

Estimating Irrigation Costs

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Having an accurate estimate of the cost of irrigation is important when making irrigation decisions. Estimates of fixed costs are critical for investment analysis. Operating cost estimates can assist in decisions regarding additional irrigations. This fact sheet examines the costs associated with owning and operating a well, pump and gearhead, power unit and irrigation system. The analysis covers furrow, flood, border, non-towable center pivot and towable center pivot irrigation systems using a standard well. Flood, border and furrow irrigation systems are further analyzed using a deep well and a stationary relift pump system. Ownership costs are addressed first. Next, operating costs are determined. Finally, total costs per acre are examined.

The irrigation system components are described as follows. The standard well depth is 120 feet or less, and the deep well is between 120 and 240 feet deep. The well used for furrow, flood and border irrigation delivers 1,800 gallons per minute (gpm) to irrigate 120 acres. The well used for the non-towable center pivot system delivers 780 gpm to irrigate 130 acres. The towable center pivot system has two 780 gpm wells, and it irrigates 260 acres total. The deep well and stationary relift pump systems are suitable for furrow, flood or border irrigation. The relift system is an installed "L" pit stationary relift pump structure with a 20-foot maximum vertical pipe and a 2,000 gpm pumping capacity at low discharge head conditions.



Irrigation tubing placed in a rice field for multiple inlet irrigation using adjustable gates.

Ownership Costs

We begin by examining fixed (or ownership) costs on an annual basis (Table 1). A new standard well, pump and gearhead and power unit for use in furrow, flood or border irrigation can be purchased for approximately \$25,000. This translates into \$2,809.72 per year in ownership costs. Dividing this number by 120 acres gives an annual fixed cost per acre of \$23.41. The total purchase price for a new standard well, pump and gearhead, power unit and center pivot is about \$75,000. This translates to approximately \$8,577 in fixed costs per year to cover 130 acres. Thus, the annual fixed cost per acre is \$65.98.

The fixed costs include depreciation, interest expense, property taxes and insurance. In this example, the well is depreciated over 20 years, while the other items are depreciated over 15 years. The interest rate is assumed to be 8.5 percent charged on the average value and represents an opportunity cost of the capital involved. The property tax rate is 1.0 percent of the average value and is paid on all of the components of the irrigation system.

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Insurance is 0.50% of the average value and is acquired for the pump and gearhead, power unit and center pivot. It is important to note that we have calculated the average fixed cost per year over the useful life. The true fixed costs are higher than the average in the early years and less than the average in the later years.

Operating Costs

Operating (variable) costs usually consist of fuel, oil and lube, repairs and maintenance and labor expenses. Operating costs may also include irrigation tubing costs. These costs are directly proportional to the use of the equipment. One of the primary operating costs is diesel fuel. This fact sheet assumes that the surface irrigation systems use 1 gallon of diesel per acre-inch (gal/ac-in) of irrigation water for the standard well and 1.5 gal/ac-in of irrigation for the deep well. The center pivot system's diesel use is assumed to be 2 gal/ac-in of irrigation, and diesel use for the relift system is assumed to be 0.5 gal/ac-in of irrigation. Cost calculations are based on a diesel cost of \$2.20 per gallon.

Ranges of annual repair and maintenance (R&M) costs for various components of irrigation systems were adapted from Jensen¹ and are expressed as a percentage of the initial cost of the component. Percentages believed to reflect R&M conditions in Arkansas were estimated (Table 2). Since the initial cost of the well, pump and gearhead and power unit differ for the two center pivot irrigation systems, their R&M figures are also different. Multiplying the percentages times the initial cost provides annual R&M expenses for each component. The annual expenses were divided by 120 acres for the surface irrigation systems, 130 acres for the non-towable center pivot and 260 acres for the towable center pivot to get the annual R&M cost per acre. Table 3 shows the estimated inches of irrigation applied by the different systems for the season. These values were multiplied by the acres covered by each system in order to calculate the acre-inches applied. The R&M expenses were divided by the acre-inch values to determine the annual R&M cost for each system on a per acre-inch basis (Table 2).

