Supplementary Irrigation for the Small Farmer

Yemane Ghebreiyessus, Southern University and A&M College

Supplementary irrigation is the application of water to plants when natural precipitation is not adequate to secure crop production. Depending on the size of the farm and type of irrigation system, application of water is possible by using modern power sources from deep well pumps and by storage of large quantities of water in reservoirs, ponds, streams and rivers. City water is also often used directly by small farmers who use drip irrigation for their vegetable gardens.

Vegetable crops are 80 to 95% water hence their performance with respect to yield and quality can suffer very quickly from water stress or drought (Ghebreiyessus et al., 1993, 1994). Under the climatic condition of the southeastern regions, supplementary irrigation during dry spell periods is essential to secure vegetable production. If water shortage occurs early in the crop's development, like we experienced last summer, maturity may be delayed and yield could be reduced significantly. Similarly, if moisture shortage occurs later in the growing season, quality is often reduced even though total yields are not affected.

Benefits of Proper Irrigation

In addition to securing crop production irrigation increases yield and improves crop quality particularly vegetables and fruit crops and thus stabilizes the farm income. In terms of field management it allows controlled time of planting and harvesting so as to find more favorable market price. Other benefits of proper irrigation include reduced damage from freezing temperature, increased efficiency of fertilizer application and reduced cost of application (fertigation).

Irrigation Methods

The methods of applying irrigation may be classified as surface, subsurface, sprinkler and drip/micro irrigation (Troeh et al., 1999, Schwab and Frevert, 1985). Subsurface irrigation is used in unique situation where the water table is raised to allow water to move up through the root zone by capillary action. Surface irrigation is the most common method of applying irrigation water, especially in arid areas. Surface methods include flood, furrow, contour dikes, and siphon irrigation. Sprinkler irrigation is a high pressure and high flow irrigation system where water is pumped and distributed through laterals and sprinklers. This system is applicable to both field crops as well as vegetable crops.

Drip irrigation is the frequent, slow and even application of water at low pressure over longer time periods directly to the root zones of plants. It has been used extensively in agricultural and commercial landscapes for over 20 years because of its many advantages over the high flow irrigation systems. Because of its high water use

efficiency, drip irrigation is most profitable where water supplies are scarce and expensive and where high cash crop and high-value specialty vegetable crops and fruit trees are being grown.

With respect to selecting the type of irrigation system, it is important for the farmer to weigh the advantages and disadvantages of each irrigation system in his planning stage. Because sprinkler and drip are popular types of irrigation systems in the south, comparison of the two systems in relation to site and situation factors is presented in the table on the following page. Ghebreiyessus et al (1994) reported no significant difference in yield of okra between drip and sprinkler methods of irrigation but weed problem was more prevalent with sprinkler irrigation.

When to Irrigate

Frequent irrigation is necessary to maintain soil moisture near field capacity and thus maximize yield. Soil moisture requirement differ with crop and stage of crop development. Availability of soil moisture varies with the amount of water in the soil and type of soil. Usually irrigate when 50% of the available water is depleted. Soil moisture is measured using tensiometers or soil gypsum blocks. An irrigation of 0.50 to 0.75 inches immediately after planting should be applied to settle the soil and to start seed germination. . With respect to determining the irrigation scheduling (irrigation interval) and for general irrigation efficiency, the farmer is advised to contact the closest USDA/NRCS office, irrigation consultants or experiment stations. . NRCS office have prepared irrigation guides suggesting design procedures for many states.

What to consider in planning irrigation for your farm

In the humid southern regions, where annual rainfall is over 1,500 mm and where irrigation primarily supplements rainfall, prospective growers need to answer several questions before considering investment on irrigation. Some of the primary questions that need to be answered are:

1. Is water supply adequate and of good quality?
2. Is sufficiency labor available to operate the irrigation system?
3. Is capital available to purchase the necessary irrigation equipment?
4. Will irrigation significantly increase yield over a period of years to justify cost?

Comparison of Sprinkler and Drip Irrigation in Relation to Site and Situation Factors.

