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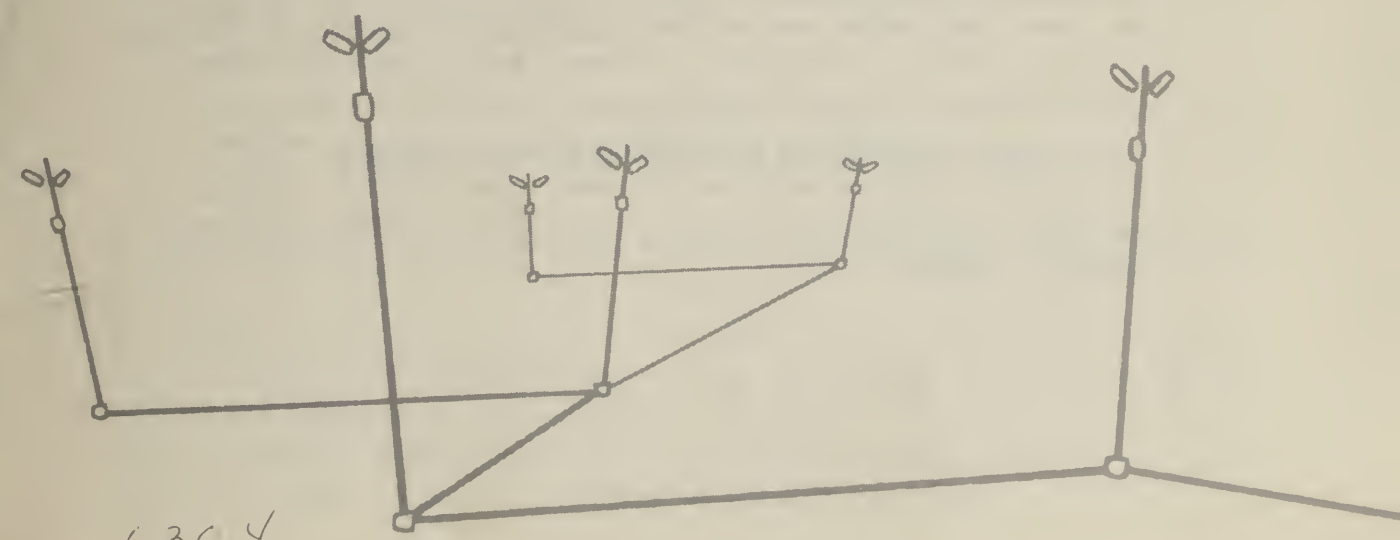
sprinkler irrigation on ranches in the southern interior of british columbia



QUESTIONS OFTEN ASKED ABOUT SPRINKLER IRRIGATION

- *Does sprinkling cut down labor costs?* Smooth fields can usually be watered easily by surface methods, but when the topography is rolling, or when the slopes are not uniform, sprinklers are more convenient.

- *Does water applied by sprinklers make better crops?* In many instances a switch to sprinklers has resulted in improved irrigation. Better irrigation by any method increases crop production.

- *Does sprinkling damage crops?* Some lodging may follow heavy applications of water. Normally, however, alfalfa recovers soon after the water has been turned off. Water on the leaves of some vegetables such as cabbage, lettuce, and beans may encourage disease.

- *Does sprinkling destroy effects of pesticide sprays?* Some of the sprayed material may be washed off by sprinkling but the amount is insignificant. A good practice, however, is to permit sprays to dry before you turn on the water.

- *Does sprinkling prevent proper pollination?* Field observations show that sprinkling does not affect the process of pollination.

- *Can a pasturing cycle be fitted into a sprinkler cycle?* A rotational system of grazing is necessary so that animals will not damage the system or cut up the wet soil by trampling. At least two fields are needed for pasture rotation. At the Research Station, Kamloops, a three-field system has been found desirable. After a field has been grazed for 7 days, the animals are removed and the field is given 14 days to recover. During this interval fertilizer is sometimes applied, clipping is done, droppings are spread with a chain harrow, and the field is watered.

