

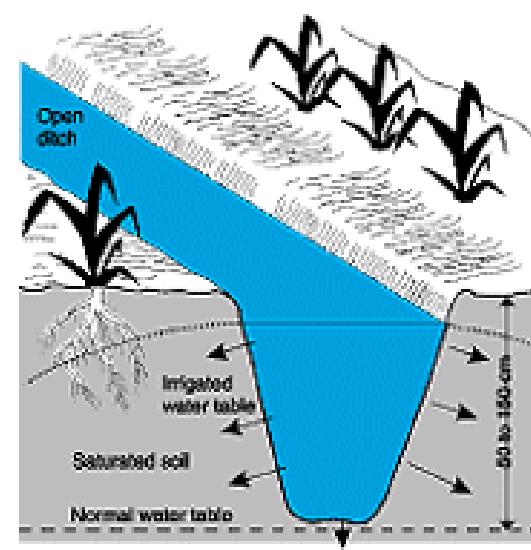
Irrigation systems

Basic Types of Irrigation Systems

- Surface irrigation
- Subsurface irrigation
- Sprinkler irrigation
- Drip/trickle irrigation

Subsurface Irrigation

- Also call subirrigation
- Artificial regulation of groundwater table elevation
- Can be used where water table is naturally shallow or where impermeable layer is overlaid by highly permeable soil
- Very uncommon irrigation technique



Surface Irrigation

- Furrow irrigation:

Surface Irrigation

- Water flows across the soil surface to the point of infiltration
- Oldest irrigation method and most widely used world-wide (90%) and in U.S. (60%)
- Used primarily on agricultural or orchard crops

Types of Systems

- **Water Spreading or Wild Flooding**
 - Relatively flat fields -- allow water to find its own way across the surface
 - Minimal preparation and investment
 - Rather inefficient
- **Basin**
 - Dikes used to surround an area and allow for water ponding (no runoff)
 - Basins are usually level





Types of Systems, Contd...

