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Crop Strategies

Offsetting Drought for Small-Scale Vegetable Production

Although 1993, 1990, 1987, 1983, and 1980 call to mind particularly bad memories with respect to drought, hot, dry periods are common during most growing seasons in the southeastern United States. Weather data may indicate that rainfall was adequate for crop production during a given month; however, the bulk of the rain may have fallen during a one-week period. The remainder of the month may have been too dry to grow most crops. On average, you can expect a 40 to 60 percent reduction from average potential yields due to inadequate rainfall.

Irrigation Improves Yields and Quality

Produce consists of about 95 percent water. For this reason, vegetables require a fairly constant supply of water to produce the best possible yields and quality. Vegetables also demand better prices in the marketplace than do field corn, soybeans, wheat, and hay. This makes irrigation of vegetable crops economically feasible. In general, vegetables should not be grown in the southeastern U.S. without irrigation. If a truck farm does not have irrigation equipment, plans should be made to buy irrigation equipment within a few years. Otherwise, you will not be able to deliver the consistent quality produce markets demand.

Another consideration is that yields per acre will usually increase with irrigation. So, although you will need to invest more initially for an irrigation system, you may actually decrease the total acreage irrigated by yielding more produce per acre. This increases your total efficiency.

Choosing Irrigation Equipment

You should first determine how and on what crops the irrigation system may be used. For instance, you may decide that you need the equipment for irrigation of vegetables in the summer and frost-freeze protection of strawberries in the spring or vegetables in the fall. This information will influence the final equipment selection.

Irrigation is expensive. Although it is practical for many producers, irrigation equipment may cost as much as the land on which it is used. Depending on the type and size of system selected, the initial investment for relatively small-scale systems (less than five acres) may vary from $1,000 to over $3,000 per acre. Operating costs may add $50 to $800 annually depending on system type. Therefore, you should obtain professional assistance to determine the most cost-effective irrigation system.

Irrigation systems can be divided into two major groups:

High-Volume Systems: Include overhead sprinkler and self-propelled gun traveler systems. One advantage to these systems is that they are relatively inexpensive compared to low-volume systems. (There is also a lot of used, high-volume equipment available for sale.) Since the technology is rather simple, installation, operation, and maintenance of these systems is easier to learn. Also, if equipped with the proper nozzles, sprinkler systems can be used for frost-freeze protection.

One disadvantage to high-volume systems is the wetting of plant leaves, which may result in foliar disease

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problems. Wind may also cause problems with maintaining even distribution of water. The labor considerations required to move much of the portable equipment can be a challenge and should not be taken lightly. For example, the time required to move pipe and set up each different 1- to 2-acre zone to be irrigated is typically 4 to 5 man-hours. The movement of 20- or 40-foot long sections of aluminum pipe is physically demanding and can be awkward to handle, especially in tall crops.

Low-Volume Systems: Include drip or trickle irrigation and low-volume sprinklers such as micro-sprays, micro-spinners, and spot spitters.

The major advantages of low-volume systems over other systems are the ability to manage timing and placement of soil moisture and to use less total water to produce a crop. Low-volume systems reduce energy costs and improve pest control because they lend themselves to the injection of fertilizers or other chemicals (known as fertigation and chemigation, respectively).

Other advantages are reduction in runoff, the ability to do other cultural practices while irrigating, and, in some cases, reduced labor. When combined with other practices, such as raised beds, black plastic mulch, and closer plant spacings, the use of low-volume systems can result in increased yields, earlier harvests, better quality, and higher profits.

Water conservation is especially important during droughts. In addition to more efficient use of water, low-volume systems lend themselves to automation. One common problem with irrigation systems is forgetting to turn off the water. To solve this problem the pump would be connected to a tensiometer or timer to shut off the pump at the right time. This saves both water and energy.

The major disadvantage to low-volume systems is the higher start-up and operation costs. Low-volume systems also require familiarization with new technology. However, these disadvantages usually are offset by many of the previously mentioned advantages.

Water Quantity

Before purchasing an irrigation system, you should determine if you have a water source which can adequately supply the quantity and quality necessary to irrigate your crops under all conditions (including drought). During peak use periods, most crops can use up to 0.25 inch of water per day. Computed over an entire acre, this represents 6,750 gallons of water. To replenish this water through irrigation, the pumping rate is 4.7 gallons per minute (gpm) from the water source. When irrigation inefficiencies are factored in, the recommended water source capacity is about 7 gpm per acre to be irrigated. This value is based on pumping 24 hours per day, 7 days per week. To apply the required water in shorter pumping periods requires proportionally more capacity for each decremental reduction in pumping time (Table 1).

To irrigate a 2-acre field in a typical 8-hour workday requires a water supply capacity of 42 gpm. This capacity is not cheaply available from groundwater in many areas. For comparison, the typical private home water system has a capacity of 5 to 10 gpm. If you do not have a good water supply, you need to make arrangements to get an adequate source before investing in any irrigation equipment. The cost of the water supply usually represents the single most expensive component of an irrigation system. Depending on availability, water supply costs may vary from about $50 per acre to over $500 per acre. Local well drillers can provide information on well drilling and groundwater sources in your area. The Soil Conservation Service can provide technical assistance for the design and construction of a pond.

Water Quality

Once you have a water source, have it tested for minerals. This can point to potential problems such as high levels of sodium, iron, or bicarbonate; low pH; or hard water. Excess levels of some minerals in irrigation lines can plug nozzles and emitters, precipitate nutrients when fertigating, or be toxic to some plants. The potential problem may not be serious; however, the problem will be easier to manage if it is identified as early as possible.

