ALTERNATIVES AND COSTS OF FLOOD AND SPRINKLER IRRIGATION SYSTEMS

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The choice of an irrigation system is based upon consideration of many soil and crop characteristics as well as on economic factors. In the case of alfalfa there are two basic methods of applying water; surface and sprinkler, both having characteristics that make them suitable to a wide range of conditions. However, as it is discussed below, technical limitations may prevent the use of surface irrigation methods while economic factors may equally restrict the use of certain sprinkler methods. This emphasizes the need for a careful analysis before selecting the most appropriate irrigation method under a given set of conditions.

Factors Affecting the Selection of an Irrigation System

Table 1A highlights some of the key factors that affect the choice of an irrigation system. Among them, high soil infiltration rates and variability in this property and in water holding capacity, strongly favors the use of sprinkler over surface methods. Shallow soils that cannot be properly leveled should also discourage the use of surface irrigation. In addition, there is a limit to the amount of soil that can be moved when leveling a field. At present leveling costs, it appears that moving more than 1500 cubic yards per acre is not economically feasible.

Sprinkler irrigation is more adaptable to variable soils and usually requires less skilled labor. It is more affected by wind than surface methods but otherwise a high efficiency may be achieved with sprinkler irrigation under a wide range of topographic and soil conditions.

TABLE 1A. FACTORS AFFECTING CHOICE OF AN IRRIGATION SYSTEM

Soils

a. Infiltration rate
b. Water holding capacity
c. Depth
d. Non-uniformity in infiltration rate and water holding capacity

Economics

a. Availability of capital
b. Cost of water
c. Cost of power
d. Cost of labor

Crop

a. Evapotranspiration
b. Salt tolerance
c. Cultivation needs
d. Economic return

Topography

a. Land slope

Climate

a. Wind patterns

In situations where the land slope is not excessive and/or soils are not too shallow, economics play a major role in the selection of the most appropriate irrigation system. Investment costs will vary for the different sprinkler systems but compare well with the initial costs for surface irrigation with the probable exception of some self-propelled sprinkler systems. On the other hand, what the farmer is interested in is the total annual cost of the system including both fixed and operating costs. Annual investment costs of sprinkler systems are likely to be higher than those of surface irrigation since the depreciation period for parts of the sprinkler system is usually less.

Operating costs are a function of several variables; water, labor, energy and maintenance costs all interact to determine operating costs. Recent sharp increases in energy costs have placed sprinkler systems in an apparent disadvantage since additional energy is required to pressurize water for sprinkler irrigation. A discussion on energy requirements and costs for alfalfa irrigation is presented on next page.

Energy Requirements for Irrigation

The seasonal energy requirements of a pressurized irrigation system depend on the amount of water applied and the operating pressure. Figure 1 presents the seasonal energy requirements for alfalfa as a function of irrigation efficiency (assuming 42 acre-inches as the net irrigation requirements) and operating pressure. As can be seen, the effect of a poor irrigation efficiency becomes more critical as pressure increases. Note that the energy requirements per acre are almost double at 85% efficiency when one changes from a low pressure system (50 psi) to a high pressure system (110 psi).

