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Economics of sprinkler irrigation systems: handline, solid set, & wheelline

Paul E. Patterson,
Bradley A. King,
and Robert L. Smathers

Introduction

The choice of an irrigation system or decision to convert from one system to another depends on technical, economic, and financial factors. Technical factors include characteristics of the physical resources, namely climate, topography, soil texture, and the quality and quantity of the water supply. Availability and quality of labor, whether the system will be used to apply chemicals or to control frost, and cropping alternatives are other important considerations. The need to improve energy and water-use efficiency is becoming increasingly important in the decision process.

Economics also plays an important role in selecting an irrigation system. Increasing water costs or water scarcity encourages the use of more efficient irrigation systems. Increased efficiency often means greater capital cost or increased management and labor to operate a system at a higher level of efficiency. The goal is to balance increased water-use efficiency and lower labor and power costs with higher ownership costs of more capital intensive irrigation systems.

This publication provides basic cost information and cost comparisons for handline, solid set, and wheelline irrigation systems applicable to southern Idaho. This information is useful to those evaluating the economics of alternative irrigation systems or developing costs and returns estimates (enterprise budgets) for crops grown under irrigation in southern Idaho. Two companion publications, bulletin 779, *Economics of Surface Irrigation Systems*, and bulletin 787, *Economics of Low-Pressure Sprinkler Irrigation Systems: Center Pivot and Linear Move*, provide similar cost information for surface irrigation systems and continuous-move sprinkler irrigation systems, respectively.

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Methodology

The cost information contained in this publication was obtained from a survey mailed to irrigation equipment dealers in southern Idaho during February 1993 and updated in May 1996. The survey requested prices on the components for six types of sprinkler systems: (1) handline, (2) solid set, (3) wheelline, (4) center pivot with endgun, (5) center pivot with a corner system, and (6) linear move. All systems but linear move included designs for three field sizes: 40 acres, 80 acres, and 160 acres. Cost information was also obtained for state-mandated chemigation equipment. The chemigation equipment was selected based on mainline size at the pump, which is dependent on system flow rates. Chemigation equipment costs are included with the irrigation system costs found in appendix C.

Sprinkler irrigation systems are designed to meet site-specific conditions, including soil water-holding capacity, root zone depth, crop mix, peak daily water requirement, and field shape and topography. The assumed site-specific conditions for which the modeled irrigation systems are designed are presented in appendix A. While these conditions are representative of some areas of southern Idaho, they will not fit all situations. The capacity of a system appropriately designed for your situation could be greater than or less than those of the modeled systems, with corresponding changes in costs. Always discuss irrigation system design criteria with irrigation company representatives familiar with local conditions and your objectives.

Irrigation system selection criteria

Irrigation system selection starts with alternative irrigation system designs that meet site-specific conditions and the owner's or operator's specific objectives. Next, the systems are compared on an economic basis to determine the least-cost method of meeting the objectives. And last, financial feasibility for the specific operator is considered.

Two issues must be addressed to avoid bias in the economic analysis. The first is which costs to include. Equipment costs are typically classified as operating and ownership. Operating costs, also referred to as variable costs, occur when

Table 1. Irrigation system land-use efficiencies.

	40-acre field		80-acre field		160-acre field	
	Irrigated acres	Land-use efficiency	Irrigated acres	Land-use efficiency	Irrigated acres	Land-use efficiency
Handline	38.5	0.96	77	0.96	154	0.96
Solid set	38.5	0.96	77	0.96	154	0.96
Wheelline	38.5	0.96	77	0.96	154	0.96

Note: Land use efficiency = Irrigated acres ÷ field acres.
Field acres: 40 acres = 1,320' x 1,320'; 80 acres = 1,320' x 2,640';
160 acres = 2,640' x 2,640'.

Table 2. Design parameters of each system configuration.

	Field area (acres)	Irrigated area (acres)	Design capacity (gpm/acre)	Total system capacity (gpm)	Required pumping head (ft)	System horsepower (hp)
Handline	40	33.5	7.5	300	142	15
	80	77	7.5	600	148	30
	160	154	7.5	1,200	152	75
Solid set	40	33.5	7.5	300	145	15
	80	77	7.5	600	151	30
	160	154	7.5	1,200	158	75
Wheeline	40	33.5	7.5	300	119	15
	80	77	7.5	600	125	25
	160	154	7.5	1,200	129	75

equipment is utilized and include items such as labor, electricity, and repairs. Ownership costs allocate capital costs over the equipment's useful life and are not dependent on level of use. These include depreciation, interest on undepreciated value of the equipment, insurance, and property taxes (in some states). Both operating and ownership costs should be evaluated when comparing systems.

The second issue is the basis on which to make the cost comparisons. For irrigation systems this means either per field acre or per irrigated acre. The percentage of the field that can be irrigated defines the irrigation system's land-use efficiency. Land-use efficiency varies according to the system's design and how well it fits the field. A center pivot has a lower land-use efficiency than a linear move or a wheelline, assuming rectangular fields.

Many fields are laid out using the rectangular survey system (figure 1). This results in rectangular fields that can vary from 20 to 640 acres. While many natural and manmade features alter this layout, the rectangular field provides a common basis for system cost comparisons. Table 1 shows typical land-use efficiencies of set move irrigation systems for 40-, 80-, and 160-acre fields. If land is presently in production and has a high value, a low-cost system with a low land-use efficiency may be less economical than a higher cost system with a higher land-use efficiency when land is included in the analysis.

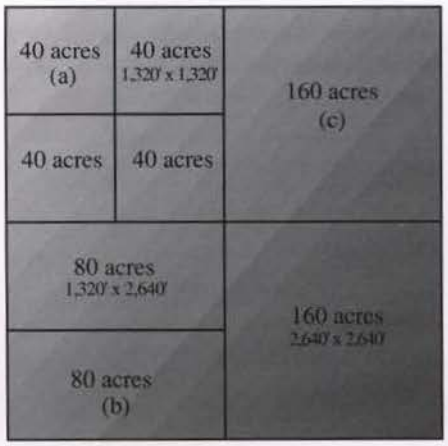

Figure 1. A full section (5,280' x 5,280') containing 640 acres or four quarter sections of 160 acres each, with the NW quarter section further divided into quarters of 40 acres each, and the SW quarter section divided into halves of 80 acres each.

