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Getting started with drip irrigation: components and costs

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What is drip irrigation?

Drip irrigation is an efficient approach that delivers water to crops at or below the soil surface. Compared to overhead irrigation, drip irrigation can reduce water use by up to 50%. This is because drip irrigation applies water directly to the soil around the bottom of plants, rather than over an entire bed or field. Reducing the surface area over which water is applied also reduces evaporation. This allows for both water and energy efficiency, as you will need less energy to pump less water to your crops compared to overhead or flood irrigation. Because drip irrigation allows you to avoid overhead spraying and excess leaf wetness, it can also help reduce some crop foliar diseases. It is appropriate to use this approach for crops with both high- or low-water demand. Growers commonly lay drip lines under plastic mulch or on bare ground. Other options include laying drip lines under organic mulches, or slightly buried in perennial crops. Sub-surface drip delivers water directly to the root zone, which means you can also deliver soluble fertilizer right to the plant.

This fact sheet presents an overview of the most common components and options in drip irrigation systems, accompanied by estimated costs. After reading the following information, you will be familiar with the components of a typical drip irrigation system for growing vegetables and small fruits. Additional materials at the end of the fact sheet will point you towards resources to help you design your own irrigation system, as well as other sources of information and cost-share programs.

Figure 1: TOP: Drip irrigation under black plastic on a vegetable farm in Northern VT (photo credit: Rachel Schattman). BOTTOM: Drip irrigation on bare ground (photo credit: hortamericas.com).

Components of drip irrigation systems

Drip tape: Drip tape is a flexible plastic tubing with small emitter holes in it. It is typically sold in rolls. When selecting drip tape, you will need to make several decisions depending on the needs of your farm and cropping system. An alternative to drip tape is to run a solid poly water line fit with individual emitters. Using individual emitters is a more efficient than drip tape for perennial crops such as blueberries.

- Drip tape thickness: Common options are 8ml, 10ml, and 15ml. Thicker tapes have greater durability, which may be preferable to growers of perennial crops.
- Emitter and tape spacing: 4”, 6”, 8”, or 12” spacing options are available. You should choose emitter spacing and the number of tapes per bed based on soil type and crop spacing. If you are growing in sandy soil, you should choose closer emitters, as water spreads down faster than out in these conditions. Densely planted crops require closer emitter spacing.
- Flow rate: Flow rates are measured in gallons per minute (GPM) per 100’ of tape. Typical flow rates are 0.4-0.5 GPM/100’. Your choice of flow rate will depend on how much water the crop requires and how much area you need to supply water to at once.
- Flow control: While most drip tape distributes water unevenly down the bed, changes in elevation or long runs of tape can cause the pressure to drop. Flow control tapes corrects for this. Flow control, also known as ‘pressure compensating’, drip tape is slightly more expensive (between $0.02-$0.04/foot), but the cost per foot is roughly equal to non-flow control alternatives. Flow control allows for better control of water and fertilizer distribution.

Figure 2: Poly pipe (top) and PVC (bottom), photos from Grainger.com

Mainlines and sub-mainlines: Drip irrigation systems require mainlines to transport water between the source and your field. Mainlines allow for high flow and low pressure drop. Aluminum pipes are commonly used, and are light, easy to move, and very durable. They are also expensive. Two less expensive options for mainline pipes are PVC and polyethylene (poly). There are two types of PVC: *schedule 40* and *schedule 80.* Schedule 80 PVC has thicker walls, higher pressure ratings, and is stronger than schedule 40. However, schedule 40 is more common. If you are purchasing PVC, you will most likely get schedule 40 unless you request otherwise.