SPRINKLER IRRIGATION ON RANCHES IN THE SOUTHERN INTERIOR OF BRITISH COLUMBIA

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INTRODUCTION

Sprinkler irrigation is gaining in importance in the interior of British Columbia mainly because it can be readily adapted to conditions where surface methods are not successful. Light aluminum tubing, quick couplers, better pumps, and more dependable power units and power supplies have contributed to the increased use of sprinkler irrigation.

Slopes up to 40 percent can now be easily irrigated. While it is possible to provide adequate physical controls to irrigate steep land by surface methods, the distribution system must be much more extensive and more costly. On steep land, application runs must be much shorter and ditches and various controls more numerous than on flat land, and so there will be a corresponding increase in the cost of farm operations such as cultivation, spraying, and harvesting. The savings that result from reducing these operations are difficult to evaluate but they may be substantial. Because of the rough topography, land leveling is not generally feasible on most British Columbia soils.

Because sprinkler systems are expensive you must recognize their advantages and limitations so that you may obtain maximum returns on your investment. Much information sought by farmers regarding the economic advisability of investing in sprinkler equipment is controversial. Development of criteria for design, operation, and use of sprinkler systems for maximum benefit and greatest economy has not kept pace with the rapid expansion of the sprinkler industry.

ADVANTAGES OF SPRINKLER IRRIGATION

- Land leveling is not necessary. Successful irrigation by surface methods requires that the land be leveled. This is often an expensive operation.

- Available water is put to better use. With surface methods some water is lost by runoff or by excessive percolating through the soil. A properly designed and operated sprinkler system eliminates surface runoff and reduces deep percolation losses to a minimum. If water is expensive or water supplies are limited, it may be important to avoid these losses.

- Erosion is kept to a minimum. Whenever water runs from a field it carries with it some topsoil. Surface methods may cause serious erosion, especially on steep slopes.

- Ditches are eliminated. Sprinkling does away with the ditch bank weed problem and the need for field ditches.

- Special skills are not required. Good surface irrigation generally demands a high degree of skill. No particular skill is needed to uncouple, move, and recouple the light aluminum laterals. The operation of wheel-move or tow-line equipment is expensive but it reduces considerably the labor costs of hand-move systems.

- Full production is possible the first year. Surface methods depend on well-prepared land and stabilized ditches, which may take three years or more to develop. When a sprinkler system is used, ditches and land leveling are not necessary, and often the entire farm can be irrigated the first year. This could justify the additional cost of some sprinkler systems.

- Crops can be "irrigated up," that is, a small amount of water to obtain germination and emergence of forage crops may be applied without the danger of washing out the shallow-seeded crop.

- Fertilizers can be applied in irrigation water. You can apply soluble fertilizers at any time during the season through the sprinkler system, regardless of the type of pump used and with little labor needed.

DISADVANTAGES OF SPRINKLER IRRIGATION

- Initial investment is high. A complete sprinkler system for areas of less than 20 acres may cost $270 an acre. However, systems designed for uniform fields of 40 acres or more may cost as little as $70 an acre.

- Pumping to develop pressure is a continuing cost unless you have access to streams that can provide water under pressure.

- Moving laterals is a disagreeable job. Laterals must be moved regularly over muddy fields and through wet foliage.

- The sprinkler system lacks flexibility. It is designed for one capacity only and is not easily adjusted to emergencies.

- Wind affects water distribution. Wind destroys the spray pattern and increases evaporation.

With tall crops, such as corn, the difficulties of adequate water coverage and the moving of pipes are obvious. From experience at Kamloops the best plan is to leave out two rows of corn every 60 feet and use the existing risers and sprinklers. Tall risers tend to vibrate and break off unless supported by a tripod. If a tripod is used, it is hard to move the pipes.