Handline system

Solid set system

Irrigation system descriptions and design parameters

The irrigation systems compared in this study were designed to meet the site-specific conditions outlined in appendix A. All irrigation systems are assumed to be located on level topography with rectangular field boundaries. The water is delivered unpressurized from an irrigation district with the delivery point located in one corner of the field and no existing piping to other locations within the field. The electrical service (including three-phase power), pumping plant, and chemigation equipment are all located at the water delivery point. Structures and appurtenances required by the irrigation district to accommodate continuous flow delivery are not considered or included in system cost. The important design parameters for each system configuration are listed in table 2.

The 40- and 160-acre fields, parcel (a) and parcel (c) in figure 1, respectively, are assumed to be geometrically square. The 80-acre field is assumed to be rectangular with the long dimension two times the short dimension, parcel (b) in figure 1. The mainline for the 40- and 80-acre fields is located along one side of the field, the long side in the case of the 80-acre field. The mainline for the 160-acre field is located down the center of the field.

All irrigation system designs are comparable to those used in the area. All are designed with a system capacity of 7.5 gpm/acre, sprinkler spacing of 40 feet by 50 feet, and one lateral per 20 acres, which is common for the area. However, this combination of sprinkler spacing and design capacity is inadequate for potato production without additional rotation management considerations. For each system design, the field is divided equally between a row crop and small grain during any year. This allows for the sprinkler laterals on the small grain crop to be used on the row crop to meet its irrigation requirement during the peak water-use period during the month of July and into August. By following this rotation management scheme, these irrigation systems are capable of producing potato and sugar beet crops of desirable yield and quality.

Wheelline system

The handline and solid set irrigation systems use 3-inch laterals and 4.3 gpm flow control nozzles, requiring 54 psi at the mainline. The wheelline irrigation systems use 4-inch laterals and 4.3 gpm flow control nozzles, requiring 44 psi at the mainline. Head loss at the pumping plant due to suction and discharge minor losses and limited suction lift is assumed to be 10 feet. The total required pumping head is specified in table 2. System horsepower, also shown in table 2, represents the nearest nominal electrical motor size above that required, based on pumping head and total system flow rate. For each system, the system components, their size, and their quantity are listed in tables C-1 through C-9 in appendix C.

Findings

Capital investment

Capital requirements for the set move sprinkler systems are shown in appendix C. The chemigation equipment is listed as a component of each system. In addition to the price by component, these tables show the assumed salvage value, years of useful life, depreciation and interest, and insurance costs. The annual equivalent capital recovery method used to calculate the ownership costs is discussed in appendix B.

Total price of an irrigation system increases with field size due to increased equipment requirements. Handline irrigation systems (tables C1-C3) ranged in price from $21,877 for a 40-acre field up to $60,089 for a 160-acre field. The price of the 80-acre system was $34,320. Solid set systems (tables C4-C6) ranged in price from $65,579 for a 40-acre field up to

Table 3. Annual costs per irrigated acre for handline irrigation systems at field sizes of 40, 80, and 160 acres ($/irrigated acre).

	Irrigated acres		
	38.5	77	154
Annual operating costs			
Maintenance[1]	14.05	9.70	7.35
Labor[2]	63.80	63.80	63.80
Water[3]	24.55	24.55	24.55
Power[4]	17.05	17.05	17.05
Interest[5]	3.00	2.85	2.80
Total operating costs	122.45	117.95	115.55
Annual ownership costs[6]			
Depreciation and Interest[7]	50.10	39.90	34.65
Insurance[8]	1.55	1.15	.90
Total ownership costs	51.65	41.05	35.55
Total annual costs [9]	174.10	159.00	151.10
Adjusted land charge [10]	125.00	125.00	125.00
Total irrigation and land costs	299.10	284.00	276.10

[1] Annual maintenance cost was calculated using irrigation system maintenance coefficients in appendix A applied to the purchase price in appendix C, divided by irrigated acres.

[2] Irrigation labor costs are the average for the four-year rotation. Calculations are found in appendix A. Labor was valued at $7.25 per hour.

[3] Water costs are based on a fixed charge per field acre, $23.55, divided by the number of irrigated acres, where the fixed charge is the average cost per acre in 1996 made by the Twin Falls Canal Co., Burley Irrigation District, and the North-Side and South-Side Minidoka Irrigation Districts.

[4] Power cost was calculated per acre inch of total water applied (appendix A) based on the 1995 Idaho Power irrigation service rate schedule 24, including customer charge $10 per month, demand charge $3.52 per kW of billing demand, and energy charge of 2.8727 cents per kWh.

[5] Interest costs were calculated for operating costs, using a nominal interest rate of 10 percent and assuming the money is borrowed for three months.

[6] Values in appendix C allocated on a per-irrigated-acre basis.

[7] Depreciation and interest were calculated using the capital recovery method discussed in appendix B and a 7 percent real interest rate.

[8] Insurance was calculated using the average level of investment, as discussed in appendix B, and an insurance rate of 0.6 percent.

[9] Total annual costs = annual operating costs + annual ownership costs.

[10] Adjusted land charge = base land value rate of return x land adjustment factor, where the land adjustment factor = the inverse of the irrigation system's land-use efficiency found in table 1. The base land value was $1,200 per acre, and the rate of return was 10 percent.

Table 4. Annual costs per irrigated acre for solid set irrigation systems at field sizes of 40, 80, and 160 acres ($/irrigated acre).