You should not drive over PVC pipes, so they must be buried if you plan to use a vehicle or tractor in areas where they are installed. You can drive over poly pipes without damaging them, though repeat traffic or destructive equipment can tear them. Poly pipes come in various pressure ratings measured in pounds per square foot (PSI). 100 PSI is a common rating. Poly pipe also comes in several diameters

Figure 3: Pumps: Centrifugal (top); submersible (middle); turbine (bottom). Images from Grainger.com and Wikkicommons

(typical choices are ½", ¾", 1", 1½", or 2"). The larger diameter pipes are harder to handle, but result in less pressure loss and may be desired for higher flow rates.

Header pipes: Poly pipes can also be used as header pipes, which lay perpendicular to the beds and are where the drip tape attaches. Another popular choice for header pipes is lay flat hose, which comes in regular and heavy duty. Heavy duty lay flat hose is twice as expensive as regular lay flat, but lasts much longer. Regular lay flat hose can be used for systems with a maximum 70-80 PSI. Heavy duty lay flat can be used with a 125-175 PSI system.

Pumps and engines: The most common electric-powered irrigation pumps are **centrifugal pumps**, which use one or more impellers to increase water pressure within a series of casings. A common subgroup of centrifugal pumps is called **end-suction pumps**. These pumps are often bolted to the electric motor that runs them. They are great at pushing water out, but do not efficiently pull water in. This means that they need to be installed less than 5 feet above the surface of the water source. These pumps can also be gasoline, diesel, or tractor PTO-powered.

An alternative, more efficient pump choice is a **submersible pump**. These are long and narrow, and often installed in wells. They can also be placed horizontally on the bottom of ponds or rivers, or attached vertically to piers or pilings. **Turbine pumps** are another underwater type of centrifugal pump; they differ from submersible pumps in that the motor remains above the water. Turbine pumps are often installed in concrete vaults that are fed by nearby water sources. Turbine and submersible pumps can both be installed as **floating pumps** by attaching them to an anchored float. Installing floating pumps is easier than traditional turbine or submersible pumps. Lastly, **booster pumps** are used to increase the pressure in an irrigation system at some point in the field. It is a common term, though all of the pumps described above can be used to serve this function. It's prudent to install a booster pump if you have elevation changes of over 70 ft. It's also important to remember that pumps wear out over time, and you will likely see a decline in performance over several years.

Pumps powered by gas or diesel engines are also common. The greatest difference between these and electric-powered pumps is the output, which can be controlled by increasing the rotations per minute (RPM) of the engine. The costs difference between powering irrigation pumps with gas, diesel, and electric engines depends on the cost of electricity (which can vary based on peak and off-peak rates) versus fuel.

Backflow preventers: Backflow preventers (also known as check valves) are important to install if you use potable water sources for irrigation. They will keep irrigation water from getting into your water source, and cost between $250-$700/each. If you are drawing your irrigation water from a municipal source, you may be required by law to install some form of backflow prevention. Even if you are not required to use one (if you are drawing from a private groundwater source), it is still a good idea to install a device to ensure that you and your neighbors do not end up with irrigation water flowing back into intended potable uses. If you plan to fertigate or use any chemicals in your irrigation system, **reduced pressure type** (also referred to as RP type) **backflow preventers** are recommended. While more expensive than other backflow prevention devices, this type is the most effective at protecting your water source.

Filters: Filtration systems are recommended when using drip irrigation, as clogged emitters can decrease the amount of water delivered to your crops and lead to increase maintenance burden. If you are irrigating from a municipal water system, a simple screen disc filter is likely appropriate, and will cost you just over $100 for a 2” filter. If you are irrigating from surface water or wells, you will likely need a more robust system. More robust filter systems include disc filters, disc filters, and sand media filters. These types of sand media filters are more expensive than screen disc filters, costing up to $245 to install a filter on a 2” line, but require the least maintenance when using water that contains a significant amount of solids (i.e., sediment, algae).

Fertilizer injectors: Two types of fertilizer injectors work with drip irrigation systems. **Proportional injectors** compensate for changes in flow and pressure in your irrigation system, allowing you to maintain a constant rate of fertilizer injection proportional to the main flow. **Nonproportional injectors** do not automatically adjust for changes in flow and pressure, but they are less expensive than proportional injectors. The cost of a proportional injector for a 2” line could be as much as $1,800 compared to $129 for a nonproportional injector. Nonproportional injectors require that you correctly match the size of the injector with the projected flow rate of the irrigation system.

