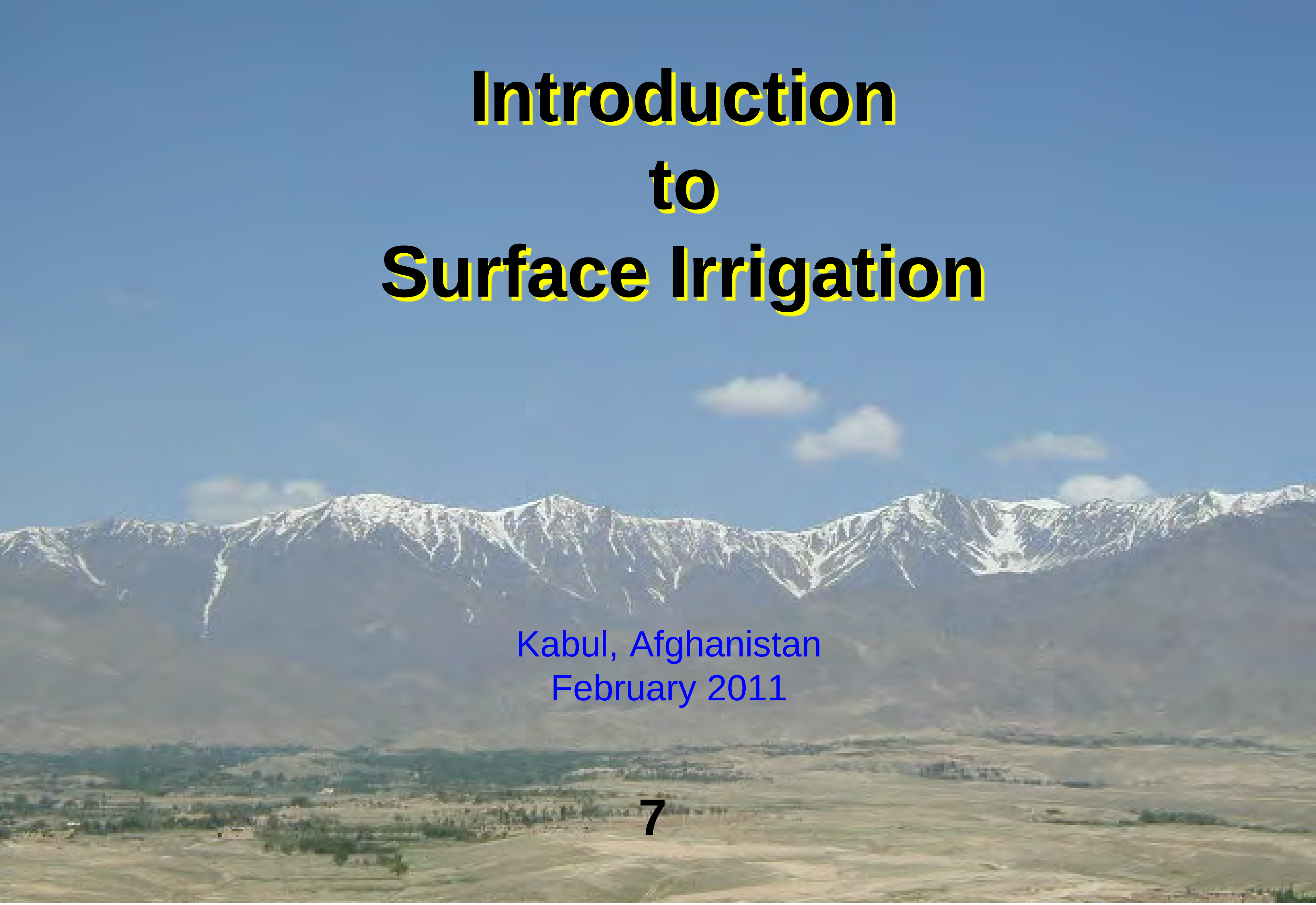

Introduction to Surface Irrigation

Kabul, Afghanistan
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This watershed rehabilitation and restoration training was prepared by the U.S. Department of Agriculture (USDA) team of Jon Fripp (Civil Engineer – USDA/NRCS), Melvin Westbrook (Director USDA-NRCS/IPD), Otto Gonzalez (International Agricultural Development Specialist - USDA Foreign Agricultural Service), Clark Fleege, (Nursery Manager, USDA Forest Service, and George Hernandez (Forester - USDA Forest Service), in consultation with Lief Christenson, (USA CJTF101 Water Resources Coordinator, Afghanistan). Contact Jon Fripp at jon.fripp@ftw.usda.gov or Otto Gonzalez at Otto.Gonzalez@fas.usda.gov for more information on this workshop.