	Irrigated acres		
	38.5	77	154
Annual operating costs			
Maintenance[1]	36.60	31.05	28.05
Labor[2]	36.25	36.25	36.25
Water[3]	24.55	24.55	24.55
Power[4]	17.35	17.35	17.65
Interest[5]	2.85	2.75	2.65
Total operating costs	117.60	111.95	109.15
Annual ownership costs[6]			
Depreciation and interest[7]	161.85	147.50	137.85
Insurance[8]	5.90	5.30	5.10
Total ownership costs	167.75	152.80	142.95
Total annual costs[9]	285.35	264.75	252.10
Adjusted land charge[10]	125.00	125.00	125.00
Total irrigation and land costs	410.35	389.75	377.10

[1] Annual maintenance cost was calculated using irrigation system maintenance coefficients in appendix A applied to the purchase price in appendix C, divided by irrigated acres.

[2] Irrigation labor costs are the average for the four-year rotation. Calculations are found in appendix A. Labor was valued at $7.25 per hour.

[3] Water costs are based on a fixed charge per field acre, $23.55, divided by the number of irrigated acres, where the fixed charge is the average cost per acre in 1996 made by the Twin Falls Canal Co., Burley Irrigation District, and the North-Side and South-Side Minidoka Irrigation Districts.

[4] Power cost was calculated per acre inch of total water applied (appendix A) based on the 1995 Idaho Power irrigation service rate schedule 24, including customer charge $10 per month, demand charge $3.52 per kW of billing demand, and energy charge of 2.8727 cents per kWh.

[5] Interest costs were calculated for operating costs, using a nominal interest rate of 10 percent and assuming the money is borrowed for three months.

[6] Values in appendix C allocated on a per-irrigated-acre basis.

[7] Depreciation and interest were calculated using the capital recovery method discussed in appendix B and a 7 percent real interest rate.

[8] Insurance was calculated using the average level of investment, as discussed in appendix B, and an insurance rate of 0.6 percent.

[9] Total annual costs = annual operating costs + annual ownership costs.

[10] Adjusted land charge = base land value rate of return x land adjustment factor, where the land adjustment factor = the inverse of the irrigation system's land-use efficiency found in table 1. The base land value was $1,200 per acre, and the rate of return was 10 percent.

$223,226 for a 160-acre field. The price of the 80-acre system was $119,686.

The wheelline systems (tables C7-C9) ranged in price from $31,770 for a 40-acre field up to $103,197 for a 160-acre field. The price of an 80-acre system was $55,272. These prices include the chemigation system, which ranged in price from $6,155 to $6,296. While total capital investment and ownership costs are necessary information, they are not the best basis for making a cost comparison. Irrigation system costs should be compared on an annual cost-per-acre basis.

Annual costs

Annual costs per irrigated acre for the set move irrigation systems are summarized in tables 3, 4, and 5, respectively, for the handline, solid set, and wheelline systems. A comparison of costs across the different systems is shown in table 6.

Total annual costs include both operating and ownership costs. Operating costs include maintenance, labor, water, power, and interest on operating capital. Operating costs are a function of use and depend on seasonal water requirements, the number of irrigations, and other basic assumptions specified in appendix A.

Ownership costs include depreciation, interest on the investment, and insurance. Ownership costs were calculated using the annual equivalent capital recovery method discussed in appendix B. The annual equivalent cost method of estimating ownership costs has the advantage over alternative methods because ownership costs for components with different years of useful life can be combined.

Table 5. Annual costs per irrigated acre for wheelline irrigation systems at field sizes of 40, 80, and 160 acres ($/irrigated acre).

	Irrigated acres		
	38.5	77	154
Annual operating costs			
Maintenance[1]	22.55	18.35	16.20
Labor[2]	19.95	19.95	19.95
Water[3]	24.55	24.55	24.55
Power[4]	13.90	13.65	13.65
Interest[5]	2.00	1.90	1.85
Total operating costs	82.95	78.40	76.20
Annual ownership costs[6]			
Depreciation and interest[7]	78.65	68.45	63.80
Insurance[8]	2.40	2.00	1.80
Total ownership costs	81.05	70.45	65.60
Total annual costs[9]	164.00	148.85	141.80
Adjusted land charge[10]	125.00	125.00	125.00
Total irrigation and land costs	289.00	273.85	266.80

[1] Annual maintenance cost was calculated using irrigation system maintenance coefficients in appendix A applied to the purchase price in appendix C, divided by irrigated acres.

[2] Irrigation labor costs are the average for the four-year rotation. Calculations are found in appendix A. Labor was valued at $7.25 per hour.

[3] Water costs are based on a fixed charge per field acre, $23.55, divided by the number of irrigated acres, where the fixed charge is the average cost per acre in 1996 made by the Twin Falls Canal Co., Burley Irrigation District, and the North-Side and South-Side Minidoka Irrigation Districts.

[4] Power cost was calculated per acre inch of total water applied (appendix A) based on the 1995 Idaho Power irrigation service rate schedule 24, including customer charge $10 per month, demand charge $3.52 per kW of billing demand, and energy charge of 2.8727 cents per kWh.

[5] Interest costs were calculated for operating costs, using a nominal interest rate of 10 percent and assuming the money is borrowed for three months.

[6] Values in appendix C allocated on a per-irrigated-acre basis.

[7] Depreciation and interest were calculated using the capital recovery method discussed in appendix B and a 7 percent real interest rate.

[8] Insurance was calculated using the average level of investment, as discussed in appendix B, and an insurance rate of 0.6 percent.

[9] Total annual costs = annual operating costs + annual ownership costs.

[10] Adjusted land charge = base land value rate of return x land adjustment factor, where the land adjustment factor = the inverse of the irrigation system's land-use efficiency found in table 1. The base land value was $1,200 per acre, and the rate of return was 10 percent.

Table 6. Set move irrigation system cost comparison per irrigated acre.

System type	Field size (acre)	Irrigated acres	Total operating cost ($/acre)	Total ownership cost ($/acre)	Total annual cost ($/acre)	Irrigation and land cost ($/acre)
Handline	40	33.5	122	52	174	299
Solid set	40	33.5	118	168	285	410
Wheelline	40	33.5	83	81	164	289
Handline	80	77	118	41	159	284
Solid set	80	77	112	153	265	390
Wheelline	80	77	78	70	149	274
Handline	160	154	116	36	151	276
Solid set	160	154	109	143	252	377
Wheelline	160	154	76	66	142	267

Note: Data summarized from tables 3, 4, and 5.

