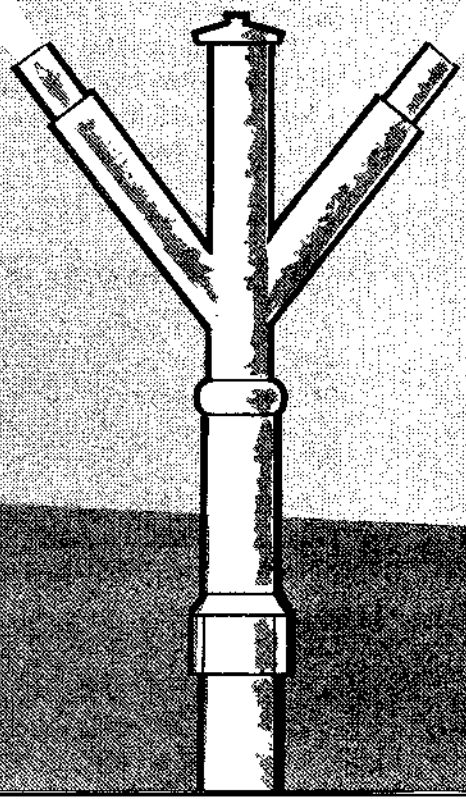
LEAFLET NO. 476

SPRINKLER IRRIGATION



U.S. DEPARTMENT OF AGRICULTURE

SPRINKLER IRRIGATION

By Claude H. Pair, *Soil and Water Conservation Research Division, Agricultural Research Service*

Sprinkler irrigation systems distribute water by spraying it over the fields. The water is piped under pressure to the fields. The pressure forces the water through sprinklers or through perforations or nozzles in pipelines and thus forms a spray. Sprinkling is man's imitation of natural rainfall.

Nearly all irrigable soils can be sprinkler irrigated. It is difficult, however, to sprinkler-irrigate if the water intake rate of your soil is less than 0.10 inch per hour.

Sprinkler irrigation is the best method to use on soils that have high intake rates, on fields that have steep slopes or irregular topography, and on soils that are too shallow to level.

Most crops can be sprinkler irrigated. However, you may have difficulty in moving portable lateral lines in tall crops, such as corn; and soft fruits should be protected from the spray when they are ripening.

Wind distorts spray patterns and usually reduces the efficiency of the system. If you live in an area where high winds often occur, you may need professional advice on how to overcome this problem. It can be overcome by selecting the right equipment and by operating it properly.

PARTS OF A SYSTEM

A sprinkler system is usually made up of four parts—sprinklers, pipelines, a pumping plant, and debris-removal equipment.

Sprinklers

Sprinklers may rotate or remain fixed. Those that rotate can be adapted for a wide range of application rates and spacings. They are effective with pressures of about 15 pounds to over 100 pounds per square inch at the sprinkler. Pressures from 35 to 60 pounds per square inch are considered the most practical for most farms.

Fixed-head sprinklers are commonly used to irrigate small lawns and gardens.

Perforated lateral pipelines are sometimes used as sprinklers. They require less pressure than rotating sprinklers. They release more water per unit of time than rotating sprinklers. Their use, therefore, should be restricted to soils that have high intake rates.

Pipelines

Pipelines are of two types—main and lateral. Main pipelines carry water from the pumping plant to many parts of the field. Lateral pipelines then carry the water from the main pipeline to the sprinklers. Sprinklers on one lateral pipeline may vary in number from one to more than 30. Either type of pipeline can be permanent or portable.

Permanent pipelines are made of steel, asbestos cement, or plastic. They are commonly buried so as to be out of the way of farming operations.

Portable pipelines are usually made of aluminum, but plastics are also being used in some places. These pipelines are generally equipped with quick-coupling devices.

Pumping Plants

Sometimes the slope of the land is sufficient to provide gravity pressure in a pipeline, or a central pumping plant is used for a number of sprinkler systems. Usually, however, the pressure must be

provided by a pumping plant for each system. The pumping plant usually consists of a centrifugal- or turbine-type pump, a driving unit, a suction line, and a foot valve.

A centrifugal pump is generally used where the distance from the pump inlet to the water surface is less than 15 feet. You can usually use a centrifugal pump to lift water from irrigation ditches, drainage canals, lakes, ponds, river channels, or shallow wells.

If the distance to the water surface is more than 15 feet, or if the water level fluctuates widely, the use of a turbine pump is recommended.

The driving unit may be either an electric motor or an internal combustion engine that burns gasoline, diesel oil, natural gas, or liquid petroleum.

