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Irrigation Cost and Return Analysis: Annual Operating Costs

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A series of four Guides provide a procedure for complete economic analysis of an irrigation system. Use this Guide with others on General Information, Annual Ownership Costs, and Cost and Return Analysis Analysis Summary.

Operating or variable costs include fuel, oil, repairs, service costs, and labor.

Follow the step-by-step procedure for itemizing annual operating costs for the example and then use information from your farm to assemble your costs of operation.

In the example explained in UMC Guide 1690, "Irrigation Cost and Return Analysis: General Information," the well is pumping 1,200 gallons per minute at a head of 57.5 feet. Water horsepower developed by the pump is 17.4 and brake horsepower is 25.9. The power unit uses gasoline. The pump is operating 270 hours per season. We will now determine annual operating costs.

Example

Work through the example using the formulas in 1b, 2b, 3b, 4b, and 5b. When working through costs for your farm use your records to enter actual costs in 1a, 2a, 3a, 4a and 5a. If you don't have records use the formulas.

Item 1: Determine fuel costs for the example with gasoline at 20 cents per gallon by using formula 1b. Obtain fuel consumption in brake horsepower hours per unit of fuel from Table 1. Multiply brake horsepower times pumping hours times cost per unit of fuel and divide by brake horsepower hours per unit of fuel to obtain the fuel cost of $139.86. Costs from an engineering pumping test have not been used in the example.

Item 2: Estimate cost of engine oil by formula 2b. Use brake horsepower hours per gallon of oil in Table 2. Multiply brake horsepower times pumping hours times cost per unit of oil and divide by brake horsepower hours per gallon of oil to obtain $7.76 for engine oil.

Item 3: Use formula 3b to estimate oil cost for the pump gear head. Use brake horsepower hours required for each gallon of oil in Table 2. Compute annual oil cost of $1.40 by multiplying brake horsepower times pumping hours times cost per unit of oil and dividing by brake horsepower hours per gallon of oil.

TABLE 1
Fuel Consumption (bhp-hrs. per unit of fuel)[1]

Fuel	Average[2]		Standard[3]
Diesel	12.5	per gallon	14.6
Gasoline	10.0	per gallon	11.5
Propane	8.0	per gallon	9.2
Natural Gas	8.0	per 100 cu. ft.	8.9
Electric	1.03	per kw.-hr.	1.18[4]

[1] To estimate fuel used per hour, divide continuous brake horsepower by the bhp-hrs/unit of fuel. For example, 60 bhp/10 bhp-hrs/gal = 6 gallons/hour.

[2] Denotes the average of a large number of irrigation pumping units tested by the University of Nebraska. Use these figures for estimating pumping costs over the life of the system.

[3] Nebraska Irrigation Pumping Test Standard. Pumping units that are new or in excellent condition and ajustment should maintain this standard.

[4] 1 hp = 746 watts, 1 kwh = 1.34 hp-hr, assuming the electric motor is 100% efficient. As 88% efficient is more realistic, .88 x 1.34 = 1.18.

TABLE 2
Oil Consumption

Type Engine	bhp-hrs. per gallon of oil
Gasoline, tractor fuel, diesel	900
Propane, natural	1000
Electric	9000
Right angle gear drive	5000

Item 4: Estimate cost of repairs and maintenance for the power unit by using formula 4b. Use cost per brake horsepower hour in Table 3. Multiply brake horsepower times pumping hours times cost per brake horsepower hour to obtain repairs and maintenance cost of $11.16.

Item 5: Use the formula in 5b to estimate repair and maintenance cost for irrigation equipment. Multiply the investment cost of $11,160 times ½ percent to obtain annual cost of $55.80.

Item 6: Routine maintenance for an irrigation reservoir includes mowing weeds and brush and eradicating muskrats. Maintain a good grass cover on the dam to prevent erosion. Sometimes wave erosion is severe enough to require riprap at the water line. Item 6 in the example is not used because the water supply is a well.

Item 7: A field that has been land-graded for surface irrigation requires maintenance for proper irrigation and drainage. This usually amounts to one or two land planings. Planing usually can be justified to improve drainage alone. If not, charge the cost as an irrigation operating expense. If more accurate figures are not available, $1.50 per acre per year may be used. In the example, the benefits of drainage justify the planing so the cost is not charged to irrigation operating costs.

Item 8: Additional seed, fertilizer, and other chemicals can be profitably invested in growing irrigated crops compared with non-irrigated crops. Additional fertilizer may cost up to $20 per acre and additional seed may cost $1 to $2. Extra harvesting costs may also be included. This cost is a highly variable item. An increase of $15 per acre is assumed in the example.

Note: the irrigator can increase his plant population and fertility levels because he plans on adequate moisture for his crops throughout the growing season. Labor and other operating expenses are saved during a year of adequate natural rainfall.

Item 9: Additional labor of irrigation must be considered in operating costs. If actual records of labor are not available use guidelines given in Table 4. In the example assume 120 acres are irrigated three times. Multiply the acreage times the number of applications times the unit of labor requirement from Table 4 to obtain total hours of labor. Multiply hours of labor times cost per hour to obtain $324 annual labor cost for the example.

Add all items to determine annual operating costs.

This material adapted from Nebraska Extension Circular 64-733, "Pump Irrigation—Cost Analysis by Deon D. Axthelm and J. F. Decker.

TABLE 3

Power Unit Repairs and Maintenance

Type Engine	Cost per bhp-hr
Gasoline, tractor fuel	$.0016
Propane, natural gas	$.0012
Diesel	$.0019
Electric motor is assumed to be $10.00 per year.	