EQUIPMENT

Design of the System

The first thing to do is to get a suitable design and then ask various pipe suppliers or suppliers of sprinkler equipment for a quotation. With improperly designed systems, the pipe size or other parts of the system do not perform well enough. When you have chosen a design, it is wise to buy the complete system from one dealer so that he can be responsible for satisfactory results.

It may be good business to compare the cost of different systems, but cost alone should not be the only consideration when you buy a sprinkler system.

The British Columbia Department of Agriculture gives advice on designs that are submitted to them. Many of the supply companies in British Columbia employ engineering personnel who will design systems.

Water Quality

Before you decide on an irrigation system of any kind be sure to find out what quality of water is available. There are two publications on the subject. *Irrigation Water Quality of the Kamloops, B. C., Area* by J.D. Beaton and T.G. Willis (1960) is available from the Research Station, Kamloops, British Columbia. *Suitability for Irrigation of Water from Lakes and Streams in the Southern Interior of British Columbia* by J.C. Wilcox and J.L. Mason (1963), Canada Department of Agriculture Publication 1179 may be obtained from the Information Division, Department of Agriculture, Ottawa, Ontario.

Types of Sprinkler Systems

A sprinkler system usually consists of a pumping plant to supply water under pressure; a main-line pipe and laterals to convey the water; and sprinklers to spread the water over the land (Figure 1).

The "*hand-move*" system has standard aluminum pipe and fittings that are moved by hand. In the "*wheel-move*" type, heavy-gauge aluminum tubing is used with large aluminum wheels at the couplings, and a gasoline motor mounted in the center of the line propels the whole line. This type of system is much more expensive than hand-move systems but it eliminates some of the labor needed to uncouple, move, and recouple.

Another type, the "*tow-line*," consists of special tow-line couplers, double-action drains, outrigger-stabilized "highride" runners, and guide wheels. This system enables a man with a jeep or light tractor to move up to one quarter of a mile of pipe at once. The tow-line method of moving irrigation pipe is suitable only for pasture because of the solid turf, which provides a firm base for the outrigger runners and the pipe. Tow-line sys-