Debris-Removal Equipment

Debris-removal equipment is needed for most sprinkler systems that obtain water from streams, ponds, canals, or other surface supplies. When the water is pumped from wells, this equipment is generally not needed. It is important to keep the system clear of sand, weed seeds, leaves, sticks, moss, and other trash that may plug the sprinklers.

CHOOSING A SYSTEM

There are many types of systems and accessory equipment from which to choose. The choice should be made after considering three main factors. These are the equipment cost, labor required, and suitability for the particular farming operations.

Sprinkler systems have been generally classified as portable, semipermanent, or permanent. The classification depends on whether the lateral pipeline (including sprinklers), main pipeline, and pumping plant are movable or fixed. Sprinkler systems may be more specifically classified according to special mechanical features that are used to move the lateral pipelines.

Permanent-type systems have permanently located main and lateral pipelines and pumping plant. Equipment and installation cost per acre is higher than that of any other system, and ranges from $400 to $700 per acre. (Here and in the following paragraphs, statements giving cost ranges refer to costs in 1969.) Irrigation labor requirements are lower than those of any other system. These systems are best adapted to long-lived crops needing full-season irrigation, such as permanent pastures, orchard or citrus groves, vineyards, and nurseries.

Semipermanent systems consist of portable lateral pipelines and permanent main pipelines and pumping plant. Cost of equipment and installation is moderate, ranging from $90 to $175 per acre. Labor requirements are moderate. These systems are especially well suited to areas needing full-season irrigation and to farms having permanent field boundaries. This is the most widely used system.

Portable sprinkler systems have portable pipelines from the pumping plant to the last sprinkler lateral. The pumping plant may be either fixed or movable, although in a completely portable system the pump and all the pipe would be portable. This type has the lowest per-acre cost of any sprinkler system. Costs range from $60 to $125 per acre. Labor requirements for operating are higher than those of any other system. Portable systems can be used anywhere sprinklers are used. They are especially well suited for occasional or supplemental irrigations.

With most systems of the portable and semiportable type, portable lateral pipelines are moved over the field by hand. The need to reduce this labor requirement has led to a trend toward mechanization. Side-roll, side-move, pull-type-wheel, drag, self-propelled continuously moving, giant-sprinkler, and solid-set systems have been developed. These labor-saving developments increase initial equipment costs. The mechanized systems work best on level or fairly uniform sloping fields.

Side-roll systems.—The lateral pipe is used as an axle. Wheels, which are 4 to 5 feet or more in diameter, are mounted on it. Hand or power-driven devices are then utilized to move the lateral into

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Side-roll lateral system power unit.

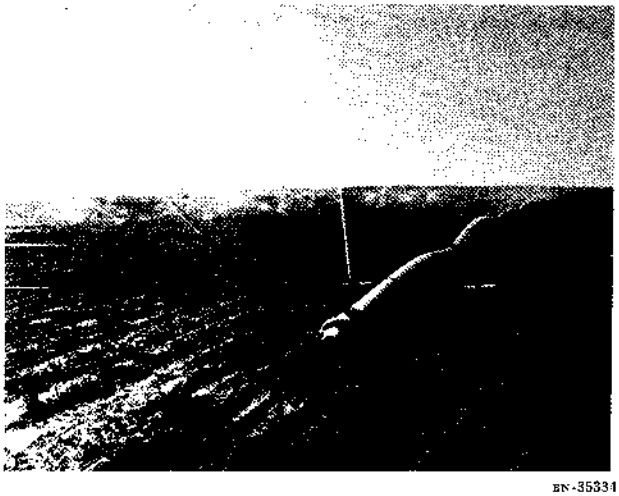
a new position. The laterals may be equipped with automatic drain valves, with brakes to prevent the wind from blowing them across the field, and with telescoping pipe or high-pressure hose sections to facilitate making connections to the main lines.

This type of system is best adapted to rectangular fields without obstructions and with uniform topography. It is limited to close-growing forage crops, low-growing row crops, and small grains.

Extra labor may be needed to line up sprinklers properly after repositioning a side-roll lateral, especially on rolling land. Side-roll sprinkler systems cost from 1¼ to over 2 times as much as comparable hand-move systems.

Side-move systems.—The lateral pipe is supported on carriages spaced 40 to 60 feet apart along the sprinkler lateral pipe. Small 1- to 3-inch diameter trailing pipelines having from one to five or more sprinklers spaced on each pipeline may be connected to the lateral pipe. The trailing pipelines are towed by the lateral when this system is moved. Cost of the system varies with the number of sprinklers on the trailer pipelines, from 1½ to 3 times the cost of a hand-move lateral system.

