

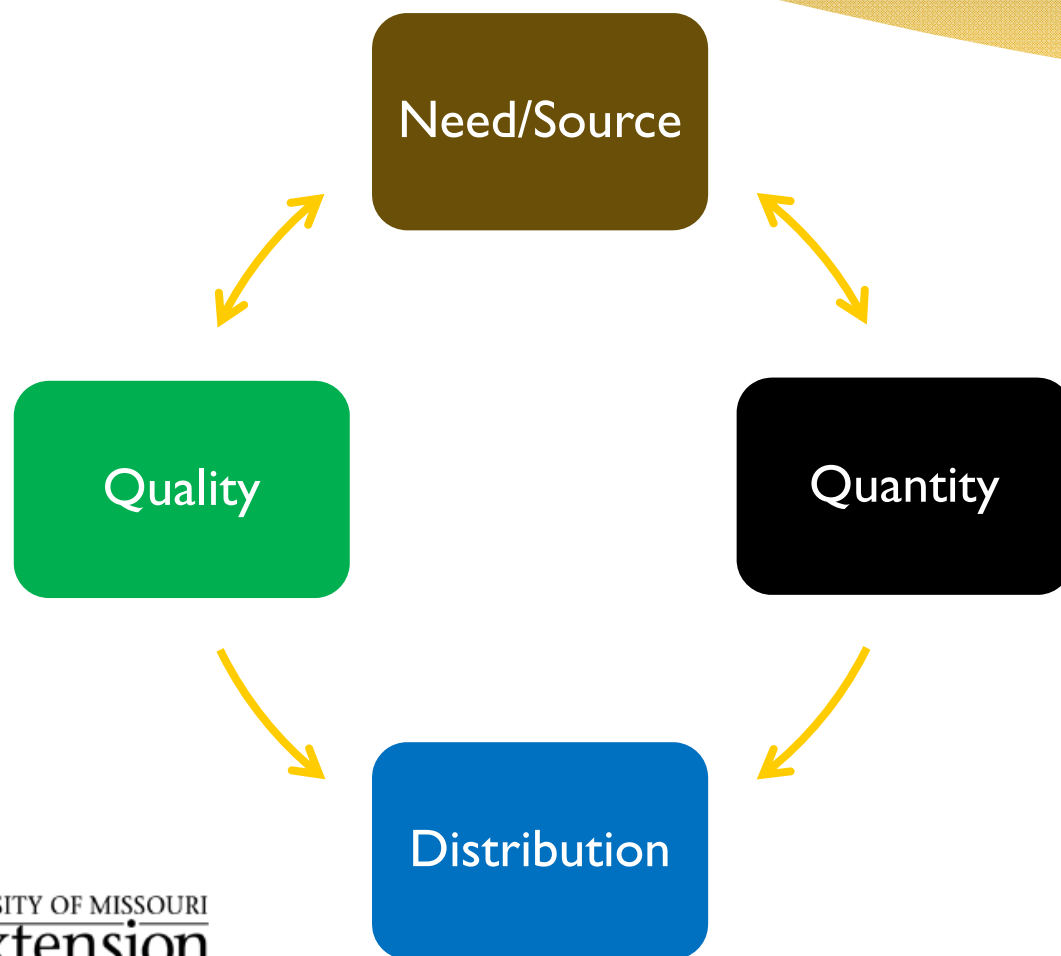
Planning and Economics of Forage Irrigation

This material is based upon work supported by the USDA/NIFA under Award Number 2012-49200-20032.



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Total Water System Overview



No direct path from need/source to distribution.

Total Water System Overview

Water Need and Source

What is the quantity and quality of water by use and where are possible sources?

Water Quantity

- Supply sizing
- Daily use requirement
- Peak demand determination

Water Quality

Does water quality from the available source meet the need? If not, water treatment?

Water Distribution

- Pipe and pump system design
- Intermediate water storage
- Water treatment incorporation

Water Need

- * Daily water need for dairy herd, equipment cleaning and cooling.
- * Estimate peak water demand and simultaneous use.
 - * Water flow rate for drinking water
 - * Water flow rate for washing equipment
 - * Water flow rate for sprinkler cooling
- * Water desired for pasture irrigation.