Module Topics:

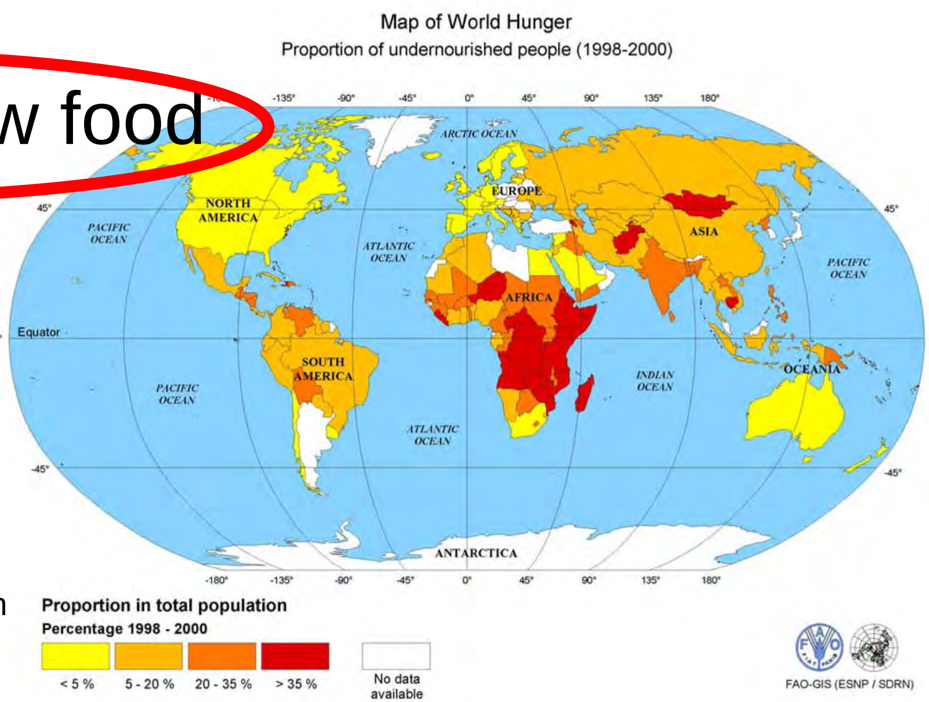
- Why Irrigate
- Types of irrigation
  - Surface
  - Sprinkler
  - Drip
- Calculations

Hunger – *what are the causes?*

Answer: Insufficient food available where and when it is needed.

Problems can be result of a combination of some or all

- War
- Storage
- Transportation
- Inability to grow food



The **child mortality rate** or under-5 mortality rate is the number of children who die by the age of five, per thousand live births. In 2007, the world average was 68 to 72 (6.8% to 7.2%). In Afghanistan , this figure is 257 (25.7%) according to UNICEF.