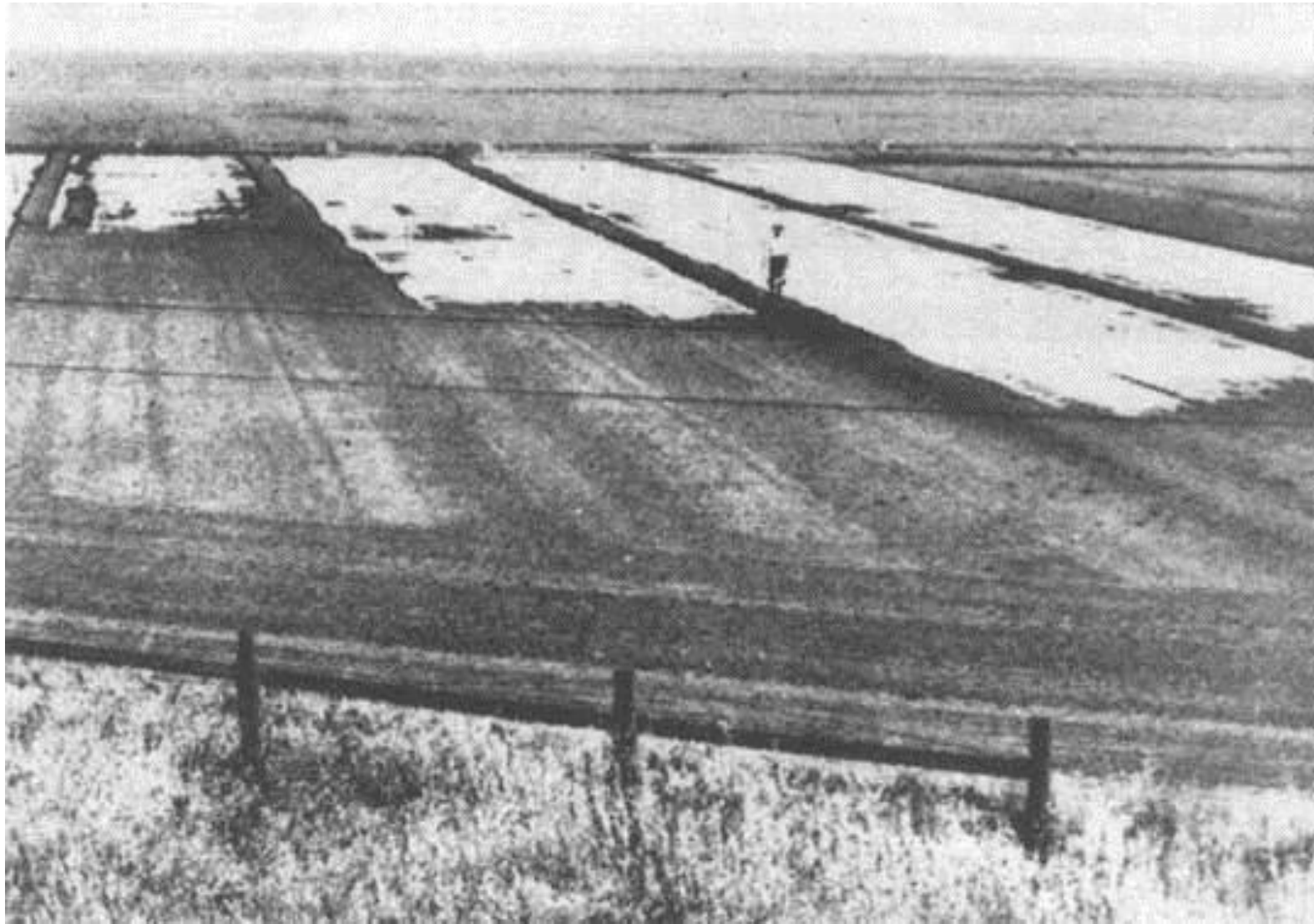
- **Border**

- Strips of land with dikes on the sides
- Usually graded but with no cross slope
- Downstream end may be diked

- **Furrow**

- Small channels carry the water (entire surface is not wet)
- Commonly used on row crops
- Lateral as well as vertical infiltration
- Furrows are usually graded

Boarder Irrigation







Water Supply

- **Methods of water supply**
 - Head ditch with siphon tubes or side-opening gates
 - Gated pipe (aluminum or plastic pipe with small gates that can be opened and closed)
 - Buried pipeline with periodically spaced valves at the surface







Water Management

- **Runoff recovery systems**
 - Drainage ditches for collecting and conveying runoff to the reservoir
 - Reservoir for storing the runoff water
 - Inlet facilities to the reservoir (including desilting basin)
 - Pump and power unit
 - Conveyance system for transporting water (to same or different field)



Surface Irrigation Hydraulics

- **Advance**
 - **Movement of water from the inlet end to the downstream end**
 - **Curve of Time vs. Distance is NOT linear**
 - **Rule-of-Thumb: 1/3 of the total advance time is needed to reach midpoint of the furrow length**

Surface Irrigation Hydraulics , Cont'd

- **Recession**

- Process of water leaving the surface (through infiltration and/or runoff) after the inflow has been cut off
- Usually begins to recede at the upstream end
- Can also be plotted as Time vs. Distance
- “Flatter” curve than the Advance Curve

Surface Irrigation Hydraulics, Cont'd

- **Infiltration**
 - **Opportunity Time: difference between Recession and Advance curves**
 - **Infiltration Depth: a function of the opportunity time and the infiltration class (rate) of the soil**

