Irrigation for Small Scale Vegetable Production

Wisconsin School for Beginning Market Growers

To achieve consistent results from year to year and to maintain quality and high yields, irrigation is a vital part of most any fresh market produce farm. A reliable, easy-to-use irrigation system is well worth the cost and should be among the first investments made when starting to grow and sell vegetables, herbs, flowers, or fruit. The following basic information was compiled and adapted by the Center for Integrated Agricultural Systems for the Wisconsin School for Beginning Market Gardeners. The resources listed at the end of the document provide more complete and detailed information.

Water needs

In general, a *minimum* of 8 gallons per minute (gpm) is required for each acre of horticultural crops to be irrigated. Using this figure as a guide, a 5 acre farm needs a water source capable of delivering 40 gpm while a 10 acre farm requires 80 gpm. A household well often provides around 10 gpm. A beginning market gardener could get by using their existing household well if they are cultivating an acre or less - and the field is close to the house. It is important to remember, however, that using a household well for irrigation obviously takes away from the water available for other uses inside the home. A booster pump (approximately $100) can be used to increase pressure so that sprinklers can adequately operate (a minimum of 30 pounds per square inch are usually required for mini sprinklers, much more for impact sprinklers). Using a household well is usually not satisfactory, however - especially over the long-term - so other sources of water for irrigation should be considered.

Water sources

Groundwater. Groundwater is generally an excellent source of irrigation water. However, locating and drilling a well can be an expensive task. Local well drillers are good sources of information about well yields in your area. The costs associated with using groundwater center around the cost of drilling the well, the well casing, the pump, and the elevation difference and distance between the well and the fields to be irrigated. It costs around $3,000 to $5000 just to drill and case a hole in the ground when installing a well. Total costs will depend on many factors including the depth to ground water. The depth to available groundwater will determine what kind of pump can be used. If water is within 15 feet of the surface, a surface pump can be used; these pumps cost between $250 and $750 for pumps providing 20-60 gpm (depending on size and whether the pump is electric or gas powered). Larger pumps providing 80-300 gpm will cost $1500 to $3000. If water is further than 15 feet from the surface either a jet pump or submersible pump is needed. Jet pumps can be used down to depth of 70 feet and cost around $800-$1000 (both gas and electric models are available). 20% of the water pumped up by a jet pump is pumped back down to help push water up. A submersible pump will cost at least $1000 and can only operate on electricity (50 amps). If electric service is not immediately available the well site costs for this kind of system go up dramatically. Filters are needed to avoid clogging irrigation tubing and sprinklers. One thing that can be particularly troubling is soluble iron precipitating and clogging irrigation lines and emitters. If faced with a nasty iron problem, options include either frequently replacing irrigation equipment (tubes, emitters, and sprinklers) or pumping water into a pond where the iron can precipitate out prior to being used for irrigation. Another type of well option is driven-point (or sand-point) wells) if you have the correct soil type and the water table is close to the surface. (Please see the DNR publication listed below for more information about driven-point wells)

Surface water. In order to irrigate using a pond or other reservoir, 1.5 acre-feet of water (the volume that would cover 1 acre to a depth of 1.5 feet) is needed for every acre to be irrigated. For example, a 5 acre farm would need a 1.5 acre pond that was 5 feet deep on average. Costs associated with using existing surface water resources depend mostly on the size of the pump and power source required. Filters are needed to avoid clogging irrigation tubing and sprinklers. Filtration needs are more significant for surface water and can add significantly to irrigation costs. Pumping from a stream or river can be an option for some farms. Because stream flow is influenced by climate it may not provide enough water during dry parts of the year or during droughts, when irrigation is needed most. Usage of such waterways in Wisconsin is regulated by the DNR (see next section).

Laws and regulations relating to irrigation water use in Wisconsin

The use of streams and other waterways in Wisconsin is regulated by the Wisconsin Department of Natural Resources. Before tapping into such sources, contact that DNR at (608) 266-8030. High-volume groundwater use also requires a special permit from the DNR.