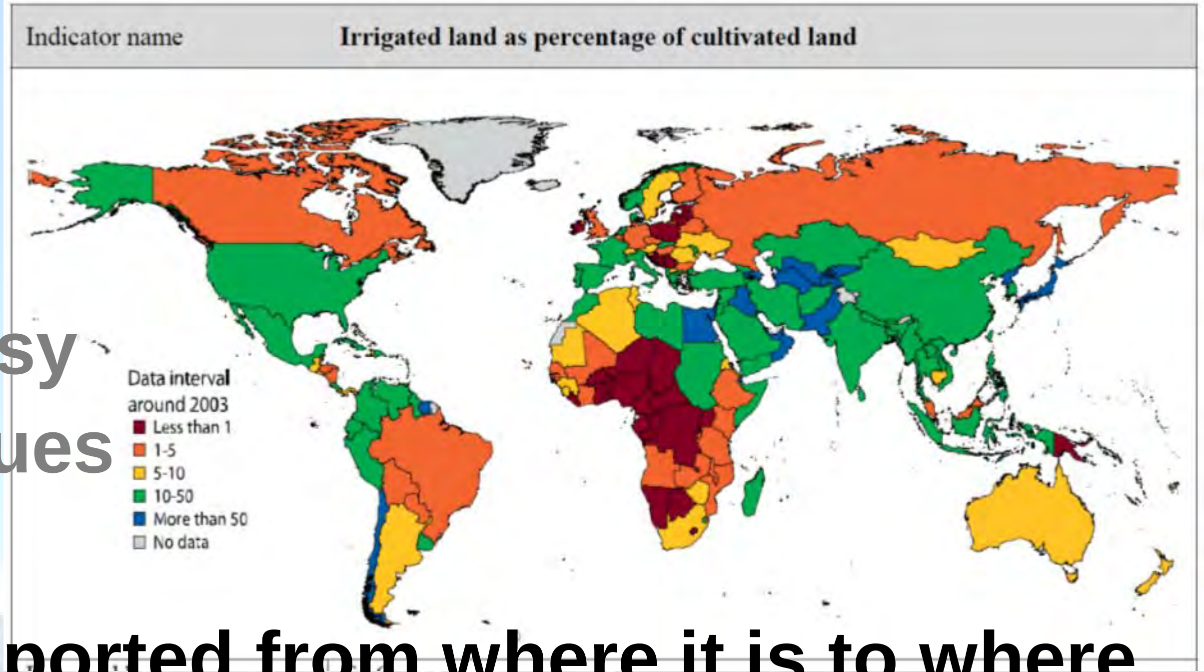
How is food produced?

Need

- Sun
- Seed
- Soil
- Water

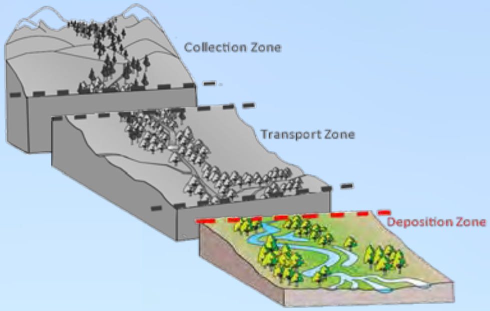
The inability to produce a reliable food supply can be because of problems with a combination of some or all

Water – *Where do we get it?*



- Rainfall
  - Cheap and easy
  - Reliability issues
- **Irrigation**
  - **Water is transported from where it is to where it is needed**
  - **17% of world cropland is irrigated**
  - **Irrigated land produces 40%-50% of world food supply**
  - **Requires infrastructure**

Irrigation may be done in any zone but is most often in the deposition zone were most agriculture occurs



Irrigation May Be A Good Idea If:

- Crops are wilting or dying from lack of water
- Crops are of a poor quality
- Crops are damaged by heat and need to be cooled
- Need to start many small seedlings
- You want to establish trees in a dry area

