Center for Crop Diversification
Martin-Gatton College of Agriculture, Food and Environment

Center for Crop Diversification Fact Sheet
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Irrigation Systems

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Introduction

Irrigation is used in Kentucky for both specialty and row crops. Irrigation systems reduce risks of low profitability from low yields and crop stress. Drip irrigation, essential for producing many specialty crops, is used throughout the state on farms of all sizes. Overhead irrigation systems are concentrated in western Kentucky, where farms of 1,000 or more acres account for most of the annual acreage changes in Kentucky's irrigated farmland.



Drip irrigation and plastic mulch are common on staked tomatoes in Kentucky.

This fact sheet focuses on drip irrigation, which increased in use as more Kentucky farms began specialty crop production. According to the Census of Agriculture, irrigated acreage increased from 2002 to 2012 on Kentucky farms of 10 to 99 acres, a farm size more likely to focus on specialty crop production. Drip irrigation is also widely used on larger farms, orchards and nurseries for both watering and fertigation (delivering fertilizers dissolved in water through a drip system).



Irrigation is essential for high-value crops.

Key Considerations

Water Source

Irrigation water may be sourced from wells and municipal water systems as well as surface water such as lakes, ponds, streams and springs. Filters are required for irrigation systems using surface water systems, and backflow prevention devices are required for municipal water. Testing of irrigation water for bacterial contamination, hardness, and chemical properties such as pH, iron and sulfur is advised both as a Good Agricultural Practice to promote food safety and prevent clogging of drip systems. The University of Kentucky Soil Laboratory in the College of Agriculture, Food and Environment conducts water tests, although growers will need to use a private lab if they want to test for sulfate sulfur. Iron is only a concern in well water. Certified organic production standards require irrigation water quality testing. For the most recent information about water-related food safety regulations, contact the University of Kentucky's Dr. Paul Vijayakumar at Paul.V@uky.edu.

Equipment Planning

Advance planning is important to design a system that meets crop and soil requirements. Equipment and supplies required for effective drip irrigation depend on several factors, including size of the fields to be irrigated, crop water requirements and soil types. In most cases an irrigation professional will be needed to help plan the most efficient system. Pumps and related equipment – such as filters, pressure regulators, valves and gauges – are installed on a system-specific basis. Soil moisture sensors (tensiometers or electronic sensors) should be used to help determine water needs.



Both gravity and a small solar-powered DC electric pump are used in this rainwater catchment system for drip irrigating this high tunnel in Kentucky.

Although water pressures of 8-12 pounds per square inch (psi) are generally required for drip, recent on-farm demonstrations in Kentucky have shown that it is also possible to use very low-pressure (1-3 psi) gravity-fed drip systems for high tunnels and other small plots up to about ¼ acre. These low-pressure systems have also been coupled with small solar-powered DC pumps and battery systems for drip.

Irrigation System Management and Labor

Properly timed irrigation applications are essential in both drip and overhead irrigation systems. In larger systems, sensor and remote technologies are available to reduce risks from either missing irrigation or applying improper amounts of water. Proper drip irrigation system design will help producers manage much of the risk associated with improper applications. Producers should also budget an adequate amount of time for managing systems for specialty crops. For small farms, inexpensive tensiometers or moisture meters can help best determine when crops need water and when the water should be shut off. Although uncommon in Kentucky, irrigation systems can also be fully or partially automated using sensors, solenoid valves, etc.

Nursery and Greenhouse Irrigation

Advanced greenhouse irrigation technology utilizes computer-controlled irrigation systems, and labor-saving irrigation technologies are available across the entire range of greenhouse sizes. The buildup of soluble salts in the soil or growing medium from fertigation is a concern in nursery, high tunnel, and greenhouse applications. Following irrigation best management practices can mitigate such concerns.

Costs of Drip Irrigation

Drip irrigation systems generate positive returns on investment by 1) dramatically increasing yields and horticultural product quality 2) minimizing risk of crop failure and/or yield loss from drought and irregular watering 3) efficiently delivering nutrients through fertigation 4) reducing the amount of water and energy needed to produce high-yielding crops 5) reducing risk from foliar fungal and bacterial diseases. Drip irrigation has been shown to provide the most yield benefits when combined with plastic mulch on commercial vegetables; however, drip tape alone is also used in some annual crops, as well as in perennial fruit crops.

In 2015, the initial equipment cost for a 1-acre drip irrigation system was estimated at $2,585, including drip tape and plastic mulch (see table below). There is a $400 cost for each additional acre of drip irrigation, up to about 10 acres.