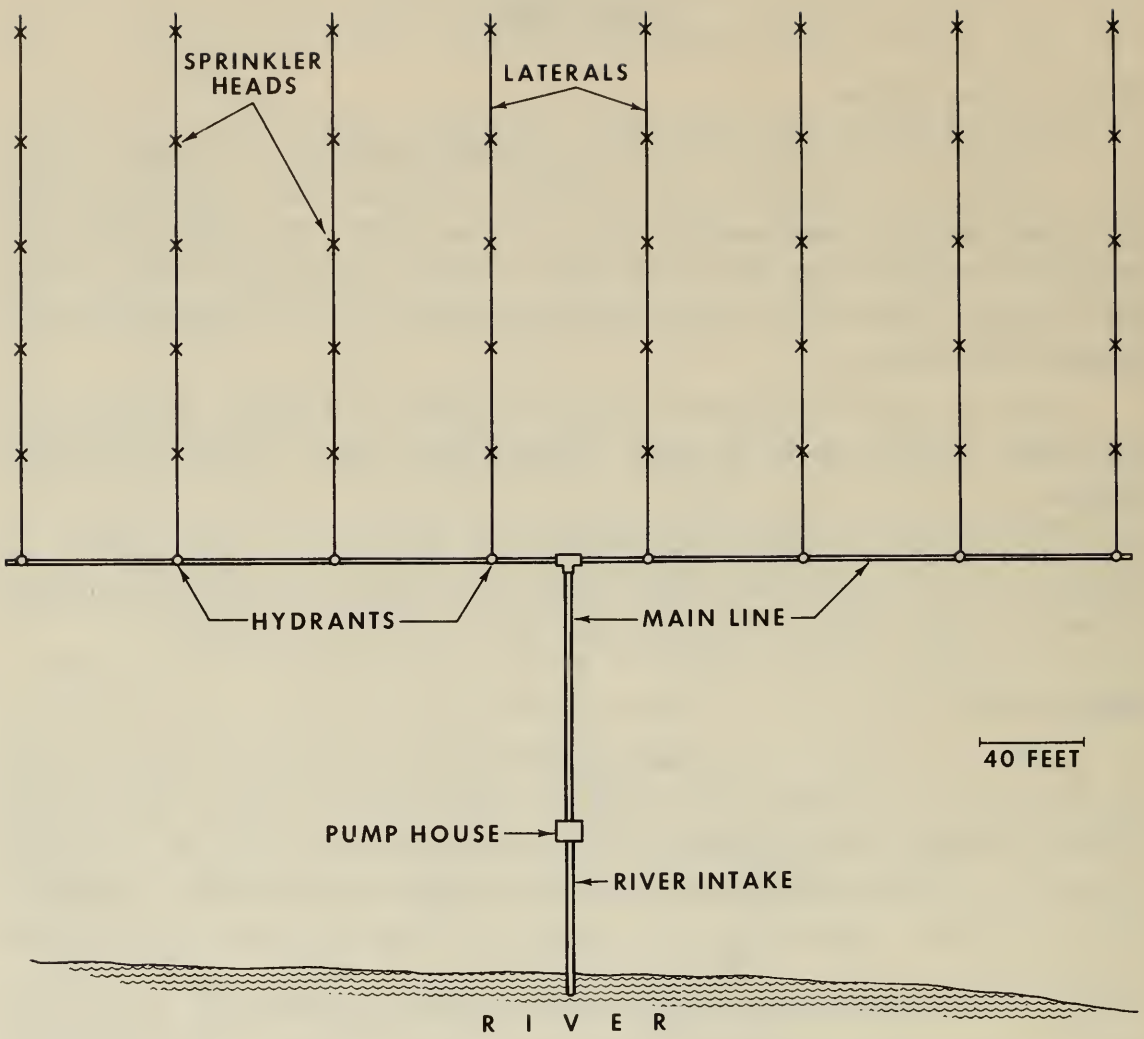

Figure 1. Diagram of a sprinkler installation.

tems will cause lodging of cereals or alfalfa.

Automatic and Semipermanent Systems

The automatic system has lateral lines that can be programed to turn on at a certain time. This means that a sprinkler program for a weekend can be carried out automatically.

The solid or semipermanent system has been used with potatoes. The lateral lines are laid out after planting is completed and they are not moved until the crop is ready for harvest.

With a normal system the pipe must be moved. If it is a hand-move operation the job can be facilitated by building a pipe rack for the farm tractor (Figure 2). The rack can be made of 1½-inch pipe welded together in the shape of an overturned rake. With one section mounted on the front

Figure 2. Tractor (with pipe rack) pulling a length of pipe to a new location.

and one on the rear of the tractor the sprinkler pipe can be set between the "tines" and moved to the other end of the field.

Pumping Plant

With the exception of a few types that operate under gravity pressure, most irrigation systems require a pumping plant. There are three types of pump: the horizontal centrifugal (the most common type), the vertical centrifugal, and the turbine. Horizontal pumps have the disadvantage that they need to be primed. Foot valves are not recommended because they increase the suction lift and often fail to work because of trash in the valve seat. Horizontal pumps have narrow limitations in suction lift and must be located as close as possible to the water source.

The vertical centrifugal pump is the same as the horizontal pump except for the position of the shaft. Horizontal pumps are more commonly used for irrigation because they are compact and easily accessible. Vertical pumps need a long shaft, which allows the motor to remain above high water while the pump is operating. A rigid frame supports the shaft bearings and the pump.

Another type of pump used in deep-well installations is the vertical turbine. As the pump bowls are usually submerged, they are not affected

by suction lift. Efficiency of deep-well turbines is comparable with that of the best horizontal centrifugal pumps. Because of their sound construction they will give long and dependable service. They do not need priming. However, they are more expensive than horizontal or vertical centrifugal pumps and are hard to inspect and repair. The amount of money spent on a pump for irrigation will depend on the value of the crops produced and the number of hours the pump will be operated during the season.