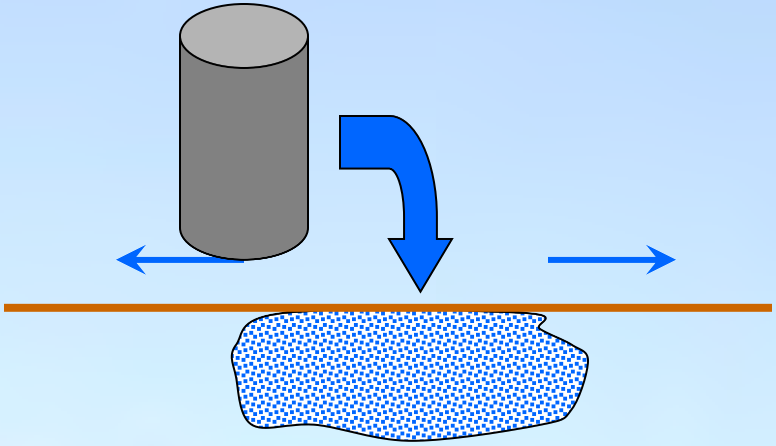



To plan irrigation we need to understand:

- -How much water the plants will need
- -When the plants will need water
- -The slope of the property that we are going to irrigate
- -Types of soils on the property
- -The source of the water we are going to use
- -How much water is available for irrigation
- -The skills of the users who will do the irrigation



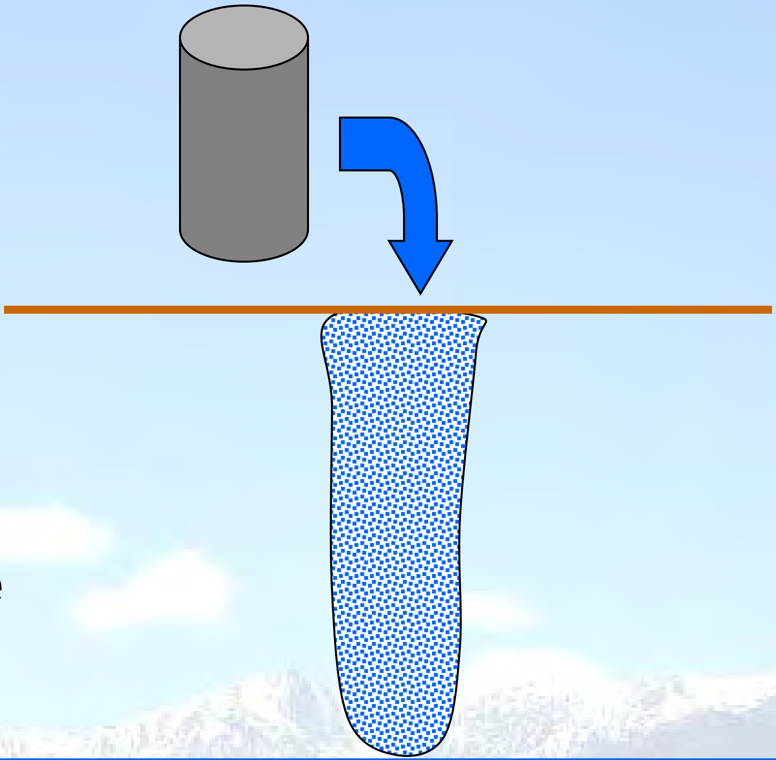

Soils - Clay



- Water soaks in slowly
- Water will stay in the soil for long time – clay soils holds the water well
- Can have runoff if the water is applied too fast