Curve of Time Vs. Distance

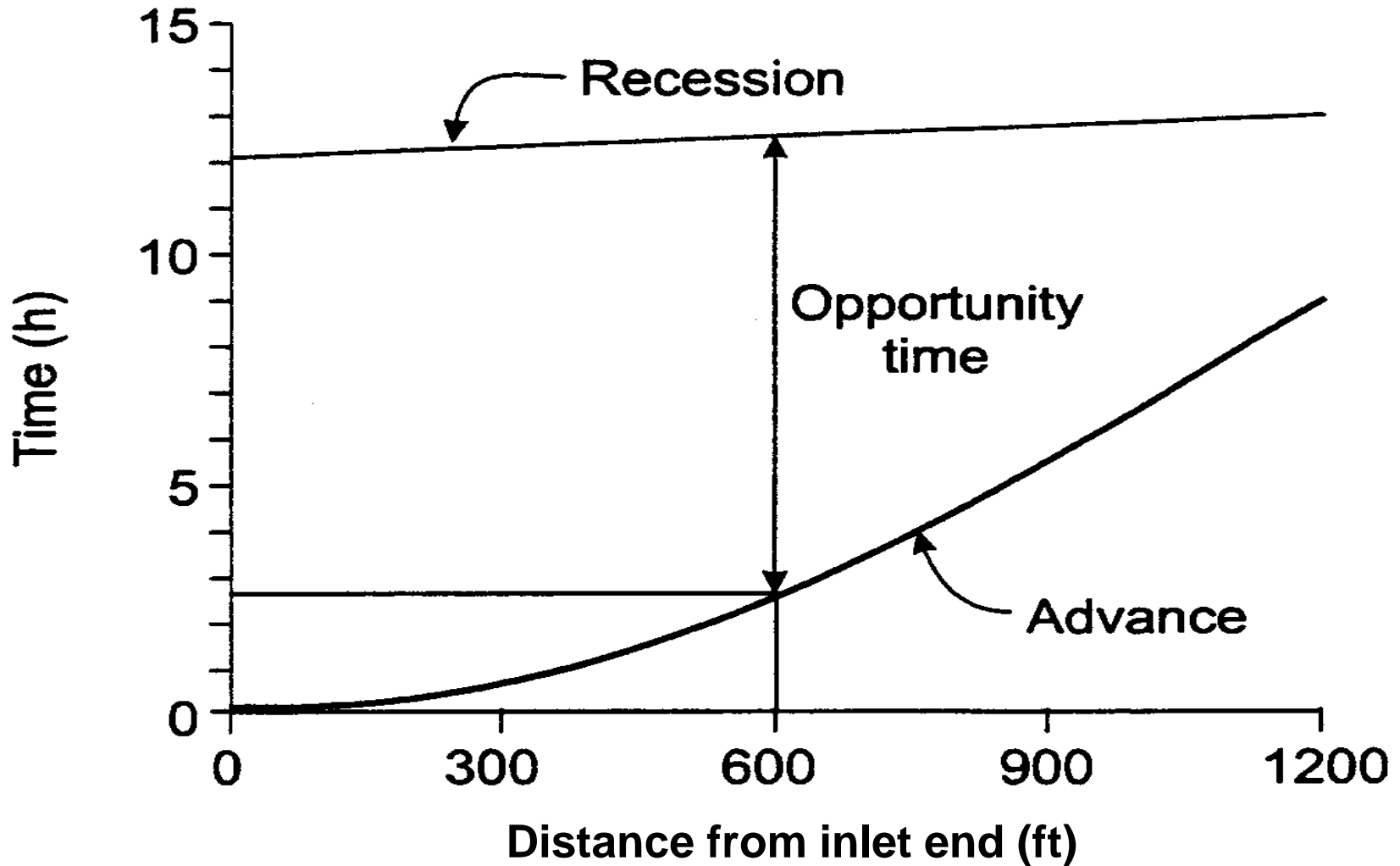


Figure 10.2. Advance and recession curves for surface irrigation.

