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RANGE WATER DEVELOPMENT

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ABSTRACT

The availability and distribution of livestock and wildlife drinking water supplies affects both the performance of the animal and the forage or plant resource of an area. Common range water development techniques include wells, earthen ponds, spring development, water hauling, pipelines and water harvesting. Each technique has advantages and disadvantages which must be considered when selecting a method for a specific area. Providing animal drinking water is an expensive range improvement practice, but there are numerous direct and indirect benefits. In addition to the livestock industry, the recreational user and hunter of wildlife and waterfowl are prime beneficiaries of increased range water supplies. One of the greatest benefits is the protection of the soil resource through proper management and utilization of the forage resource.

Livestock and wildlife drinking water supplies affect the performance of the animal and forage or plant resource of an area. The relationship between drinking water supplies and animal performance is only partially understood. Limited studies have shown that a 25% reduction in water availability for 25 days can cause a temporary reduction in animal weight gains. A 50% water restriction for 25 days caused weight losses that were not regained in 25 days of free access to water. These weight losses were a result of reduced forage intake during the water restriction period (Butcher *et al* 1959). Other factors, such as air temperature, humidity, type of forage, etc., can influence the severity of the effect a water restriction will have on the animals' performance.

Perhaps a more important factor is the effect of drinking water availability on the forage resource. A forage utilization study on a 2435-acre pasture in New Mexico showed heavy forage utilization (>60%) for the first 0.2 miles out from water, then a general decline (50-40%) to 0.8 miles. Over 0.8 miles there was a major decrease in utilization (<20%). A similar study in Montana showed utilization of less than 40% at distances of 0.2 to 0.8 miles (Holscher and Woolfolk 1953). An average forage utilization of 50% is considered by many to be a satisfactory goal (Renner and Love, 1955). This figure varies, depending upon grass species and topography, from 40% to 75% in the Northern Green Plains (Stoddart and Smith 1955) to 35% to 50% in the arid Southwest, with adjustments to permit consideration of rainfall occurrences (Reynolds and Martin 1968).

In many areas of our western rangelands the distribution of natural water supplies, such as springs and rivers, is not adequate to allow access to all grazing areas. This results in overgrazing adjacent to the water, while

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extensive areas further away from the water are not used. Herbel *et al* (1967) reported that cattle would graze at distances of up to 3.5 miles from drinking water supplies. This is too far for optimum animal performance. When animals spend an appreciable time traveling to water there is less time available for grazing and feed digestion (Squires 1978). Reynolds and Martin (1968) recommend that permanent water sources be a maximum of 4 to 5 miles apart on flat land, 3 miles on rolling land and 1 to 2 miles on rough terrain.

Sneva (1979) suggested that drinking water supplies should be developed at distances of ¼ to ¾ miles apart to achieve the greatest uniformity of grass utilization. Frasier (1981) showed that halving animal travel distance from 1 mile to ½ mile to improve the availability of forage in the outlying areas increased the animal-carrying capacity by 30%.

TECHNIQUES OF RANGE WATER DEVELOPMENT

There is no best method for increasing range water supplies. All techniques have certain advantages and disadvantages. Common water development methods include wells, earthen ponds, spring development, water hauling, pipelines and water harvesting. The specific technique selected will depend upon factors such as topography, climate, grazing system, type and quantity of forage, type of animals and costs. Table 1 lists the various methods of range water supply, along with an estimate of initial costs and advantages or disadvantages of each method.

Springs

Spring developments require favorable geological conditions and without auxiliary pumps or other transfer methods can only supply water to lower areas. A modification of the free-flowing spring is a well drilled horizontally into underground water-bearing strata. Horizontal wells and spring developments are relatively low-cost methods of water supplies when local site conditions are favorable.

Wells

Wells are the primary water source in many areas. With winds of sufficient duration, dependability and velocity, windmills are efficient methods of pumping. Wells equipped with electric pumps have limited application to locations with electrical service. Gasoline engines for pump power can be used in remote areas but have significant labor requirements. Well development in areas where groundwater qualities and quantities are unknown can be an expensive gamble. Also, falling water tables have caused shallow stockwater wells to go dry.

Pipelines

Pipelines from a central water supply are effective in many areas. The costs of pipeline installations depend upon the type and size of pipe, land topography and soil type. Energy costs for pumping can be a factor when the water source is lower than the outlying locations. Some buried plastic pipe systems have been damaged by burrowing animals or earth movement. Undetected leaks can cause a catastrophic loss of the stored water. Annual maintenance requirements and costs are low for properly installed systems.

Table 1. Methods of supplying range drinking water.