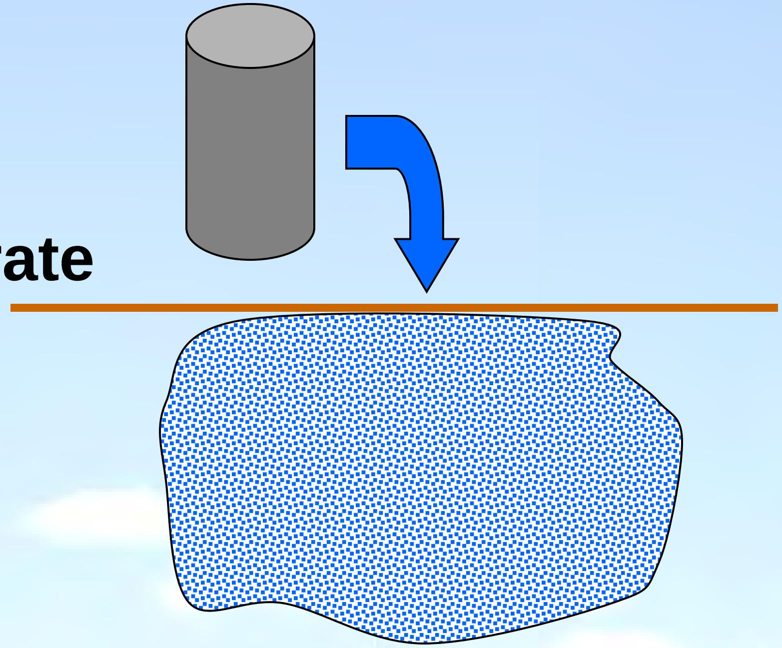
Soils - Sand

•Water soaks in quickly
•But water does not stay in the soil for long
•Water goes in much deeper than in clay
•The water will not spread as wide as in clay soil



Soils - Loam

- Loam soil is good for plants
- Water soaks in at a moderate rate
- Water stays in the soil for a moderate amount of time



When do you irrigate?

1- Feel the soil
2- Use soil probes
2- Examine rain gages
3- Know the history of the area
4- Know your crop
5- Know your soil

A simple rain gage:
a can on a stick

You do not want to add too much or too little water

Types of Irrigation

Surface Irrigation – Water is applied to the ground by flowing out. Water is supplied as if by a small flood.

Sprinkler Irrigation – Water is applied to the ground by spray. Water is applied like rain.

Drip Irrigation – Water is applied to the ground at the plants in small amounts. Water is applied at close to the rate that the soil will absorb it and the plants will use it.

Surface Irrigation - Level Basin

•A plot of land is contained with a level berm or mound of soil
•A quantity of water is supplied quickly like a small flood and then allowed to soak into the ground

•The entire area is saturated
•Easy to do
•May not work well with crops that rest on the soil

Surface Irrigation – Contour Basin

- **Level basins can also be formed along the contour of the land.**
- **The water must be able to be supplied quickly to the area and must be able to spread over the entire area.**

- **Works well on steep slopes**
- **Can drown the plants if use too much water for too long**

Surface Irrigation - Furrow Irrigation

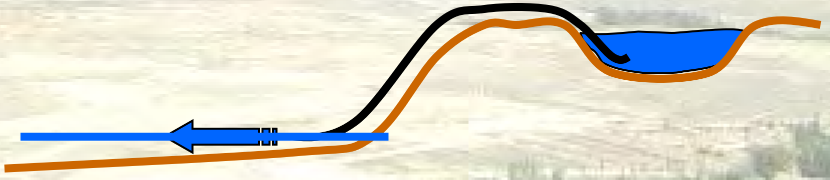
- Water is provided into closely spaced small ditches.
- The crops or trees are located on the small berms between the ditches

- Very common
- Less water than flood
- Good for trees, corn, cotton, and many others

Surface Irrigation – Getting the Water In

Must be able to control the water into and out of the area to be irrigated

You can use siphon tubes



Do not provide water too fast or it may erode the soil!

Surface Irrigation – Getting the Water In

Or a gate to get the water into the area to be irrigated

Turn out gate

Check board

Do not provide water too fast or it may erode the soil!