Maintenance

Annual maintenance costs were calculated as a percentage of the irrigation system's initial purchase price using the maintenance coefficients listed in appendix A. The maintenance cost for the entire system was then divided by the number of irrigated acres. Capital costs and maintenance costs per irrigated acre decline with increasing system size due to economies of scale for most irrigation systems.

Maintenance cost per irrigated acre for the handline system ranged from $7.35 on the 160-acre field up to $14.05 on the 40-acre field (table 3). Maintenance cost per irrigated acre for the solid set system was the highest of the three systems, ranging from a low of $28.05 on the 160-acre field up to $36.60 on the 40-acre field (table 4). Maintenance cost per irrigated acre for the wheelline system was higher than the handline system but lower than the solid set system, ranging from a low of $16.20 on the 160-acre field to a high of $22.55 on the 40-acre field (table 5).

Labor

Irrigation labor hours, based on the crop rotation average, were calculated by multiplying the number of irrigations times the irrigation labor coefficient (appendix A). The irrigation labor coefficient is the amount of labor, in hours, required per irrigation on a per-acre basis. Labor was valued at $7.25 per hour and includes a base labor rate plus 20 percent for Social Security, Medicare, unemployment insurance, workman's compensation, and other labor overhead expenses. The irrigation labor coefficient is 0.8 hours per irrigation for the handline system and 0.25 hours per irrigation for the wheelline system. The solid set irrigation system has an irrigation labor coefficient of 0.05, plus four hours per acre to set out and pick up the laterals.

Water and power

Water cost was the average of the rates charged in 1996 by the Twin Falls Canal Company, Burley Irrigation District, and the North-Side and South-Side Minidoka Irrigation Districts. The $23.55 charge was made on a field-acre basis, but allocated only to the irrigated acres. Irrigation systems with a higher land-use efficiency would therefore have a lower water charge.

Power costs were calculated using the 1995 Idaho Power irrigation service rate schedule 24. This includes a customer charge of $10 per month, a demand charge of $3.52 per kW of billing demand, and an energy charge of 2.8727 cents per kWh. Interest on the operating expenses was calculated using a 10 percent nominal interest rate and assuming the money was borrowed for three months.

Total operating costs

Total operating costs per acre decreased slightly as the size of the irrigation system increased for all three systems. This was primarily influenced by the lower maintenance cost per acre on the larger fields. Across the different sized systems, handlines had the lowest maintenance cost per acre and solid set systems had the highest. Among the three systems, wheellines had the lowest total operating costs and handlines the highest across the three field sizes.

Annual ownership costs per irrigated acre are also influenced by economies of scale and design characteristics. Costs per acre were highest for the smaller systems. Ownership costs for the handline system (table 3) ranged from a high of $51.65 for the 40-acre field to a low of $35.55 for the 160-acre field. Ownership costs for the solid set system (table 4) ranged from a high of $167.75 for a 40-acre field to a low of $142.95 for a 160-acre field. The ownership costs for the wheelline system (table 5) ranged from a high of $81.05 for the 40-acre field to a low of $65.60 for the 160-acre field.

Total annual costs

Ownership and operating costs are summed to show the total annual costs for each irrigation system in tables 3, 4, and 5 and summarized in table 6. The costs range from a low of $142 for a wheelline designed for a 160-acre field to a high of $285 for a solid set designed for a 40-acre field. The wheelline systems have the lowest total annual costs of the three systems across all field sizes, and the solid set systems have consistently the highest. The cost difference between the wheelline and handline systems is slight.

Adjusted land charge

The adjusted land charge in tables 3, 4, and 5 is based on a 10 percent return on land valued at $1,200 per acre, or $120. A land adjustment factor accounts for how efficiently the irrigation system utilizes land in the assumed field shape. The land adjustment factor is the inverse of the irrigation system's land-use efficiency (table 1). This adjustment assumes all field acres have the same value, but that only the irrigated acres pay for the land. If an adjusted land charge is included when computing irrigation system costs, the value of the land can influence the relative ranking of the different systems based on the cost per irrigated acre. Since all the set move systems compared in this study have the same land use efficiencies (table 1) the adjusted land charge will not affect the rankings.

Comparisons among systems

To facilitate the comparison among the different systems, table 6 summarizes the cost information. Comparing the cost of the same system across different field sizes shows that costs are not linear. Decreasing costs for the larger systems indicate economies of scale.

Further readings

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The authors

Paul E. Patterson, extension agricultural economist, Department of Agricultural Economics and Rural Sociology, Idaho Falls Research and Extension Center

Bradley A. King, research irrigation engineer, Department of Biological and Agricultural Engineering, Aberdeen Research and Extension Center

Robert L. Smathers, research associate, Department of Agricultural Economics and Rural Sociology, Moscow

Appendix A. Irrigation system design and operation assumptions

Location: The Mini-Cassia area of southern Idaho.
Soil type: A silt loam soil with a water-holding capacity of 2.6 inches per foot. Soil depth does not limit crop root zone.
Pumping plant efficiencies: 75 percent.

Table A-1. Allowable soil moisture depletions and crop rooting depths.

Crop	Allowable depletion (%)	Rooting depth (feet)
Potato	35	2
Sugar beet	50	2.5
Winter wheat	50	3
Spring barley	50	3

Table A-2. Peak water use month and amount.

Crop	Peak month	Water requirement (inches)
Potato	July	9.5
Sugar beet	July	9.5
Winter wheat	June	9.0
Spring barley	June	8.5

Table A-3. Peak daily water requirement (PDWR).

Crop	PDWR	
	inches/day	gpm/acre
Potato	0.31	5.9
Sugar beet	0.30	5.7
Winter wheat	0.28	5.3
Spring barley	0.30	5.7

Note: PDWR = Peak month evapotranspiration ÷ number of days per month.

Table A-4. Application efficiencies.

System type	Application efficiency (%)
Handline	65
Solid set	65
Wheelline	70

Table A-5. Crop-year irrigation water applications and number of irrigations.

