



# The Centre Pivot Irrigation System

## IRRIGATION

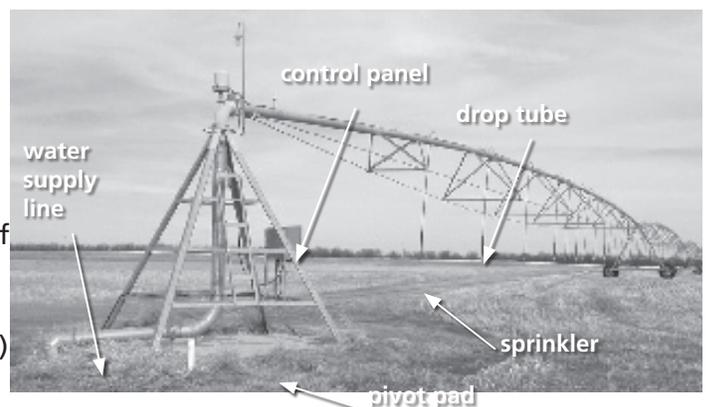
Centre pivots are the most common irrigation system used in Saskatchewan. The rapid rise in the province's irrigated acreage in the early 1980s is attributed to this machine's ability to irrigate rough topography, as well as to its wide range of operating pressures and its low labour requirements.

The centre pivot is a sprinkler irrigation system that applies small amounts of water at frequent intervals to a unit area of crop. It consists of a span of pipe which is supported on wheeled A-frame towers and is self-propelled around a central pivot point. The pipe delivers the water to the sprinklers. Water is usually delivered to the pivot point through a buried mainline pipe.

In-line pressure regulators can prevent over watering as the topography of a field changes. For example, in low-lying areas of a field, regulators maintain constant pressure for consistent flow, compensating for the higher system pressure normally resulting from such variable terrain conditions. The systems can also be adapted with corner sections which rotate independently to more completely irrigate rectangular or odd-shaped fields. Corner systems can increase the irrigated area under a centre pivot by up to 15 per cent.



The system may vary in length from approximately 60 m to 790 m (200 to 2,600 ft.) and is capable of irrigating a circular area up to 200 ha (500 ac.). The most common system irrigates a circle of approximately 54 ha (133 ac.) of a square quarter section. Pressure required at the pivot may vary from approximately 70 kPa (10 psi) when low-pressure spray nozzles are used, to 550 kPa (80 psi) when high-pressure impact sprinklers are used.



The current Saskatchewan recommendations for matching pivot and pressures to soil and topography are listed in Tables 1 and 2.

|                                    | kPa     | psi   |
|------------------------------------|---------|-------|
| Low Pressure Spray Nozzle (LPS)    | 175     | < 25  |
| Low Pressure Impact or Spray (LPI) | 175-275 | 25-40 |
| Medium Pressure                    | 275-380 | 40-55 |
| High Pressure                      | 380+    | 55+   |

<sup>1</sup>Pressure conversion: 1 kPa = 0.145 psi

Although low-pressure systems (LPS) represent a considerable savings in energy costs, care must be taken in choosing the most suitable system. Low pressure pivots have a higher rate of application than other systems. They are most suitable for coarse textured soils with relatively flat topography. Use of an LPS on fine-textured soil or hilly landscapes could result in ponding of water, erosion and run-off. Sprinkler technology is constantly changing and new designs can sometimes overcome some of these problems with operating pressures. Surface drainage to eliminate potential wet areas is essential on all fields, whether high or low pressure systems are used.

## DRIVE SYSTEMS

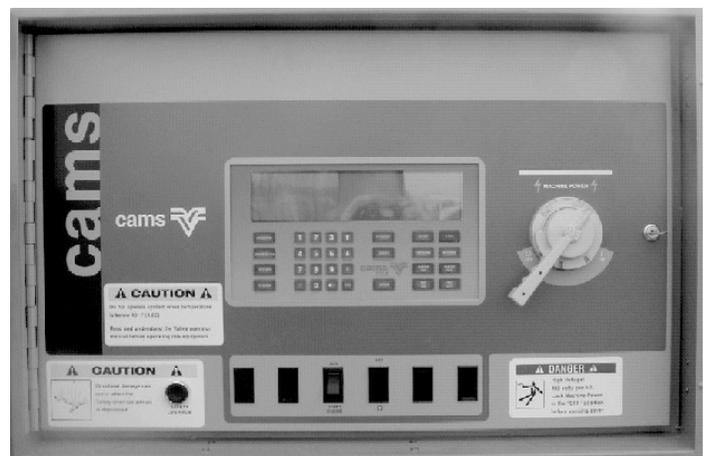
### Electric Drive

The wheels are driven by the electric motor, which is mounted in the centre on the tower mainframe between the wheels. Drive shafts run from the motor to a gearbox on each wheel, which provides the power transfer from the motor to the wheels. The pivot can be moved with or without water running through the system. This allows an irrigator to move the pivot out of the way of field operations.