Surface Irrigation – Advantages

- After constructed, it is easy to maintain
- Most are easy to operate
- Most all of the water soaks into the ground

Surface Irrigation –Disadvantages

- Initial work required to make the land level and build the berms or furrows
- Requires a lot of water
- Application efficiency of 50% (can be less)
- Does not work well on sandy soils
- Irrigated area needs to be relatively flat
- May add too much water near the inlet and not enough water at the edges
- Can waterlog soil (kill seedlings)
- Can increase salt in soil
- Can cause soil erosion

Sprinkler Irrigation

•Water is pumped and distributed to the plants with sprinklers
•Water is given to the plants like rain

Many different types

Sprinkler Irrigation – Small Sprinklers

Also called micro sprinklers

- **Small sprinklers can be used to apply water to small areas or single plants**

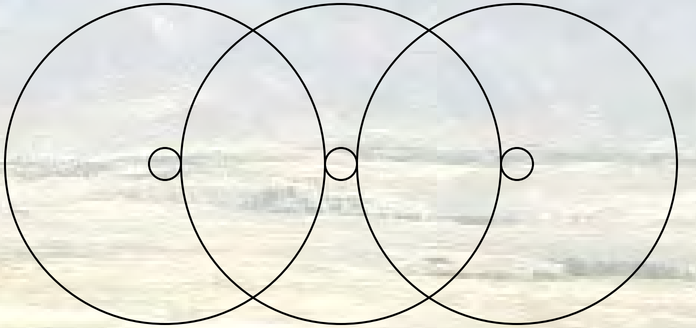
- **Easy to set up and move**
- **Can be attached to a main line with smaller tubing**
- **Water needs to be filtered**

Sprinkler Irrigation – Advantages

- Acts like rain
- Works well on sand and loam soils
- Can work well on a wide range of slopes
- Can be automated
- Can be used to prevent damage to plants by freezing
- Can be used to cool crops
- Can be used to apply fertilizer and pesticides
- Application efficiency about 75-90%

Sprinkler Irrigation –Disadvantages

- Initial work required to construct systems – can be expensive
- Requires some skill to operate
- Wind can push the spray away from the plants
- Requires water that is under pressure (need a pump)
- If too much water is added, it may not soak in and could cause erosion
- High evaporation – may waste water



Overlap by 50%

Drip Irrigation

Provides a gradual amount of water to specific plants

Water is provided through small holes or emitters (application efficiency approaching 100%)

Drip Irrigation

Good for orchards, vines, wind breaks, vegetables, nursery crops and others

Drip Irrigation

- The key to drip irrigation is to make the soil moist but not too wet
- Most of the water is absorbed into the plant in the top 30 to 60 cm of the soil

Drip Irrigation

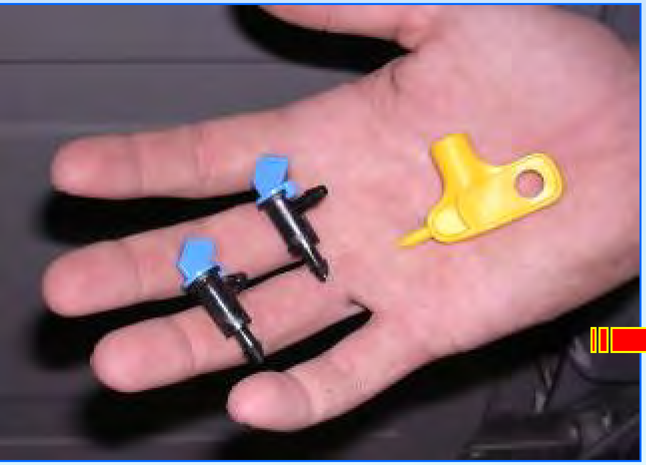
Before you set up a large drip system, evaluate the soils with a jug test