Opportunity Time

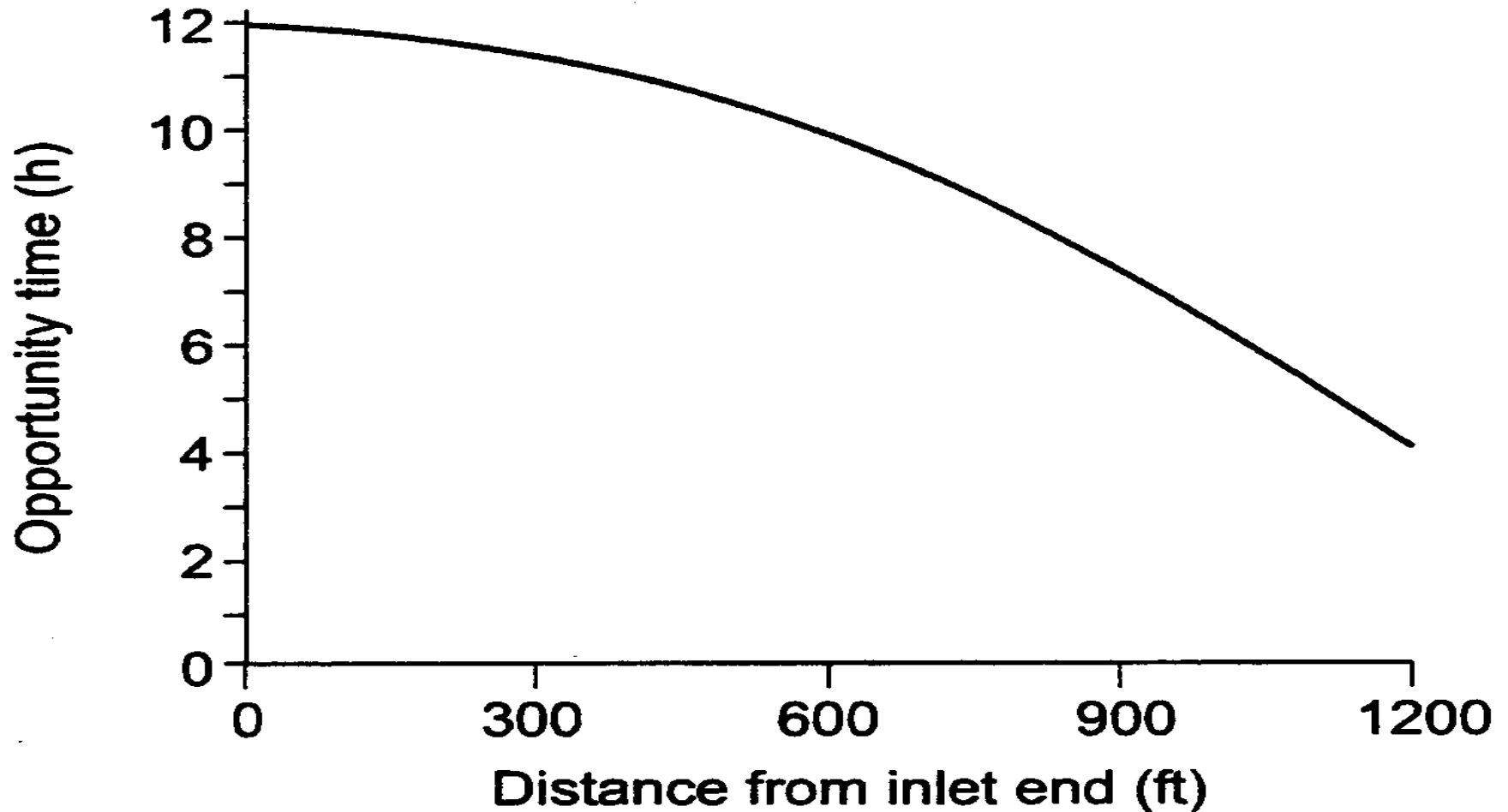


Figure 10.3. Opportunity time for surface irrigation.

