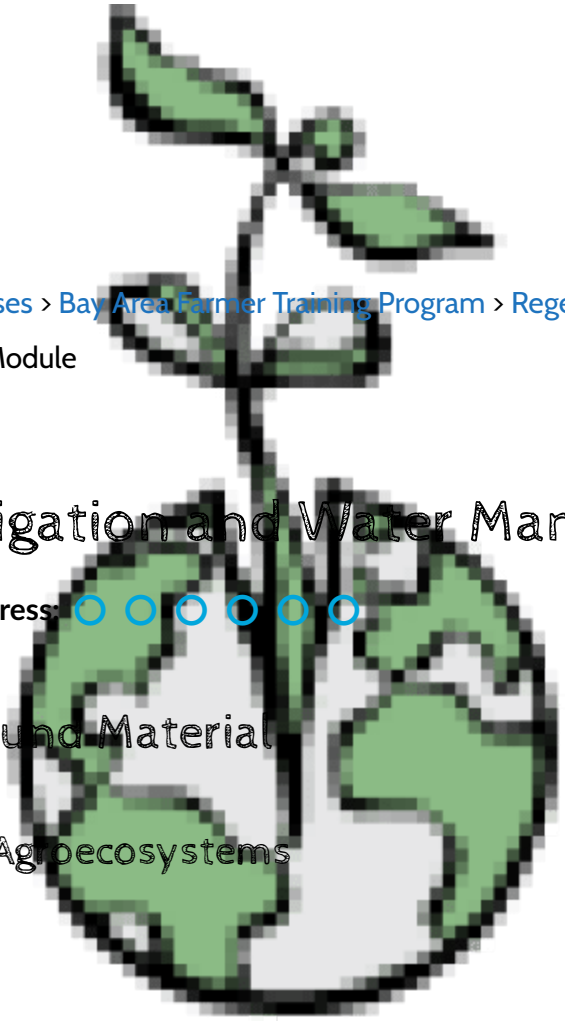
FARM CENTERED LEARNING NETWORK



Module

09. Irrigation and Water Management

Module Progress:

Background Material

Water in Agroecosystems

Abuela Grillo

from **Denis Chapon**

Water is essential to the health of plants and entire agroecosystems. The CASFS manual describes seven contributions made by water.

1. Sustains soil biological and chemical activity and mineralization
2. Promotes soil solution and nutrient uptake
3. Provides carbohydrate building block through photosynthesis
   $6\ CO_2 + 6\ H_2O \rightarrow C_6H_{12}O_6 + 6\ O_2$
4. Provides plant structure and support
5. Promotes the maintenance of optimal temperatures within the plant
6. Protects crops from frost damage
7. Reduces plant stress and thus increases plants' resistance to pests and disease

These functions of water apply regardless of whether it is delivered by rainfall or by artificial means like irrigation. In this section, students will learn how water moves in and out of a farm or garden, as well as where water is held in agroecosystems.

Water generally moves into the system through **precipitation** or **irrigation** and leaves the system by returning to the atmosphere from the soil surface (**evaporation**), entering the soil surface (**infiltration**), moving downward through the force of gravity (**percolation**), uptake by plant roots and release through vegetative tissues (**transpiration**).

Depending on environmental conditions and soil characteristics, the amount of time that water is held in the system may be affected. Some strategies for increasing local water storage in the system include:

- Building soil structure through conservation tillage or zero tillage
- Increasing organic matter
- Surface mulching
- Growing cover crops and green manures
- Recycling water (e.g. gray water diversion)
- Rainwater harvesting from rooftops or rainwater runoff in catchment systems (e.g. ponds, swales, and tanks)

Irrigation

When to Irrigate, and for How Long?

From the CAFSF Manual, **irrigation is needed when the amount of water being lost to the atmosphere (called evapotranspiration) exceeds rainfall**. Factors affecting the frequency and volume of irrigation:

1. Climate
    - Air temperature
    - Precipitation
    - Humidity

- Wind
- Capillary action
- Infiltration and percolation

2. Soils
    - Sandy soils: rapid drainage; poor water-holding capacity
    - Silty soils: drain slowly; good water-holding capacity
    - Clay soils: drain very slowly; tightly hold water
    - Loam soils: drain well; good water-holding capacity
    - Organic matter maintains the good drainage and retention of agricultural soils
3. Crop-Type and Stage of Crop Development
    - Water-loving crops require less fluctuation in soil moisture (e.g. celery)
    - Drought-tolerant crops may need little to no irrigation (e.g. tomatoes, winter squash, amaranth, etc.)
    - Maturation period may require a gradual reduction in watering (e.g. garlic)
    - Tree needs depend on multiple factors

Estimating a Farm or Garden's Water Budget

A water budget approach is not easily applied to small, diverse systems. Scheduling irrigation by feel may be more appropriate in these cases (refer to the ribboning techniques presented in module 1 on Soil Health). However may still offer insight into the movement of water through agroecosystems. It also has the potential to increase water use efficiency.