Pressure regulators: Pressure regulators are needed in drip irrigation systems to ensure that you deliver the intended amount of water and soluble fertilizer to your crops. The emitter ratings are based on their specific size and an assumed upstream pressure. If the pressure of the water upstream of the emitter is reduced, the flow through the emitter is also reduced. Pressure regulators cost $10-$300 depending on the size of the line. If installing a pressure regulator in a drip irrigation system, is recommended that you install the regulator between the mainline and the header. This is so the water can come into the zone with full pressure and overhead can be run off of the main line as well.

Fittings: Like fittings used by plumbers, drip irrigation fittings are sized to fit specific diameter tape or polypipe. Typical sizing is 1/8” (micro) ¼”, ½”, ¾”, 5/8”, or 1”. Each end of the fitting can be barbed, threaded, compression, or easy-lock. They can be used to create branches in the irrigation system, attach drip tape to mainlines or sub-mainlines, reduce from a one size diameter pipe to a smaller diameter pipe or tape, or to mend torn drip tape. Some fittings include valves that allow you to turn on and off irrigation zones. For setting drip tape fittings into poly pipe, it is helpful to use a tool called a *punch* (which cost around $10-$15). “Goof-plugs” are fittings that can be used to plug holes previously used for an emitter fitting. Some growers dedicate a toolbox just to their irrigation fittings, plugs, emitters, valves and tools so they are organized and easily found when needed.

Estimating the cost of a drip irrigation system

Table 1: Estimated cost of drip irrigation system components, as of 2018. Table does not show all options for each system component. Price breaks may be available from suppliers for high volume orders.

System component	Details		Estimated cost per unit	
Drip tape	*Standard tape*	*8ml*	$145/roll (7,500' per roll)	$0.02/ft
		10ml	$165/roll (4,000' per roll)	$0.04/ft
		15ml	$148/roll (4,000' per roll)	$0.04/ft
	Flow control tapes	*8ml*	$165/roll (7,500' per roll)	$0.02/ft
		10ml	$166/roll (6,000' per roll)	$0.03/ft
		15ml	$167/roll (4,000' per roll)	$0.04/ft
	No price differences between emitter spacing: 4", 6", 8", or 12" spacing or flow rate. Typical flow rates are 0.4-0.5 GPM/100'			
Mainlines and sub-mainlines	*Aluminum pipes*	*3"*	$93 per 30'	$3.10/ft
		4"	$126 per 30'	$4.20/ft
		6"	$311 per 30'	$10.37/ft
	Polyethylene pipes	*½"*	$60/coil (300' per coil)	$0.20/ft
		¾"	$84/coil (300' per coil)	$0.28/ft
		1"	$90/coil (300' per coil)	$0.30/ft
		1 ½"	$173/coil (250' per coil)	$0.69/ft
		2"	$288/coil (300' per coil)	$0.96/ft
	PVC pipes	*½"*	$95/coil (100' per coil)	$0.95/ft
		¾"	$120/coil (100' per coil)	$1.20/ft
		1"	$126/coil (100' per coil)	$1.26/ft
		1 ½"	$115/coil (300' per coil)	$0.38/ft
		2"	$145/coil (300' per coil)	$0.48/ft
		3"	$250/coil (300' per coil)	$0.83/ft
Header pipes	*Polyethylene pipes*	*½"*	$120/roll (1,000' per roll)	$0.12/ft
		¾"	$70/roll (500' per roll)	$0.14/ft
		1"	$100/roll (500' per roll)	$0.20/ft
		1 ½"	$140/roll (660' per roll)	$0.21/ft
		2"	$145/roll (450' per roll)	$0.32/ft
	Lay flat hose	*1.5"*	$115/roll (300' per roll)	$0.38/ft
		2"	$145/roll (300' per roll)	$0.48/ft
		3"	$250/roll (300' per roll)	$0.83/ft
	Heavy duty lay flat hose	*2"*	$325/roll (300' per roll)	$1.08/ft
		3"	$625/roll (300' per roll)	$2.08/ft
		4"	$790/roll (300' per roll)	$2.63/ft
Pumps	*Centrifugal pumps*	*¾ HP*	$699	
		1 HP	$800-$850	
		1 ½ HP	$918	
		2 HP	$1,085	
		3 HP	$1,380	
		5 HP	$1,568-$2,530	
	End-suction pump	*3 HP*	$3,044	
		5 HP	$3,447	
		7 ½ HP	$4,018	
		10 HP	$4,584	
	Submersible pump	*½ HP*	$335-$350	
		¾ HP	$453	
		1 HP	$486	
	Turbine pump	*½ HP*	$712	
		¾ HP	$773	