Primary Water Uses and Quantities for Dairy Operations

	Drinking Water (gallons/head/day)	Supplemental Cooling Water (gallons/head/day)	Parlor Wash Water (gallons/cow/day)
Calves	6 to 10		
Heifers	10 to 15		
Dry Cows	20 to 30	8 to 12	
Milk Cows	35 to 50	10 to 15	10 to 50

Irrigation Water – about 27,200 gallons per acre-inch of water {acre-inch = 1 inch of water applied on 1 acre of pasture}

Water Quantity - General

- * Estimate daily water need based on use values.
- * Estimate peak water need based on use values and behavior of animals.
 - * Single animal water drinking rate
 - * Number of animals drinking at one time
 - * Additional water uses when animals are drinking
 - * Irrigation water demand

Potential Water Sources

- * Ground water accessed by using well
 - * Surface water impoundment
 - * Streams and rivers
 - * Public water
-
- * Missouri major water users (100,000 gallons per day {70 gpm}) – should register water use annually with Missouri Department of Natural Resources.

Water Source - Wells

- * Determine if well can deliver daily demand.
- * If daily demand not met, additional wells or water sources must be located or size of operation downsized.
- * Can well supply peak water use demand?
- * If peak demand not met, intermediate water storage and booster pump is required.

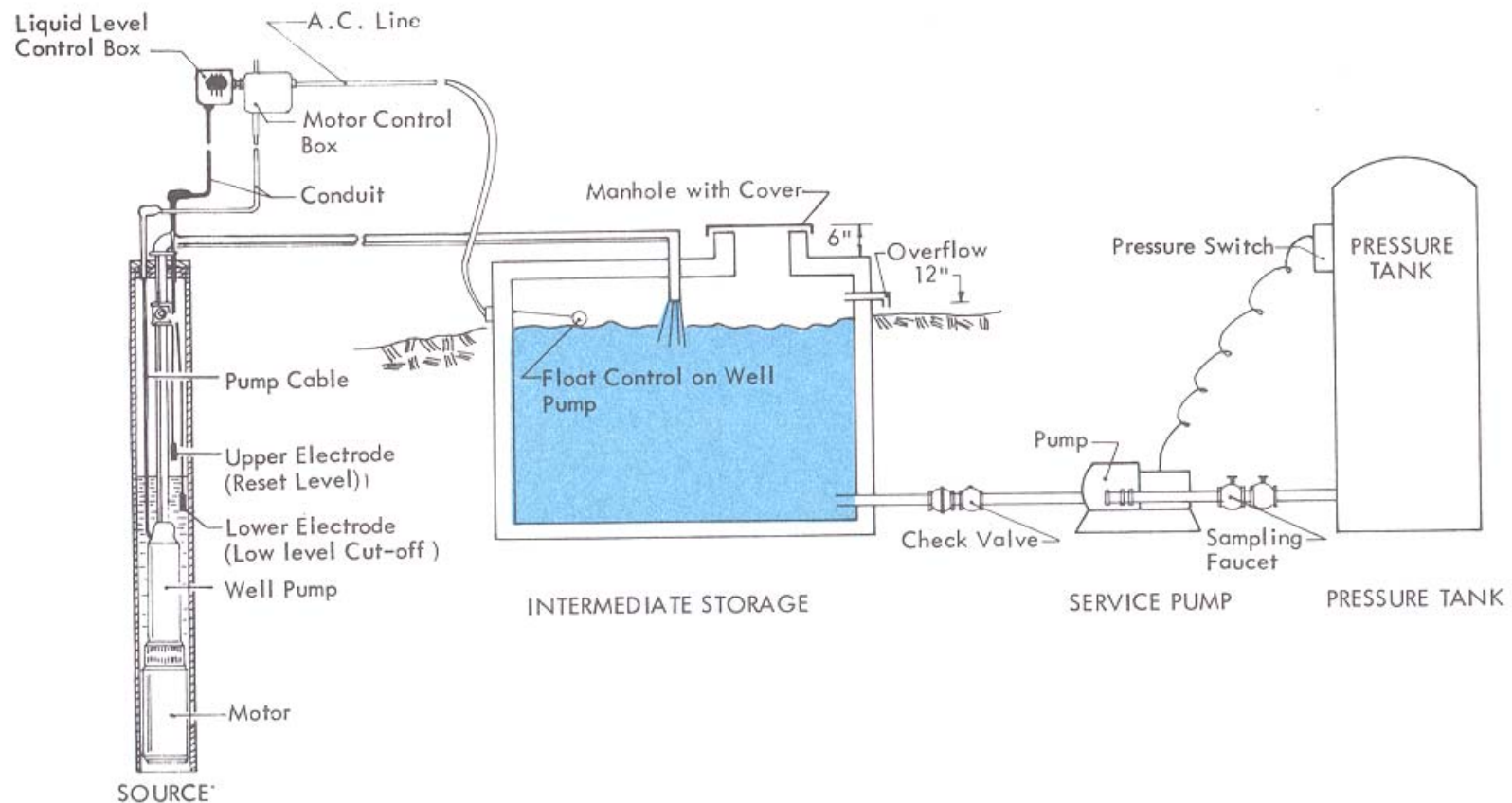
Well System Capacity

- * Well system capacity needs to be large enough to supply daily water need in 10 to 12 hours. Some designers assume 5 to 8 hours to supply daily need.
- * Maximum pump size needs to be slightly smaller than maximum well yield capability.
- * Can a well system be constructed to meet water need for location?

Well Water Delivery

- * If well can supply peak water need, pump in well supplies water to operation.
- * If well can deliver daily need but not meet peak demand, then an intermediate water storage system needs to be designed and installed.
- * If well system can not provide daily need, re-evaluate operation's goals or find additional water supply capability.

Intermediate Storage



Water Source - Impoundments

- * Size pump and pipe system to supply peak demand.
- * Water impoundment should be large enough to store at least one year and better - two year water supply.
- * Ensure watershed area draining runoff is large enough to refill impoundment within a normal year.
- * Are other surface water sources needed to refill impoundment?

Estimating Surface Water Storage Requirements in Missouri

1. Estimate daily water usage in gallons per day
2. Annual estimated water usage = Step 1 * 365
