BUYING YOUR SPRINKLER IRRIGATION SYSTEM

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A PORTABLE SPRINKLER IRRIGATION SYSTEM can be one of your largest capital investments in farm operating equipment. Irrigation will probably mean changes in both your field operation and the management of your entire farm. These changes not only must increase your farm income enough to cover the costs of purchasing, installing, operating, and maintaining an irrigation system, but they must also give you a reasonable return on your investment. So before you invest in any irrigation equipment, be sure that irrigation will pay you a profit. Once you decide that irrigation is feasible for you, be sure that the design of the system you buy is engineered to fit both your present and future needs.

Reading this circular won't make you a design engineer, but it will help you to evaluate the proposed systems of various equipment dealers and decide which system is best for you.

The American Society of Agricultural Engineers and the Sprinkler Irrigation Association have formulated certain minimum requirements for the design, installation, and performance of sprinkler irrigation equipment with which you should be familiar. These requirements, which are accepted by most reliable manufacturers and dealers, can be obtained from your local farm adviser or soil conservationist.

BALANCING YOUR LABOR AND CAPITAL

The size of your labor force will influence the design of your irrigation system and the amount of capital to be invested in it. In general, the more labor you have available, the less capital you will need to invest. A limited labor force will reduce the number of hours a day that you can irrigate, and to cover a given area, you may need additional standard equipment or giant sprinkers, boom sprinklers, or a self-propelled system. These variations in system design mean a greater capital investment.

So before you have an irrigation system designed, decide how many hours a day you can operate it. Many farmers think they have enough labor to operate a system 24 hours a day, but they later discover that their labor force is adequate for only 15 to 18 hours a day. Don't
plan on 24-hour operation unless you have enough labor to work several shifts.

**APPLYING THE CORRECT AMOUNT OF WATER**

Although the roots of certain crops will reach down as far as 5 feet for moisture, it is not economically practicable to irrigate this depth of soil. The irrigation root zone for crops varies from 9 inches to 36 inches, depending on the rooting characteristics of the crop and the texture of the soil. Each irrigation should replace the soil water in the irrigation root zone. Applying more than this amount will waste water, and applying less will not produce maximum yields. Irrigation should be started before the soil becomes so dry that it is impossible to reach the last part of the irrigated field before the crop in that area is damaged by lack of soil moisture.

Table 1 shows the amount of water that the soil will hold in the irrigation root zone of various crops for the soil textural groups. When 40 percent of this moisture has been used by the plants, irrigation should be started; it should be continued until the required moisture has been replaced. To get the most from your irrigation system, keep your eyes on the soil, not on the weather.

**DETERMINING SYSTEM CAPACITY AND NUMBER OF DAYS TO COVER AREA**

In deciding what size system you need, you must know both the number of days you have to cover your area and the capacity of your system in gallons per minute.
Table 1. — Average Amount of Water in Irrigation Root Zone Available to Crops Based on Soil Texture and Permeability

<table>
<thead>
<tr>
<th>Type of soil</th>
<th>Amount of water</th>
<th>Very deep-rooted crops*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Shallow-rooted</td>
<td>Medium-rooted crops*</td>
</tr>
<tr>
<td></td>
<td>(inches)</td>
<td>crops</td>
</tr>
<tr>
<td>Sandy soil</td>
<td>1.0</td>
<td>1.25</td>
</tr>
<tr>
<td>Dark-colored, permeable prairie soil</td>
<td>1.75</td>
<td>2.25</td>
</tr>
<tr>
<td>Dark-colored soils, slowly permeable subsoils</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Light-colored soils, slowly permeable subsoils</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Fine-textured soils, very slowly permeable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>subsoils</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*a Celery, gladioli, lettuce, nursery seedlings, onions, potatoes, radishes, spinach, strawberries
*b Beans, cabbage, carrots, cotton, cucumbers, nursery transplants, peas, peppers, soybeans
*c Asparagus, bramble fruits, corn, grain, grass-legume forage, horseradish, melons, pumpkins, tomatoes
*d Alfalfa, fruit trees, grapes

The maximum number of days available to irrigate a given area depends upon the amount of water held in the soil and the rate of water use by your crop or crops. The capacity of your system must be large enough to enable you to cover your area in the specified number of days. The number of days available equals 0.5 (a factor for the amount of water used from the soil) times the average amount of water in the irrigation root zone (Table 1) divided by the peak water-use rate of the crop.

