WHICH IRRIGATION SYSTEM?

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At the beginning of the 1970 irrigation season, 44 percent of the Columbia Basin irrigated acreage was being sprinkled for a total of 446,596 acres. Percentage sprinkled by district was 22, 55, and 73 respectively, for the East, Quincy, and South districts. In 1959, only 25.6 percent of the irrigated acreage was sprinkled.

Practically 100 percent of newly developed land in the Basin is being sprinkled, as are private developments along the Snake and Columbia Rivers, where most of Washington's irrigation development is and will continue to take place in the next several years.

Potatoes are, and will continue to be, successfully grown by surface methods, particularly by the smaller operators who either do their own irrigating or have land and systems highly suitable to surface methods with low labor costs.

Many growers are considering changing to sprinklers and a major decision many growers and the U.S. Bureau of Reclamation must make in the next few years, concerns the method of water delivery in the east high area of the Columbia Basin project. Many would like the system pressurized at each farm unit.

Economics

Capital and annual costs of various types of sprinklers gives some clue to their effectiveness and suitability. The following table from Columbia Basin studies show little difference in annual cost of these systems. The study was not prepared specifically for potatoes, so the cost differential would be greater in favor of automated or solid set systems, with the greater number of irrigations for potatoes.

Selections of equipment are often made of the basis of availability of capital and/or of a suitable and dependable labor supply. Table 2 is a more general treatment of material shown in Table 1, but does include other systems not commonly used in potatoes in this area.

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Table 1. * Annual per acre cost of owning and operating selected sprinkler systems, Columbia Basin, Washington. 1/

160 Acres	Hand Move 60'	Hand Move 50'	Wheel Move 60'	Wheel Move 50'	Center-Pivot Hyd.	Center-Pivot Elect.
	$	$	$	$	$	$
Operating Costs						
Labor	16.40	16.27	6.56	6.51	.69	.69
Power	6.79	5.48	6.79	5.48	6.84	6.73
Other Operating	4.40	4.23	5.88	5.67	3.90	5.63
Total Operating Costs Per Acre	27.59	25.98	19.23	17.66	11.43	13.05
Overhead Costs						
Deprec. and Int.	9.09	8.97	18.75	18.15	12.25	15.40
Loss of Crop 2/					7.50	7.50
Total Overhead Costs Per Acre	9.09	8.97	18.75	18.15	19.75	22.90
Total Annual Costs Per Acre	$36.68	$34.95	$37.98	$35.81	$31.18	$35.95
-Per Acre-Inch of Water	$ .87	$ .83	$ .90	$ .85	$ .74	$ .86

1/ Costs based on distributing 42 acre-inches of water per season.

2/ Based on $100. per acre loss of crop on non-irrigated land.

* Doran, Samuel M. and Mel A. Hagood, "Economic Comparisons of Selected Semi-Portable Sprinkler Systems," Paper No. 69-230, American Society of Agricultural Engineering, 1969.

TABLE 2. COST BY TYPE OF SYSTEM.

TYPE OF SYSTEM	RELATIVE FIRST COST	RELATIVE LABOR REQUIRED FOR OPERATION
HAND-MOVE	1.0	100 %
TOW-LINE	1.5	40 %
SIDE-ROLL	1.9	40 %
TRAIL-LINE	2.0	35 %
GIANT SPRINKLER (STATIONARY)	1.2	75 %
TRAVELER (MOVING SPRINKLER)	1.7	30 %
CENTER-PIVOT	1.8	15 %
RECTANGULAR (MOVING)	2.0	25 %
SOLID-SET OR PERMANENT	5.0 and up	20 % or less

Solid Sets

Although a few systems have been installed with buried lines and pop-up risers, most systems are of two different types. One consists of portable pipe which is moved for cultural practices and the other is left more or less permanently in uncultivated strips.

The design and cost of these systems vary with their capabilities and spacing. Normal spacing of laterals and heads fall somewhere between 60 x 60 feet to 40 x 40 feet, with the most common practice being somewhere between them to fit row spacings. Although no information is available on the best design for the optimum yield, the closer spacing will provide better uniformity of water distribution in most cases, which in turn will allow higher use efficiency for water and fertilizer. Designs are possible for a wide variety of lateral and sprinkler spacings, which work satisfactorily until the wind variable is considered. Uniformities of from 80 down to 40 can be expected just from wind, but with most systems a C_u of around 75 can be planned. Uniformity Coefficient (C_u) is a term used based on a mathematical formula for computing uniformity of water distribution.