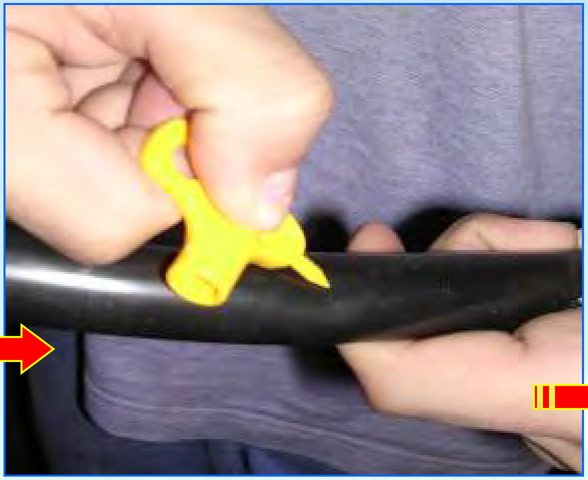
Put a drip emitter into a full jug of water and allow it to drain overnight

Drip Irrigation

- Examine how fast the water soaks into the ground
- Dig a hole and examine how the water spreads through the soil
- Think about how a plant would use the water

Drip Irrigation



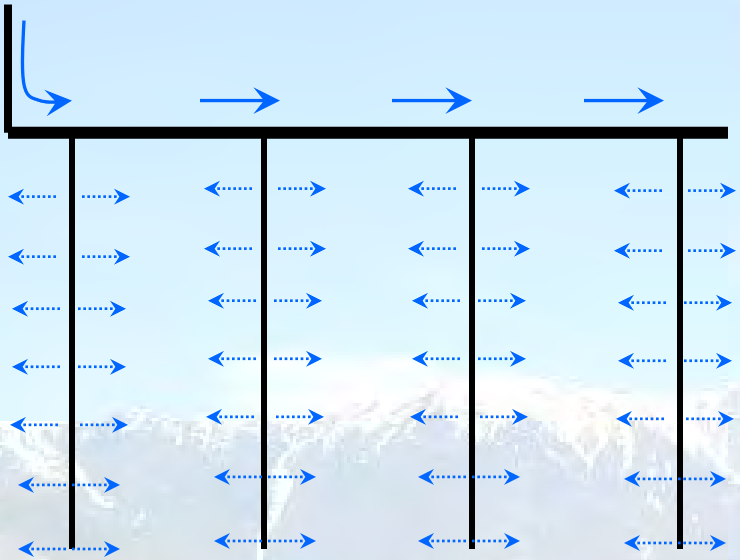


- The emitters can be installed with a punch at the points where irrigation water is needed
- Emitters need to be closer on sandy soil

There are many different types of emitters, some work at low pressure

Drip Irrigation

Typically connect smaller lines to a larger

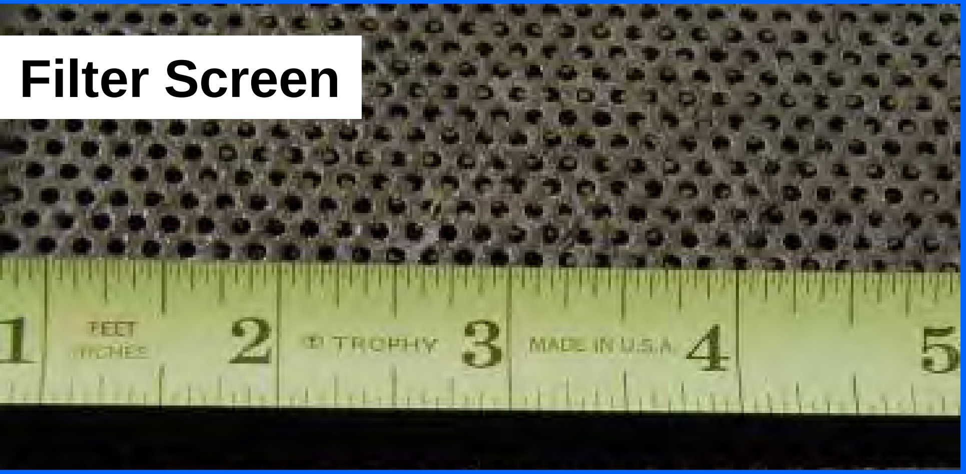


- **Typical spacing of emitters is 50 to 100 cm**
- **Can add small sprinklers**
- **Maximum length of a 2.5 cm line is 100 m**
- **Keep lines as flat as possible, do not change elevation by more than 1 m**
- **Do not have high or low areas in a line**