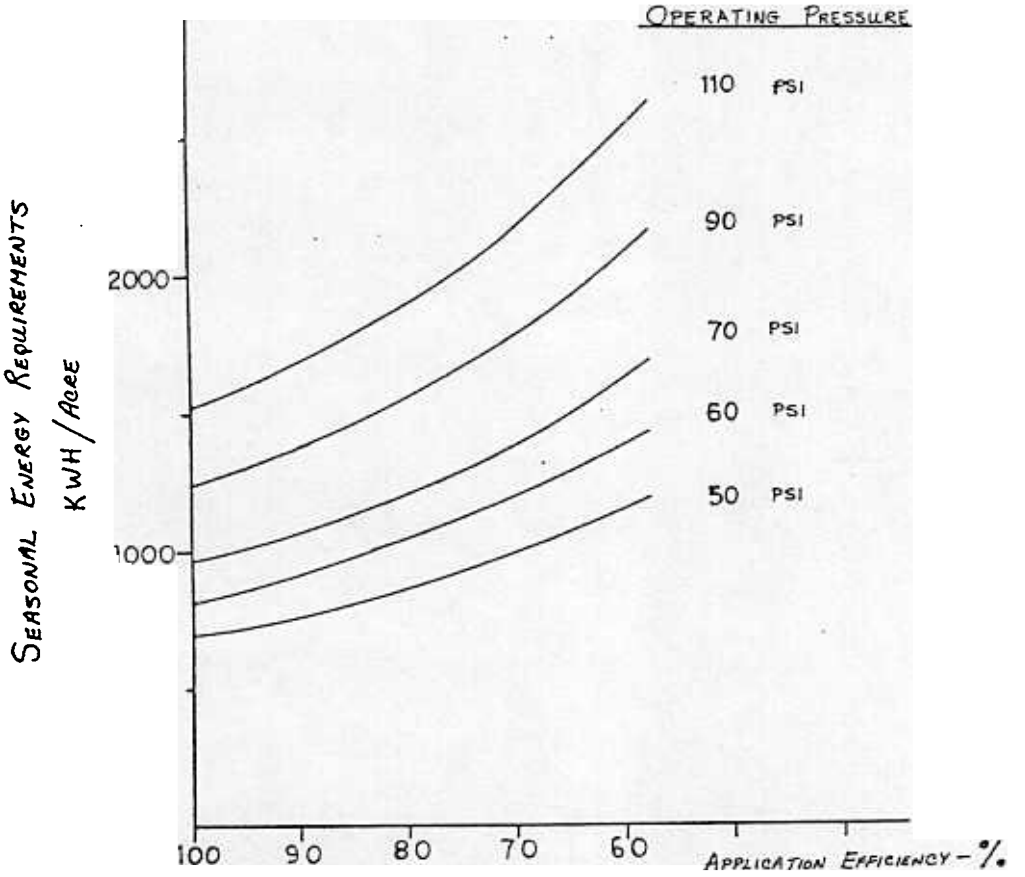

FIGURE 1 Seasonal Energy Requirements for a Pressurized Irrigation System in Alfalfa as a Function of Irrigation Efficiency and Operating Pressure

Current electrical power rates (effective July, 1977) were used in Figure 2 to calculate the pumping costs for irrigating alfalfa (net irrigation requirements equal to 42 acre-inches). Under the conditions selected for these calculations (well water, 100 foot pumping lift), the pumping costs for surface irrigation are significantly less than those calculated for sprinkler irrigation. Only when the surface irrigation efficiency decreases below 30% the energy costs approach those of the low pressure sprinkler systems at 85% efficiency.

If the pumping lift required at the well would increase, the differences between sprinkler and surface irrigation would decrease. For instance, with a 300 foot pumping lift at the well, an efficiency above 55% is needed in surface irrigation to use less energy than a sprinkler system with 85% efficiency.