Peak moisture-use rates for different crops normally range from about 0.25 to 0.30 inch per day. But these values are modified by air temperature, wind velocity, and humidity. A value of 0.30 inch per day is used in this publication.

Let's assume that you want to design a system for 60 acres of corn on dark-colored, permeable prairie soil. You will operate the system 16 hours (960 minutes) a day.

The water in the root zone for dark-colored, permeable prairie soil is 3.25 inches (Table 1).

The moisture used is 0.30 inch per day.

The moisture to be replaced in the soil is 0.5.

The maximum number of days you have to cover the area, then, is

\[
\frac{0.5 \times 3.25}{0.30} = 5.42 \text{ or } 5\frac{1}{2} \text{ days.}
\]

The capacity of the system must meet the maximum demand of continuous irrigation. Capacity is determined in gallons per minute. It is governed by the number of acres to be irrigated, the amount of
moisture to be replaced in the soil, the peak water use rate of the crop, the hours of operation, and the efficiency of water application by the system (70 percent).

To determine the capacity of the system, use the following formula:

\[
g.p.m. = \frac{27,154 \times \text{peak water use rate} \times \text{acres to irrigate}}{\text{minutes of operation a day} \times \text{efficiency}}
\]

Number of gallons of water necessary to put one inch of water on one acre = 27,154
Peak water use rate = .30 inch per day
Number of acres to be irrigated = 60
Number of hours operator will work = 16 (960 minutes)
Efficiency of system = .70

Substituting the known values into the formula, then, we find that the capacity of the system is

\[
\frac{27,154 \times .30 \times 60}{960 \times .70} = 727 \text{ gallons per minute}
\]

**FINDING THE RATE OF APPLICATION**

Irrigation is most efficient if the water is absorbed by the soil where it falls. During an irrigation, there should be very little water standing on the soil surface and no water running over it. If either of these two conditions occurs, the rate of application is too high and
erosion may take place. You are also wasting water and money by pumping water that is not being used.

If the soil can absorb water faster than it is being applied, you may be able to increase the rate of application and cover more acres with your system, provided that your water supply is adequate. But on many Illinois soils the problem is applying water too fast rather than too slow.

The recommended maximum rate of application for textural groupings of Illinois soils is shown in Table 2. These are grouped values and are averages for various soil types. Since soils vary widely and infiltration rates change under different cropping systems and management, it may be necessary to modify the values for your soil. If you want to find out exactly what kind of soil or soils you have on your farm, see your local farm adviser or soil conservationist. He has specific data on individual Illinois soils.

To apply water in the field at the specified rate of application, the designer selects a combination of operating pressure and sprinkler nozzle sizes as rated by the sprinkler manufacturer. He chooses this equipment as one of the final steps of the design after system capacity and the number and size of laterals have been determined.

Table 2.—Rate of Application Based on Soil Texture and Permeability

<table>
<thead>
<tr>
<th>Soil texture and permeability</th>
<th>Application rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bare soil (clean, cultivated crops)</td>
<td>Cover crop (wheat, oats, hay, pasture, etc.)</td>
</tr>
<tr>
<td>Sandy soil</td>
<td>1.0</td>
</tr>
<tr>
<td>Dark-colored, permeable prairie soils</td>
<td>.7</td>
</tr>
<tr>
<td>Dark-colored soils, slowly permeable subsoils</td>
<td>.5</td>
</tr>
<tr>
<td>Light-colored soils, slowly permeable subsoils</td>
<td>.3</td>
</tr>
<tr>
<td>Fine-textured soils, very slowly permeable subsoils</td>
<td></td>
</tr>
</tbody>
</table>