Labor expenses consist of the hourly wage rate times the number of irrigation labor hours required. The wage rate is assumed to be \$8.12/hr.² The hours of labor required depend on the type of irrigation system being used. The hours of labor required per irrigation and per acre-inch of irrigation applied are displayed in Table 3 for each of five irrigation systems.

Costs associated with the use of flexible irrigation tubing may be applicable to furrow and border irrigation systems. These costs can include charges

for the irrigation tubing plus installing and picking up the tubing. Typical field operations associated with the use of tubing are shown in Table 4. Estimated total operating and ownership costs are \$10.30 per acre. This charge is comprised of (1) tubing machine setup, \$0.55 per acre; (2) installing tubing, \$1.76 per acre; (3) tubing cost, \$6.25 per acre; (4) inserting gates/holes, \$0.61 per acre; and (5) the cost to pick up the used irrigation tubing, \$1.13 per acre. Machinery use assumptions are footnoted in the table.

Total Cost

Knowing the ownership and operating cost associated with each component of the irrigation system allows us to look at the total cost per acre of irrigation. The annual per acre costs for 11 different irrigation systems are displayed in Table 5. A full season of furrow or border irrigation totaling 12 inches of water has an estimated total cost of approximately \$54/acre using a standard well, \$80/acre using a deep well or \$43/acre if a stationary relift system is utilized. The annual cost for a flood-irrigated row crop is approximately \$59/acre using a standard well, \$88/acre with a deep well and \$46/acre using a stationary relift. Flood irrigation for rice is estimated to cost approximately \$98/acre using a standard well, \$146/acre if a deep well is utilized or \$67/acre using a stationary relift system. A full season of sprinkler irrigation totaling 9 inches of water has an estimated total cost of \$97/acre using a towable center pivot or \$116/acre using a non-towable center pivot. Center pivot is the most expensive method of row crop irrigation. However, the cost associated with land forming and installing underground pipe with risers for the surface irrigation systems is not included in this comparison.

Marginal Cost of an Additional Irrigation

Farm managers must oftentimes decide whether or not to make an additional irrigation. The information in Table 6 on the per acre operating cost of one irrigation can help managers make this decision. An additional 3-inch irrigation using furrow or border irrigation costs approximately \$8/acre using the standard well, \$11/acre using a deep well and \$4/acre using a stationary relift system. The cost of an additional 3.5-inch flood irrigation on row crops is approximately \$9/acre using a standard well, \$13/acre with a deep well and \$5/acre using a stationary relift system. The cost of an additional 1-inch irrigation with a non-towable and towable center pivot system is \$5.61 and \$6.19/acre, respectively.

¹ Jensen, M.E., editor, "Design and Operation of Farm Irrigation System." ASAE Monograph No. 3. American Society of Agriculture Engineers, St. Joseph, Michigan.

² National Agricultural Statistics Service. Farm Labor. Washington, D.C.: U.S. Department of Agriculture, 2006.

Table 1. Investment and Annual Fixed Cost Estimates for Irrigation Systems in Arkansas.