3. Annual acre-feet usage = Step 2 divided by 325,828.8
4. For two year supply → multiply step 3 by 4 (2 year supply and 50% loss)
5. Estimate watershed area → multiply step 4 by 2.4 to get watershed area to refill pond in one average year

Water Source – Rivers & Streams In Missouri

- * Ensure that you have ownership of land connected to the water source where pump is to be located.
- * Estimate volume of water to be pumped each year.
- * Consider pumping to an intermediate storage impoundment – especially for low flow sources.
- * Best to use a floating intake (minimize stream bank and channel impacts).
- * Do not adversely impact a downstream owner or downstream fish habitat.

Water Source – Public Supplies

- * Do not assume water for dairy operation can come from public water system.
- * Experience has indicated any one of the following responses can be given to a prospective dairy operation.
 1. Connect and use as much as desired (not typical)
 2. Connect and use a limited amount or for emergency purposes only (typical response)
 3. Do not connect (a more common response for systems having trouble meeting current demand for water)

Important Point

**No water supply, don't bother
with irrigation!**

Factors When Choosing an Irrigation System

- * Amount of water available
- * Shape, slope and soil type of the land
- * Energy cost and availability
- * Labor considerations
- * Irrigation system cost and return

Forage Response

- * Rapid growth stages for forages represent times of the year when one can achieve the most forage yield improvement from irrigation if rainfall is inadequate.
- * Note that for cool-season species, that rainfall is often adequate when temperatures are ideal for growth.

Missouri guidelines for irrigation forage response

Species	lbs. D.M./acre-inch water *
Cool season perennial grass	450 to 700
Warm season grass	600 to 1,000

* Response is based on effective water available for plant growth. Soil water holding capacity, growth conditions and application efficiency should be a part of any irrigation planning program.

Pod-Line Irrigation System

(Low Pressure)

- * Series of pod sprinklers on a drag hose
- * Each pod irrigates 50 ft. x 50 ft.
- * Advantages:
 - * Flexibility
 - * Low capital investment
- * Disadvantages:
 - * Small acreage (~ 10 acres per line)
 - * Manual move system



Traveling Irrigator

(Low Pressure)

- * Wheeled system
- * Sprays water in a spinning motion
- * Advantages:
 - * Flexibility
 - * Low pressure (20-50 psi)
- * Disadvantages:
 - * Labor intensive, reset system after each run



Traveling Gun

(High Pressure)