Infiltration vs. Opportunity Time

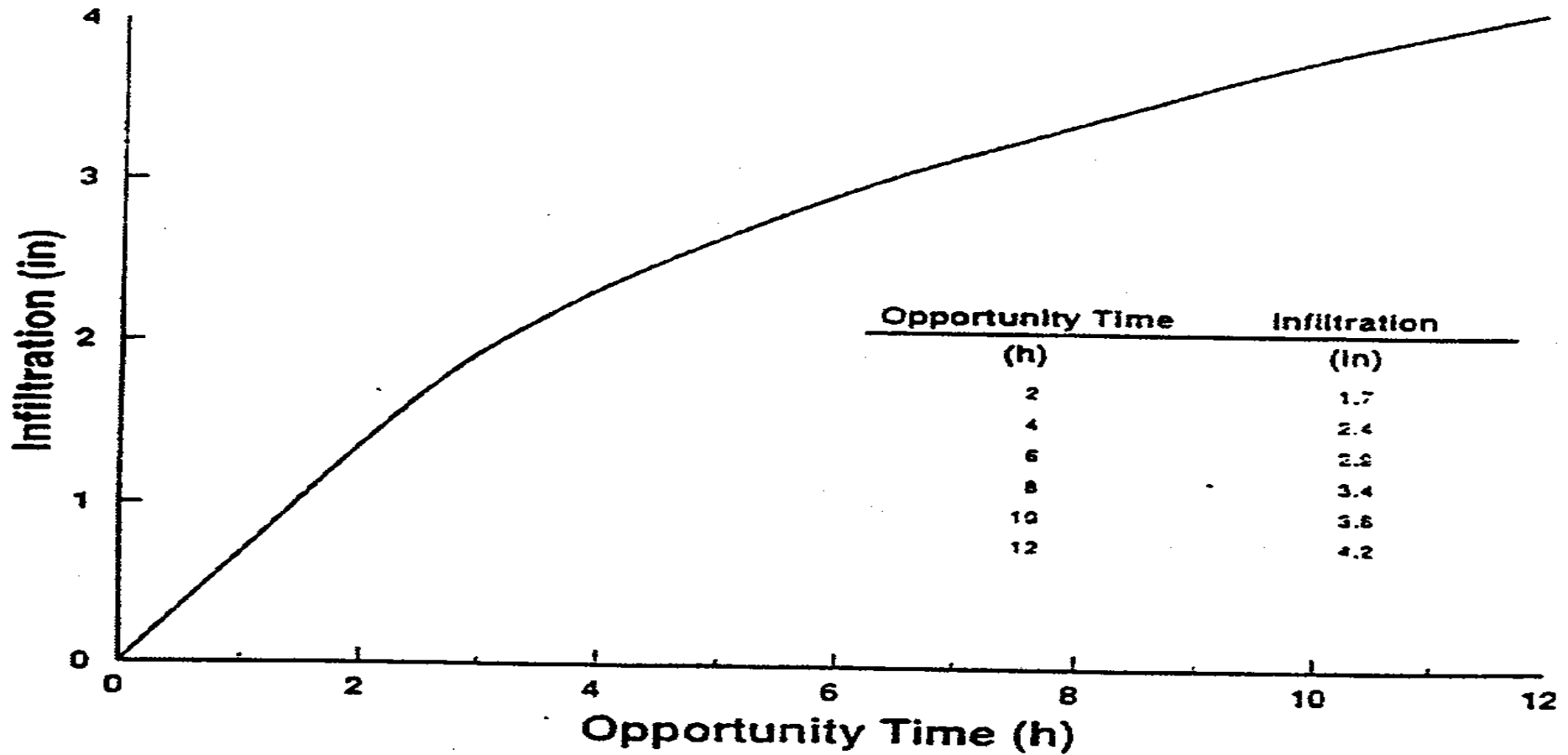


Figure 10.4. Infiltration vs. opportunity time.

Infiltration Profile

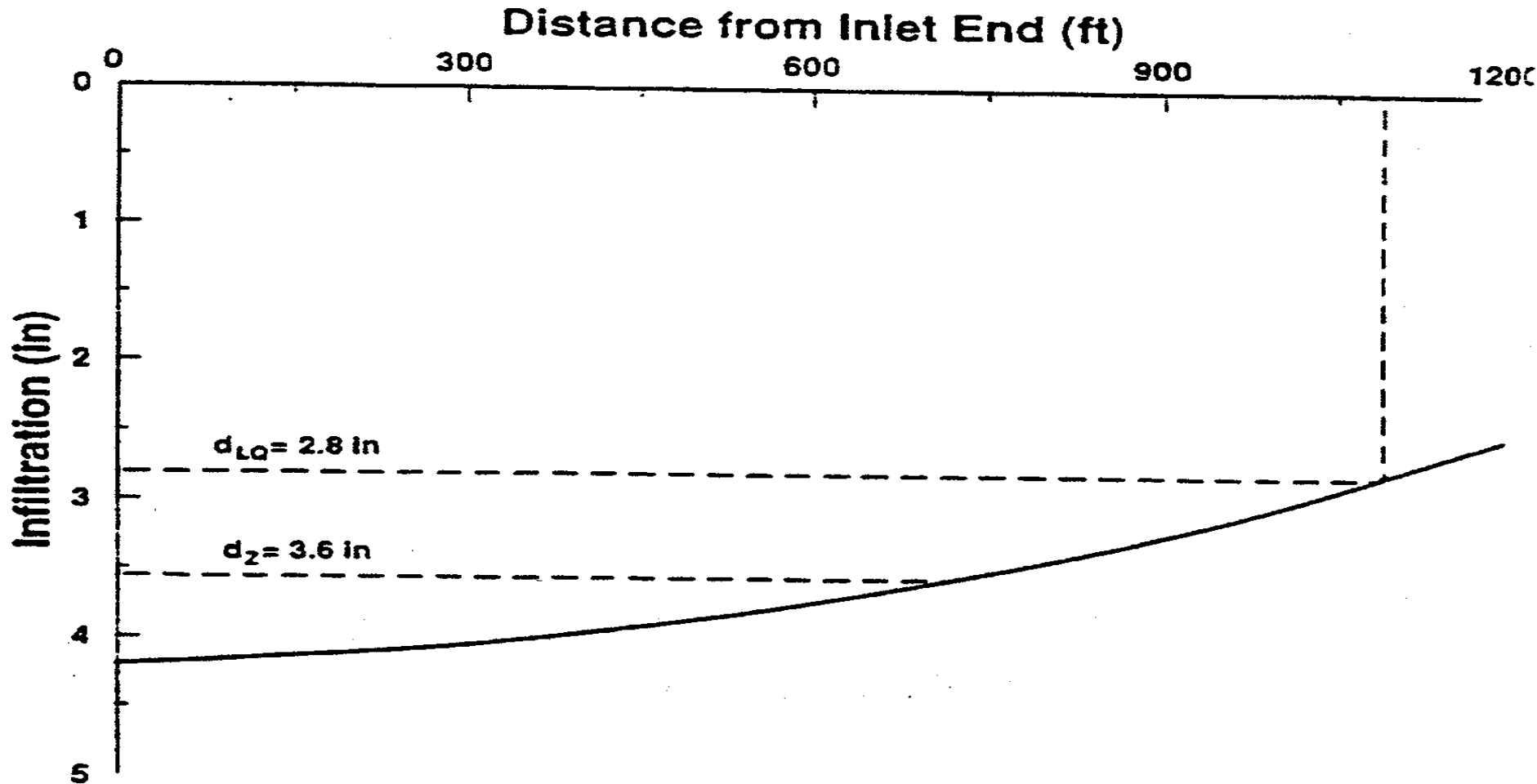


Figure 10.5. Infiltration profile.

