# Irrigation System Selection

Several decisions must be made before an irrigation system is installed in a field. Some determinations are technical in nature, some economic, and others involve a close scrutiny of the operation and crop to be irrigated.

## Management

Irrigation is not a substitute for poor management. Often, if there is a management problem, irrigation intensifies instead of solves the problem. High-level management is needed to make an irrigation system successful. Accurate decisions of timing and irrigation amount often make the difference between a successful or unsuccessful irrigation system.

## Conviction

After an irrigation system is installed, it must generate enough extra income to pay for itself. Yield increases are not produced automatically. **A producer must use the irrigation system when it is needed and not when it is convenient.** Starting irrigation too late to benefit the whole field, not putting on enough water, or stopping an irrigation too soon often can decrease yield and cause more problems than no water at all.

## Field Constraints

Drainage is a major field problem that can affect irrigation. Poorly drained fields, because of poor surface and internal soil drainage, can cause problems waterlogging or drowning crops. Irrigated fields need good surface drainage so that fieldwork is timely and excess water is removed in reasonable time. Poor internal drainage can cause rooting restrictions, diseases, fertility problems, reduced yields, and other soil related problems because of a high water table in excessively wet periods. Surface drainage is an absolute must where internal drainage is a problem.

Also, the more water-application control achieved, the better aerated the soil.

Topography of a field is a decision aid in the type of irrigation system selected or size of irrigation system installed. Sprinklers fit rolling topography, but surface irrigation systems require graded fields.

## Water Supply

An adequate water supply to meet crop demand is important for ease of operation and for management of an irrigation system. With probability of rainfall at almost any time, a water supply should be large enough to meet crop demand when the root zone reaches the level of depletion desired.

The water source for irrigation should be as clean as possible. Surface water often carries sediments and trash. Large particles should be screened out, letting fines pass. Be careful and occasionally flush out or drain accumulations of fine particles from pipes. Also, check pump impellers and bearings for wear. Groundwater supplies should be contracted as sand free; almost any formation can be gravel packed and screened to eliminate sand pumping. Sand causes excess impeller, bearing wear on pumps, and nozzle wear on sprinklers. Wells also should be test pumped and cleaned with the driller's pump; then install the producer's pump.

Location, quantity, and quality of water should be determined before any type of irrigation system is selected. No assumptions should be made with the water supply.

Secure water rights on all groundwater wells with casings 6" inside diameter or greater and all streams used as irrigation water supplies. Make sure the water source is large enough to meet the irrigation system's demand by test pumping groundwater sources or measuring flow rate of streams.

Use Table 1 to help determine the amount of water needed for various irrigation systems.

TABLE 1.

Irrigation System Water Requirements

| GPM/A | Gross Capacity ins/day | Efficiency % | System |
|---|---|---|---|
| 4.5 - 7 | .24 - .37 | 80 | Stationary Pivot |
| 5 - 7 | .27 - .37 | 80 | Towable Pivot |
| 5 - 7 | .27 - .37 | 75 | Traveling Gun |
| 5 - 7 | .27 - .37 | 70 | Wheel Roll, To Tow Line, Hand Move |
| 10+ | .53 | 60 | Furrow |
| 15+ | .80 | -- | Flood |
| *4 - 6 | .21 - .32 | 90 | Drip* |

*This assumes 100% canopy coverage in an acre. Crop spacing often reduces this value by 50% or more.

# Irrigation Systems

Several irrigation systems are on the market, and all are in three major categories -- surface, sprinkler, or drip. Each system has advantages, disadvantages, and uses. A discussion of several systems explains their roles and capabilities in irrigated crop production.

## Flood

Flood irrigation predominantly is a weed control method for rice. Crops such as soybeans can be watered by flood irrigation, but most crops could show a yield decline if water stays on the crop too long or if the soil stays in a waterlogged condition for several days. If you are set up for rice production and have the equipment to pull levees, flood irrigation may be acceptable; otherwise, furrow irrigation is a better choice for row crops.

If it is possible, water each levee individually when watering row crops with flood irrigation. To maintain control with flood irrigation, discharge the well into the top levee until the desired application is achieved. The total well discharge then is moved to the second levee interval and the first levee cut so it drains into the second levee. This process requires a certain amount of labor as the water "steps down" the field. This gives better water control for application amounts and increases the amount of water available for irrigation. Each levee is watered individually from the well and the water stored in the levees above. Levee intervals usually are on 0.2-foot intervals for rice and sometimes increased to as much as 0.4-foot intervals for row crops.

## Furrow

A furrow is a small, evenly spaced, shallow channel installed down or across the slope of the field to be irrigated parallel to row direction. Furrow irrigation is one of the oldest controlled irrigation methods known and one of the few methods that has changed the least. It is an efficient system if properly managed and a most inefficient one if improperly managed.

Two major advantages for furrow irrigation are (1) developed gradually as labor or economics allow, and (2) developed at a relatively low cost after necessary land-forming costs for drainage are deducted.