Choose a new or used pump carefully. Most pumps are built to fit a narrow set of specifications. Unless you are given the performance curve that shows the characteristics of the pump, you will not know if it is suited to your conditions. The range of conditions under which any pump will operate at high efficiency is rather limited. Beyond this range, even though the pump delivers the required amount of water, the pump operates with less efficiency and higher power cost. When you buy a sprinkler system, be sure you get all the component parts from the same source.

Power Source

Where it is available at reasonable rates, electricity is the most satisfactory power for irrigation pumping. The low cost of electric motors, their reliability, high efficiency, compactness, low cost of upkeep, and the limited attention they need when in operation make them especially desirable for the operation of pumps.

Where electricity is not available or where it is too expensive, a gasoline or diesel engine must be used. The decision on which type of engine to use will depend on the number of pumping hours required (Table 1). As an example, the high initial cost of a diesel engine may not be justified

Table 1. Cost of fuel and electric energy for pumping[1]

Power source	Unit cost of fuel or energy[2] (cents)	Cost of pumping one acre-foot each foot of elevation (cents)
Electricity	0.85 per kilowatt-hour	1.4[3]
Gasoline	23.9 per gallon	4.04
Diesel	20.9 per gallon	3.26

[1] Adapted from *Should You Buy a Sprinkler System?* Utah State Agricultural College Extension Circular 215, 1954.

[2] Costs quoted are for the Kamloops area.

[3] Overall efficiency of pump and motor assumed to be 60 percent for all types of energy.

if it is to run less than 500 hours a year and the life requirement of the engine is less than 10 years.

Main Line and Laterals

The main line can be portable or permanent. In most cases it is permanent and it can be buried. Aluminum is the usual material for pipes on or above the ground. In some installations wood stave pipe or asbestos-cement pipe is used. However, asbestos-cement is not available in sizes under 4 inches in diameter. If 2-inch pipe is needed, the answer may be wrapped aluminum or PVC plastic. Tees and shutoff valves are usually placed at every third coupler of the portable line to permit ready connection of the sprinkler laterals.

All lateral pipes now being sold are of aluminum tubing. It comes in lengths of 20, 30, and 40 feet. Until recently, 20-foot lengths were the ones most commonly used. However, more and more 40-foot lengths are now being sold because most of the sprinkler layout patterns are 40 by 60 feet, 40 by 50 feet, or 40 by 40 feet, and a 4-foot length of tubing will eliminate either a blank or an extra coupling. Forty-foot lengths of 2-inch tubing are not suitable because they buckle too easily. Flow water in laterals is usually controlled by a special main-line tee valve and a combination valve opener and elbow, or just the valve opener and elbow. These valves are simple to operate and can be disconnected and moved without shutting off the main line.

Water Intakes

For relatively long main lines sloping up from the pump it is essential that "non-slam" check valves designed to close at zero velocity be installed to prevent detrimental backflow.

If screening of the water supply is under the authority of the federal Department of Fisheries, their specifications must be adhered to in all intake installations (Figure 3). This is to prevent the loss of young salmon and trout. Recommended screen is 8-mesh wire cloth with wire 0.028 inch or 0.025 inch in diameter. The screen should be noncorrosive and an area of 10 square feet must be provided for each cubic foot of water moved per second.