A filtration system is a normal part of most low-volume systems. Surface water (from ponds and streams) normally contains more dirt and debris than does well water. Sand filters are required for surface water. However, this should not stop you from considering low-volume systems since the benefits will more. than pay for the extra filters in the long run.

Scheduling Irrigation

The most often asked question following the purchase of an irrigation system is, "How do I know when to turn the water on and off?" During summer in the southeastern U.S., two inches of rainfall per week are normally considered adequate for most vegetable crops. However, this

Table 1. Pump Capacity Required To Supply Daily Crop Water Needs During Peak Demand Periods (Hot, Dry Day)

Pumping Period (hours/day)	Pump Capacity to Irrigate Area Shown (gpm)				
	1 acre	2 acres	3 acres	4 acres	5 acres
24	7	14	21	28	35
12	14	28	42	56	70
8	21	42	63	84	105
4	42	84	126	168	210
2	84	168	252	336	420

may vary with the crop, stage of development, and temperature. With all systems, you should buy a rain gauge and keep a daily record of the rainfall. This information will help determine if there has been adequate water for the crop to grow. With high-volume systems, you should irrigate weekly to bring the total water received by a crop up to two inches. For example, if 0.5 inch of rain fell during the week, you should apply 1.5 inches to make up the shortfall.

It is important to realize that low-volume, drip irrigation systems are handled differently from other irrigation systems. **This is a new way to irrigate.** Drip irrigation supplies small amounts of water near the plant **when the plant needs it.** This does not mean once every 5 to 10 days, but daily, or even hourly, in intensively managed systems. Since you are irrigating a small area near the plant, water-use can be reduced by 50 to 60 percent. However, in intensively managed systems you apply more water than you do with conventional systems. This phenomenon is due to increased plant populations and higher yields. Although you may use more water per acre, when you factor in these increased plant populations and yields, you may actually use less water per unit of product produced. Thus water-use efficiency is increased.

You can use a tensiometer or gypsum block (electrical resistance block) to determine soil moisture. Tensiometers are best suited for use in light-textured soils (sand, loamy sand, sandy loam, and the coarser-textured soil range of loam and sandy loam). Gypsum blocks are best suited for use in fine-textured soils (silts and clays).

The tensiometer or gypsum block should be placed on the opposite side of the row from the drip tube, about 4 inches from the row at a depth of 6 inches and between plants. The "turn on" point for the tensiometer should be at 70 to 80 percent of available soil moisture (ASM) and the "turn off" point should be 90 percent of ASM. The tensiometer reading will vary with soil type. For sands and sandy loams, 20 to 30 centibars is the "turn on" and 10 centibars is the "turn off." For clays, 35 to 40 centibars is the "turn on" and 15 centibars is the "turn off."

Another method of determining when to turn the system on or off is to take several soil cores on both sides of the row and feel the soil. With time, you can learn the proper moisture level by this feel method. At the end of an irrigation cycle, soil on the drip tube side should be too wet to plow and about ready to plow on the away side. With some crops, like tomatoes, faint color changes can be seen when the crop needs water, but in others, this is very difficult to see. Wilting should not be seen at any time. Another quick field check is to feel the softness of the soil with your foot on both the drip tube and opposite sides. The opposite should have some give. This will vary with soil type.

An example of drip system operation for tomatoes might be to run the system for 1 to 2 hours every other day, early in the season when the crop is young and the weather cool. As the crop grows, you may irrigate 2 to 3 hours daily. During fruit sizing and hot weather, you may run the system 3 to 5 hours daily and still experience some crop stress.

Diversification

You may partially avoid a drought by making multiple plantings (several plantings over several weeks). It is then hoped that a few of these plantings will survive and yield during the drought. However, this is actually more costly than irrigating. Extra acreage and other resources are tied up with crops that may not make it to market. Another problem with this strategy is that the market is dictated by supply and demand. Growers receive the best prices when less of the crop is being sold in the market. In other words, irrigated vegetables during a drought normally sell for more money. If you have fields that avoided the drought, then other growers probably do too.

Although drought may occur at any time during the year, some crops such as cabbage, kale, collards, turnip greens, lettuce, and spinach are grown during the fall and spring. This tends to make these crops less prone to drought problems. However, irrigation will also enhance the yield and quality of these crops. And the market dictates the price of these crops too. For these reasons, you should not choose a crop simply to avoid a drought. Choose a crop because you can make a fair and equitable profit. An investment in irrigation probably will pay off in the long run.

Mulches

Mulches are beneficial in decreasing water loss from the soil around plants. However, they are only effective if there is water available in the soil. This is true during early stages of a drought or in combination with irrigation. Mulches cannot substitute for the timely application of water. Also, some organic mulches such as straw and compost may cool the soil. Cooler soil temperatures may benefit fall plantings of cool-season vegetables such as lettuce, cabbage, and kale. However, cooler soil temperatures may be detrimental to some warm-season vegetables by delaying the crop.

Summary

Water is a simple but necessary requirement for plant growth. Techniques such as crop diversification and mulches can be used during drought situations. However, nothing will substitute for the timely application of water. Growing vegetables in the southeastern U.S. without irrigation can be costly. There are many different irrigation systems available. You must decide which system fits your needs and budget. A good source of water is a necessity for producing quality vegetables.

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