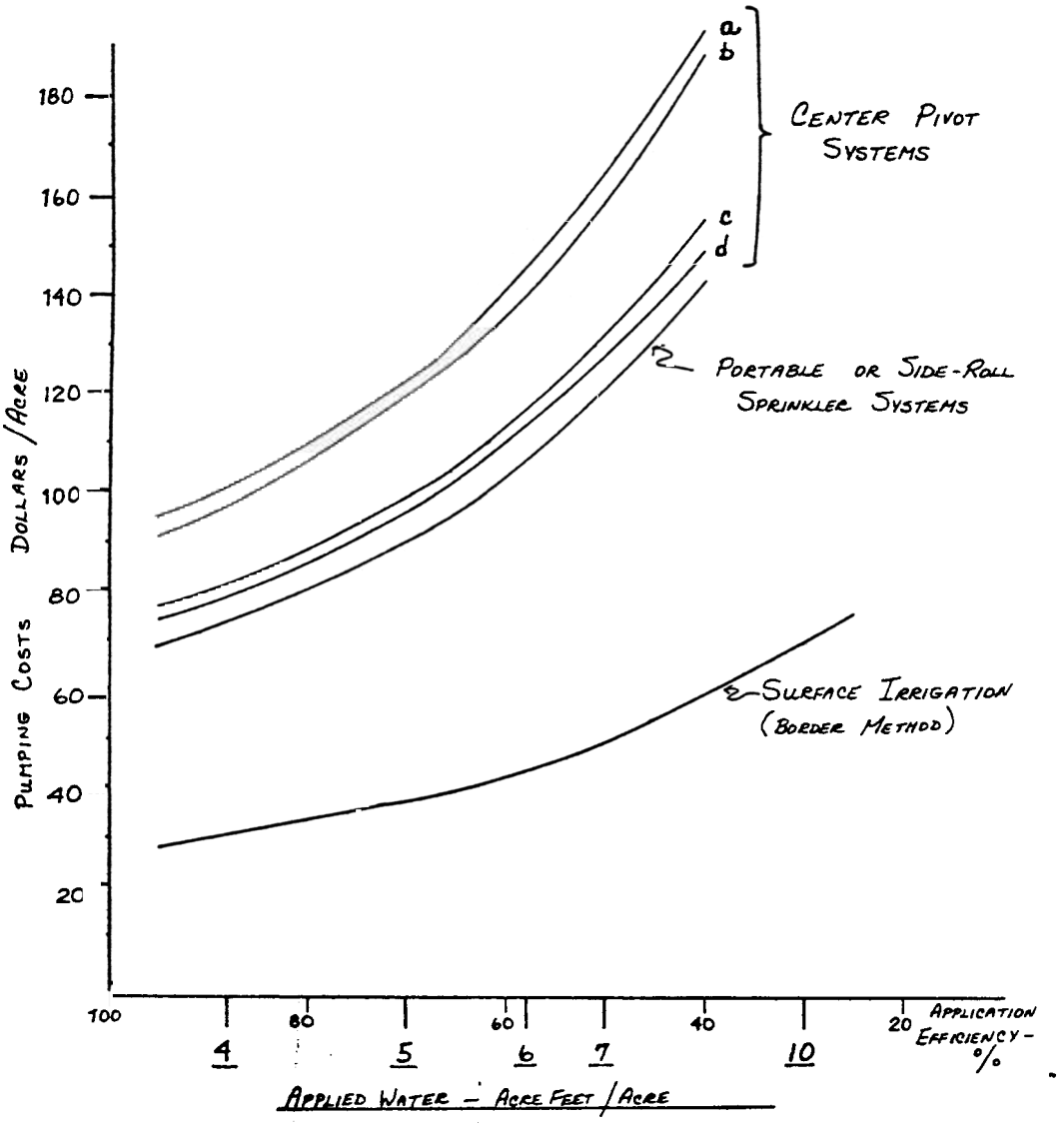

FIGURE 2. 1977 Pumping Costs for Alfalfa Irrigation as a Function of Irrigation Efficiency For Different Irrigation Systems. Water Supplied From Well (100 foot pumping lift). Center Pivot Systems Are: a) High-Pressure, Impact Sprinkler Heads, b) High-Pressure, Impact Sprinkler Heads With Cornering System, c) Low Pressure, Spray Nozzle and d) Low-Pressure, Spray Nozzle With Cornering System.

The present high energy costs have a very significant impact in the total cost of irrigation. Total irrigation costs per acre for different systems commonly used in alfalfa were calculated and are presented in the Appendix. Irrigation costs analysis are based on a number of assumptions and experience and to some extent, they may be subjective. However, a comparison between different systems can be made if uniform criteria has been used in performing the calculations.

From examining the tables in the Appendix one can tentatively conclude:

a. At the present time, it is cheaper (around $50/Acre) to irrigate alfalfa by border irrigation than by any sprinkler method.
b. Standard, high-pressure center pivot appears to be the most expensive system for alfalfa irrigation due primarily to the high energy costs and to the fact that given a 160 acre farm, only 130 acres can be irrigated with this system.
c. Low-pressure center pivot with cornering system appears much more promising and competes successfully with the side roll system. The annual costs for both systems are less than that of a hand move sprinkler system.

Investment Costs

	Per Acre	Depreciation and Interest	Taxes etc.	Total $/Acre
Grading	200	$16.00	$ 4.00	$20.00
	125	11.70	2.50	14.20
Pump	100	11.70	2.00	13.70
Pipeline & Valves	200	18.70	4.00	22.70
Tailwater System	25	2.90	.50	3.40
Total	650	$61.00	$13.00	$74.00

Operating Costs

	$ 39.30
Labor	27.00
Maintenance	6.50
	72.80
	$146.80

TABLE 2. HAND MOVE SPRINKLER SYSTEM

Investment Costs

	Per Acre	Depreciation and Interest	Taxes etc.	Total $/Acre
Well	125	$11.70	$2.50	$14.20
Pump	165	19.30	3.30	22.60
Pipes, Sprinklers	200	29.80	4.00	33.80
Total	490	$60.80	$9.80	$70.60