These systems may cost from $400 to $500 per acre and up to $800 to $900 when sufficient capacity for frost protection is included. Several growers rent solid set systems for their main fields and others for irrigating the corners where circle systems are being used. These are often leased with an option of purchase at the salvage value after five years of use. Yearly rental is around $65 to $75 per acre without pump and motor.

Continuous Moving Side Roll Systems

One system of this type has been used in Washington State the past two years with another five in use in 1971. Uniformity of distribution is high with this method, with tests showing C_u of 93 and an overall efficiency of 90 with five mile per hour winds. Application rates are generally lower than the outer portions of the center pivot systems, but can be high when winds blow parallel to the lateral. Where water intake problems occur and no other prohibiting factors dominate, the laterals should move into and away from prevailing winds.

The wenching system has given some problems when the required larger hoses have been used in our area. These problems are being solved, but careful attention should be given to hose size selection and friction losses, and extending the machine use beyond the acreage with the limited water capacity, especially during years like 1971 with its long hot period.

Several features of the machine give it flexibility for management. It can move from around six inches to 24 inches per minute to change the rate of application. Nozzle sizes or heads can be changed to provide a change of rate of application and amount applied. Pressures can be controlled to meet changing needs also, although these changes will alter distribution uniformity in most cases. Although the task is not unpleasant nor very time consuming, this system must be moved two times for each irrigation. This is a great improvement from hand lines and side rolls, but it is more costly than circle systems.

Center Pivot Systems

There are approximately 400 center pivot systems in the state of Washington, with some farming operations using from 40 to 50 each. Their popularity is due to low labor cost when frequent irrigations are applied. Normally from one to two revolutions per day are made on potatoes during peak water use periods.

Major problems which occur are associated with the necessary high application rates at the outer end of the system when large circles are used. Many aspects of this problem were covered in the Proceedings of the Potato Conference in 1970 in an article entitled "When Water and Soil Won't Mix." At that time, the effects of speeding up the systems, the effects of compaction, straw mulches, and minimum til-

lage, and shorter laterals were emphasized.

Two additional management practices are being considered. John Aarstad and David Miller, Agriculture Research Service located at the Irrigated Agriculture Research and Extension Center, Prosser, Washington, have shown increased yields from pitting as shown in Table 3.

TABLE 3.* EFFECT OF PITTING ON YIELD

	2' PITS		NO TREATMENT	
	TONS/ACRE			
BEETS 1970				
MERCER	32.4		22.6	
MERCER	14.8		8.9	
BEETS 1971				
MERCER	41.7		32.4	
NAKAMURA	37.4		35.8	
POTATOES 1971	TOTAL	US NO.1	TOTAL	US NO.1
MERCER	27.9	18.4	25.5	16.7
NAKAMURA	30.6	22.9	24.5	15.3

* Aarstad, John and D. E. Miller, adapted from unpublished reports. A.R.S., U.S.D.A., Prosser, Wash., 1970-1971.

Pitting consists of a series of dams and pits in the furrows between the rows for confining water where it falls. Pits were made by hand in 1970 and by a cultivator in 1971. A pitting or damming machine was used by Mercer Ranches in the Horse Heaven area on three cirlces in 1971 with an estimated 15 percent increase in yield. The machine made dams seven and one-half feet apart, which were too widely spaced for steeper slopes. The Mercer's plan to construct their own machine for the 1972 season. Another management practice which may be practical, is the planting of a deep rooted crop, an early season crop, or one of low value in the outer portions of the circle when potatoes are grown. This would allow concentrations of water on the potatoes during peak water use periods. This can be accomplished by shutting off sprinklers on the outer crops completely or by reducing the flow enough to concentrate the amount needed on the potatoes.

Two chemicals, which had been recommended for improved infiltration, were tried in a test in 1971 with the following results.

TABLE 4. INFILTRATION UNDER A CENTER PIVOT SYSTEM

TREATMENT	RUNOFF GALLONS
CHEMICAL A	5.75
CHEMICAL B	5.50
PITS	.125
NO TREATMENT	5.68

It would appear from experiences of others and from these tests that a chemical is not the answer to the compaction problem caused by falling water.