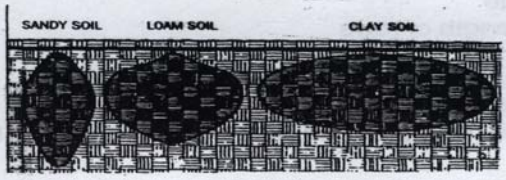
Irrigation systems

Sprinkler and trickle (or drip) are the two basic systems used to irrigate vegetables and fruit.

Sprinklers can be used to irrigate, for frost protection (running water prevents frost and ice from forming on plants), and to keep heat-sensitive crops cool on hot days. Whether portable or permanently installed, sprinklers apply water overhead and therefore wet the entire plant surface. Many different kinds of sprinklers are available from those that cover very small areas (mini-sprinklers) to those that cover large areas (up to an acre). Large-scale, commercial growers sometimes use “center pivot” irrigation systems that cover much larger areas. Like drip systems, mini-sprinklers can clog and should be carefully selected and maintained. Sprinklers generally demand more water pressure (usually at least 30 pounds per square inch) than trickle irrigation (see below) and therefore have higher energy costs. They also can be less uniform and less efficient especially in windy or very hot conditions, when water is wind blown or lost to evaporation (15% or more).

Trickle or drip irrigation applies water directly to soil and there to the plant root zone through tubes that run the length of crop rows. Drip tape or emitters (water delivery devices) located at intervals along a tube can be used to deliver water directly where it is needed and not between rows where it will be used by weeds. Because of this - and the fact that less water is lost to evaporation - drip systems are generally 95 percent efficient. Emitter holes are very small and can become clogged by mineral deposits, algae, and other matter. Filters are required to keep the system operating and a backflow prevention device should be used to keep the water supply from becoming contaminated. Most emitters or drip tape operate at pressures of 5 to 20 pounds per square inch with flow rates of 1 to 2 gallons per minute per 100 feet of tubing - much lower than the requirements for sprinklers. The low pressure requirements can result in a greater sensitivity to pressure losses, however, which result from using such systems on rolling terrain. Pressure compensating emitters can be used if fields are not flat. Adequate emitter and drip tape spacing depends on row spacing and soil type. Water will be distributed in the soil differently depending on type.

Figure (from Rain-Flo catalog):



Drip irrigation can reduce disease problems because plants are not wetted. They also allow for field operations to continue without interruption because only a limited area around the plant is wetted. Disadvantages include the tendency for emitters to clog and the fact that drip lines can be damaged by rodents, insects and laborers. Also, because moisture distribution in the soil is limited, a grower may need to irrigate more frequently (even daily) to maintain adequate soil moisture during dry conditions or on sandy soils. Another factor to consider is that drip systems tend to be more management intensive than sprinkler systems.

Some companies sell garden-scale drip irrigation kits. Even if your looking for something more extensive for a larger area, these example are instructive as they list the basic components of a drip line system. One example includes the following basic components:

- Garden hose adapter
- Filter (¾") and Pressure regulator (¾")
- T with pressure gauge
- 50' soft poly head line pipe
- 20 drip line connectors with shut off valves
- Hole punch for head line
- 1000' 10 mil drip line
- 25 drip line end sleeves
- 6 drip line repair couplers
- End cap for head line

Drip or overhead?

For many farms a combination drip and sprinkler system is likely to achieve the most economical and efficient results. For example, drip tape is usually best for crops with wide row spacing like vine crops and tomatoes and especially crops grown using plastic mulch. Lettuce, salad greens, herbs, and other more closely spaced crops can be effectively and economically irrigated with mini-sprinklers, especially after factoring in the labor and hassle associated with moving drip tape lines to allow for close cultivation and hand hoeing.

