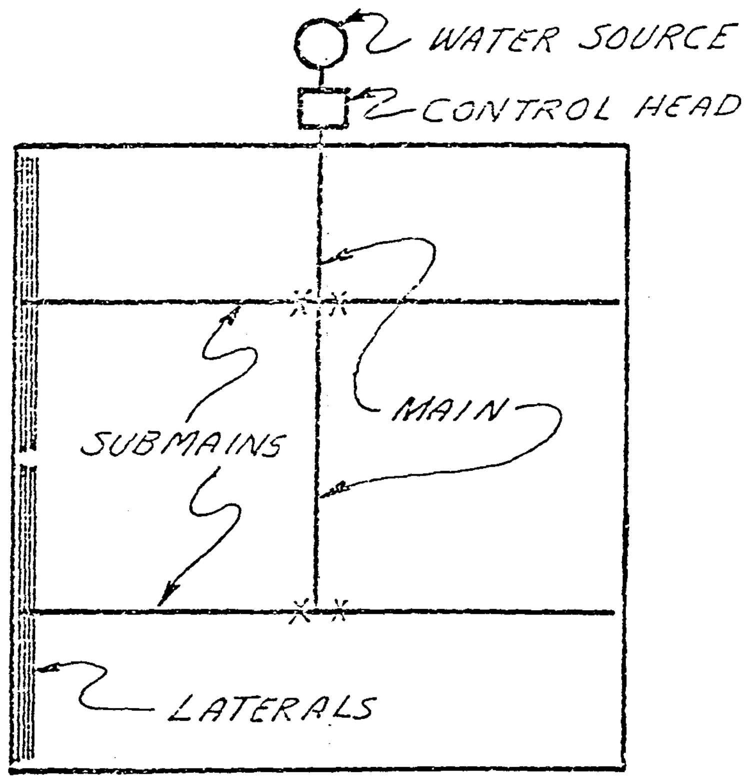
3. A control head which often consists of water measuring devices, valves, injectors, automatic controllers, pressure controllers, and a filtration system

4. A main water supply line

5. A series of submains, also called manifolds or headers (in unusual cases, these are not required)

6. A series of lateral lines which are generally constructed semi-rigid or flexible PVC or polyethylene hose

7. Drippers or emitters: In certain cases, the dripper function may be satisfied by the type of lateral line used. Examples of this are twin bore pipe, porous pipe, and perforated pipe



The pump, power unit, and control head may consist of any of a wide variety of these types of equipment available. Anyone interested in designing or installing a drip irrigation system should consult manufacturer's literature.

The main line and submains may consist of any noncorroding and nonscaling material such as polyethylene, PVC, galvanized steel, or asbestos cement. It may be buried or open to the atmosphere. Buried lines should be rigid or semirigid pipe and surface lines may be rigid, semirigid, or flexible.

The lateral lines may be constructed of small diameter flexible PVC or polyethylene hose and placed on the surface. In cases where the lateral is buried, it should consist of rigid or semirigid pipe. Emitters are fixed at predetermined spacings on the lateral and are connected to laterals by various means.

There are many different types of emitters. The commercially available ones are:

1. Microtube
2. Double wall hose; also serves as a lateral line
3. Porous hose; also serves as a lateral line
4. Hose with flap using orifice emitters; also serves as lateral
5. Orifice
6. Grooved
7. Labyrinth
8. Adjustable
9. Pressure compensating
10. Foggers
11. Bubblers

The hydraulic design of a drip irrigation system involves:

1. Determining water requirements
2. Choosing the arrangements of submains and laterals
3. Choosing an emitter
4. Designing laterals
5. Designing mains and submains

The water requirements can be found in the Irrigation Guide, Part 3. Irrigation, Drip Standard requires that the system be capable of delivering the average daily water requirements of the crop during the peak use month in not more than 18 hours of operation per day. The remaining 6-hour period of each day is considered as reserve capacity for use during those daily periods when the water use rate exceeds the average daily use rate for the peak month.

The system of submains and laterals is influenced by the field size and shape, the field topography, the lateral pipe size, the water application rate, and the emitter design. Since the permissible lengths of drip irrigation laterals can vary from 200 feet to 1,500 feet or more, several trial designs may be required to determine the most desirable system arrangement.

The choice of emitter is greatly influenced by the lateral length chosen. The wetting characteristics of the soil is also an important factor in emitter choice. More emitters that apply less water are required in soil where the lateral movement is poor.

Irrigation, Drip Standard requires that for lateral lines operating at the design pressure, the discharge rate of any applicator served by the lateral will not exceed a variation of ± 10 percent of the design discharge rate.

Mainlines and submains must be designed in accordance with the Standard for Irrigation Water Conveyance, Pipeline.

Advantages

One of the advantages of drip irrigation is that it enables direct water infiltration into soil combined with very limited surface lateral expansion, so most application losses are negligible. Properly designed and managed systems produce no surface runoff. The entire field can be irrigated up to the boundaries without wetting areas outside of the planted area.

Another of the benefits of drip irrigation is the potential of using restricted quality water. In Israel, the water used has ranged up to 3,000 ppm of total salts. The outstanding yields that have been obtained using the high saline water is explained by the high soil moisture content and the leaching of the salts from the relatively small root zone. The dilution of any salt in the soil by the constant application of moisture permits plants to grow satisfactorily in that soil even though the water contains high salts.

Salt accumulates in the upper few inches of the soil at the outer edges of the boundaries of the wetted area and on the lower soil due to leaching. In areas of normal or heavy rainfall, the salts that have accumulated during the irrigation season will be leached sufficiently during the periods of rainfall. In areas where insufficient rainfall occurs, a portable irrigation system may be required to wet the entire soil area in order to leach out the salts prior to the next season's operation. Much more information is needed on the relationship of water quality, irrigation applications, and soil types.

Other advantages are:

- Increased yields and improved quality of produce
- Accelerated growth in young plants or trees
- Water and fertilizer can be applied at the same time
- Significant irrigation water conservation

- Area between rows remains firm and dry, thus improving trafficability

- Weed growth between rows is greatly reduced

- Can be used on sloping shallow soils

Perhaps the main problem connected with drip irrigation is the difficulty in keeping the small orifices open. They are very susceptible to clogging. The most common causes of clogging are particles of sand and organic growths. Slow clogging can result from deposition of chemical precipitates or clay and a buildup of silt in the emitter passages. Clogging also causes poor distribution along the laterals. This may damage a crop severely if emitters are clogged for a long time before being discovered and repaired.

A high degree of management skill may be required with saline waters or in the more arid areas. Some salt accumulation is inevitable. The most critical zones of accumulation are along the fringes of the wetted surface strip. A light rain can move these accumulated salts down into the zone of extensive root activity and severely injure the plants. To reduce this hazard to a minimum, the drip irrigation system can be operated during the rainy period to wash the salts down through the profile. Supplemental applications of sprinkler or surface irrigation may be necessary to eliminate critical levels of salt buildup.

Since this method wets only part of the surface an odd phenomenon may take place in windy areas. Dust may be blown from the dry, cultivated strips between the rows and cover the crops sufficiently to damage them.