Sprinklers

There are several kinds of rotating sprinklers but only two or three are in common use in British Columbia. Capacities of the rotating sprinklers commonly used vary from 2 to 25 gallons a minute. The pressure at the sprinkler nozzle should be the same as the average sprinkler spacing. As examples, 30 pounds of pressure is needed for a spacing of 30 by 30 feet

Figure 3. River intake, which can be moved up and down as the water level changes.

and 50 pounds of pressure for a spacing of 50 by 50 feet. Of the smaller sprinklers, the single-nozzle types are the most satisfactory. They give more uniform application than the double-nozzle ones. There are also some large sprinklers that have capacities of 200 to 600 gallons a minute. These need very high pressures and have not been used often in British Columbia. If it is found that the spray is too fine, a larger nozzle can be installed, and if the drops are too large, the size of the nozzle can be reduced. Sprinklers are also available with a low angle for watering under trees.

Various soil types have different water requirements, so it is difficult to give a general rule for an irrigation interval or the amount of water per setting. The information in Table 2 is a guide to water requirements of different soils under sprinkler irrigation.

The Research Station at Summerland recommends the use of pressure and flow control regulators. These eliminate the problems that accompany high pressures. For further information see Mimeo Soil Circular 15 (1965) entitled *Pressure and Flow Regulation for Sprinkler Irrigation* by J.C. Wilcox, Research Station, Summerland, British Columbia.

Fittings for an Irrigation System

Fittings include couplers, ells, tees, reducers, tee-type valves for

Table 2. Guide to water requirements of soils under sprinkler irrigation

Safe interval[1] (days)	Soil texture	Amount per irrigation (inches)	Amount per month (inches)	Flow per acre[2] (U.S. gallons per minute)
5	Sand and gravel	1.80	10.79	6.80
7	Loamy sand	2.26	9.68	6.11
10	Coarse sandy loam	2.85	8.54	5.39
12	Sandy loam	3.20	8.00	5.04
15	Fine sandy loam	3.60	7.21	4.55
20	Loam	4.18	6.27	3.96
25	Silt loam	4.60	5.51	3.48
30	Clay loam and clay	4.94	4.94	3.12

[1] The maximum number of days that can be allowed between irrigations in the heat of the summer without danger of the soil drying out too much.

[2] The greatest flow per acre required with steady irrigation.

main-line hydrants and valve opener elbows. In most sprinkler systems in British Columbia couplers appear every 20, 30, and 40 feet along a portable lateral line. Most couplers are quite similar. They have either one or two replaceable rubber seals to prevent the loss of water between the pipe and the coupler when pressure is applied, and to permit water to drain out whenever pressure is released. Couplers vary in the way they are fastened to the pipe. Some have a latch on both ends, others are bolted to the pipe on one end, and still others have one end rolled or pressed on the pipe. All couplers have enough flexibility to allow the pipe to bend slightly. Many couplers have a guard apron that helps to keep dirt from being scooped up when the pipe end is inserted.

Pressure, Nozzle Sizes, and Risers

The best overall results are had when the pressure is 45 pounds per square inch with nozzle sizes up to and including 3/16 inch, beginning with 7/32 inch, and 5 pounds of pressure for every 1/32-inch increase in nozzle size.

Because of the turbulence set up when water is diverted from one stream to another, it is necessary to have varying riser heights for different water pressures. With a recommended pressure of 45 pounds the riser height should not be less than 12 inches to ensure a well-knit stream at the nozzle.

COST OF SPRINKLER IRRIGATION

The present cost of installing a sprinkler system varies from $70 to $270 an acre; the larger the system the cheaper the cost per acre. Investment in a sprinkler system can be spread over several years. To determine the annual irrigation costs, include the interest on the investment and depreciation on the equipment. To estimate the rate of equipment depreciation, a useful life of 15 years if often used. Besides interest and depreciation charges there are the costs of power, labor, and maintenance.

The main items to consider in comparing costs of sprinkler and surface irrigation methods follow.

