Drip Irrigation

Introduction

There are several types of irrigation systems that are used by farmers in New Jersey. Since the majority of crops in this region are vegetables, overhead sprinkling has been the most popular choice for farming applications. For many years it has been accepted that this type of irrigation is the best choice for optimal crop yield and quality. However, controlled studies in New Jersey, such as at Rutgers Cook College, as well as throughout the country and world (modern drip irrigation originated in Israel) have shown that there is potential to increase crop yield and quality by implementing surface and or subsurface drip irrigation systems[2]. Energy and water consumption, deterred plant disease, erosion prevention, and sediment erosion are likely to be reduced by utilizing drip irrigation.

Background

Drip/Trickle irrigation is comprised by low pressure networks of tubing that combine in to subsections of equal and conserved water flow. Less energy is required to transport water at lower pressures and velocities. Drip systems operate with high water use efficiency (90% as opposed to 45% for overhead) because they supply water directly to the parts of a plant where it is needed most[1]. This allows drip irrigation systems to be designed specific to each and every farmer regardless of their farm operations or crop types. Now that an era of sustainable farm awareness has been ushered in by an increase of energy costs and environmental deterioration, drip/trickle systems are proving to be a cost-effective and environmentally friendly choice for irrigation. A large portion of farm energy is generally expended in the fields to power irrigation pumps (energy both by fuel and by grid). Although it is noted that on large farms, electric pumps are most frequently used at times when their full capacity is required to meet irrigation demand in extreme dry conditions (as opposed to using only diesel powered pumps), there may be considerable benefits in the form of energy reduction resulting from re-evaluating potential for electric pumps to contribute water to an irrigation system via drip irrigation at times other than during peak hours. Consider a five acre plot of land (Figure 1). This plot is one that is part of an existing overhead sprinkler irrigation system. Overhead watering has its advantages particularly for the early growth stages of the crops that are planted on this specific farm (spinach field) however plant growth and quality of the same
degree that is harvested currently may be achieved by utilizing a drip system on this plot or a plot similar to it.

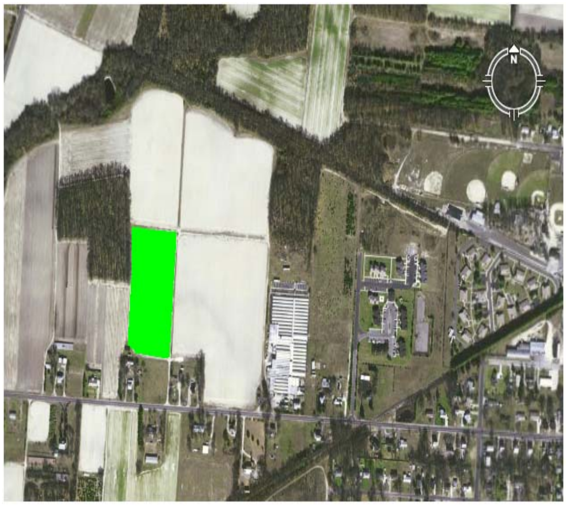

Figure 1: Five Acre Proposed Drip System

There is a misconception that drip systems are not cost effective, but it is important to realize that no irrigation system is cost effective if it is over or under used. Although systems are usually expensive to install ($700 - $1200 per acre), installation costs will be paid for by the system's production over time if it is designed, operated, and maintained properly. In addition the installations costs will likely become inevitable since population sprawl has significantly influenced the availability of water (remember that drip systems are generally 90% efficient as opposed to overhead systems that are only 45%). Fortunately in New Jersey there are opportunities to receive financial assistance and consulting by qualified irrigation engineers. Farmers may be eligible for assistance for equipment required to set up a drip system. This includes pumps, filters, drip tubing, valves, regulators, connectors, ground sensors, and data collectors which accompany the sensors.

The benefit of sensors will be to allow a new system to be utilized properly and to ensure that it is not overused or underused thus rendering the highest of quality for the specific crops that will be grown on the plot. As drip applies water evenly to the ground, sensors allow the user to monitor the water storage capacity, temperature, and other soil variables below the surface of the ground. Crop burning may result from overhead watering as the sun's light is magnified through beads of water that collect on the leaves of various plants. Drip will significantly reduce this effect since the water will be evenly distributed into the ground. While directing water into the ground, evaporation of excess water into the atmosphere will be held at a minimum. This will reduce the overall volume of water that is required to be pumped. Since the demand for water volume will be reduced greatly, the resulting duration of time spent watering will also be reduced. In addition to the above benefits, plant diseases will also be deterred since there will not be a significant collection of water on the outside of plant leaves. Labor and fuel costs will be diminished since the system may enable the farmer to add nutrients or pesticides directly into the flow stream. Above all, the most substantial benefit will be reduction in energy demand.

Case Study

Note that for simplicity the upcoming suggestions for drip irrigation are derived from estimations made on the five acre plot depicted in Figure 1 and also that implementation is not necessarily a means for replacement of an entire existing system but rather for an addition to system on a year to year basis as the farmers sees fit. Historical rainfall documents indicate that southern New Jersey may receive up to approximately 24 inches of rainfall per year. Most species of crops that are grown on New Jersey farmland require approximately 30 to 45 inches of water per season. This indicates that, depending on rainfall for a particular season, crops require up to 25 inches of irrigated water cover per season. If this value is used as a reference quantity for water cover approximation, the equivalent energy consumption per acre of field may be approximated. Since much more than 5 acres may be irrigated (on the remaining portion of a farm) and the majority of irrigation is likely being pumped by diesel motors, the following energy consumption approximations may not be verified by annual energy bills. However they can indeed be compared to projections of the required energy it would take to operate a replacement drip system of the same area of field. From the following tables one can see the current method of over head watering as compared to drip/trickle. These values show data across five acres for both over head diesel and drip diesel pumps based on the assumptions for water cover from the previous column.

Table 1: Pump Savings for Five Acres

-	Time (hr)	Power (kWh)	Dollars
Over Head Diesel	100	12,210	$990.00
Drip Diesel	62	7,570	$614.00
Savings	**38**	**4,640**	**$376.00**

Note: The payback period of the above system is between 6 to 8 years (after adding demand charge), but that is for payback by energy savings alone. Assistance is available and yield and quality increase in bushels per acre will increase harvest profits which may reduce the payback to fewer than 6 years. Finally water consumption will be reduced making the decision more lucrative.

More Information

If you are irrigating your crops with overhead sprinklers or guns and are interested in increased crop yield and quality while reducing energy and water consumption drip irrigation is a viable solution. To receive information about project costs, how to initiate a drip irrigation project on your farm or how to receive local assistance visit www.nrcs.usda.gov (NRCS contact for resource conservation is Terry D'Addio). To find quality information related to water quality, conservation, drought and irrigation visit www.attra.org/water_quality.html.

References

[1] Capra, Antonina and Scicolone, Baldassare. "Water Quality and Distribution Uniformity in Drip/Trickle Irrigation Systems." Journal of Agricultural Engineering Research. Vol 70. (1998) 355-365.

[2] Hanson, Blaine and May, Donald. "Crop coefficients for drip-irrigated processing tomato." Agricultural Water Management. Vol 81. (2006) 381-399.

[3] Kessler, Lisa S. Sprinklers & Drip Systems. United Kingdom: Sunset Corporation, 2006.