Crop	Net applied (inches)	Handline/ solid set total applied (inches)	Wheelline total applied (inches)	Handline/ wheelline irrigations	Solid set irrigations
Potato	22	34	31	14	24
Sugar beet	24	37	34	15	25
Spring barley	17	26	24	7	15
Winter wheat	16	25	23	7	15
Rotation acre	20	31	29	10.75	19.75

Note: Includes all water applied to the field rounded to the nearest inch, starting after harvest of the previous crop.

Table A-6. Irrigation labor coefficients, hours per irrigation per acre.

System type	Without chemigaton	With chemigaton
Handline	0.80	—
Wheelline	0.25	—
Solid set[1]	0.05	0.07

[1]Does not include set out and pick up labor.

Table A-7. Handline irrigation system labor per irrigation and labor costs.

Crop	Irrigations (no./acre)	Labor coefficient (hr/irrigation/acre)	Irrigation labor[1] (hr/acre/season)	Irrigation labor cost [2] ($/acre)
Potato	14	0.8	11.2	81.20
Sugar beet	15	0.8	12.0	87.00
Spring barley	7	0.8	5.6	40.60
Winter wheat	7	0.8	5.6	40.60
Rotation acre	10.75	0.8	8.8	63.80

[1]Irrigation labor = irrigation x labor coefficient.
[2]Labor valued at $7.25/hr, rounded to nearest $.05.

Table A-8. Solid set irrigation system labor per irrigation and labor costs.

Crop	Irrigations (no./acre)	Set-out pick-up labor (hr/acre)	Irrigation labor coefficient (hr/irrigation/acre)	Irrigation labor[1] (hr/acre/season)	Irrigation labor cost [2] ($/acre)
Potato	24	4	0.05	5.20	37.70
Sugar beet	25	4	0.05	5.25	38.05
Spring barley	15	4	0.05	4.75	34.45
Winter wheat	15	4	0.05	4.75	34.45
Rotation acre	19.75	4	0.05	5.0	36.25

[1]Irrigation labor = (irrigations x labor coefficient) + set-out and pick-up labor.
[2]Labor valued at $7.25/hr, rounded to nearest $.05.

Table A-9. Wheelline irrigation system labor per irrigation and labor costs.

Crop	Irrigations (no./acre)	Labor coefficient (hr/irrigation/acre)	Irrigation labor[1] (hr/acre/season)	Irrigation labor cost [2] ($/acre)
Potato	14	0.25	3.50	25.35
Sugar beet	15	0.25	3.75	27.20
Spring barley	7	0.25	1.75	12.65
Winter wheat	7	0.25	1.75	12.65
Rotation acre	10.75	0.25	2.75	19.95

[1]Irrigation labor = irrigation x labor coefficient.
[2]Labor valued at $7.25/hr, rounded to nearest $.05.

Table A-10. Irrigation system maintenance coefficients.

Item	Percent
Mainline	
Buried PVC pipe	0.5
Risers, valves, outdive, openers	3.0
Thrust blocks, reducers, elbows	0
Installation/setup	0
Pump	
Pump and motor	4.0
Base and housing	1.0
Elec. base, housing panel, and wiring	2.0
Suction and discharge	3.0
Installation/setup	0
Laterals	
Handline and solid set	2
Wheelline	3
Miscellaneous	
Chemigation equipment	2
Pipe trailer	3
Concrete pond	1.0

Appendix B. Ownership cost calculations

Ownership costs for an asset lasting more that one year must be allocated over its useful life to derive an annual ownership cost. Ownership costs include both the decline in value over time based on expected use or obsolescence (depreciation) and the opportunity interest on the value of the asset. Ownership costs also include property tax and casualty insurance.

The following methods for calculating depreciation and interest and for calculating taxes and insurance are consistent with the recommendations of the National Task Force on Commodity Costs and Returns Measurement Methods sponsored by the American Agricultural Economics Association. Consistent with their recommendations, a real rather than a nominal interest rate is used.

Depreciation and interest

Depreciation and interest was calculated using the annual equivalent capital recovery technique. This method is recommended over the estimation technique using straight-line depreciation (repayment) plus return on the average investment. A real interest rate of 7 percent was used.

$$\text{Depreciation and interest} = B(a/p)^{i}_{n} - V(a/f)^{i}_{n}$$

where B = initial investment

V = salvage value

i = interest rate in decimal form

n = years of useful life

$(a/p)^{i}_{n} = i(1+i)^{n}/[(1+i)^{n}-1]$ = uniform series end-of-period amount (a) equivalent to present sum (p); or capital recovery factor.

$(a/f)^{i}_{n} = i/[(1+i)^{n}-1]$ = uniform series end-of-period amount (a) equivalent to future sum (f); or sinking fund factor.

Source: Thuesen, H. G., W. J. Fabrycky, and G. J. Thuesen. 1971. Engineering economy. New York: Prentice-Hall.

Taxes and insurance

In Idaho, irrigation equipment is exempt from personal property tax. The insurance cost calculation was made using a rate of 0.6 percent applied to the average level of investment.

$$\text{Insurance} = I\,[(B+V)/2]$$

where B = initial investment

V = salvage value

I = insurance rate

Appendix C. Capital and ownership cost summaries

Table C1. Capital investment and ownership cost summary for a 40-acre handline system, 38.5 irrigated acres.

Item	Purchase price[1] ($)	Salvage value ($)	Useful life (years)	Depreciation and interest[2] ($/year)	Insurance[2] ($/year)	Ownership costs[3] ($/year)
Mainline						
1300' of 6" PVC pipe 125#	1,898	0	30	152.95	0	152.95
26 risers and valves for 6" pipe	1,529	153	30	121.60	5.05	126.65
1 6" outdive assembly	239	0	20	21.95	0	21.95
2 thrust blocks	113	0	30	9.10	0	9.10
Installation/setup charge	1,222	0	30	98.50	0	98.50
Laterals						
2 1,300' x 3" laterals complete with valve opener, end plug, risers, 3/4" heads, and 4.3 FCN	4,046	1,214	15	395.90	15.80	411.70
Delivery charge	40	0	15	4.40	0	4.40
Pump equipment						
Pump and motor (15 hp)	1,329	266	20	118.95	4.80	123.75
Base and housing	249	25	20	22.90	.80	23.70
Electrical base, housing panel, and wiring	1,004	201	20	89.85	3.60	93.45
Suction and discharge assembly	1,384	138	20	127.25	4.55	131.80
Installation/setup charge	470	0	20	44.35	0	44.35
Miscellaneous						
Chemigation equipment[4]	6,155	923	20	558.45	21.25	579.70
Pipe trailer	1,250	250	20	111.90	4.50	116.40
Sump pond (10' x 10' x 5')	950	0	15	104.30	0	104.30
Total	**21,877**	**3,170**		**1,928.35**	**60.35**	**2,042.70**

[1]Based on 1996 prices.