		1 HP	$990
		3 HP	$786
	Floating pump	*½ HP*	$716-$820
		¾ HP	$827-$1,978
		1 HP	$897
		1 ½ HP	$1,080
		2 HP	$752-$1,389
		3 HP	$1,703
		5 HP	$2,724
	Booster pump	*1/3 HP*	$238
		½ HP	$388
		¾ HP	$478
		1 HP	$782
Backflow preventers	*RP type*		$250-$700
Filters	*Screen disc filter*	*¾"*	$16
		1"	$18
		2"	$110
	Disc filter	*¾"*	$24
		1"	$30-$75
		1 ½"	$117
		2"	$150-$245
		3"	$250
Fertilizer Injectors	*Proportional injectors*	*¾"*	$325-$489
		1"	$390-$569
		1 ½"	$775-$849
		2"	$1,200-$1,749
	Nonproportional injectors	*½"*	$58-$65
		¾"	$58-$90
		1"	$90-$150
		1 ½"	$95-$195
		2"	$129
	Sand media filters		$169
Pressure regulators		*¾"*	$9.46-$14
		1"	$11.64-$12.64
		1 ¼"	$24-$32
		1 ½"	$30-$33
		2"	$115-$172
		3"	$295-$310
Fittings	*Easy loc with valve*		$2.05/each
	Easy loc coupler		$0.79/each
	Easy loc three-way coupler (Tee)		$1.79/each
	Compression coupler		$0.59/each
	Compression coupler with valve		$1.79/each
	Tape coupler		$0.60/each
	Tape coupler with valve		$2.00/each
	Drip tape/lay flat connector		$1.50/each
	End cap		$0.55/each
	Goof plugs (for repair)		$5.95/100 pack

Sources for pricing table include:
Dripworks (California): https://www.dripworks.com (1-800-522-3747)
Brookdale Farm (New Hampshire): www.brookdalefruitfarm.com (603-465-2240)
Berry Hill Irrigation (Virginia): https://www.berryhilldrip.com/ (434-374-5555)

Frequently asked questions

Do I have to use plastic mulch with drip irrigation? No, but if you use drip irrigation without plastic mulch, it is recommended that you bury your drip line 2-3 inches below the soil surface to prevent snaking.

Is there a "right side up" to drip tape? Yes. Lay drip tape with emitters facing up to reduce clogging.

What are the disadvantages of drip irrigation? Drip irrigation systems require time to manage: you will need to monitor the system and fix leaks promptly in order to ensure that your crops receive adequate irrigation. There is also an annual material cost (and disposal) associated with drip irrigation, as it is not recommended to reuse drip tape due to clogging issues. Headers and drip lines can also complicate cultivation activities.

Are drip irrigation systems appropriate for all crops? No. For crops that require uniform water application across the whole bed (e.g. baby greens or carrots during germination phases), drip irrigation is not the best choice.