Item	Purchase Price	Years of Life	Depreciation ¹	Property Tax ² (1.0%)	Insurance ² (0.5%)	Interest ² (8.50%)	Total	Total Per Acre ³
<i>Furrow, Border and Flood Irrigation on 120 acres: Standard Well⁴</i>								
Well	\$7,000	20	\$350.00	\$35.00		\$297.50	\$682.50	\$5.69
Pump and Gearhead	\$8,890	15	\$592.67	\$44.45	\$22.23	\$377.83	\$1,037.17	\$8.64
Power Unit	\$9,343	15	\$622.89	\$46.72	\$23.36	\$397.09	\$1,090.06	\$9.08
Total	\$25,233		\$1,565.56	\$126.17	\$45.59	\$1,072.42	\$2,809.73	\$23.41
<i>Non-Towable Center Pivot Irrigation on 130 acres: Standard Well⁴</i>								
Well	\$7,465	20	\$373.27	\$37.33		\$317.28	\$727.88	\$5.60
Pump and Gearhead	\$8,890	15	\$592.67	\$44.45	\$22.23	\$377.83	\$1,037.17	\$7.98
Power Unit	\$10,000	15	\$666.67	\$50.00	\$25.00	\$425.00	\$1,166.67	\$8.97
Center Pivot	\$48,391	15	\$3,226.04	\$241.95	\$120.98	\$2,056.60	\$5,645.58	\$43.43
Total	\$74,746.00		\$4,858.65	\$373.73	\$168.20	\$3,176.71	\$8,577.29	\$65.98
<i>Towable Center Pivot Irrigation on 260 acres: Standard Well⁴</i>								
Well	\$14,931	20	\$746.54	\$74.66		\$634.56	\$1,455.76	\$5.60
Pump and Gearhead	\$17,780	15	\$1,185.33	\$88.90	\$44.45	\$755.65	\$2,074.33	\$7.98
Power Unit	\$10,000	15	\$666.67	\$50.00	\$25.00	\$425.00	\$1,166.67	\$4.49
Center Pivot	\$52,439	15	\$3,495.91	\$262.19	\$131.10	\$2,228.64	\$6,117.84	\$23.53
Total	\$95,150		\$6,094.45	\$475.75	\$200.55	\$4,043.85	\$10,814.61	\$41.59
<i>Furrow, Border and Flood Irrigation on 120 acres: Deep Well⁴</i>								
Well	\$12,380	20	\$619.00	\$61.90		\$526.15	\$1,207.05	\$10.06
Pump and Gearhead	\$13,250	15	\$883.36	\$66.25	\$33.13	\$563.14	\$1,545.88	\$12.88
Power Unit	\$13,148	15	\$876.56	\$65.74	\$32.87	\$558.80	\$1,533.97	\$12.78
Total	\$38,778		\$2,378.92	\$193.89	\$66.00	\$1,648.09	\$4,286.90	\$35.72
<i>Furrow, Border and Flood Irrigation on 120 acres: Stationary Relift⁵</i>								
Intake Structure	\$6,320	20	\$316.00	\$31.60		\$268.60	\$616.20	\$5.14
Relift Pump	\$10,380	10	\$1,038.00	\$51.90	\$25.95	\$441.15	\$1,557.00	\$12.98
Power Unit	\$8,000	15	\$533.33	\$40.00	\$20.00	\$340.00	\$933.33	\$7.78
Total	\$24,700		\$1,887.33	\$123.50	\$45.95	\$1,049.75	\$3,106.53	\$25.90

¹ Salvage value is assumed to be zero at the end of the useful life.

² Annual fixed cost estimates for property taxes, insurance and interest are calculated by multiplying the appropriate percentage by the average value of the asset over its useful life, assuming a zero salvage value.

³ Total costs are spread across 120 acres for surface irrigation systems, across 130 acres for the non-towable center pivot irrigation system and across 260 acres for the towable center pivot irrigation system.

NOTE: The same power unit is used at both wells for the towable center pivot.

⁴ The standard well depth is 120 feet or less. The deep well is between 120 and 240 feet deep.

⁵ An installed "L" pit stationary relift pump structure with a 20-foot maximum vertical pipe and 2,000 gpm pump capacity at low discharge head conditions.

Table 2. Repair and Maintenance Per Year, Per Acre and Per Acre-Inch.¹

Standard Well² on 120 acres with Furrow, Border and Flood Irrigation Systems		Repairs and Maintenance			
Item	Annual Percentage of Purchase Cost	\$/year	\$/acre	Furrow and Border \$/ac-in	Flood Row Crop \$/ac-in
Well	1.0%	\$70.00	\$0.58	\$0.05	\$0.04
Pump and Gearhead	1.0%	\$88.90	\$0.74	\$0.06	\$0.05
Power Unit	1.0%	\$93.43	\$0.78	\$0.06	\$0.06
Total		\$252.33	\$2.10	\$0.19	\$0.15