Pull-type wheel systems.—A fixed or swiveling two-wheel carriage supports the lateral 12 or more inches above the ground. The lateral is then towed endways by a tractor or truck to the new setting. This system is best adapted to close-growing forage crops. However, it can be adapted for use on most crops. Some farmers sow grass strips in row crops and use the strips when moving the laterals of a pull-type wheel system. These systems cost about 1½ times as much as comparable hand-move systems.



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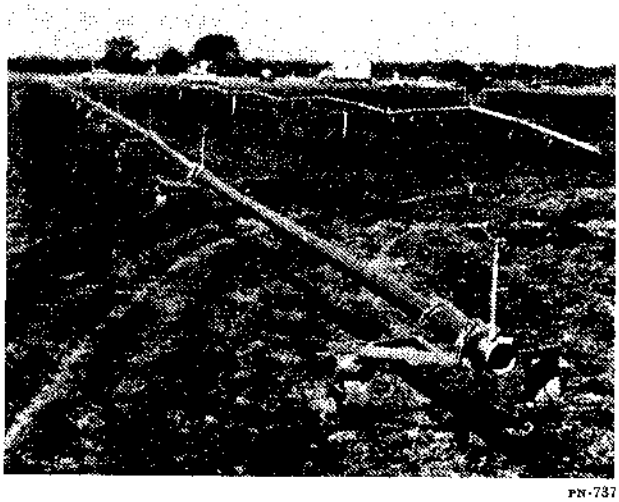
Side-move lateral system.



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Pull-type wheel lateral system.

Drag-type systems.—These systems have laterals similar to pull-type wheel systems. A skid pan or outrigger attachment is substituted for the wheeled carriage. The skid pan or outrigger helps to stabilize the laterals, but frequent moves in abrasive soils may cause them to wear excessively. This system is best adapted to well-sodded forage crops. Drag-type lateral systems cost up to 1½ times as much as comparable hand-move systems.

Self-propelled continuously moving systems.—There are circular center-pivot and straight lateral systems under this type. Lateral pipe in both these systems is mounted on wheeled supports with each wheel being driven by hydraulic power or electric motors. Valves on the hydraulic systems and switches on the electric systems are controlled by safety devices to keep the various sections of the lateral in alignment as it moves continuously around the field in the circular center-pivot systems or across the field in the straight-moving lateral systems. The rate of travel is adjustable. Self-propelled continuously moving systems cost from 2 to 3 times as much as comparable hand-move systems.

Giant-sprinkler systems.—Individual sprinklers are usually mounted on a stand or trailer and moved by a tractor or truck. Each sprinkler has one to eight or more nozzles. Pressures vary from 60 to 120 pounds per square inch. Sprinkler discharges vary from 150 to 600 gallons per minute. Areas covered by the spray vary from 1 to 5 acres per set. Minimum application rates vary from 0.3 inch to over 0.6 inch per hour.

Giant-sprinkler systems have been converted to a continuously moving sprinkler system by mount-

PN-740

Preparing to move drag-type lateral system.

ing the sprinkler on a trailer and connecting the sprinkler to the main pipeline with a length of high-pressure hose. A power-driven winch and a cable connected to the trailer pulls the trailer and hose slowly across the field.

Giant-sprinkler systems are not recommended in areas having high winds. Some of these sprinkler systems can be used only on high-infiltration-rate soils. Others are limited to fairly uniform fields. The cost is 1 to 1½ times that of a comparable hand-move system.

Solid-set systems.—These systems may have portable or buried laterals. There are enough laterals and sprinklers to irrigate the field without repositioning any lateral. Laterals may be operated individually or in blocks of laterals depending on the water supply.

Automatic sequencing valves are now available that, when placed on each riser, allow only one sprinkler on each lateral to operate, thus enabling the use of smaller lateral pipe. A control system then activates the sequencing valves and shuts off one sprinkler and turns on the next sprinkler at a pre-set time. Electrically, hydraulically, and air-pressure controlled valves are used in these sequencing solid-set systems.

Solid-set systems may be used for irrigation, fertilization, temperature and humidity control, and the application of insecticides and herbicides. These systems are adapted to use on all crops that are sprinkled, but the cost limits their use to high-income-producing crops.