Site and situation	Sprinkler system	Drip system
Topography	Level to rolling	Ideal for any landscape

Crops	All but trees	All high value crops
Weed problem	High	Low
Water supply	Small streams and wells	All including city water
Water quality	Salt water may harm plants	All but clean – can potentially use high salt waters
Runoff and erosion	Moderate to high	No runoff or erosion
Efficiency	Average 70-80%	Average 80-90%
Water saving	High loss of water and high evaporation	Minimum loss by leaching and evaporation
Labor requirement	Low to high	Low to high, some training
Capital requirement	High initial capital	Lower initial capital
Energy requirement	Moderate to high—high pressure,>30psi	Low energy and pressure 5-15 psi
Management skill	Moderate	High
Machinery operation	Some interference	May have considerable interference
Weather	Uneven distribution in windy condition	Even distribution at all conditions
Fertigation and other chemical application	Good	Very good
Duration of use	Medium to long term	Long term, but durability unknown
Automation	Not easy	Easy to automate

The most important part in planning and designing an irrigation system is to assure uniform and precise application of water. Otherwise some plants will get too much water and others not enough. Design is based on leaky pipe hydraulics. A good hydraulic design a) promotes optimum yield or plant growth, b) saves on the cost of the system, and c) reduces waste of energy, water, and chemicals.

Drip irrigation installation procedures

Installation procedures of a drip system depend on how much one wants to invest and automate the system. The major components and types of drip parts are presented in the table below.

Major Components and Types of Drip Parts

Major drip components:	Type and description of drip parts	
Water Source:	Surface (pond, river, creek), well or municipal water	
Pumping System:	Electrical powered pump, gas or diesel driven pumps or gravity system	
Distribution system:		
Permanent:	Underground mainlines Pipe –PVC plastic or polyethylene plastic Hydrant – attachment point for manifold lines Drainage valve – important for maintenance of system	
Annuals - above ground mainlines:	<u>Pipes</u> Vinyl layflat hose Polyethylene plastic PVC plastic Aluminum	<u>Fittings</u> Hydrants Air relief valves Solenoid valves
Filtration Systems:		
Primary filters:	Media type – for use with surface or wells	
	Screen type – some wells or community water systems or secondary for ponds	
	Sand separators- remove sand from well and surface water	

	Disk core – use as secondary filter for ponds	
Secondary filter:	Screen type	Holding/settling pond
Injection Units-Chemicals and Fertilizers (fertilizers must be soluble):	Electric powered pump Venturi Water siphon device	
System controls:	Pressure regulators	Flow control valves
	Air relief valves	Water meters
	Flow meters	Totalizing meters
	Soil moisture measuring devices (tensiometers or soil blocks)	Pressure gauges – (line gauges or portable check gauges)
	Daily water records	
Zone controls:	Hand valves	Electric valves (controlled by timer)
	Volumetric valves (shuts off when a volume of water is applied)	
In-field delivery system:		
Feeder tubes (¼" or ¾") Row laterals:	Line source tubes- most row crops Water emission distances 8, 12, 18 inches, etc. Flow rates (gallons per 100 ft per hour)	
Point sources/emitters – fruits, nursery, and greenhouse crops:	Pre-spaced plug-ins Emission rates – 0.5, 1, 2 gallons/hr (10 to 20 psi)	
Water quality maintenance	Manifold ends Row laterals	

(flushing):	
Miscellaneous:	Time clocks Computer controls Radio control devices Master computer controller

Since there are different types of materials out in the market, it may be advisable for the farmer to contact his county agent or seek advice from an irrigation consultant to help him make the right choice. The basic design and installation of a drip system is not complex at all however, computer driven systems require training at some of the irrigation firms and workshops conducted at several places in the country. A simple drip layout is shown in Figure 1 and the instructional procedures are presented below (Robbins, 1998).

1. Screw pressure regulator (1) onto existing hose or faucet
2. Attach female hose swivel (2) LLDPE hose and regulator (1)
3. Place hose (3) across rows to be watered . Use hose tees (7) and ball valves (9) to arrange and operate system as desired
4. Cut drip tape (to desired lengths and place along rows. The drip Tape (4) may be buried
5. At each row punch a hole in the hose (3) and connect the hose (3) to the drip tape (4) using an adapter (5)
6. Flush system two times by turning on water before closing ends
7. Close ends LLDPE hose (3) using figure 8 hose end (6)
8. Close ends of drip tape (4) as shown in Fig 1. Or with Loc-Sleeve male ends or auto-drain valves to make right closures
9. For best response irrigate as frequently as possible depending on the soil texture. Always keep the soil moist and avoid flooding
10. . Use clean water
11. . A water timer and controller can be used to control the system.
12. . Fertilizers and other chemicals may be applied with the system by using chemical injectors