Standard Well² on 120 acres with Flood Irrigation System		Repairs and Maintenance		
Item	Annual Percentage of Purchase Cost	Flood Rice		
		\$/year	\$/acre	\$/ac-in
Well	2.3%	\$161.00	\$1.34	\$0.04
Pump and Gearhead	2.3%	\$204.47	\$1.70	\$0.06
Power Unit	2.3%	\$214.90	\$1.79	\$0.06
Total		\$580.37	\$4.83	\$0.16

Standard Well² on 130 acres with Non-Towable Center Pivot		Repairs and Maintenance		
Item	Annual Percentage of Purchase Cost	Non-Towable Center Pivot		
		\$/year	\$/acre	\$/ac-in
Well	1.7%	\$126.91	\$0.98	\$0.11
Pump and Gearhead	1.7%	\$151.13	\$1.16	\$0.13
Power Unit	1.7%	\$170.00	\$1.31	\$0.15
Center Pivot	1.7%	\$822.64	\$6.33	\$0.70
Total		\$1,270.68	\$9.78	\$1.09

Two Standard Wells² on 260 acres with Towable Center Pivot		Repairs and Maintenance		
Item	Annual Percentage of Purchase Cost	Towable Center Pivot		
		\$/year	\$/acre	\$/ac-in
Well	3.4%	\$507.65	\$1.95	\$0.22
Pump and Gearhead	3.4%	\$604.52	\$2.33	\$0.26
Power Unit	3.4%	\$340.00	\$1.31	\$0.15
Center Pivot	3.4%	\$1,782.91	\$6.86	\$0.76
Total		\$3,235.08	\$12.44	\$1.38

Table 2. Repair and Maintenance Per Year, Per Acre and Per Acre-Inch¹. (cont.)

Deep Well² on 120 acres with Furrow, Border and Flood Irrigation Systems		Repairs and Maintenance			
Item	Annual Percentage of Purchase Cost	Flood Rice			
		\$/year	\$/acre	Furrow and Border \$/ac-in	Flood Row Crop \$/ac-in
Well	1.0%	\$123.80	\$1.03	\$0.09	\$0.07
Pump and Gearhead	1.0%	\$132.50	\$1.10	\$0.09	\$0.08
Power Unit	1.0%	\$131.48	\$1.10	\$0.09	\$0.08
Total		\$387.78	\$3.23	\$0.27	\$0.23

Deep Well² on 120 acres with Flood Irrigation System		Repairs and Maintenance			
Item	Annual Percentage of Purchase Cost	Flood Rice			
		\$/year	\$/acre	\$/ac-in	\$/ac-in
Well	2.3%	\$284.74	\$2.37	\$0.08	\$0.08
Pump and Gearhead	2.3%	\$304.76	\$2.54	\$0.08	\$0.08
Power Unit	2.3%	\$302.41	\$2.52	\$0.08	\$0.08
Total		\$891.91	\$7.43	\$0.24	\$0.24

Stationary Relift³ on 120 acres with Furrow, Border and Flood Irrigation Systems		Repairs and Maintenance			
Item	Annual Percentage of Purchase Cost	Flood Rice			
		\$/year	\$/acre	Furrow and Border \$/ac-in	Flood Row Crop \$/ac-in
Intake Structure	1.0%	\$63.20	\$0.53	\$0.04	\$0.04
Relift Pump	1.0%	\$103.80	\$0.87	\$0.07	\$0.06
Power Unit	1.0%	\$80.00	\$0.67	\$0.06	\$0.05
Total		\$247.00	\$2.07	\$0.17	\$0.15

Stationary Relift³ on 120 acres with Flood Irrigation System		Repairs and Maintenance			
Item	Annual Percentage of Purchase Cost	Flood Rice			
		\$/year	\$/acre	\$/ac-in	\$/ac-in
Intake Structure	2.0%	\$126.40	\$1.05	\$0.04	\$0.04
Relift Pump	2.0%	\$207.60	\$1.73	\$0.06	\$0.06
Power Unit	2.0%	\$160.00	\$1.33	\$0.04	\$0.04
Total		\$494.00	\$4.12	\$0.14	\$0.14

¹ Assumptions for surface irrigation systems: 120 acres and the irrigation applied per year is 12 inches for furrow and border irrigation, 14 inches for flood irrigated row crop and 30 inches for rice. Assumptions for center pivots: 9 inches per year on 130 acres for non-towable center pivot and 9 inches per year on 260 acres for the towable center pivot.