Operating Costs

Power	(426.7 Kwh/ac.ft.)	$ 76.90
Labor	(12 hrs x 4.50 $/hr)	54.00
Maintenance	(- 1% of investment)	4.90
	(- 4% of sprinkler system)	8.00
		$143.80

Total Irrigation Cost Per Acre

TABLE 3. SIDE ROLL SPRINKLER SYSTEM

Investment Costs

	Per Acre	Depreciation and Interest	Taxes etc.	Total $/Acre
Well	125	$11.70	$ 2.50	$14.20
Pump	165	19.30	3.30	22.60
Pipes, Sprinklers	250	37.20	5.00	42.20
Total	540	$68.20	$10.80	$79.00

Operating Costs

Power	(426.7 Kwh/ac.ft.)	$ 76.90
Labor	(6 hrs x 4.50 $/hr)	27.00
Maintenance	(-1% of investment)	5.40
	(-4% of sprinkler system)	10.00
		$119.30
	Total Irrigation Cost Per Acre	$198.30

TABLE 4. CENTER PIVOT SYSTEM (IMPACT SPRINKLERS)

Investment Costs

	Per Acre	Depreciation and Interest	Taxes etc.	Total $/Acre
Well	125	$ 11.70	$ 2.50	$ 14.20
Pump	175	20.40	3.50	23.90
Sprinkler	270	40.20	5.40	45.60
Unused Land (.23 acres)	460	36.80 (interest only)	9.20	46.00
Total	1030	$109.10	$20.60	$129.70

Operating Costs

Power	(565 Kwh/ac.ft.)	$104.30
Labor	(1.5 hrs @ 4.50)	6.80
Maintenance	(- 1% of investment	5.70
	(- 4% of sprinkler system)	10.80
		$127.60
	Total Irrigation Cost Per Acre	$257.30

TABLE 5. CENTER PIVOT WITH CORNERING SYSTEM (SPRAY NOZZLE)

Investment Costs

	Per Acre	Depreciation and Interest	Taxes etc.	Total $/Acre
Well		$11.70	$ 2.50	$14.20
Pump	165	19.30	3.30	
Sprinkler	325	48.40	6.50	54.90
Total	615			$91.70

Operating Cost

Power	(447 Kwh/ac ft.)	$ 82.40
Labor	(1.5 hr @ $4.50)	
Maintenance	- 1% of investment)	6.20
	- 4% sprinkler system)	13.00
		$108.40
	Total Irrigation Cost Per Acre	$200.10

Assumptions Involved in Calculation of Irrigation Costs

a. A 160-acre field was assumed to be irrigated with water supplied by a well having 100 foot pumping lift.

b. Operating pressures required for various sprinkler systems were assumed to be 65 psi for hand-move and side-roll sprinkler systems; 70 psi for spray nozzle center pivot and 100 psi for center pivot with impact sprinkler heads.

c. Alfalfa seasonal net irrigation requirements were assumed to be 42 acre-inches (3.5 acre-feet). Assumed border irrigation efficiency of 70% (5 acre-feet of applied water) and sprinkler irrigation efficiency of 85% (4.1 acre-feet of applied water).

d. Investment costs were calculated using capital recovery factors with an 8% interest rate and considering depreciation periods of 25 years for wells, 15 years for pumping plants, and 10 years for sprinkler systems. Unused land for standard center pivots was assessed at $2000/Acre.

e. Power costs were calculated assuming an overall power plant efficiency of 60% and using the current P.G. & E. rates (Agricultural Power Schedule PA-1 effective July 19, 1977).

$$\text{Kwh/ac.ft.} = 1.024 \frac{\text{Total suction lift (ft)}}{\text{Overall plant efficiency (.6)}}$$

f. The following list of references were used for the computation of irrigation costs.

- Planning for an Irrigation System. AAVIM Engineering Center. Athens Georgia 30601. 1971. 107 ppm.
- Sprinkler Irrigation. 4th Edition by SIA, 13975 Connecticut Ave. Silver Spring, Md. 20906, 1975. 615 pp.
- Irrigation Costs. A.D. Reed, J.L. Meyer, F.K. Aljibury and A.W. Marsh Div. of Agricultural Sciences Leaflet 2875, June 1977. 6 pp.