Item	Sprinkler irrigation	Surface irrigation
Fixed costs		
Depreciation	On all equipment, wells, pumps, power-unit pipe, sprinklers	On wells, pumps, power units, pipe conveyance, and control structures
Interest	On total capital investment for equipment, facilities, and necessary land grading	On total capital outlay for structures, equipment, facilities, and necessary land grading
Water supply	Basic water charges, purchase of water rights, construction costs to make supply available, and operation and maintenance charges	Same as sprinkler
Operating costs		
Power	For delivering water and providing necessary pressure for sprinkler operation	For pumping if source of supply is not at highest point on farm
Labor	For moving system	For applying water
Maintenance	Pumping plant and distribution system, and for silted debris removal	Floating land, surface irrigation structures, ditches, and reconstruction of furrows and borders
Benefits		
Returns	Gross return from crops	Gross return from crops

In their publication, *Cattle Ranching in the Interior of British Columbia* (Economics Division, Canada Department of Agriculture, Ottawa, Ontario, 1961), Acton and Woodward reported that the average investment for pipe sprinklers and pump for hay lands on 80 full-time ranches in British Columbia was $73 per acre irrigated. They stated that the value of irrigation equipment per animal unit varied from $5.41 to $11.78.

It is difficult to compare costs of sprinkler versus surface methods of irrigation. Topography of the land is a main factor. Some areas that can be sprinkled successfully would be impossible to irrigate by surface methods. It is wise, however, to consider whether the system will produce enough extra crop with the same or less water to make the following savings: pay the full cost of the system before it wears out, pay interest on the investment, pay increased operating costs, and leave a margin for incidentals and profit.

The cost of a hypothetical sprinkler irrigation system follows. The example shows how to arrive at a total annual cost of irrigating a 100-acre field.

Investment in equipment

Complete irrigation system	$10,000.00
Complete system per acre	100.00

Annual cost per acre irrigated

Interest: 6 percent of $100 (average investment)	6.00
Insurance and taxes: 1 percent of $100	1.00
Depreciation: $100 over 15 years	6.66
Energy for power (British Columbia Hydro provides power for pumping at $6.60 per horsepower from April 1 to October 31)	3.50
Labor for irrigating and attendance	10.00
Maintenance of the system	5.50
Total cost	32.66

The comparative cost of a 1500-foot sprinkler line exclusive of pump or main line for different types of systems is: hand-move, $1.00 per foot for 4-inch lateral; tow-line, $1.43; and wheel-move, $2.65 (Figure 4).

The measure of the success of a system is the difference between costs and returns or profits. Cost surveys in Western Canada and the United States have shown that the initial cost of sprinkler systems is almost always more than that of surface systems, and that sprinkler systems

Figure 4. Wheel-move sprinkler.

usually cost more to operate. In spite of this, irrigation by sprinklers has been rapidly increasing.

FACTORS AFFECTING THE USE OF IRRIGATION SYSTEMS

Wind

One of the most important factors to consider is the wind. Always run the lateral lines across the wind. This puts the sprinklers closer together and helps compensate for the wind. If winds are higher than 4 miles an hour, you may need to use closer spacing of sprinklers. Where a 40-foot spacing is usual you may have to place the sprinklers every 20 or 30 feet on the laterals and reduce the number of gallons per minute per sprinkler proportionately to maintain the same precipitation rate as with 40-foot spacing.

Soil Depth and Texture and Kind of Crop

The amount and frequency of water applied will depend on soil depth,

soil texture, and the crop that is growing. The texture of the soil will determine the rate of application. At the Research Station, Kamloops, the application rate is 0.22 inches per hour for an 8-hour duration. Tests have shown that the amount needed to produce 6 tons of hay per acre is 33 inches of total moisture for the growing season.

Soil Moisture

Check moisture before and after irrigating, first to see whether the wilting point has been reached and afterwards to see if the soil is near field capacity. A simple check is to try to make a ball of the soil in one hand. If it will not hold together, the moisture is low and irrigation should begin as soon as possible. If it forms a ball and also has a water sheen when squeezed in the hand, the soil will be near field capacity and contains the right amount of moisture.

This publication was prepared with the assistance of Mr. Thomas G. Willis, formerly Superintendent of the Experimental Farm, Kamloops, British Columbia.

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