NOTE: The same power unit is used at both wells for the towable center pivot.

² The standard well depth is 120 feet or less. The deep well is between 120 and 240 feet deep.

³ An installed "L" pit stationary relift pump structure with a 20-foot maximum vertical pipe and 2,000 gpm pumping capacity at low discharge head conditions.

Table 3. Estimated Hours of Labor Required Per Acre-Inch for Various Irrigation Systems.

Irrigation System	Water Volume			Labor Required		
	(in/irr)	(irr/yr)	(in/yr)	(hrs/irr)	(hrs/yr)	(hrs/ac-in) ¹
Furrow/Border Row Crops	3	4	12	6	24	0.017
Non-Towable Center Pivot Row Crops	1	9	9	2	18	0.015
Towable Center Pivot Row Crops	1	9	9	13	117	0.05
Flood Row Crops	3.5	4	14	10.5	42	0.025
Flood Rice	30	1	30	54	54	0.015

¹Assuming a 120-acre field for each scenario except the center pivot scenario which assumes a 130-acre field.

Table 4. Estimated Per Acre Ownership and Operating Costs for Installation and Removal of Irrigation Tubing.¹

Operation/Operating Input	Diesel Fuel ²	Irrigation Labor ³	Repairs and Maintenance	Ownership Costs	Total Costs
Furrow and Border Irrigation					
Set Up Equipment		\$0.55			\$0.55
Install Pipe	\$0.43	\$0.62	\$0.07	\$0.64	\$1.76
Irrigation Tubing ⁴					\$6.25
Insert Gates/Holes		\$0.61			\$0.61
Pick-Up Pipe	\$0.21	\$0.30	\$0.03	\$0.32	\$0.86
Haul/Remove Pipe		\$0.27			\$0.27
Total					\$10.30

Assumptions

- ¹ Flood, furrow and border irrigation systems have one (1) well delivering 1,800 gpm to irrigate 120 acres. The well supplies water to three (3) risers, and each riser is located on the high side and in the center of a 40-acre field that is 1,320 feet long and 1,320 feet wide. The row length of each field is 1,320 feet, and the irrigation tubing runs 660 feet in both directions from the riser allowing the field to be irrigated in two (2) 20-acre sets.
- ² Diesel fuel cost is estimated at \$2.20/gallon. Installation and removal costs based on use of one (1) 150 hp tractor with irrigation tubing machine.
- ³ Labor cost is estimated at \$8.12/hour. Laying irrigation tubing required three (3) laborers. Picking up used irrigation tubing required two (2) laborers.
- ⁴ Irrigation tubing is 15-inch diameter, 10 mil and costs \$250 per 1/4 mile or 1,320-foot roll. Calculation is based on \$750 for three (3) rolls divided by 120 acres for a cost of \$6.25/acre.

Table 5. Annual Per Acre Ownership and Operating Costs for Alternative Irrigation Systems.