Uniformity

- **Inherent non-uniformity because recession and advance curves are not parallel**
- **Factors affecting**
 - Inflow rate
 - Slope
 - Soil infiltration
 - Roughness
 - Channel shape
 - Inflow time
 - Length of run
- **Part of infiltration may go to deep percolation**

Efficiency

- **Volume balance**
 - $V_g \equiv V_z + V_s + V_r$
 - g → gross
 - z → infiltration
 - s → surface storage
 - r → runoff
- (or depth basis): $d_g \equiv d_z + d_s + d_r$
- Part of infiltration may go to deep percolation

Improving Irrigation Efficiency

- **Alternate furrow irrigation**
 - Increases advance time, but reduces average infiltration depth (twice the width)
- **Cutback irrigation**
 - Use large inflow rate during advance, and then reduce the inflow to match the soil's steady-state infiltration rate
 - Intensive management is required

Improving Irrigation Efficiency Cont'd

- **Land smoothing and laser grading**
 - Helps to improve uniformity
- **Surge irrigation**
 - Alternate on-off periods for applying water
 - Achieve higher efficiencies and uniformities in some soils
 - Lends itself to semi-automation









Sprinkler Irrigation (impact sprinkler)



- Impact Sprinklers
- High pressure system commonly used prior to current concerns about energy prices and water conservation.
- Application diameters range from 50 to more than 100 ft
- Water loss during application can range from 25-35% or more

[Picture from:](http://www.irrigationmuseum.org/item1.aspx?id=125)

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Sprinkler Irrigation (impact sprinkler)

- Reducing the upward angle can reduce water loss
- These systems are still used for waste disposal because large nozzles and high evaporation can be beneficial
 - In humid environments excess soil moisture is primary limitation for waste disposal



<http://www.irrigationtutorials.com/advice/why-not-use-those-huge-sprinklers/>

Sprinkler Irrigation (Low Pressure Applicators)

- Mid-elevation spray application (MESA)
- Low-elevation spray application (LESA)
- Low energy precision application (LEPA)

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Sprinkler Irrigation (LESA)

- Apply water at low pressures (as low as 6 psi)
- 12-18 inches above the ground
- Less crop foliage is wet
- Drops are spaced at 60 to 80 inches apart depending on crop row spacing
- Application efficiency is 85 to 90%



Application Efficiency

- Proportion of water leaving the irrigation nozzle which hits the ground
- Influenced by:
 - Nozzle height
 - Upward angle
 - Droplet size
 - Wind speed
 - Humidity
 - Canopy interception

Sprinkler Irrigation (LESA)



- Can be a problem in narrow row crops when drops drag through canopy which causes uneven water distribution
 - Just through the drops over the truss rods to raise it.
- LESA is currently the most common irrigation system in the Panhandle

Sprinkler Irrigation (LEPA)

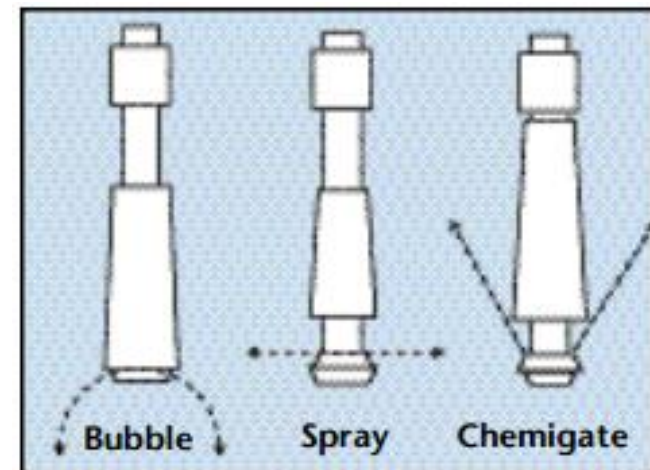
- Applicators are located 12-18 inches above the ground which apply water in a bubble pattern
- Or, drag socks or hoses that release water at the ground are use.