Installation Cost Estimate for Drip Irrigation in Kentucky
Source: 2016-17 Vegetable Production Guide for Commercial Growers

Item	Cost
2 in. centrifugal pump and 163cc engine	$700
Sand filter*	$725*
Single filter backflush valve	$260
Fertilizer injector	$200
Layflat, 2” (300 feet)	$105
Suction hose and strainer	$95
Fittings, valves, gauges	$100
Total Equipment Cost for Installation	$2,185
Plastic mulch and drip tape, per acre	$400
Total Cost for 1-acre drip irrigation system	**$2,585**

** Cheaper disc filters ($170) can also be used on small farms in place of sand filters, although sand filters may be needed for surface water*

Growers using plastic mulches will also need a plastic mulch layer/bed shaper costing from $1,200 to $5,000, depending on size and model. A waterwheel setter, for transplanting into plastic mulch, is also commonly used, costing approximately $2,000 to $2,500. Many Kentucky counties have purchased mulch layers and waterwheel setters to rent or loan to farmers. The expense of renting or sharing this equipment reduces the farm-level investment needed for drip irrigation, making the practice more feasible for small farmers. The cost estimate below uses a 10-year depreciation expense for these two pieces of equipment, or $400 annual cost.



Small farm bed-shaper/plastic layer forms raised beds, lays plastic mulch, and installs drip irrigation tubing in one operation.

Simple Economic Evaluation of the Value of Drip Irrigation in Tomatoes

Drip irrigation systems are easily justified for small-scale producers because of the potential yield and quality losses from inadequate watering. Hundreds of demonstrations promoting drip and plastic mulch systems on small farms in Kentucky have shown that, in most cases, marketable yields are doubled compared with rain-fed production. Based on the sample annual costs of a drip irrigation system (below), a tomato producer would need to generate $1,237 more in the value of production to justify installation and utilization of an irrigation system for an acre of tomatoes. This value represents the gross revenue from approximately 600 to 1,000 pounds of production. Inadequate irrigation or non-irrigated tomatoes can result in yield losses of 5,000 to 10,000 pounds or more per acre. The case for investing in an adequate irrigation system is easily justified.

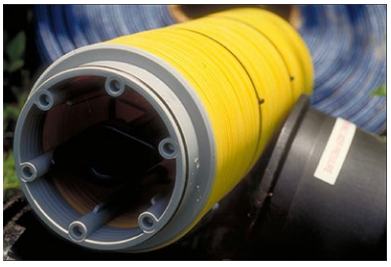
Sample Annual Costs of Drip Irrigation System	
Plastic mulch and drip tape	$400
Total Annual Variable Cost	$400
Fixed Cost of Irrigation System (5-year depreciation $2,185)	$437
Fixed Equipment Cost (10-year depreciation $4,000)	$400
Total Annual Fixed Cost	$837



Drip irrigation tubing or "tape" is thin-walled plastic tubing with built-in emitters for slow and precise water application. Drip irrigation wets the soil around the roots and permits application of nitrogen fertilizers directly to the root zone.



Sand filters are often used with surface water sources.



Disc filters are commonly used for specialty crops on small farms in Kentucky.



Thick-walled tubing and layflat is often used for main and submains for drip irrigation on small farms in Kentucky.

References/Resources:

- Drip Irrigation for Vegetable Production (Penn State University Ag Alternatives) http://extension.psu.edu/business/ag-alternatives/horticulture/horticultural-production-options/drip-irrigation-for-vegetable-production
- Irrigation (Texas A&M AgriLife Extension) http://aggie-horticulture.tamu.edu/vegetable/guides/texas-vegetable-growers-handbook/chapter-v-irrigation/
- Drip-Irrigation Systems for Small Conventional Vegetable Farms and Organic Vegetable Farms (University of Florida, 2015) http://edis.ifas.ufl.edu/hs388
- Midwest Vegetable Production Guide for Commercial Growers (2017) https://ag.purdue.edu/btny/midwest-vegetable-guide/Pages/default.aspx
- 2017 Vegetable Crop Handbook for Southeastern United States (page 18) https://pubs.ext.vt.edu/AREC/AREC-66/AREC-66_pdf.pdf
- Understanding Irrigation Water Test Results and Their Implications on Nursery and Greenhouse Crop Management (HO-111, University of Kentucky, 2014) http://www2.ca.uky.edu/agcomm/pubs/HO/HO111/HO111.pdf
- Sample water and nutrient solution form from the University of Kentucky College of Agriculture, Food and Environment http://soils.rs.uky.edu/forms/sample/w.PDF
- "Biodegradable Pots and Sensor-Based Irrigation Practices in Ornamental Crop Production Systems," (UK Nursery and Landscape Program 2011 Research Report, page 18) http://www2.ca.uky.edu/agcomm/pubs/PR/PR641/PR641.pdf
- "Irrigation Water Volume and Soluble Salt Levels in Two PNP Irrigation Delivery Systems," (UK Nursery and Landscape Program 2007 Research Report, page 15) http://www2.ca.uky.edu/agcomm/pubs/pr/pr554/pr554.pdf

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