Disadvantages to surface irrigation include these:

- labor
- efficiency
- water requirements
- potential over irrigation and resulting yield reduction
- versatility

Furrow irrigation has limitations or field constraints to acknowledge as a guideline when considering this method. Row lengths should not exceed 1,320 feet on heavy soils and, depending on soil texture and slope, can be shorter. The coarser the soil or the steeper the slope, the shorter the run length. Row slopes should be between 0.05 feet per 100 feet to 0.5 feet per 100 feet. Ideal slopes would be .2 - .3 feet per 100 feet, especially on soils that have poor internal drainage. Cross slopes should be less than or equal to row slope, except in a permanent-graded furrow design.

Depending on surface conditions, stream size used should be as large as possible to move water through the field quickly without causing erosion.

Automation is close to breaking into furrow irrigation. This takes some of the labor out of changing gates and allows for better set design but does not totally eliminate the nonuniformity and overland-flow effects that cause inefficiencies in furrow irrigation. The best success from a furrow irrigation program is the result of hard work and good management. When using properly designed row slopes, row lengths, set times, stream sizes, and a re-use system, furrow efficiencies have been shown by research to be as high as 90%.

## Border

Border irrigation is a modern method of surface irrigation. Borders generally are prepared with zero side slope and a small but uniform longitudinal slope not exceeding one percent. The borders are divided by levees running down the slope at uniform spacings. The lower end of the border is opened to a drainage ditch or closed with a levee to create ponding on the end of the border. Levees are pulled across the end on steeper borders. Border irrigation is best adapted to grain and forage crops where there are large areas of flat topography and water supplies are large. The major investment is land preparation, and border irrigation is relatively inexpensive to operate after installation.

The main design considerations for border irrigation include flow rate, width, length, slope, and outlet conditions. Water requirements range from 15 to 45 gallons per minute per foot of width depending on length, slope, and soil type of the border. Sometimes crops are planted across borders or planted flat parallel to the border or parallel to the border with shallow furrows or corrugations to help guide the water down the border, especially if there is a small side slope.

Border irrigation could be used on precision leveled rice fields where beans or other grain crops are grown in rotation with rice.

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## Sprinklers

Sprinkler irrigation systems come in various shapes, sizes, costs, and capabilities but share a common trait: to simulate or replace rainfall during dry weather. There are some land-forming needs for drainage even with sprinkler irrigation.

Sprinklers adapt to a range of soil and topographic conditions. When choosing sprinkler or any other type of irrigation system, there are several considerations:

- ability of the system to meet crop needs
- energy requirements
- labor availability and requirements
- adaptability to soil characteristics, crop, terrain, and field shape
- economics
- water quantity available

Regardless of the sprinkler system you consider, a reputable dealer is vital. The system is set up and designed for the specific site (soil conditions, crop, field shape, and water source) where it will operate. Also, as with any machine, a sprinkler system needs servicing, so select a system your dealer can service. You do not want a "bargain" if it cannot be serviced quickly and professionally. The system selected is a major factor in professional service required and to what extent you can service it.

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## Center Pivots

When considering a center pivot, some choices to be made:

- type of drive unit
- type of nozzles
- shape of field to be watered
- quantity of water available

**Drive Unit** -- The three types of drive units available for center pivots are electric, water, and oil.

Electric drive units require three-phase power. This is supplied directly by the electric supplier; it can be from a single-phase power source through a phase converter or can be supplied by an auxiliary generator. The electric drive system is easily reversed. It runs wet or dry, and there usually is a range of speeds available. The electric drive systems need skilled-maintenance people to deal with electrical problems that occur. Also, the electric units run at high or low pressure.

Oil drive systems use an auxiliary hydraulic pump generally connected to the pumping plant but make sure the hydraulic pump can be run independent of the water supply pump. This makes it possible to operate the system dry. This system also can be operated at high or low pressure. The oil hydraulic system lends itself to owner-operator service more than the electric system. Rotation speeds are variable with this unit but should be checked to make sure the range fits your management objectives.

Water drive systems require no auxiliary power units since a portion of the energy from the pumped water is used. Higher operating pressures must be maintained, usually 55 psi or greater, depending on the terrain. Water drive units cannot be used with low pressure sprinklers without using pressure regulators on each sprinkler head.

Two drive units are available for a water drive system: the cylinder or piston and the spinner. This system cannot be moved dry. Reversing the system is possible with the spinners but requires special adaptors for the cylinder or piston. Owner-operator service lends itself to this type of unit also. Variable rotation times are standard, but check to make sure it fits your operation.

The fixed costs for a center pivot depend on the acres the system covers. The operating costs are about the same or lower than other systems. Labor is the biggest savings, and energy cost depends on the system and the type of energy but is relatively low in comparison. Maintenance and repairs are probably higher than other systems, since there are more mechanical parts than on other systems. Total operating costs are competitive with other types of movable sprinklers.