[2]See appendix B

[3]Ownership costs = Depreciation and interest + Insurance.

[4]Includes chemigation assembly, injection pump and motor, mixing tank, agitator, and calibration tube.

Table C2. Capital investment and ownership cost summary for an 80-acre handline irrigation system, 77 irrigated acres.

Item	Purchase price[1] ($)	Salvage value ($)	Useful life (years)	Depreciation and interest[2] ($/year)	Insurance[2] ($/year)	Ownership costs[3] ($/year)
Mainline						
1300' of 8" PVC pipe 125#	3,263	0	30	262.95	0	262.95
1320' of 6" PVC pipe 125#	1,927	0	30	155.30	0	155.30
26 risers and valves for 8" pipe	1,725	173	30	137.20	5.70	142.90
26 risers and valves for 6" pipe	1,529	153	30	121.60	5.05	126.65
1 6" outdive assembly	239	24	20	21.95	0	21.95
1 8" x 6" reducer	68	0	30	5.50	0	5.50
3 thrust blocks	169	0	30	13.60	0	13.60
Installation/setup charge	2,489	0	30	200.60		200.60
Laterals						
4 1,300' x 3" laterals complete with valve opener and hose, levelers, 3/4" heads, 4.3 FCN, end plug, and movers	7,892	2,368	15	772.25	30.80	803.05
Delivery charge	60	0	15	6.60	0	6.60
Pump equipment						
Pump and motor (30 hp)	2,210	442	20	197.85	7.95	205.80
Base and housing	274	27	20	24.50	.90	25.40
Electrical base, housing panel, and wiring	1,330	266	20	119.05	4.80	123.85
Suction and discharge assembly	1,984	198	20	182.45	6.55	189.00
Installation/setup charge	775	0	20	73.15	0	73.15
Miscellaneous						
Chemigation equipment[4]	6,186	928	20	561.30	21.35	582.65
Pipe trailer	1,250	250	20	111.90	4.50	116.40
Sump pond (10' x 10' x 5')	950	0	15	104.30	0	104.30
Total	**34,320**	**4,829**		**3,072.05**	**87.55**	**3,159.60**

[1]Based on 1996 prices.

[2]See appendix B

[3]Ownership costs = Depreciation and interest + Insurance.

[4]Includes chemigation assembly, injection pump and motor, mixing tank, agitator, and calibration tube.

Table C3. Capital investment and ownership cost summary for a 160-acre handline irrigation system, 154 irrigated acres.

Item	Purchase price[1] ($)	Salvage value ($)	Useful life (years)	Depreciation and interest[2] ($/year)	Insurance[2] ($/year)	Ownership costs[3] ($/year)
Mainline						
1320' of 12" PVC pipe 125#	7,405	0	30	596.75	0	596.75
1300' of 10" PVC pipe 125#	5,148	0	30	414.85	0	414.85
1320' of 8" PVC pipe 125#	3,313	0	30	267.00	0	267.00
26 risers and valves for 10" pipe	1,797	180	30	142.90	5.95	148.85
26 risers and valves for 8" pipe	1,725	173	30	137.20	5.70	142.90
1 8" outdive assembly	287	29	20	26.40	0	26.40
1 12" x 10" reducer	131	0	30	10.55	0	10.55
1 10" x 8" reducer	93	0	30	7.50	0	7.50
1 90-degree 12" elbow	174	0	30	14.00	0	14.00
5 thrust blocks	281	0	30	22.65	0	22.65
Installation/setup charge	3,938	0	30	317.35	0	317.35
Laterals						
8 1,300' x 3" laterals complete with valve opener, end plug, risers, 3/4" heads, 4.3 FCN	15,600	4,680	15	1,526.55	60.85	1,587.40
Delivery charge	120	0	15	13.20	0	13.20
Pump equipment						
Pump and motor (75 hp)	5,431	1,086	20	486.15	19.55	505.70
Base and housing	349	35	20	32.10	1.15	33.25
Electrical base, housing panel, and wiring	2,173	435	20	194.50	7.80	202.30
Suction and discharge assembly	2,534	253	20	233.00	8.35	241.35
Installation/setup charge	1,094	0	20	103.25	0	103.25
Miscellaneous						
Chemigation equipment[4]	6,296	944		571.25	21.70	592.95
Pipe trailer	1,250	250	20	111.90	4.50	116.40
Sump pond (10' x 10' x 5')	950	0	15	104.30	0	104.30
Total	**60,089**	**8,064**		**5,333.35**	**135.55**	**5,468.90**

[1]Based on 1996 prices.

[2]See appendix B

[3]Ownership costs = Depreciation and interest + Insurance.

[4]Includes chemigation assembly, injection pump and motor, mixing tank, agitator, and calibration tube.

Table C4. Capital investment and ownership cost summary for a 40-acre solid set irrigation system, 38.5 irrigated acres.