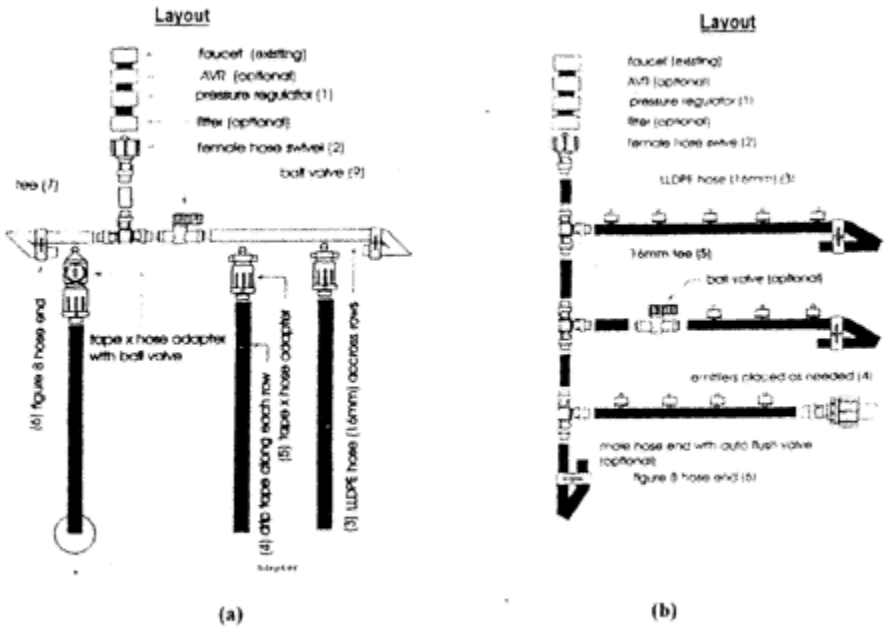

Fig. 1. Layout of a drip irrigation system for (a) row crops and (b) orchard or shrubbery plants.

Drip layout for row crops and orchards are similar except use of emitters for orchards. For row crops a drip tape which has small holes in the line are used and are either laid on the surface or buried at three to six inches depth. Flow rates range from 0.28 to 1.4 GPM/100ft @ 8PSI pressure depending on the spacing of the holes (4 –24 inches) (Robbins, 1998).

Plastic Mulch and Drip Irrigation

This method has become a common practice with most vegetable growers particularly organic farmers. The drip lines are either buried or left on surface under the plastic mulch. Its advantages and disadvantages are as follows:

Advantages:

Increased soil temperature
Reduced fertilizer leaching
Reduced evaporation loss
Less cultivation to control weed
Earlier crops
Reduced soil compaction
Reduced drowning of crops
Cleaner product
Reduced weed problems
Increased growth

Disadvantages:

Costly to remove
Increased management
Increased crop/weed competition
Greater initial cost
Increased soil erosion

This practice of incorporating drip and plastic much is environmentally sound farming practice as it conserves soil moisture and minimizes use of some agricultural chemicals that control weed. Plastic mulch, however, often increase soil temperature, clear plastic having greater heating effect than black plastic. This practice enables early planting that could give farmers the advantage of higher prices offered by early season markets. During summer months, the soil-heating effect of plastic mulches may be quite detrimental, inhibiting root growth in the upper soil layers and sometimes significantly decreasing yield. It is widely accepted practice by organic farmers. However, it is not environmental friendly practice if provisions are not made in terms of removing of the plastic mulch after harvest.

Cost of irrigation in relation to gross income sales

Based on the cost of irrigation materials used to install sprinkler and drip irrigation at the Southern University Horticulture farm and based on the sale price of some vegetable crops at the super markets in Southern Louisiana, cost analysis that clearly show advantages of having an irrigation system is presented in the tables below. Although the cost comparison is based on one acre of a vegetable garden, the irrigation materials can be moved to irrigate more acres, depending on the irrigation interval of the particular soil, for efficient and maximum return. Note that the cost analysis does not include the cost of seed, fertilizers, pesticides, and labor. However, irrigation investment is largely one time expense except for the cost of municipal water or pumping cost in the case of underground wells.

The above analysis show a significant difference in cost of irrigation between the two systems. Although the cost for drip irrigation was lower than that of the sprinkler, the maintenance cost could be higher for drip than for sprinkler. Obviously the plastic composition of the drip materials are not comparable to the aluminum laterals of the sprinkler irrigation. However, according to some studies sited by Brady (1999) the capital cost for drip irrigation tend to be higher than for other systems but the differences are not so great. The direct cost of installation reported were $600 – 1,200 and 700 – 1,500 for sprinkler and drip irrigation systems, respectively. The irrigation costs in the following two tables fall almost in these ranges.