Irrigation System	Crop	Diesel Fuel¹	Irrigation Labor²	Repairs and Maintenance³	Ownership Costs	Total Costs⁴
<i>Standard Well⁵</i>						
Furrow/Border (12 in)	Row Crops	\$26.40	\$1.66	\$2.10	\$23.41	\$53.57
Non-Towable Center Pivot (9 in)	Row Crops	\$39.60	\$1.10	\$9.77	\$65.98	\$116.45
Towable Center Pivot (9 in)	Row Crops	\$39.60	\$3.65	\$12.44	\$41.59	\$97.29
Flood (14 in)	Row Crops	\$30.80	\$2.84	\$2.10	\$23.41	\$59.16
Flood (30 in)	Rice	\$66.00	\$3.65	\$4.83	\$23.41	\$97.90
<i>Deep Well⁵</i>						
Furrow/Border (12 in)	Row Crops	\$39.60	\$1.66	\$3.23	\$35.72	\$80.21
Flood (14 in)	Row Crops	\$46.20	\$2.84	\$3.23	\$35.72	\$88.00
Flood (30 in)	Rice	\$99.00	\$3.65	\$7.43	\$35.72	\$145.81
<i>Stationary Relift⁶</i>						
Furrow/Border (12 in)	Row Crops	\$13.20	\$1.66	\$2.07	\$25.89	\$42.80
Flood (14 in)	Row Crops	\$15.40	\$2.84	\$2.07	\$25.89	\$46.19
Flood (30 in)	Rice	\$33.00	\$3.65	\$4.12	\$25.89	\$66.66

¹ Diesel consumption is 1 gallon per acre-inch (ac-in) for surface irrigation systems using a standard well, 2 gallons per ac-in for the center pivot, 1.5 gallons per ac-in for surface irrigation systems using a deep well and 0.5 gallons per ac-in for surface irrigation systems using a relift system. Diesel price is \$2.20 per gallon.

² Irrigation labor expense is calculated as \$8.12/hour times the hrs/ac-in and the in/yr from Table 3.

³ Repairs and maintenance is the R&M cost per ac-in Table 2.

⁴ Total costs are spread across 120 acres for the surface irrigation systems, across 130 acres for the non-towable center pivot irrigation system and across 260 acres for the towable center pivot irrigation system.

NOTE: The furrow and border irrigation total cost includes the \$10.30/acre cost for irrigation tubing from Table 4.

⁵ The standard well depth is 120 feet or less. The deep well is between 120 and 240 feet deep.

⁶ An installed "L" pit stationary relift pump structure with a 20-foot maximum vertical pipe and 2,000 gpm pumping capacity at low discharge head conditions.

Table 6. Per Acre Cost of an Additional Irrigation for Alternative Irrigation Systems.

Operating Costs	Furrow/Border (3 in)	Flood (3.5 in)	Non-Towable Center Pivot (1 in)	Towable Center Pivot (1 in)
	Row Crops	Row Crops	Row Crops	Row Crops
Standard Well¹				
Diesel Fuel ²	\$6.60	\$7.70	\$4.40	\$4.40
Irrigation Labor ³	\$0.41	\$0.71	\$0.12	\$0.41
Repairs and Maintenance ⁴	\$0.54	\$0.53	\$1.09	\$1.38
Total	\$7.55	\$8.94	\$5.61	\$6.19
Deep Well¹				
Diesel Fuel ²	\$9.90	\$11.55	na	na
Irrigation Labor ³	\$0.41	\$0.71	na	na
Repairs and Maintenance ⁴	\$0.81	\$0.81	na	na
Total	\$11.12	\$13.07	na	na
Stationary Relift⁵				
Diesel Fuel ²	\$3.30	\$3.85	na	na
Irrigation Labor ³	\$0.41	\$0.71	na	na
Repairs and Maintenance ⁴	\$0.51	\$0.51	na	na
Total	\$4.22	\$5.07	na	na

¹ The standard well depth is 120 or less. The deep well is between 120 and 240 feet deep.

² Diesel consumption is 1 gallon per acre-inch (ac-in) for surface irrigation systems using a standard well, 2 gallons per ac-in for the center pivot, 1.5 gallons per ac-in for surface irrigation systems using a deep well and 0.5 gallons per ac-in for surface irrigation systems using a relift system. Diesel price is \$2.20 per gallon.

³ Irrigation labor expense is calculated as \$8.12/hour times the hrs/irr from Table 3.

⁴ Repairs and maintenance is calculated using the R&M per ac-in values in Table 2 times the number of inches shown for each system in this table.

⁵ An installed "L" pit stationary relift pump structure with a 20-foot maximum vertical pipe and 2,000 gpm pumping capacity at low discharge head conditions.

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