- * Large sprinkler gun on a wheeled cart and a reel system
- * Advantages:
 - * Flexibility
 - * Cover larger acreage (80-100 ac.)
- * Disadvantages:
 - * High energy requirements
 - * Labor intensive, reset system after each path



Center Pivot

(Low or High Pressure)

- * Series of sprinklers on a self-propelled system that rotates around a pivot point
- * Advantages:
 - * Easy to operate / low labor needs
 - * Towers can be added/subtracted to accommodate field size
 - * Can spread effluent or cool cows
- * Disadvantages:
 - * Not all fields are conducive (irregular field or high slopes)
 - * High capital investment



Economics

- * Should be carefully considered when investing in a forage irrigation system.
- * Understand the other alternatives for drought risk mitigation.
 - * Investing in additional storage for harvested forages and carrying additional hay or silage inventory
 - * Weather insurance (such as PRF or TWI)
- * Irrigation costs to consider:
 - * Ownership
 - * Operating

Ownership Costs

- * **Depreciation on capital investments (equipment, piping, pumps, storage)**
 - * *(Purchase price – salvage value) / useful life*
- * **Interest on the capital investments**
 - * *(Purchase price + salvage value, divided by 2) x annual interest rate*
- * **Property taxes**
 - * *Assessed value (12% on farm equipment) x local tax rate*
- * **Insurance**
 - * *Vary by insurance carrier and policy chosen*

Operating Costs

- * **Power (pumping)**
 - * Varies by fuel price, operating pressure, pumping lift and volume of water applied
- * **Labor (setup and operation)**
 - * Labor rate (wages, SS, Medicare, etc.) x labor hours
- * **Equipment repair / maintenance**
 - * Vary by component, its usage and age of life
 - * Tend to run from one to five percent per year of average investment (purchase price + salvage value, divided by 2)



Decision Tool

- * A spreadsheet tool was developed for producers to estimate the cost of using irrigation on forage systems.
- * Users detail an irrigation system based on water application, pumping rate, capital investments, and cost assumptions.
 - * Total annual costs
 - * Cost per dry matter ton, lb. or grazed intake
- * Spreadsheet downloaded at <http://crops.missouri.edu/irrigation/decisiontool.xlsx>

Small Scale Forage Irrigation System Cost Analyzer			
Total acres irrigated in system	10 acres		
Water applied per year	10 acre-inches/year		
Irrigation System Costs	Annual Cost	Per Acre	Per Cow
Ownership Costs			
Depreciation	\$366.67	\$36.67	\$3.67
Interest	\$137.50	\$13.75	\$1.38
Taxes	\$6.88	\$0.69	\$0.07
Insurance	\$13.75	\$1.38	\$0.14
Total Annual Ownership Cost	\$524.79	\$52.48	\$5.25
Operating Costs			
Labor	\$400.00	\$40.00	\$4.00
Repair	\$82.30	\$8.23	\$0.83
Power - Source/Intermediate Storage to Field	\$245.14	\$24.51	\$2.45
Total Annual Operating Cost	\$727.64	\$72.76	\$7.28
Total Annual Costs	\$1,252.44	\$125.24	\$12.52
Cost Analysis	Value	Units	
Cost per Dry Matter Ton Produced	\$41.75 dollars/ton		
Cost per Dry Matter Pound Produced	\$0.02 dollars/pound		
Cost per Dry Matter Pound of Grazed Intake	\$0.03 dollars/pound		

Pod-line Irrigation Example



Water volume applied:
2,715,400 gallons/year

Water source: nearby river,
lake or lagoon

**Additional dry matter
expected from irrigation:**
30 tons/year

Capital investments:

- * Pod-line system (12 pods with tubing) - \$3,000
- * Source pump and power unit (35 gpm) - \$1,000
- * Distribution pipe, connections, intake - \$1,500

Pod-line irrigation (10 acres, 10 acre-inches per year)

	Assumptions	Annual Cost	Per Acre
Ownership costs:			
Depreciation	15 years of useful life	\$366.67	\$36.67
Interest	5% of avg. investment	\$137.50	\$13.75
Taxes	0.25% of avg. investment	\$6.88	\$0.69
Insurance	0.50% of avg. investment	\$13.75	\$1.38
	Total ownership costs	\$524.79	\$52.48
Operating costs:			
Labor	6 hrs./irrigation @ \$10/hr.	\$600.00	\$60.00
Repair	3% of avg. investment	\$82.50	\$8.25
Power	Electric @ \$0.11/kWh, 2.3 hp	\$245.14	\$24.51
	Total operating costs	\$927.64	\$92.76
	Total annual costs	\$1,452.44	\$145.24
	Irrigation cost per dry matter ton produced		\$48.41 dollars/ton