Drip Irrigation

- Drip irrigation must have a filter
- If a filter is not used, the emitters can clog
- There are many types of filters

Sand Filters



Filter Screen

Small screens

Sand Filter

Photo from John Tiedeman

Drip Irrigation

- Can make a basic sand filter
- But it must be maintained

There are many ways to make a sand filter

Drip Irrigation

- **Any filter must be installed before the emitters**
- **This photograph shows a basic sand filter installed along the main line before the emitters**

Drip Irrigation

Most drip systems operate in a range of 15 to 20 psi. When designing large systems, it is important to know the pressure that can be provided at different flow rates from the water source.

Simple measurement: Measure the time that it takes to fill a bucket of a known size. Record the pressure at that flow rate

Drip Irrigation – Advantages

- Saves water (near 100% application efficiency)
- Low evaporation and runoff loss
- Water goes to the plant so fewer weeds grow
- Works well on all soil types
- Can work well on a wide range of slopes
- Can be used to apply fertilizer and pesticides
- Can be automated
- Not affected by wind
- Can be adjusted easily

Drip Irrigation –Disadvantages

- Requires water that is under some pressure – can use a pump or supply water from a higher elevation
- Too high of pressure can cause problems
- Initial work required to construct systems – can be expensive
- Requires some skill to operate and maintain
- Can be easily damaged
- Requires clean water – it can clog

Test Time

- ***What appears to be wrong in this picture?***

- Too much water
- Not irrigating the dry plants

Example Calculation

- Given 210 tomato plants (assume 1 gallon/week required per plant)
- Given 1 gallon per hour drip emitters used. (assume one per plant). Irrigate every other day
- Calculate length of time drip is to be applied

1. Calc: 1 gallon / 3.5 days = 0.29 gallons per irrigation application per plant required
2. Calc: 0.29 gallons x 60 = 17 minutes

<u>Bonus Question 1:</u> How many gallons per irrigation application is required?
210 x 1 / 3.5 = 60 gallons

<u>Bonus Question 2:</u> Assume 4 year old trees. Assume 1 gal per week per year of growth water requited. Assume 1 gpm emitter per tree and irrigate every other day. Calculate application time.
4 x 1 / 3.5 = 1.14 gallons per irrigation application required
1.14 x 60 = 69 minutes of irrigation needed

1 gal = 3.78 liter
1 acre = 0.4 hectare

Example Calculation

- Given 10 acres of corn is to be irrigated (Assume 24” water consumptive use)
- Given sprinkler irrigation (assume 90% application efficiency)
- Assume irrigation of 120 days
- How large of a pump is needed?

pump efficiency usually refers to power use (horse power) but this is an overall use.

1. Calc: 10 x 24 = 20 acre feet needed
2. Calc: 20 x 43560 x 7.48 /120 = 54,300 gallons per day needed
3. Calc: 54,300 /24 / 60 / 0.90 = 42 gpm needed from pump

<u>Bonus Question 1:</u> What would pump size be for wheat? Assume 12” consumptive use.

Example Calculation

- Given 6 inches must be provided to a 10 acre field
- Given unlined diversion ditch (assume 50% loss)
- Given flood irrigation to be used (assume 50% application efficiency)
- How much water must be diverted?

1. Calc: 6 inch / 12 in/ft * 10 acre = 5 acre feet irrigation water needed
2. Calc: 5 / .5 = 10 acre feet needed at field
3. Calc: 10 / .5 = 20 acre feet of water to be diverted

The End

There are many different types of irrigation that can be used