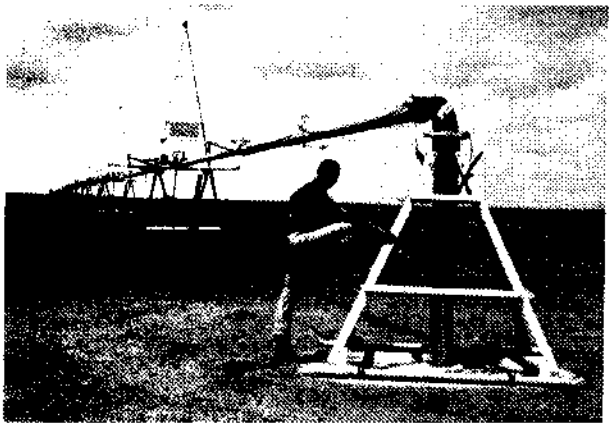
Conventional solid-set systems cost about 4 to 6 times as much as comparable hand-move systems. Sequencing solid-set systems cost about 3 to 4 times as much as comparable hand-move systems.

SYSTEM DESIGN

After the type of sprinkler system has been selected, the size of the various parts of the system must be determined. Selecting the proper size of sprinklers, pipelines, pumping plant, and debris-removal equipment is involved in the design of a sprinkler system.

Designing a sprinkler irrigation system is a job for an engineer. Farmers should understand the principles involved, however, so they will get a good system at a reasonable cost. Many dealers in sprinkler irrigation systems are qualified to perform designing services.

A good sprinkler system fits the farm on which it is to be used. It is large enough, but not too large. It is capable of replenishing the soil mois-



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Self-propelled continuously moving system.

ture at a rate at least equal to the peak rate of use by the crop.

It applies water uniformly. The point of lightest sprinkling has a depth of application at least 80 percent as great as the average depth over all the field.

A good sprinkling system has an economical balance between pipe cost and power cost. The larger the pipe, the more expensive it is. More pumping power, however, is needed to force water through small pipes because of increased water friction.

To plan a sprinkler system, you need this basic information:

- A map showing field boundaries, location of water source, natural gas or electrical powerlines, elevation of points around field boundaries, water level, and highest and lowest points in proposed irrigated areas.
- The kind and depth of soil and root-zone depth of the crops to be irrigated.
- The rate at which water enters the soil. This information is needed to determine the time sprinklers need to be operated to refill the soil with moisture. The rate may vary from 0.04 inch to 2 inches or more per hour.
- The capacity of the soil to hold water for plant use. This capacity may vary from 0.5 inch of water per foot of root-zone depth for sandy soils to more

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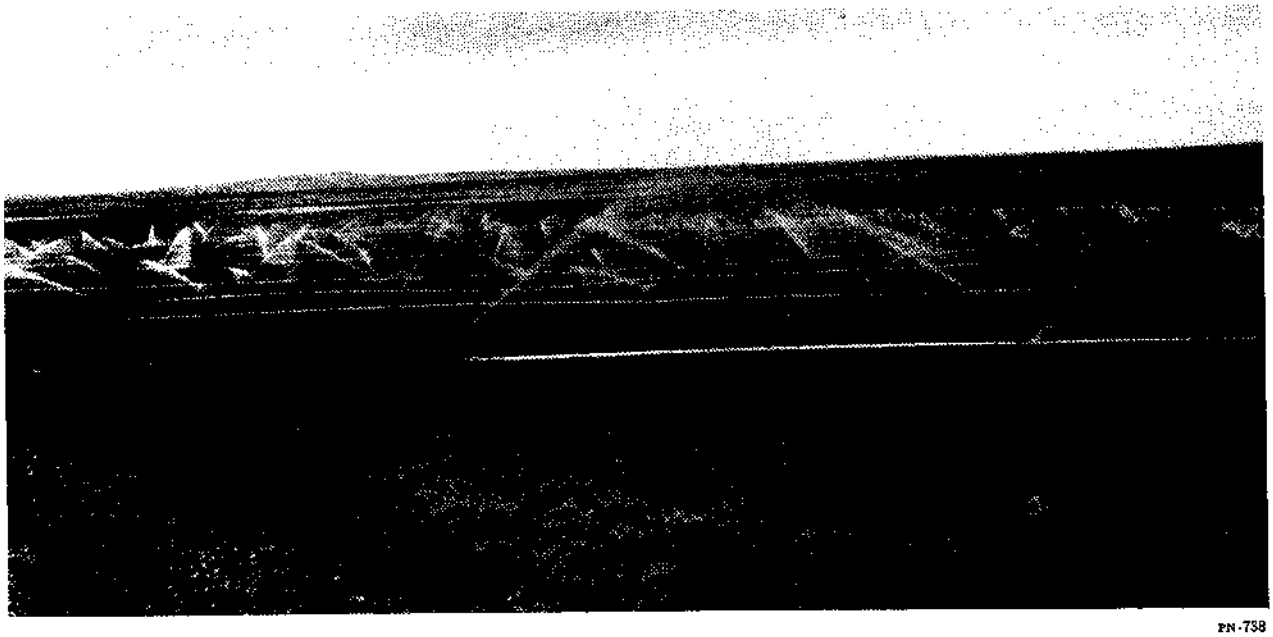
Giant sprinkler system.