Traveling Irrigator Example



Water volume applied:
12,219,300 gallons/year

Water source: nearby
river, lake or lagoon

**Additional dry matter
expected from
irrigation:** 135 tons/year

Capital investments:

- * Traveling irrigator - \$6,000
- * Source pump and power unit (120 gpm) - \$2,250
- * Distribution pipe, connections and intake - \$3,000

Traveling irrigator irrigation (30 acres, 15 acre-inches per year)

	Assumptions	Annual Cost	Per Acre
Ownership costs:			
Depreciation	15 years of useful life	\$750.00	\$25.00
Interest	5% of avg. investment	\$281.25	\$9.38
Taxes	0.25% of avg. investment	\$14.06	\$0.47
Insurance	0.50% of avg. investment	\$28.13	\$0.94
	Total ownership costs	\$1,073.44	\$35.78
Operating costs:			
Labor	9 hrs./irrigation @ \$10/hr.	\$900.00	\$30.00
Repair	3% of avg. investment	\$168.75	\$5.63
Power	Electric @ \$0.11/kWh, 7.8 hp	\$1,103.15	\$36.77
	Total operating costs	\$2,171.90	\$72.40
	Total annual costs	\$3,245.34	\$108.18
Irrigation cost per dry matter ton produced			\$24.04 dollars/ton

Traveling Gun Example



Water volume applied:
24,438,600 gallons/year

Water source: nearby
river, lake or lagoon

**Additional dry matter
expected from
irrigation:** 270 tons/year

Capital investments:

- * Traveling gun and cart - \$30,000
- * Source pump and power unit (350 gpm) - \$17,500
- * Distribution pipe, connections and intake - \$5,000

Traveling gun irrigation (60 acres, 15 acre-inches per year)

	Assumptions	Annual Cost	Per Acre
Ownership costs:			
Depreciation	15 years of useful life	\$3,500.00	\$58.33
Interest	5% of avg. investment	\$1,312.50	\$21.88
Taxes	0.25% of avg. investment	\$65.63	\$1.09
Insurance	0.50% of avg. investment	\$131.25	\$2.19
	Total ownership costs	\$5,009.38	\$83.49
Operating costs:			
Labor	18 hrs./irrigation @ \$10/hr.	\$1,800.00	\$30.00
Repair	3% of avg. investment	\$787.50	\$13.13
Power	Electric @ \$0.11/kWh, 34.6 hp	\$3,364.98	\$56.08
	Total operating costs	\$5,952.48	\$99.21
	Total annual costs	\$10,961.86	\$182.70
Irrigation cost per dry matter ton produced			\$40.60 dollars/ton

Center Pivot Example



Water volume applied:
54,579,540 gallons/year

Water source: Well

Additional dry matter expected from irrigation: 603 tons/year

Capital investments:

- * Pivot machine, electric generator and concrete pad - \$77,000
- * Source pump and power unit (780 gpm) - \$28,000
- * Well (500 foot) - \$11,000
- * Fuel tank - \$1,100

Center pivot irrigation (134 acres, 15 acre-inches per year)

	Assumptions	Annual Cost	Per Acre
Ownership costs:			
Depreciation	25 years of useful life	\$4,684.00	\$34.96
Interest	5% of avg. investment	\$2,927.50	\$21.85
Taxes	0.25% of avg. investment	\$146.38	\$1.09
Insurance	0.50% of avg. investment	\$292.75	\$2.18
Total ownership costs		\$8,050.63	\$60.08
Operating costs:			
Labor	6.7 hrs./irrigation @ \$10/hr.	\$670.00	\$5.00
Repair	4% of avg. investment	\$2,342.00	\$17.48
Power	Diesel @ \$3.50/gal., 179 hp	\$32,203.61	\$240.33
Total operating costs		\$35,215.61	\$262.80
Total annual costs		\$43,266.24	\$322.88
Irrigation cost per dry matter ton produced			\$71.75 dollars/ton

Questions?