TABLE 4

Labor Requirements

Equipment	Hours Labor Per Acre Per Application
Traveling gun sprinkler	.25[1]
Boom sprinkler	.78
Towline sprinkler	.54
Side-roll sprinkler	.55
Center pivot sprinkler	
135 acre size	.05[2]
35 acre size	.07[3]
Gated pipe	.60[4]
Hand carry portable sprinkler	.92
Solid set sprinkler	[5]

[1] This assumes four man-hours of labor plus one hour of supervision per day for a sprinkler covering 20 acres per day (2 sets). A system with buried pipe and a hose reel requires approximately one hour of labor per set plus one-half hour supervision per set.

[2] This requirement is without moving time. This is two hours per revolution for lubrication, adjustment, etc. plus two hours supervision per day. Moving requires eight man-hours.

[3] This requirement is without moving time. This is one hour per revolution for lubrication, adjustments, etc. plus one and one-half hours per day supervision. Moving requires six man-hours.

[4] This requirement is for systems requiring some pipe moving, and no tailwater pits. A system utilizing a tailwater return pump and no pipe moving should require approximately two-tenths hours/acre/application.

[5] These systems can be completely automated. One hour of supervision per day is generally sufficient.

Sample

Annual Operating Costs
(Rounded off to nearest dollar)

1. Fuel: Kind ___Gasoline___
   - a. From your records, amount used ________ x $________/unit = $ ________
   - b. If records not available, estimate from Table 1: 25.9 bhp x 270 hrs. pumping x $.20/unit of fuel ÷ 10.0 bhp-hrs/unit of fuel = $ 140
   - c. If engineering pumping test was made, ________/hr. x ______hrs. used x $______/unit = $ ________
2. Oil-Engine
   - a. From your records, amount used ________ x $________/gal. = $ ________
   - b. Estimate from Table 2: 25.9 bhp x 270 hrs. pumping x $1/gal. ÷ 900 bhp-hrs./gal = $ 8
3. Oil-Gear Drive or Electric Motor
   - a. From your records, amount used: ________ gal. x $________/gal. = $ ________
   - b. Estimate from pumping test or Table 2: 25.9 bhp x 270 hrs. pumping x $1/gal ÷ 5000 bhp-hrs./gal. = $ 1
4. SUBTOTAL: Annual Pumping Costs (1. + 2. + 3.) $ 149
   - a. Pumping cost per acre-inch: $149 ÷ 720 acre-inches = $ .21
   - b. Pumping cost per hour: $149 ÷ 270 hours = $ .55
5. Repairs and Maintenance-Power Unit
   - a. Amount spent during season = $ ________
   - b. Estimate from Table 3: 25.9 bhp x 270 hrs. pumping x $.0016/bhp-hr. = $ 11
6. Repairs and Maintenance-Irrigation Equipment
   - a. Amount spent during season
   - b. Estimate at .005 x $11,160 purchase price of irrigation equipment = $ 56
7. Irrigation Reservoir Maintenance = $ ________
8. Maintenance of fields put to grade: $ ________
   - a. From your records: $ ________
   - b. Estimate: $________/acre x ________ acres = $ ________
9. Labor
   - a. From your records, ________ hours x $________/hour = $ ________
   - b. Estimate from Table 4: .60 hrs./acre/application x 3 applications x 120 acres x $2.00/hr. = $ 432
10. Additional seed, fertilizer, and other chemicals, plus additional harvesting costs: $15/acre x 120 acres = $ 1800

Total Annual Operating Costs (4. + 5. + 6. + 7. + 8. + 9.) $ 2448

Total Annual Operating Costs/Acre: $2448 ÷ 120 acres = $ 20.40

Annual Operating Costs

1. Fuel: Kind______________________.
   a. From your records, amount used:________x $________/unit = $______________
   b. If records not available, estimate from Table 1:________bhp x________hrs. pumping x
   $________/unit of fuel ÷ ________bhp-hrs./unit of fuel = $______________
   c. If engineering pumping test was made,________fuel/hr x________hrs. used x
   $________/unit = $______________
2. Oil-Engine
   a. From your records, amount used________x $________/gal. = $______________
   b. Estimate from Table 2:________bhp x________hrs. pumping x $________/gal. ÷
   ________bhp-hrs./gal. = $______________
3. Oil-Gear Drive or Electric Motor
   a. From your records, amount used:________gal. x $________/gal. = $______________
   b. Estimate from pumping test or Table 2:________bhp x________hrs. pumping x
   $________/gal. ÷ ________bhp-hrs./gal. = $______________
4. SUBTOTAL: Annual Pumping Costs (1. + 2. + 3.) $______________
   a. Pumping cost per acre-inch: $________ ÷ ________acre-inches = $______________
   b. Pumping cost per hour: $________ ÷ ________ hours = $______________
5. Repairs and Maintenance-Power Unit
   a. Amount spent during season = $______________
   b. Estimate from Table 3:________bhp x________hrs. pumping x $________/bhp-hr. = $______________
6. Repairs and Maintenance-Irrigation Equipment
   a. Amount spent during season = $______________
   b. Estimate at .005 x $________purchase price of irrigation equipment = $______________
7. Irrigation Reservoir Maintenance = $______________
8. Maintenance of fields put to grade:
   a. From your records: $______________
   b. Estimate: $________/acre x ________acres = $______________
9. Labor
   a. From your records,________hours x $________/hour = $______________
   b. Estimate from Table 4:________hrs./acre/application x________applications x
   ________acres x $________/hr. = $______________
10. Additional seed, fertilizer, and other chemicals, plus additional harvesting costs:
   $________/acre x ________acres = $______________

Total Annual Operating Costs (4. + 5. + 6. + 7. + 8. + 9.) = $______________

Total Annual Operating Costs/Acre $________ ÷ ________acres irrigated = $______________

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