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Portable solid-set system.

than 2.5 inches for clays. The water-holding capacity of the soil determines both the amount of water that should be applied at each irrigation and the length of time between irrigations.

- The amount of water that is available for irrigation. The seasonal variation in delivery is also important. It is delivered on a continuous flow basis or is it shared with neighbors on a rotation basis?
- The power source. This is important to those having to pump the water for the necessary pressure to operate the sprinklers.
- Labor needed. Is it available for one, two, or more moves of the sprinkler laterals each day?
- Information on the cropping system and planned rotation of crops. This information is needed to permit the sprinkler-system planner to determine the root-zone moisture to be replaced, peak rate of water use, and the frequency of irrigation during the period of highest water use.

If you have any questions about developing this information, consult your county agricultural agent or a representative of the Soil Conservation Service, U.S. Department of Agriculture.

BUYING A SYSTEM

Shop around but do not buy the cheapest system offered. Cheap systems do not always have enough laterals or sprinklers. The pipe may be too small and the pump and power units may not fit the system.

Choose a dealer in irrigation equipment who has a reputation for satisfactory designing and for selling good equipment. Established dealers carry the repair and replacement parts needed when breakdown occurs.

The lack of adequate moisture during the peak growing season results in lowered production in some crops and low-quality produce in other crops. An inadequate, cheap system that does not deliver the water needed may prove to be very expensive in the long run.

OPERATION

Proper design of a sprinkler irrigation system does not assure success. The system should be operated in keeping with good irrigation practices. Too often farmers have the mistaken impression that a sprinkler system is the solution to all water-need problems.

Several general rules should be followed when sprinkler irrigating.

- Irrigate only when the crop needs water. Keep in mind that there is a timelag for complete coverage of the farm with a sprinkler system. Once you get behind crop needs, it may be difficult to catch up because the capacity of any system is limited.
- Testing the soil moisture helps to determine

BN-35335

Buried solid-set sequencing system.

when to irrigate. If soil moisture is adequate over the entire farm, shut off the sprinklers for a few days during this period to save water and labor.

- Apply enough water to fill the soil throughout the root zone. (Apply greater amounts only when leaching to remove harmful salts.)
- Often, when establishing new crops, only a few inches of surface soil need to be moistened. The system should be operated only long enough to supply this moisture.
- Do not operate the system full time throughout the entire irrigation season. Most systems are designed for full-time operation only during the period of peak moisture demand, which usually occurs during midsummer.
- Do not overirrigate. Too much water may carry valuable soluble nitrates below the reach of plant roots. This would require more fertilizer to obtain good crop production. Overirrigation may also cause drainage problems. If a system is designed to cover the farm in 10 days during the peak water-use period, running continuously, it needs to run only one-third to one-half of that time in spring and fall.

MAINTENANCE

A sprinkler-irrigation system, like other farm equipment, needs maintenance to keep it operating at peak efficiency. Parts of the system subject to the most wear are the rotating sprinkler heads, the pump impeller, and the power unit.

Examine the sprinkler heads after each season's use. Replace worn, bent, or damaged parts.

Wear on the pump impeller reduces pump efficiency, which increases power costs. Have an experienced pump repairman examine the pump and replace the impeller when needed.

Power units should also be examined for wear and placed in top operating condition before the start of each irrigation season. Preventive maintenance saves money by correcting causes of system failures before they actually occur.

Store portable aluminum pipes, couplers, and sprinklers in a dry place when they are not in use. Proper storage extends the life of sprinkler-system parts.

After months of satisfactory operation, the system may suddenly start operating at reduced pressure, or the motor may heat. An inspection usually shows that the cause of the first problem is an air leak in the suction line, a clogged pump impeller, or a clogged foot valve. Sometimes the water level in a pump sump or well drops. This would give an excessive suction lift to a centrifugal pump, which would cause reduced pressure.

Overheating of the power unit may be traced to wear in the bearings of the pump and motor or a pumping head much lower than that at which the pump was designed to operate.

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