Cost of drip irrigation in relation to gross income sales of sweet corn or cucumbers from an acre of a vegetable garden (200 x 218 ft). This comparison does not include cost of seed, labor, fertilizers, pesticides, and machinery cost.

Cost/Income Items	Quantity	Amount

Description of Materials		
Turbo tape 4,000ft/reel @$90/reel	3	$270.00
16 mm hose for laterals, 1000 ft	1	40.00
Loc-sleeve adapter with valve @$0.90/pc	60	54.00
Auto drain /flush end @$0.90/pc	60	54.00
Valves, adapters, tee, elbows, clamps, etc (2 each)	8	32.00
Pressure regulator, 20 psi	1	25.00
Filter	1	25.00
		$500.00
Sub total	**10,890ft^3**	**$105.00**
Water 6" of supplementary irrigation @$0.967/100ft^3		$605.00
Total Irrigation Cost		**$710.00**
Gross Income		
Crop-- Sweet corn ($0.20/ear at supper market and farmer receives@$0.10/ear, assuming crop yield of 20,392 ears/acre	20,392	$2,039.00
Crop – Cucumbers, yield 400 bushels/acre @$ 19.25/bushel	400 bushels	$7,700.00

Conclusions

With the unpredictable weather conditions in the Southern regions, supplementary irrigation for the small farmer is of vital importance to secure crop production, for farming to become profitable and for the small farmer to stay in farming. The benefits of irrigation are clear and installation of an irrigation system as presented on this paper is not complicated at all. In complex computer driven systems the farmer may need some training at one of the irrigation workshops conducted in the nation. However, in planning and designing an irrigation system, it is recommend that the small farmer contact the closest USDA/NRCS office, irrigation consultants or experiment stations. NRCS office have prepared irrigation guides suggesting design procedures for many states. In general selection and quality of an irrigation system depend upon the judgment and experience in managing water under specific soil type and amount of capital investment a farmer wants to make.

Cost of Sprinkler Irrigation in Relation to Gross Income Sales of Sweet Corn or Cucumbers from an Acre of Vegetable Garden (200 X 218 Ft) and One Year Produce. This Comparison Does Not Include Cost of Seed,labor, Fertilizers, Pesticides, and Machinery Cost.

Cost/Income Items	Quantity	Amount
Description of Materials		
Sprinkler heads, # 10@$12.00	60	720.00
Metal risers 1' x 1" x ½"	60	280.00
Aluminum laterals with couplers and latches (20'x2'Al) @$10.00/pc	60	600.00
Main line, layflat hose 2' x 200'@$100/pc	1	100.00
Plugs, valves, adapters, tee, elbows, clamps, etc 2 each @$10.00	8	100.00
		$1800.00
Sub total		210.00
Water: 6" of supplementary irrigation @$0.967/100ft^3	21,780ft^3	**$2,010.00**
Total Cost of Irrigation		
Gross Income		
Crop-- Sweet corn ($0.20/ear at super market and farmer receives @$0.10/ear, assuming crop yield of 20,392 ears/acre	20,392	$2,039.00
Crop – Cucumbers, yield 400 bushels/acre @$ 19.25/bushel	400 bushels	$7,700.00

References

Brady,. N. C., & R.R. Weil. 1999. Soil and the hydrologic cycle. In The Nature and Properties of Soils. Prentice Hall p213-264.

Ghebreiyessus, Y. T., O. A. Bandele, & C. E. Carter. 1993. Nitrogen and water table effects on vegetable crops under multiple cropping system. Abstracts of the Southern Branch of American Society of Agronomy, p. 13.

Ghebreiyessus, Y. T., M. Berhane, & J. Egbe. (1994). Nitrogen and water management effects on vegetable crops under multiple cropping system. Tenth Biennial Research Symposium Association of Research Directors meeting, p. 101.

Schwab, G. O and R. K. Frevert. 1985. Elemetary and Water Engineering. John Wiley and Sons.

Robbins, J. 1998. Irrigation Mart. 1998 catalog /buying guide

Troeh, F. R., J. A. Hobbs, and R. L. Donahue. 1991. Soil and Water Conservation. Third edition. Prentice Hall.

Campus address for the author: College of Agricultural, Family and Consumer Sciences, Southern University and A&M College, Baton Rouge, Louisiana 70813.

Back to Table of Contents