Item	Purchase price[1] ($)	Salvage value ($)	Useful life (years)	Depreciation and interest[2] ($/year)	Insurance[2] ($/year)	Ownership costs[3] ($/year)
Mainline						
1300' of 6" PVC pipe 125#	1,898	0	30	152.95	0	152.95
13 risers and valves for 6" pipe	764	76	30	60.75	2.50	63.25
13 T-valve openers	709	71	30	56.40	0	56.40
26 3" aluminum line elbows	868	0	30	69.95	2.60	72.55
13 50' x 3" aluminum pipe	826	248	30	63.95	3.20	67.15
1 6" outdive assembly	239	24	20	21.95	0	21.95
2 thrust blocks	113	0	30	9.10	0	9.10
Installation/setup charge	1,222	0	30	98.50	0	98.50
Laterals						
26 1,300' x 3" laterals complete with end plug, risers, 3/4" heads, and 4.3 FCN	45,760	13,728	15	4,477.90	178.45	4,656.35
Delivery charge	390	0	15	42.80	0	42.80
Pump equipment						
Pump and motor (15 hp)	1,329	266	20	118.95	4.80	123.75
Base and housing	249	25	20	22.90	0.80	23.70
Electrical panel and wiring	1,004	201	20	89.85	3.60	93.45
Suction and discharge assembly	1,384	138	20	127.25	4.55	131.80
Installation/setup charge	470	0	20	44.35	0	44.35
Miscellaneous						
Chemigation equipment[4]	6,155	923		558.45	21.25	579.70
Pipe trailer	1,250	250	20	111.90	4.50	116.40
Sump pond (10' x 10' x 5')	950	0	15	104.30	0	104.30
Total	**65,579**	**15,950**		**6,232.20**	**226.35**	**6,458.55**

[1]Based on 1996 prices.

[2]See appendix B

[3]Ownership costs = Depreciation and interest + Insurance.

[4]Includes chemigation assembly, injection pump and motor, mixing tank, agitator, and calibration tube.

Table C5. Capital investment and ownership cost summary for an 80-acre solid set irrigation system, 77 irrigated acres.

Item	Purchase price[1] ($)	Salvage value ($)	Useful life (years)	Depreciation and interest[2] ($/year)	Insurance[2] ($/year)	Ownership costs[3] ($/year)
Mainline						
2570' of 8" PVC pipe 125#	6,451	0	30	519.85	0	519.85
26 risers and valves for 8" pipe	1,725	173	30	137.20	5.70	142.90
26 T-valve openers	1,417	142	30	112.70	0	112.70
52 3" aluminum line elbows	1,737	0	30	127.80	5.20	133.00
26 50' x 3" aluminum pipe	1,651	495	30	140.00	6.45	146.45
1 8" outdive assembly	287	29	20	26.40	0	26.40
2 thrust blocks	113	0	30	9.10	0	9.10
Installation/setup charge	2,467	0	30	198.80	0	198.80
Laterals						
52 1,300' x 3" laterals complete with end plug, risers, 3/4" heads, and 4.3 FCN	88,920	26,676	15	8,701.40	346.80	9,048.20
Delivery charge	780	0	15	85.65	0	85.65
Pump equipment						
Pump and motor (30 hp)	2,210	442	20	197.85	7.95	205.80
Base and housing	274	27	20	25.20	.90	26.10
Electrical panel and wiring	1,110	222	20	99.35	4.00	103.35
Suction and discharge assembly	1,634	163	20	150.25	5.40	155.65
Installation/setup charge	525	0	20	49.55	0	49.55
Miscellaneous						
Chemigation equipment[4]	6,186	928	20	561.30	21.35	582.65
Pipe trailer	1,250	250	20	111.90	4.50	116.40
Sump pond (10' x 10' x 5')	950	0	15	104.30	0	104.30
Total	**119,686**	**29,547**		**11,359.00**	**408.20**	**11,766.80**

[1]Based on 1996 prices.

[2]See appendix B

[3]Ownership costs = Depreciation and interest + Insurance.

[4]Includes chemigation assembly, injection pump and motor, mixing tank, agitator, and calibration tube.

Table C6. Capital investment and ownership cost summary for a 160-acre solid set irrigation system, 154 irrigated acres.

Item	Purchase price[1] ($)	Salvage value ($)	Useful life (years)	Depreciation and interest[2] ($/year)	Insurance[2] ($/year)	Ownership costs[3] ($/year)
Mainline						
1320' of 12" PVC pipe 125#	7,405	0	30	596.75	0	596.75
2570' of 10" PVC pipe 125#	10,177	0	30	820.15	0	820.15
52 risers and valves for 10" pipe	3,593	359	30	285.75	11.85	297.60
52 T-valve openers	2,834	283	30	225.40	0	225.40
1 12"x10" reducer	131	0		10.55	0	10.55
1 90-degree 12"x12" elbow	174	0	30	14.00	0	14.00
1 outdive assembly	317	32	20	29.15	0	29.15
4 thrust blocks	225	0	30	18.15	0	18.15
Installation/setup charge	4,093	0	30	329.85	0	329.85
Laterals						
104 1,300' x 3" laterals complete with end plug, risers, 3/4" heads, and 4.3 FCN	172,640	51,792	15	16,893	673.30	17,567.20
Delivery charge	1,560	0	15	171.30	0	171.30
Pump equipment						
Pump and motor (75 hp)	5,431	1,086	20	486.15	19.55	505.70
Base and housing	349	35	20	32.10	1.15	33.25
Electrical panel and wiring	2,173	435	20	194.50	7.80	202.30
Suction and discharge assembly	2,534	253	20	233.00	8.35	241.35
Installation/setup charge	1,094	0	20	103.25	0	103.25
Miscellaneous						
Chemigation equipment[4]	6,296	944	20	571.25	21.70	592.95
Pipe trailer	1,250	250	20	111.90	4.50	116.40
Sump pond (10' x 10' x 5')	950	0	15	104.30	0	104.30
Total	**223,226**	**55,470**		**21,231.40**	**784.25**	**21,148.95**

[1]Based on 1996 prices.

[2]See appendix B

[3]Ownership costs = Depreciation and interest + Insurance.

[4]Includes chemigation assembly, injection pump and motor, mixing tank, agitator, and calibration tube.

Table C7. Capital investment and ownership cost summary for a 40-acre wheelline irrigation system, 38.5 irrigated acres.