How do I know what size pump to use? First determine the amount of water you need to apply over what amount of bed space and over what period of time. For example, if you have one acre of beds planted in a crop that requires 1" of water per day, you will need a system that can deliver 27,154 gallons of water per day. Next, you need to select a pump that can deliver this amount of water. To do so, divide the number of gallons you need per minute. For example, if you need to apply 1" of water per day, calculate 27,514 gallons/day divided by 24 hours/day divided by 60 minutes/hour. This calculation equals 19 gallons per minute (GPM), which is the flow rate you require from the pump.

Next you should determine the pressure requirement of the pump, sometime referred to as *pounds per square inch (PSI)* or *feet of head*.(1 PSI = 0.433 feet of head.) Pumps can have either unit listed in their specifications. To determine the pressure requirement in PSI, you need to determine three things:

1. The pressure needed to overcome elevation loss between your pump and your output point: multiply the amount of elevation (in feet) by 0.433. For example, to pump the water up 25', you'll need 25 x 0.433 = 11 PSI.
2. The pressure needed to overcome the friction associated with your filter and valves. This is determined by the manufacture of these components. For our example, we'll say you have a filter with a 2 PSI rating.
3. The pressure needed to get the water through the specific length of your pipe. You will need to know your pipe diameter (let's say you're using a ¾" pipe), the length of pipe (for this example, 200'), and the GPM you need (19, as calculated above). You can find a pressure look up table at https://www.engineeringtoolbox.com/pe-pipe-pressure-loss-d_619.html

Add the results of 1, 2, and 3 (above) to determine the PSI or feet of head rating that you require from a pump. You can also use a professional irrigation design service to do these calculations. See *additional resources* at the end of this document. To help you select your pipe system, consider using the UVM Ag Engineering *Pump and Pipe Pressure Calculator*: http://blog.uvm.edu/cwcallah/pump-and-pipe-pressure-calculator-3/

I want to use a PVC header pipe. How do I know what size to get? The maximum operating pressure of PVC pipe changes depending on the size of pipe and whether it is schedule 40 or schedule 80 pipe. See ratings provided by The Engineering Toolbox for more information: https://www.engineeringtoolbox.com/pvc-cpvc-pipes-pressures-d_796.html

Are there cost share programs available? Yes. USDA NRCS includes cost shares for irrigation systems in its EQIP program, including micro irrigation. Note that these are the criteria for the federal EQIP program, and that criteria may be slightly differ state by state. Check with your State NRCS office for specifics.

Additional resources

- USDA NRCS Drip Irrigation Standard (Standard 441) can be found at: https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/cp/ncps/?cid=nrcs143_026849 . Note that these are the criteria for the federal EQIP program, and that criteria may be slightly differ state by state. Check with your State NRCS office for specifics.
- University of Vermont Extension Agricultural Engineering and the New Farmer Project have a helpful blog posting on solar pumps that also includes a step-by-step guide for selecting the right size pump: https://newfarmerproject.wordpress.com/2012/06/14/solar-water-pumping-basics/
- Drip Irrigation for Vegetable Production, Pennsylvania State University: https://extension.psu.edu/drip-irrigation-for-vegetable-production
- Brookdale Fruit Farm Irrigation Supplies also provides irrigation system design services: www.brookdalefruitfarm.com/Irrigation/
- University of Florida video on drip systems https://youtu.be/E55hKioRco0
- University of Maryland video on drip and plasticulture systems: https://youtu.be/M3-TGwiVJv0
- Irrigation Tutorials by Jess Stryker: www.irrigationtutorials.com

Questions? Contact Rachel E. Schattman, Associate with the UVM Extension Vegetable and Berry Program: rschattm@uvm.edu, or call 802-656-1710

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Figure 4: Irrigation water is drawn from the Winooksi River on the Intervale Community Farm in Burlington, VT. A PTO-driven pump then delivers water out to 20-acres of mixed vegetable crops (Photo credit: Rachel Schattman).