DESIGNING AN ECONOMICAL MAIN LINE

The main line of an irrigation system should be designed on the basis of economy. The designer chooses the most economical main line by comparing the cost of the pipe with the approximate cost of the power required for pumping. The total cost of the power required
depends upon the quantity of water pumped per minute, the size of pipe, the fuel used, the type of engine, the total hours of operation per year, and the efficiency of the combined pump and power unit.

Economical sizes of main line aluminum pipe are shown below. These sizes are for a system operating 600 hours a year and using a liquid-cooled gasoline engine with an over-all pump-power unit efficiency of 65 percent.

<table>
<thead>
<tr>
<th>Pipe size (inches)</th>
<th>Capacity (gallons per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>60-120</td>
</tr>
<tr>
<td>4</td>
<td>120-220</td>
</tr>
<tr>
<td>5</td>
<td>220-375</td>
</tr>
<tr>
<td>6</td>
<td>375-650</td>
</tr>
<tr>
<td>7</td>
<td>650-900</td>
</tr>
<tr>
<td>8</td>
<td>900-</td>
</tr>
</tbody>
</table>

The most economical pipe sizes for systems with other power units (Diesel, air cooled, etc.) will vary slightly from those shown above.

**SELECTING YOUR PUMP-POWER UNIT**

The best pump and the best power unit on the market will not give economical operation unless they are carefully matched to fit the job. The pump must deliver the required quantity of water at the specified pressure at its best efficiency, and the power unit must be operating at its most efficient speed and power output. Buy only a matched pump-power unit. Don’t buy a pump and a power unit and hook them together yourself. Your chances of getting a matched unit are very remote.

Farm tractors may be used as power units for portable pumps, but it’s important to remember that irrigation pumping is a constant load requiring a heavy power output from the tractor for long periods of time. For this reason, the design power requirements of the pump for the irrigation system should not exceed 75 percent of the available rated belt horsepower of a tractor in good mechanical condition.

A Diesel is an economical investment only if the difference in fuel cost over the life of the engine pays the difference in initial cost, interest on investment, and repairs and maintenance between it and another power unit. You will want to closely investigate the economics of your operation before buying a Diesel engine.

Or you may prefer an electric motor as the power unit for your pump. An electric motor requires a minimum of maintenance and is easily controlled automatically. But before purchasing one, find out if your power supplier can supply power to meet your load requirements.
POINTS TO REMEMBER

The following points are worth remembering in buying and operating your irrigation system:

- For efficient operation, the suction lift of your centrifugal pump should not exceed 15 feet.

- Buy a pressure gage or portable pitot gage and check the pressure in the laterals. The pressure difference along a lateral should not exceed 20 percent of the pressure in the main line.

- A main line consisting of two sizes of pipe is almost always the most economical one for a multiple lateral system.

- Place the main line up and down the slope; laterals across the slope.

- If you have a choice of well location on a level field, the most economical location is in the center of the field.

- Buy safety switches for your power unit to shut it off in case of high temperature, low oil pressure, or loss of prime on the pump.

- Double-end couplers cost more initially than ordinary couplers, but permit easier handling of laterals in the field.

- Laterals can be moved efficiently in corn with a tractor and trailer for the pipe. A drive strip made by omitting two corn rows and seeding to a cover crop will give good footing and room for a lateral and the tractor and trailer to move through the field.

- Investigate the possibility of applying fertilizer and insecticides with your irrigation system. A system can also be used for frost control for berries and some vegetable crops.

- Consider the reputation of the dealer and his willingness to give continual service before buying an irrigation system.

- Be sure that your system meets the minimum requirements set up by the American Society of Agricultural Engineers and the Sprinkler Irrigation Association.

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