Item	Purchase price[1] ($)	Salvage value ($)	Useful life (years)	Depreciation and interest[2] ($/year)	Insurance[2] ($/year)	Ownership costs[3] ($/year)
Mainline						
1300' of 6" PVC pipe 125#	1,898	0	30	152.95	0	152.95
26 risers and valves for 6" pipe	1,529	153	30	121.60	5.05	126.65
1 6" outdive assembly	239	24	20	21.95	0	21.95
2 thrust blocks	113	0	30	9.10	0	9.10
Installation/setup charge	1,222	0	30	98.50	0	98.50
Laterals: mechanical end-drives						
2 1,300' x 4" laterals complete with valve opener and hose, levelers, 3/4" heads, and 4.3 FCN, end plug, and movers	14,406	2,881	15	1,467.05	51.85	1,518.90
Delivery/setup charge	823	0	15	90.35	0	90.35
Pump equipment						
Pump and motor (15 hp)	1,329	266	20	118.95	4.80	123.75
Base and housing	249	25	20	22.90	.80	23.70
Electrical panel and wiring	1,004	201	20	89.85	3.60	93.45
Suction and discharge assembly	1,384	138	20	127.25	4.55	131.80
Installation/setup charge	470	0	20	44.35	0	44.35
Miscellaneous						
Chemigation equipment[4]	6,155	923	20	558.45	21.25	579.70
Sump pond (10' x 10' x 5')	950	0	15	104.30	0	104.30
Total	**31,770**	**4,611**		**3,027.55**	**91.95**	**3,119.50**

[1]Based on 1996 prices.

[2]See appendix B

[3]Ownership costs = Depreciation and interest + Insurance.

[4]Includes chemigation assembly, injection pump and motor, mixing tank, agitator, and calibration tube.

Table C8. Capital investment and ownership cost summary for an 80-acre wheelline irrigation system, 77 irrigated acres.

Item	Purchase price[1] ($)	Salvage value ($)	Useful life (years)	Depreciation and interest[2] ($/year)	Insurance[2] ($/year)	Ownership costs[3] ($/year)
Mainline						
1300' of 8" PVC pipe 125#	3,263	0	30	262.95	0	262.95
1320' of 6" PVC pipe 125#	1,927	0	30	155.30	0	155.30
26 risers and valves for 8" pipe	1,725	173	30	137.20	5.70	142.90
26 risers and valves for 6" pipe	1,529	153	30	121.60	5.05	126.65
1 6" outdive assembly	239	24	20	21.95	0	21.95
1 8" x 6" reducer	68	0	30	5.50	0	5.50
3 thrust blocks	169	0	30	13.60	0	13.60
Installation/setup charge	2,489	0	30	200.60	0	200.60
Laterals: mechanical end-drives						
4 1,300' x 4" laterals complete with valve opener and hose, levelers, 3/4" heads and 4.3 FCN, end plug and movers	28,812	5,762	15	2,934.10	103.70	3,037.80
Delivery/setup charge	1,715	0	20	188.30	0	188.30
Pump equipment						
Pump and motor (25 hp)	1,837	367	20	164.45	6.60	171.05
Base and housing	274	27	20	25.20	.90	26.10
Electrical panel and wiring	1,330	266	20	119.05	4.80	123.85
Suction and discharge assembly	1,984	198	20	182.45	6.55	189.00
Installation/setup charge	775	0	20	73.15	0	73.15
Miscellaneous						
Chemigation equipment[4]	6,186	928	20	561.30	21.35	582.65
Sump pond (10' x 10' x 5')	950	0	15	104.30	0	104.30
Total	**55,272**	**7,899**		**5,271.00**	**154.65**	**5,425.65**

[1]Based on 1996 prices.

[2]See appendix B

[3]Ownership costs = Depreciation and interest + Insurance.

[4]Includes chemigation assembly, injection pump and motor, mixing tank, agitator, and calibration tube.

Table C9. Capital investment and ownership cost summary for a 160-acre wheelline irrigation system, 154 irrigated acres.

Item	Purchase price[1] ($)	Salvage value ($)	Useful life (years)	Depreciation and interest[2] ($/year)	Insurance[2] ($/year)	Ownership costs[3] ($/year)
Mainline						
1320' of 12" PVC pipe 125#	7,405	0	30	596.75	0	596.75
1300' of 10" PVC pipe 125#	5,148	0	30	414.85	0	414.85
1320' of 8" PVC pipe 125#	3,313	0	30	267.00	0	267.00
26 risers and valves for 10" pipe	1,797	180	30	142.90	5.95	148.85
26 risers and valves for 8" pipe	1,725	173	30	137.20	5.70	142.90
1 8" outdive assembly	287	29	20	26.40	0	26.40
1 12" x 10" reducer	131	0	30	10.55	0	10.55
1 10" x 8" reducer	93	0	30	7.50	0	7.50
1 90-degree 12" elbow	174	0	30	14.00	0	14.00
5 thrust blocks	281	0	30	22.65	0	22.65
Installation/setup charge	3,938	0	30	317.35	0	317.35
Laterals: mechanical end-drives						
8 1,300' x 4" laterals complete with valve opener and hose, levelers, 3/4" head and 4.3 FCN, end plug, and movers	56,648	11,330	15	5,768.75	203.95	5,972.70
Delivery/setup charge	3,430	0	15	376.60	0	376.60
Pump equipment						
Pump and motor (75 hp)	5,431	1,086	20	486.15	19.55	505.70
Base and housing	349	35	20	32.10	1.15	33.25
Electrical panel and wiring	2,173	435	20	194.50	7.80	202.30
Suction and discharge assembly	2,534	253	20	233.00	8.35	241.35
Installation/setup charge	1,094	0	20	103.25	0	103.25
Miscellaneous						
Chemigation equipment[4]	6,296	944	20	571.25	21.70	592.95
Sump pond (10' x 10' x 5')	950	0	15	104.30	0	104.30
Total	**103,197**	**14,464**		**9,827.05**	**274.15**	**10,101.20**

[1]Based on 1996 prices.

[2]See appendix B

[3]Ownership costs = Depreciation and interest + Insurance.

[4]Includes chemigation assembly, injection pump and motor, mixing tank, agitator, and calibration tube.

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