From the CASFS Manual,

> Determining irrigation scheduling using the water budget approach a) Water budgeting is often compared to managing a savings account: The starting

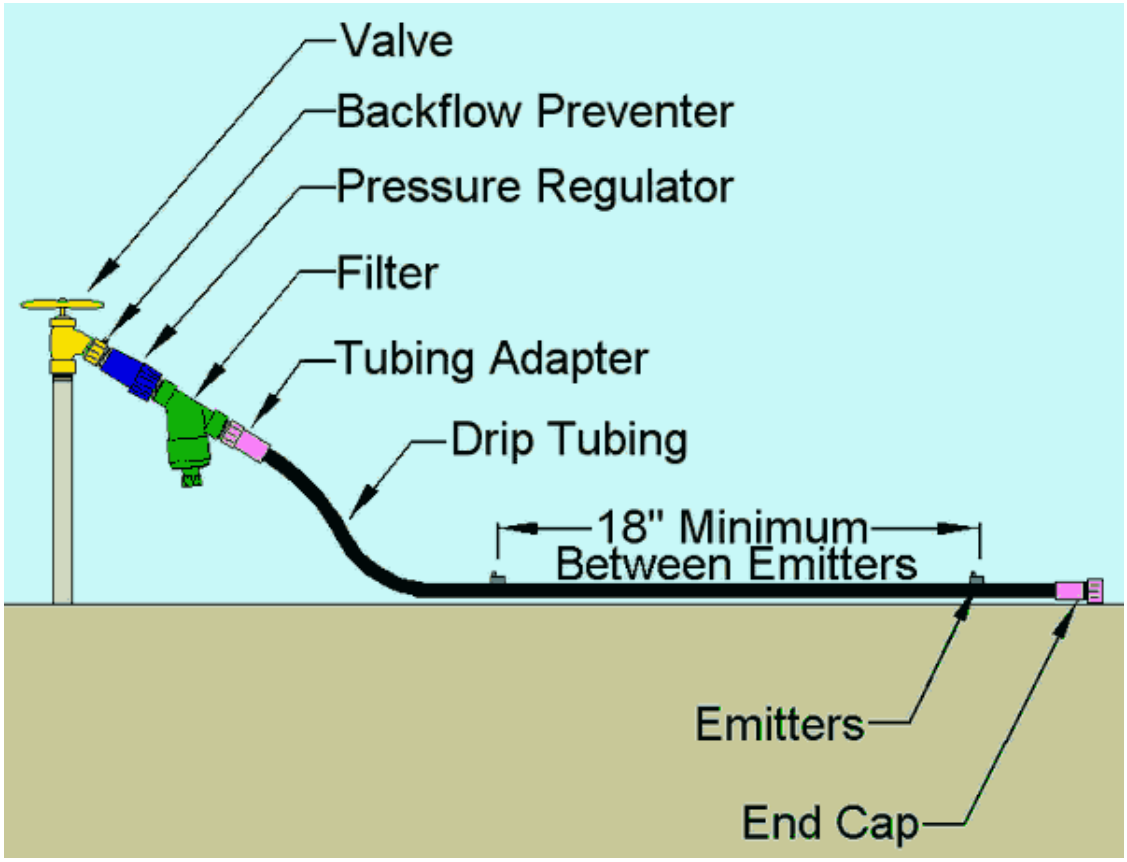
point is field capacity (see definitions, above), and as water is removed and the "savings balance" drops, it is replaced as needed by the crop. Water budgeting is a quantitative approach using existing models that analyze temperature and crop water use to determine evapotranspiration (ET) rates. Growers use these models to determine irrigation timing and amounts.