The speed of the pivot is controlled by controlling the motor on the end tower – the tower furthest from the pivot point. The control panel (pictured above), which is located at the pivot point, is

| Topography  | Soil Texture |             |             |
|---|--------------|-------------|-------------|
|   | Coarse       | Medium      | Fine        |
| None – Level to Nearly Level<br>Less Than 2% Slopes | LPS          | LPI         | Medium      |
| Slight – Very Gently Rolling<br>2-5% Slopes         | LPS          | LPI         | High-Medium |
| Moderate – Slightly Rolling<br>6-9% Slopes          | LPI          | Medium      | High        |
| Severe – Rolling to Hilly<br>9-30% Slopes           | Medium       | High-Medium | High        |

|        |   |
|--------|---|
| Coarse | Sandy (S), Loamy Sand (LS), Sandy Loam (SL), Fine Sandy Loam (FSL)                                  |
| Medium | Loam (L), Silt Loam (SiL), Very Fine Sandy Loam (VL)  |
| Fine   | Clay Loam (CL), Sandy Clay Loam (SCL), Sandy Clay (SC), Silty Clay (SiC), Clay (C), Heavy Clay (HC) |



equipped with a timer which controls the percentage of time per minute that the motor on the lead tower is operating. Computerized control panels are capable of determining their position in the field, and an irrigator can program different application rates in different parts of the field.

The movement of the end tower causes the other towers of the pivot to move, responding to an alignment system designed to keep the pivot towers in a straight line formation. Alignment is controlled in electric pivots by either a cable system or by a micro switch linkage system. As a tower lags behind the lead tower, a micro switch is triggered to start the motor and move the lagging tower back into alignment.

Safety systems are built to shut the whole system off if a tower fails to come back into alignment. The system will also shut down if the pressure drops below a set working pressure or if the system is not advancing through the field fast enough.

### **Oil Drive**

The basic design of an oil drive pivot is similar to the electric drive pivot. However, rather than electricity, the driving force is pressurized oil, delivered from a hydraulic pump located at the pivot point. Hydraulic pressure lines travel the length of the pivot, providing oil to the hydraulic motors at each wheel. The speed of a hydraulic drive pivot is controlled by an oil flow control valve, which regulates oil delivery to the hydraulic motors.

The oil drive pivot has the same advantages as the electric drive pivot – it can be operated at any pressure and can be moved easily to allow for field operation.

### **Water Drive**

The water drive pivot operates similarly to the oil or electric pivot, in that the end tower controls the speed. However, it differs in that the power to propel the pivot comes from water pressure rather than from oil or electrically powered motors. Water drive pivots can either be powered by spinner drive or piston drive systems.

The major limitation of the water drive pivot is that it must be watering to be moved, and therefore cannot be moved out of the way of field operations. Also, these systems must be run at high pressure, which can increase the cost of pumping as compared to a low pressure system. Because of these limitations, water drive systems are no longer manufactured.

## **CENTRE PIVOT WATER APPLICATION**

A centre pivot's water application is fixed by the pumping flow rate, regardless of the speed of the pivot's

**RULE OF THUMB: 450 U.S. gpm = 1 acre-inch per hour**

revolution. The pumping flow rate is measured in U.S. gallons per minute (gpm). A centre pivot that puts out 800 U.S. gpm will apply about 1.8 acre inches per hour.

Not all the water pumped enters the soil for crop use. Wind and evaporation losses occur. For design purposes, a figure of 80 per cent efficiency is used. In other words, 80 per cent of the pumped water gets to the crop.

To calculate your centre pivot's application rate:

- a) Divide your total U.S. gallons per minute by your irrigated acreage; for example:

$$\frac{800 \text{ U.S. gpm}}{133 \text{ acres}} = 6.0 \text{ US gpm per acre}$$

- b) Use the chart below to determine your application rates:

| <b>Litres per minute per hectare</b> | <b>U.S. gpm per acre</b> | <b>Inches per day 80% efficiency</b> | <b>Inches per week 80% efficiency</b> | <b>Hours to apply 12 in. to 133 ac.</b> |
|--------------------------------------|--------------------------|--------------------------------------|---------------------------------------|---|
| 47                                   | 5.0                      | 0.20                                 | 1.5                                   | 1400                                    |
| 51                                   | 5.5                      | 0.24                                 | 1.7                                   | 1200                                    |
| 56                                   | 6.0                      | 0.26                                 | 1.8                                   | 1100                                    |
| 61                                   | 6.5                      | 0.28                                 | 1.9                                   | 1000                                    |
| 66                                   | 7.0                      | 0.30                                 | 2.1                                   | 950                                     |
| 70                                   | 7.5                      | 0.32                                 | 2.2                                   | 900                                     |
| 75                                   | 8.0                      | 0.34                                 | 2.4                                   | 850                                     |

## **OPERATING TIPS**

### **Land Preparation**

- Drain all sloughs prior to installing pivot.
- Over-cut drains to ensure water drains out of low areas prior to accumulation.
- If drains are grassed, mow grass periodically during and after season.
- Avoid building "roads" across a slough instead of draining. Roads do not solve water accumulation problems.
- Once the pivot rut is established, fill the bottom six inches with crushed rock where traction problems occur.