Sprinkler Irrigation (LEPA)



- Drag socks or bubblers can be replaced with chemigation or spray plates
- Spray plates may be useful for crop emergence



Sprinkler Irrigation (LEPA)

- Nozzles are placed in every other row
- Dry rows improve rainfall storage
- LEPA systems can provide 95-98% application efficiency



Sprinkler Irrigation (I



- Water is applied above the crop canopy
- Can require 20 to 30 psi operating pressure
- Newer systems can operate on 6-10 psi depending on drop spacing
- Above canopy irrigation reduced efficiency:
 - Interception and evaporation

Sprinkler Irrigation (I



- In corn production 10 to 12 % of water applied above canopy can be lost by wetting foliage
- Above canopy irrigation will lose 20-25% more water than LESA and LEPA systems

Runoff control in sprinkler irrigation

- Irrigation rate must match soil infiltration rate
- Infiltration can be increased with
 - Furrow diking
 - Deep tillage of compacted soil
 - Maintaining residue



Subsurface drip Irrigation

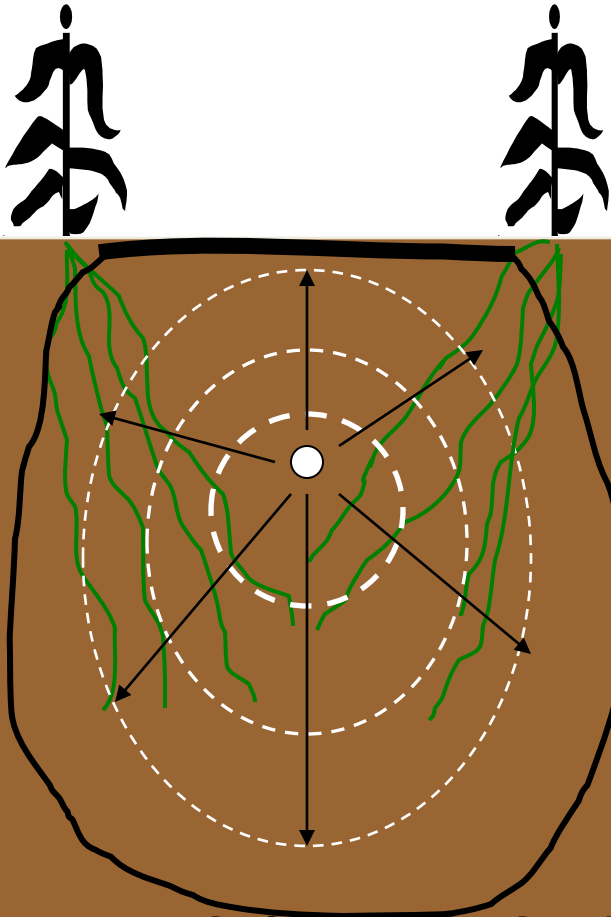
- Provides 100% application efficiency
- High yield/quality
- Field operations can be done during irrigation
- Decreased energy requirements
- Reduced salinity hazard
- Adaptable for chemigation
- Reduced weed growth and disease problems
- Can be highly automated
- No dry corners.

Subsurface Drip Irrigation

- Disadvantages:
 - High initial cost
 - Maintenance requirements (emitter clogging, etc.)
 - Restricted plant root development
 - Salt accumulation near plants (along the edges of the wetted zone)
 - Crop establishment can be difficult during droughts