Irrigation Delivery Systems

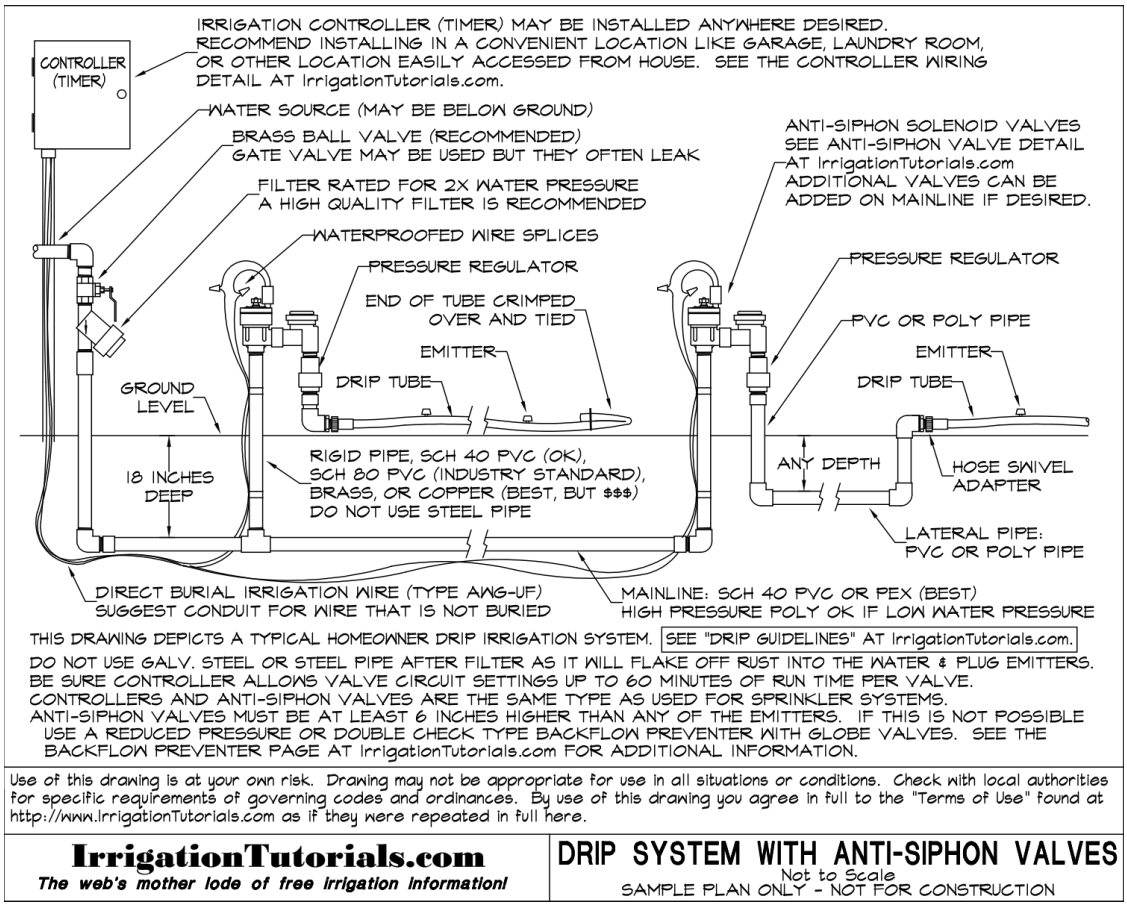
Various irrigation technologies exist. A few of these include:

1. Sprinklers
    - Micro sprinklers
    - Moveable aluminum pipes with rotator heads
    - Hand-moved PVC "riser system"
    - Oscillators
2. Drip Irrigation
    - Rigid poly-tubing with inline emitters
    - Drip tape
3. Hand Watering
    - Wands
    - Watering cans

Drip irrigation and hand watering are very common for small and medium scale farms and gardens. More information on drip irrigation is available at Irrigation Tutorials. The two images below show various components of a simple and complex irrigation setup.



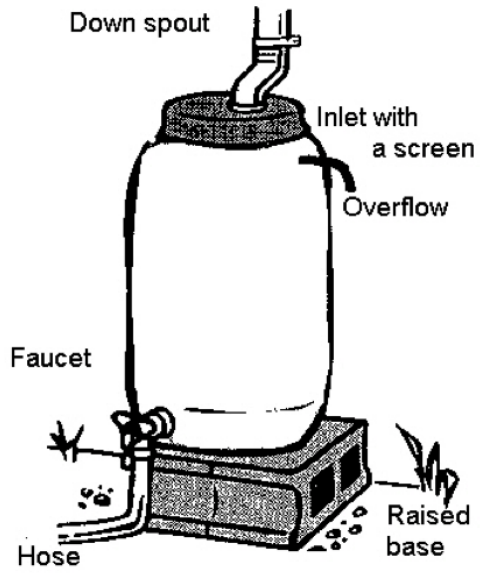
Schematic of simple drip irrigation system from Irrigation Tutorials



Schematic of complex drip irrigation system from Irrigation Tutorials

Residential Rainwater Harvesting Systems

This section is retrieved from City of Berkeley web page. Rainwater harvesting is collected precipitation from rooftops and other above-ground impervious surfaces that are stored in catchment tanks for later use. Rainwater harvesting systems can range from a simple barrel at the bottom of a downspout to multiple cisterns with pumps and filtration. Untreated rainwater can be used to water all your outside plants – including edible plants.

