

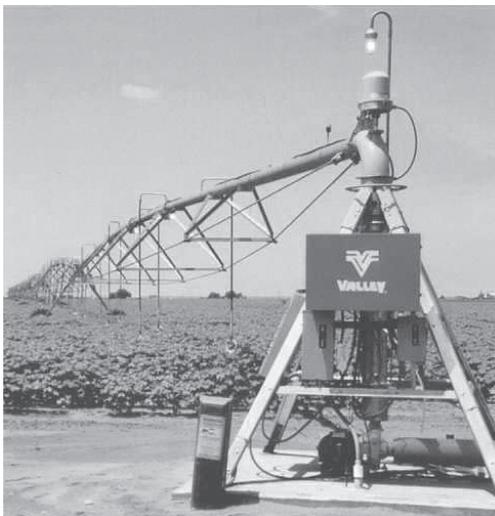
CHAPTER 10: The center pivot irrigation systems

INTRODUCTION

The center pivot system consists of one single sprayer or sprinkler pipeline of relatively large diameter, composed of high tensile galvanized light steel or aluminum pipes supported above ground by towers move on wheels, long spans, steel trusses and/or cables (Figure 10.1). One end of the line is connected to a pivot mechanism at the center of the command area; the entire line rotates about the pivot. The application rate of the water emitters varies from lower values near the pivot to higher ones towards the outer end by the use of small and large nozzles along the line accordingly.

The center pivot (CP) is a low/medium pressure fully mechanized automated irrigation system of permanent assemble. It has become very popular in the Near East region in recent years for irrigation of most of field crops, cereals, legumes, forage and vegetables. It is also used for supplementary irrigation for rain fed grain. The cost of each system unit is relatively high and is therefore best suited to large irrigated farms. The area covered can be from 3.5 ha to 60 ha, according to the size of the CP, and the larger the area the lower is the cost of the system per unit area.

FIGURE 10.1 - The center pivot.



SYSTEM LAYOUT AND COMPONENT PARTS

The typical center pivot system consists of a single long **irrigating pipeline** attached to a **central tower** and moves slowly over the field in a circular pattern and irrigates the plants with **sprayers, or sprinklers** placed on it at frequent spacing. The central tower with a **pivot mechanism and main control panel (electric)** is anchored to a small concrete base at a fixed water supply point (hydrant) at the center of the field. The entire irrigating pipeline is supported above ground by **"A" frame towers** move on wheels, **long spans**, steel trusses and/or cables; the end of the pipe is **overhung** with a sprinkler gun. The whole system rotates slowly, at a typical speed (last span) of 2–3 m/min., around the fixed pivot, self-propelled, applying water in the form of overhead spray irrigation and covers the area in a circular pattern. The **drive system** features small individual power units mounted on each wheeled tower. These units are electric drive, but can be hydraulic (water, oil) or mechanical drive. An automatic **alignment system** keeps always the irrigating pipeline straight (Figure 10.2).

The typical CP systems can be fixed permanent installations or movable/towable type with the central tower based on wheels or a skid, easily move from one field to another. The Linear Center Pivot is another common type towable system, which can irrigate rectangular or square shaped fields using a canal water resource parallel to the travel direction. Computer aided management systems (CAMS) models (MULTICENTER) and self-propelled are now available and the whole installation can be managed through a remote control for towing from one place to another. Corner systems are also available for irrigation of square, rectangular and odd shaped fields. Monospan systems are also available for small fields.

FIGURE 10.2 - A center pivot overview.



The Pipeline

The long irrigating pipeline (Lateral) with water emitters (sprinklers, bubblers, or sprayers) can be from 140 to 250 mm diameter, according to the system flow and the length; standard sizes of approximate 160 mm (6 inches) and 200 mm (8 inches) are very common. The length of the pipeline can be from 50 to 750 meters according to the design. It is made of high tensile material galvanized light steel, or aluminum, with extra strong couplers to stand the system operating pressures.

The pipeline is placed on wheeled “A frame” towers of typically 3 meters minimum height above ground and spaced 35–55 meters distance apart (length of spans). The common or “standard” length of spans is 40 m. Truss rod arches maintain the even distribution of weight and loads between the towers. On level ground the ground clearance varies from 2.75 to 4.5 meters for high profile machines. The spans are equipped with flexible joints at the ends allowing the pipeline to articulate and to allow side-to-side, up and down and rotational movement with no stress on the pipeline.