Salt Movement Under Irrigation with Saline Water

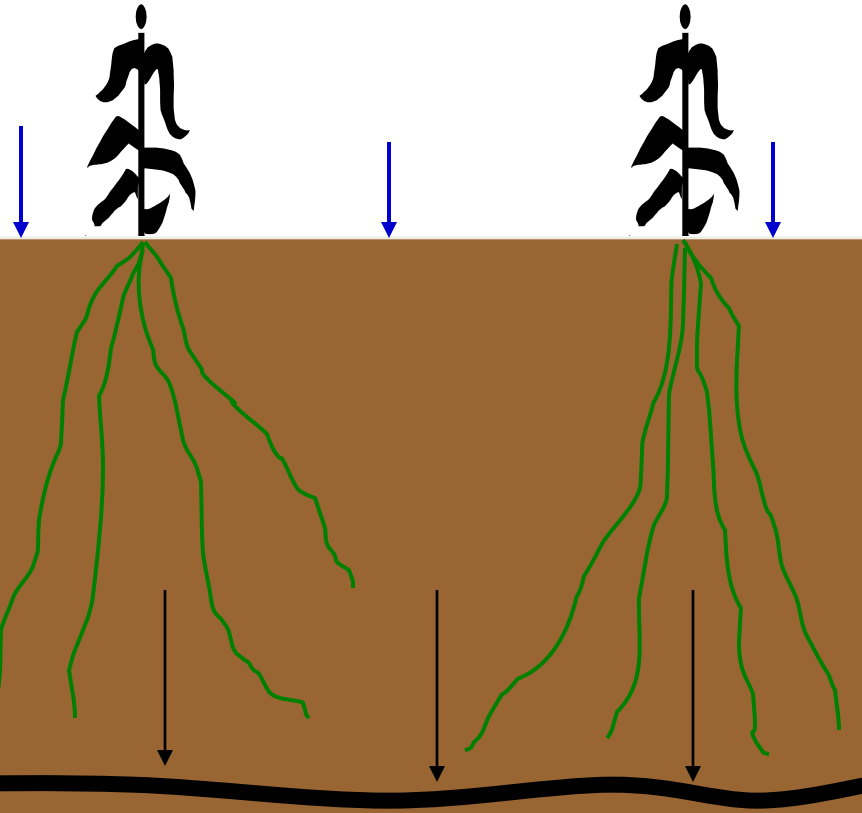
Subsurface Drip



Salt accumulation leached radially outward from drip tubing

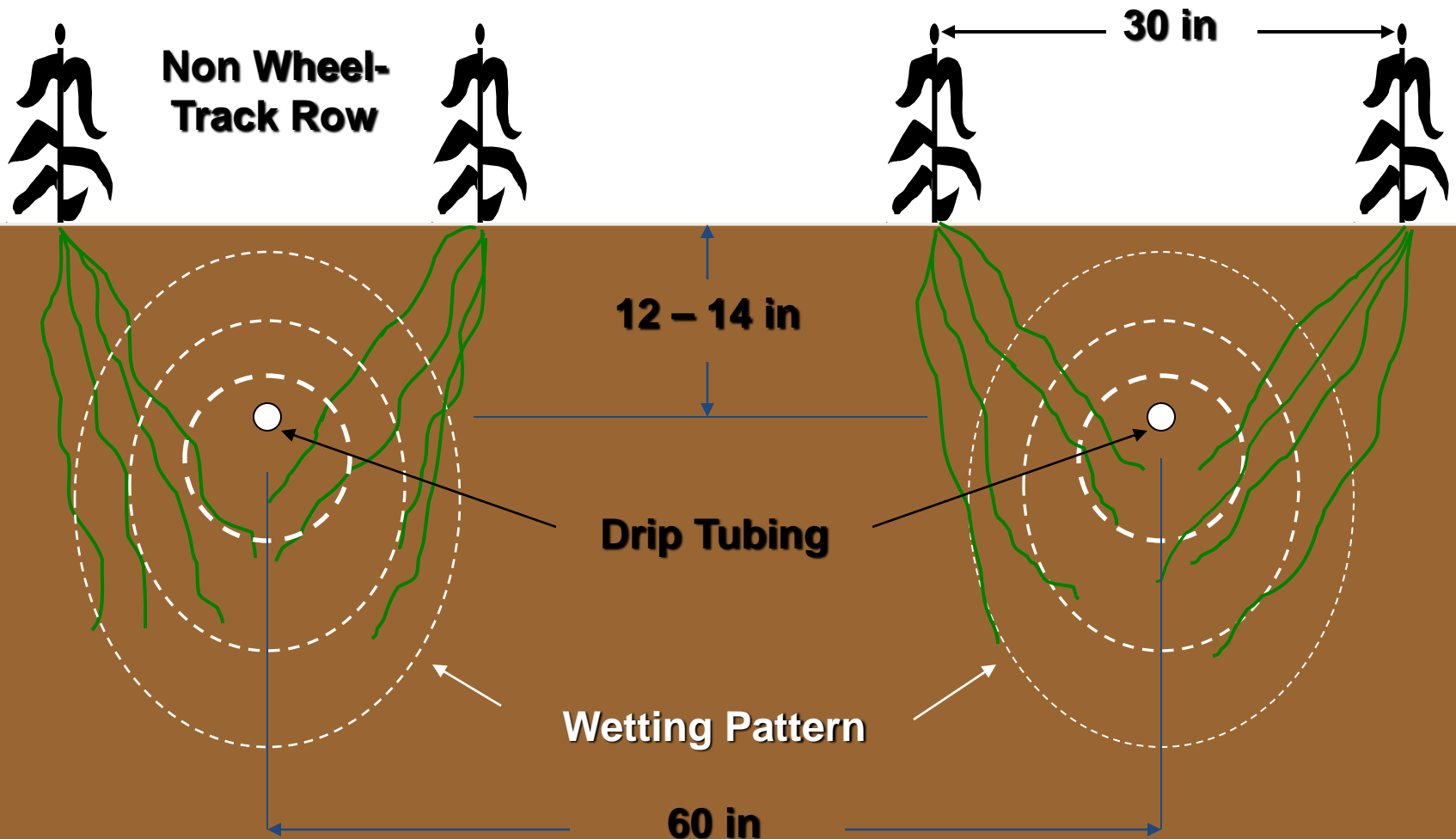
Water

Sprinkler/Flood



Salt accumulation leached downward by successive water applications

Typical Subsurface Drip Tubing Installation for Row Crops



60-inch dripline spacing is satisfactory on silt loam & clay loam soils