### **Pivot Design Considerations**

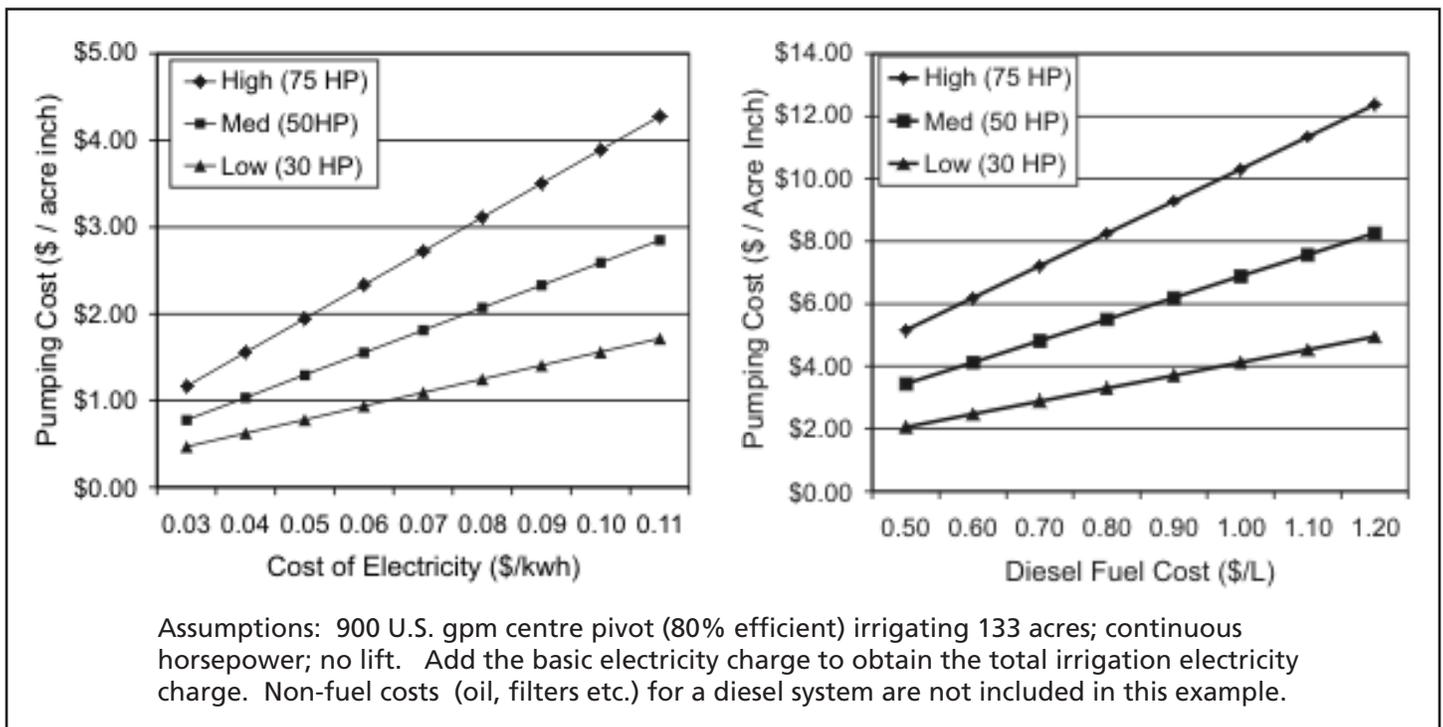
- High pressure machines cause less runoff, but are less efficient.
- Pick a sprinkler system suited to your soil type and topography.
- Tall tires provide better traction than wide tires and produce ruts easier to farm over.
- Low pressure systems have sprinkler options available that keep the area in front of the tower dry. Boom backs and part circle sprinklers are examples of this technology.

## Pivot Operations Considerations

- Run the first full circle at high speed to allow packing of the wheel track to occur;
- Watch your system for runoff. Run fast enough to avoid runoff down the wheel tracks into the low areas, but run as slow as the soil will allow to avoid excessive pivot traffic throughout the year.
- Most pivots are run at  $\frac{3}{4}$  to 1 inch per pass. Vary this on your land according to your own experience.

## Pivots as Multi-use Tools

- Pivots are often used to apply liquid fertilizer.
- Centre pivots can also be used to distribute municipal and agricultural effluent on agricultural lands.



For more information, contact SA irrigation staff at:

Outlook (306) 867-5500