The water emitters

The water emitters, computerized sized and spaced for high uniformity of application, are mounted on the pipeline at spacing of 1.5 to 3.0 m, and 6 m approx. according to the type and coverage of the sprayer emitters, and operate when the system is in motion. The emitters in the past were full-circle rotating sprinklers. Since the early eighties the Low Energy Precision Application (LEPA) mode is using sprayers, bubblers or angle mist sprayers, fitted on flexible “hose drops” hanging down from the lateral at a height above ground of about 20 to 45 cm for the bubblers and 1.0–1.8 m for the sprayers. The “hose drops” are connected to the pipeline by a “gooseneck” or furrow arm and operate at lower pressures of about 0.5 to 1.5 bars. Goosenecks and drops are usually installed alternately on each side of the Lateral to even stresses on the line when used on high profile crops. There are several models of sprayers with excellent performance, long radius and uniform rain precipitation. Pressure/flow regulators are used in most cases. The discharge rate of the emitters along the pipeline is not the same along the line, but varies from lower values near the center to higher ones towards the outer end by the use of small and large nozzles along the line accordingly and sometimes variable spacing. Good overlapping is essential. Part circle sprayers are used near the towers to avoid over wetting the area along the wheels. The most common sprayers in use the last few years are the Senninger’s wobblers and the Nelson’s rotators.

A sprinkler gun is placed at the end of the overhang pipe (Figure 10.3) and may increase the length of the line by $\frac{3}{4}$ of its sprinkling radius, yet under low pressures rotating sprinklers have poor performance. Operating

pressures along the line are low, that makes the system sensitive to pressure changes caused from friction losses or differences in elevation and uneven ground. Installation of pressure gauges for frequent monitoring is important to ensure proper flow and good application efficiency and uniformity. A pressure gauge is always needed at the last drop of the pipeline. Since 0.4 Bars pressure regulators often used with LEPA need at least 0.65 bars at the inlet to function properly, then maintaining 0.65 bars at the end of the line will ensure that all regulators are operating properly. The inlet pressure needed for the CP normal operation is slightly less than 3 bars.

BOX 10.1 - Low Energy Precision Application

Low Energy Precision Application (LEPA irrigation) is defined as: a low pressure irrigation method for uniformity applying small frequent irrigations at or near the ground level to individual furrows (usually alternate furrows) with a mechanical move system accompanied by soil-tillage methods or tillage plus crop residue management to increase surface water storage capacity. It is used on-farm with small diameter bubblers located about 0.3 m above ground and with socks or sleeves discharging water directly into furrows.

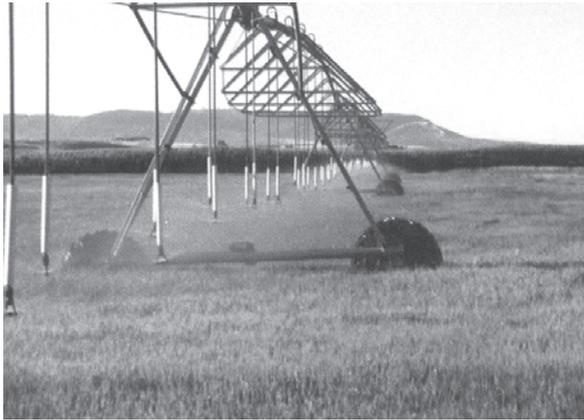
Spray irrigation is defined as: the application of water by a small spray or mist to the soil surface, where travel through the air becomes instrumental in the distribution of the water. It was developed to reduce the droplet evaporation and drift inherent with impact sprinklers. The sprinkler manufacturers have developed many types of spray heads and today many combinations of pressure regulators and spray heads, nozzles and deflector plates are commercially available.

Today the CP irrigation systems are mainly available in three types: a) The LEPA sock, b) The LEPA bubbler, c) The sprayer.

The bubbler mode produces an umbrella shaped pattern approximately 0.4 to 0.5 m in diameter, which minimizes wind effects and only wets part of the soil surface. This so called true LEPA system as developed and introduced by Lyle and Bordovsky (1981). The spray mode produces a horizontal spray approximately 2.5 to 3.3 m in diameter, which wets the entire soil surface. The so-called chemigate mode produces a 60° upward spray, which sprays the underside of the leaves). Lately new sprayers have been developed.

Commercial LEPA heads and nozzles, which can operate in the three different modes by changing the pad and hood positions, are now available. So, the same product can be used for pre-irrigation and germination, irrigation with the bubbler mode and chemigation.

FIGURE 10.3 - Hose drops with sprayers.



The Central Tower

This is a pyramidal structure of about 3.5–4.5 m height, built up with galvanized steel angular profiles and anchored on a concrete square platform. This structure has an access ladder. It is the head of the system and carries all equipment necessary for the control of the system, such as the system water fed up-going piece of pipe with the elbow on the top and inlets for fertilizer injection; the Collector ring, the Central Control Panel.

The CP System Control

A modular control panel, protected in a cabinet, is installed on the pivot central tower and enables handling of the irrigation machine and the programming of irrigation, thus the control of flow and pipeline movement—operation time and speed/time per lap (Figure 10.4). A voltmeter and several pilot lights indicate control tension, support tower alarm and lack of pressure. Automatic starter, position stop device, automatic shut-off and hour counter are included too in a standard control panel. Manufacturers offer several models of various level of control including full telemetry control with the use of cellular telephone.