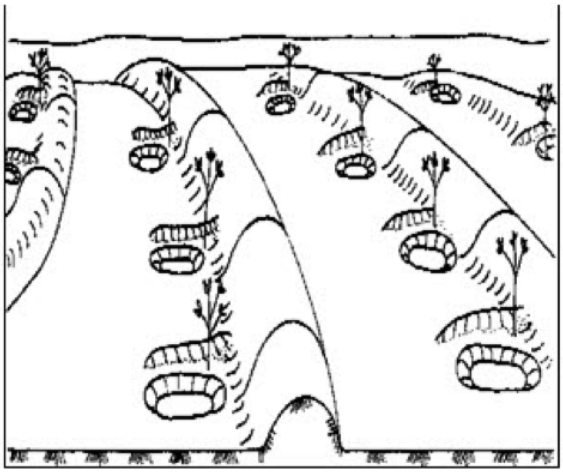


A diagram of a water harvesting cistern.

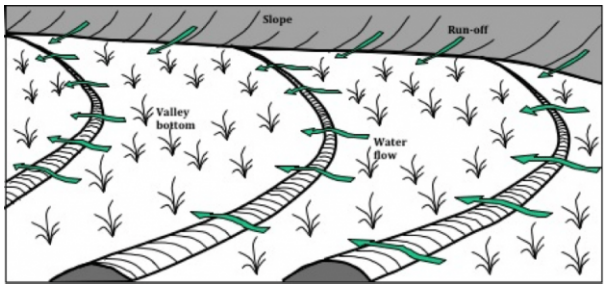
Farm Rainwater Harvesting Systems

Water harvesting is the collection of runoff for productive purposes. Instead of runoff being left to cause erosion, it is harvested and utilized. In the semi-arid drought-prone areas where it is already practiced, water harvesting is a directly productive form of soil and water conservation. Both yields and reliability of production can be significantly improved with this method. (www.fao.org)

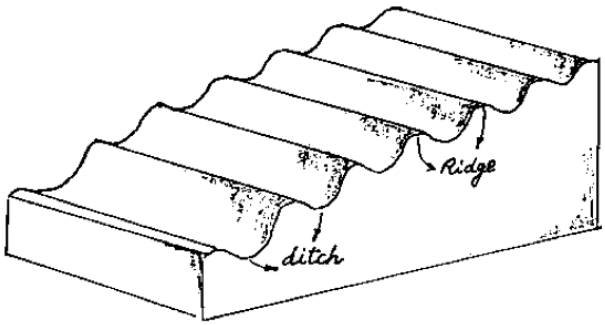
Examples



Micro catchments (for trees)



Contour Bunds (for trees)



Contour Ridges (for crops)

Farm ponds

Gray water catchment

Gray water is untreated household wastewater generated from hand washing, laundry, and bathing. This wastewater can be diverted from the sewer to irrigate outdoor plants and landscape. Graywater cannot include any wastewater from toilets, kitchen sinks, dishwashers or washing machines laundering soiled diapers or other sources of contamination such as darkrooms (City of Berkeley)

The easiest way to use greywater is to pipe it directly outside and use it to water ornamental plants or fruit trees. Greywater can also be used to irrigate vegetable plants as long as it doesn't touch edible parts of the plants. In any greywater system, it is essential to use "plant friendly" products, those without salts, boron, or chlorine bleach. (Graywater action)

Basic Greywater Guidelines

From Graywater action:

Greywater is different from fresh water and requires different guidelines for it to be reused.

- **Don't store greywater** (more than 24 hours). If you store greywater the nutrients in it will start to break down, creating bad odors.
- **Minimize contact with greywater.** Greywater could potentially contain a pathogen if an infected person's feces got into the water, so your system should be designed for the water to soak into the ground and not be available for people or animals to drink.
- **Infiltrate greywater into the ground, don't allow it to pool up or run off** (knowing how well water drains into your soil (or the soil percolation rate of your soil) will help with proper design. Pooling greywater can provide mosquito breeding grounds, as well as a place for human contact with greywater.
- **Keep your system as simple as possible, avoid pumps, avoid filters that need upkeep**. Simple systems last longer, require less maintenance, require less energy and cost less money.
- Install a 3-way valve for easy switching between the greywater system and the sewer/septic.

Match the amount of greywater your plants will receive with their irrigation needs.

Optional Reading

Plumbing Code 2013 California Plumbing Code (specifically Chapter 17)

Bay Area Stormwater Management Rain Barrels and Cisterns

Irrigation

American Rainwater Catchment System Association (ARCSA)

East Bay Municipal Utility District (EBMUD)

City of Berkeley Graywater Reuse Graywater Collection Systems

Reflection Questions

09. Irrigation and Water Management

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