**Nozzles** -- High-pressure sprinklers generally operate at 75-90 psi. The impact sprinkler is used in this case. Impact sprinklers have a large area of coverage, thus producing the lower application rates.

Low-pressure sprinklers operate in the 20-50 psi range. There are various sprinkler types with different arrangements possible. The low-pressure sprinkler packages usually have a fairly high application rate. When considering low-pressure sprinklers, soil-intake rate, soil-moisture storage, crop water requirements, and elevation changes are important design components. Low-pressure packages have the advantage of lower energy requirements but can cause problems if not designed for the specific site.

Check application rates for all sprinkler systems to make sure they match soil intake rates. This prevents runoff.

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## Side-Roll Systems

The side-roll sprinkler system is best adapted for rectangular fields. The standard length is a quarter mile, but variations in length can be purchased. The operating pressure is in the 35-60 psi range with an impact sprinkler head, primarily to increase area of coverage and decrease number of sets. The lateral pipe to which the sprinklers are attached also acts as the axle for the wheels that are from four to eight feet in diameter. Therefore, crop height is a limiting factor. The system is moved from set to set by an engine mounted on the lateral pipe, usually in the middle. Each set is run in a stationary position, then the engine is started and the system walked forward to the next set without the sprinklers operating. A flexible hose is used to connect the system to risers strategically located along the edge of the field. One set usually covers two or three acres, so one side-roll system can cover up to about 50 acres per system. Other favorable features of the side-roll are medium labor requirements and a moderate investment.

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## Linear

The new lateral-move type system is a combination of the sideroll and center pivot. These systems move continuously through the field on towers like pivots. The water source is from a feeder ditch, flexible hose, or buried pipe.

The power unit, pump, and all controls are located together on the moving system. This system is fairly new and most expensive. A system configuration with the length of run 2-4 times longer than the system width is needed to make it competitive costwise with a pivot. Many options and characteristics available for center pivots apply to the lateral move system.

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## Traveling Gun System

The two types of traveling guns are a hard-hose or hose-reel system and a cable tow or hose drag system. Either system is adaptable to various crop heights, variable travel speeds, water application amounts, odd shaped fields, and rolling terrain. Both require high operating pressures (80-150 psi). The larger systems cover from 5 to 10 acres per set.

These systems require some labor in changing sets; however, one gun should not be used on much more than 100 acres at a time. This is about the limitation of a gun to maintain a good soil moisture regime in a growing crop.

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## Consider differences in systems:

The cable tow system is usually cheaper; it requires a wider alley to run in so the hose doesn't get kinked; the hose life may be shorter, and the cable pulls the system while the hose drags behind. The hose is usually rolled up mechanically at the end of a set before the system is moved. The cable tow carries a 660-foot hose and the hard hose up to 1320 feet. Both systems can water sets up to twice as long as the hose by turning the system around and pulling the hose back out.

The hard hose system is ready to move when it gets the hose reeled in at the end of a set. The hard hose is easier to set up for a partial set.

Both systems require a moderate amount of labor, but both have a place in irrigated crop production, especially on odd shapes or long narrow fields.

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## Tow Lines

The tow line system takes advantage of low investment and low operation pressure. It combines a medium labor requirement to irrigate rectangular fields without crop height limitations. Each 1320-foot lateral is moved the 60 feet between sets by towing with a tractor. Cornfields should be laid out with two strips planted to a low growing crop -- such as sorghum, soybeans, small grains, or grass -- to allow proper water distribution and to avoid tractor damage to the taller crop. One lateral can irrigate 30 to 40 acres.

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## Drip Irrigation

Drip irrigation is a highly efficient system and is effective in watering tree crops, trellis crops, or high-value horticulture crops. Drip irrigation is designed to water the crop and not the whole area on which the crop is planted. In widely spaced crops such as pecans or peaches, small water supplies can be spread over more acres than a conventional row crop because of point-source water distribution. Labor requirements for drip irrigation are low; the system is easily automated or could be operated manually with little effort with the proper design. The heart of drip irrigation is the filtration, and a good filtration system is required to prevent plugging of emitters.

Plant spacing and size determine the type and quantity of drip irrigation emmiters used around the individual pants. A hose or tube with built-in emitters is more desirable for plants with close spacing. There are limitations on the length of drip line that can be used based on slope, crop, drip line-type, spacing, and discharge rate of emitters. Drip irrigation can be run on the surface or buried.

The cost of drip irrigation systems is reasonable on wide-spaced crops such as trees. The closer the crop spacing, the higher the system cost is per acre. In a conventional row crop pattern, drip irrigation is about the most expensive system available.

Selecting the right irrigation system for your farm is important. Be sure you understand all of the operating factors before you purchase a system. Most system failures are as much a result of operator error as the system itself. For assistance in selecting an irrigation system, contact your county agent, Soil Conservation Service, or consultants and dealers. Get as many ideas as possible from outside sources and do not be close-minded. The ideas and experiences of others are valuable.

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