When to irrigate

Temperature, rainfall, plant root depth, canopy development, growth habits, and nutrient requirements all help determine when to irrigate. Plant water demands can be estimated daily using various formulas and irrigation scheduling programs (see the publication on the Wisconsin Irrigation Scheduling Program in the resource section below). With experience, the appearance of a handful of soil (taken with an inexpensive soil sampling probe from the root zone - not the surface!) after it has been squeezed can be used to estimate soil moisture. Another method assumes that 1.0 to 1.5 inches of water are required weekly for most crops. With accurate measuring of weekly rainfall, irrigation can then be used to make up the difference. This method does not take into account the differing needs of various crops nor the fact that many crops have higher or lower water needs at certain times during the year. This method also does not take into account the vastly different moisture holding potential of different soil types. Soil monitoring stations can be set-up to more accurately measure soil moisture for $100 to $300 (for more information, contact irrigation supply companies).

Planning your irrigation system

Irrigation supply companies can be very useful in planning an irrigation system. The companies listed in the resource section below and others can help determine irrigation system needs given some basic information, including:

1. Acres to irrigate
2. Number and length of rows
3. Water source
4. Distance from water source to field
5. Elevation difference from water source to field
6. Gallons per minute (gpm) and pounds per square inch (psi) provided by water source
7. And whether you want to irrigate the entire field at one time or break it up into zones

You will also need to determine *how* (i.e. drip or overhead) you want to irrigate your crops. As mentioned above, a combination is often the best route to go on a diversified, fresh market vegetable farm. As a hypothetical sample case, an irrigation supply company provided an estimate (1999 prices) based on a 1 acre operation using 30% overhead irrigation (using mini-sprinklers) and 70% drip irrigation. The total came to $1882.86 with tax (but not shipping). This may be a bit high as it assumes a row system rather than a bed system and assumes that all rows will have their own irrigation lines (as opposed to moving lines or electing not to irrigate certain crops (such as corn or potatoes). A far simpler, but certainly adequate system might cost between $500 and $600 for a one-acre market garden. When planning your system, talk to experienced growers, ask lots of questions when speaking to supply companies, think about where you'll be in a few years in terms of acreage expansion, and compare prices.

Resources*

Agricultural Alternatives: *Irrigation for Fruit and Vegetable Production*. Penn State College of Agricultural Sciences, Cooperative Extension. 1995. 4 pages.

You and Your Well. Wisconsin Department of Natural Resources. 1996. 4 pages

Driven-Point (Sand-Point) Wells. WI Department of Natural Resources. 1996. 12 pages.

'Weatherproof' Your Farm with Irrigation. From the chapter "Equipping Your Whatley-Style Farm, Sensibly and Economically" in How To Make $100,000 Farming 25 Acres. Booker T. Whatley. Rodale Press. 1987. Pages 49-52.

"When drip irrigation just won't work, mini-sprinklers may be the answer". John Greenler. in *Growing for Market*, Vol 5, no 4. 1996. pages 5-7.

Rain-Flo Irrigation. 884 Center Church Road, East Earl, PA 17519. (717) 445-6976.

DripWorks. 380 Maple Street, Willits, CA 95490. Orders: (800) 522-3747. Technical Assistance: 707-459-6323.

Zimmerman Irrigation. Rural Route 3, Box 309; Mifflinburg, PA 17844. (717) 966-9700.

Roberts Irrigation, PO Box 490 Plover, WI 54467; 715-344-4747.

Kifco, PO Box 290 Havana, IL 62644; 309-543-4425; www.kifco.com

"Overhead irrigation systems: these factors will determine what's best for your farm." Chris and Kim Blanchard in *Growing for Market*, Vol.8, no. 4. April 1999.

Tips for keeping overhead irrigation running." Chris Blanchard in *Growing for Market*, May '99.

"CSA farmer reveals the benefits, costs of his automated irrigation system." Marc Boucher-Colbert in *Growing for Market*, October 1999.

* *The listing of any companies does not constitute an endorsement of any kind.