Water supply method	Initial cost estimate	Advantages	Disadvantages
Springs	\$1000-\$3000	1. Low initial and annual costs.	1. Many areas not geologically suited.
Wells	\$3000-\$10000	1. Dependable water supply in many areas. 2. Low annual costs.	1. Some areas not geologically suited. 2. Pumping costs can be a factor.
Pipelines	\$5000-\$15000[1]	1. Dependable water supply in many areas. 2. Low annual costs.	1. Requires a dependable source of water. 2. Expensive if used for long distances.
Hauling	Highly variable	1. Highly mobile. 2. Low initial cost if existing equipment can be used.	1. Labor intensive. 2. High annual costs. 3. Not practical for extended periods.
Earthen Ponds	\$1000-\$5000	1. Low initial and annual costs.	1. Seepage and evaporation losses a factor. 2. Many areas not geologically suited.
Water Harvesting	\$7000-\$25000	1. Potentially suited for any area.	1. High initial costs. 2. Requires scheduled maintenance program.

[1]Based on distances of 1-2 miles.

Hauling

Water hauling is an old method of providing drinking water supplies that is still used in some places during periods of extended drought, when normal water supplies have gone dry. Some ranchers use water hauling to remote areas as a temporary means to encourage wider dispersion of livestock. This method is labor intensive and costs are relatively high, depending upon the quantity of water, distance, fuel costs and type of tank truck used (Roberts 1971).

Earthen Stock Ponds

In many areas, earthen stock ponds have been a major water supply technique to provide necessary livestock drinking water. They are relatively low-cost and easy to construct using bulldozers or small earthmovers. Unfortunately, newly constructed ponds often have high seepage losses. With time, many ponds may seal themselves with fine silts and clays washed into the storage with the runoff water. With some soil types, ponds can be sealed by mixing a sodium-based salt into the soil on the pond bottom (Reginato *et al* 1973).

Most stockponds gradually fill with sediments and require periodic cleaning to maintain adequate storage capacity. The cleaning process often destroys the bottom seal and high seepage losses occur until the bottom is resealed by sediments or other means. Stockponds are susceptible to failure if water overtops the dam because of improperly designed spillways or unusually large runoff events. Unless stabilized channels or erosion-resistant grassed waterways are provided, spillways on unconsolidated soils may erode and fail if used at frequent intervals.

The reliability of stockponds for animal drinking water supplies is influenced by the amount of runoff water from the watershed drainage areas, seepage and evaporation losses from the pond and the frequency of runoff-producing storm events. Seepage and evaporation losses can be significant factors. Water used by livestock frequently represents only a small percentage of the water lost by evaporation and seepage.

Water Harvesting

Water harvesting is a method of water supply which collects water from small catchment areas that are chemically treated or covered with an impervious membrane to reduce infiltration. Water-harvesting techniques are being used to provide livestock and wildlife drinking water on rangelands where other methods are not feasible (Cooley *et al* 1978).

Table 2 lists several catchment treatments being used on operational water-harvesting systems. Included in the table is a brief summary of site factors, costs, life and runoff efficiency for each treatment. The asphalt-fabric treatment is presently being used on operational catchments in the hot, arid climate of the southwestern United States, cold mountainous regions of Colorado and New Mexico and the humid, tropical regions of Hawaii. Any container which prevents seepage and evaporation losses is potentially suitable for water storage on a water-harvesting system. Table 3 lists some general types and costs of water storages which have been used in water-harvesting systems. Water storage costs often represent 50% of the total cost.

Table 2. Approximate site requirements, costs, and performance data for field-tested catchment construction materials (Frasier and Myers 1983).

Treatment	Catchment slope: 3-5 percent	Catchment slope: 5-10 percent	Soil Texture: Silt	Soil Texture: Silt loam >20 percent sand	Soil Texture: Sandy loam	Soil Texture: Sand and loamy sand	Soil Texture: Clay and clay loam	Air Temperature: Freezing	Air Temperature: Summer >90°F	Air Temperature: Summer <90°F	Catchment Surface: Rough	Catchment Surface: Smooth	Materials[1]	Labor[1]	Approximate average life in years with good maintenance	Design runoff percentage
Asphalt-fabric	X	X	X	X	X	X	X	X	X	X	X	X	$ 2.00[2]	$0.50[3]	20	95+
Gravel-covered sheeting	X	O	X	X	X	X	X	X	X	X	O	X	1.75	.80	15	85+
Paraffin wax	X	O	O	X	---[4]	O	---[5]	X	X	O	X	X	1.00	.10	7	75+
Artificial rubber membrane	X	X	X	X	X	X	X	X	X	X	O	X	10.00	.50	15	95+
Sheet-metal covering	X	X	X	X	X	X	X	X	X	X	X	X	15.00	---	20	95+
Concrete	X	X	X	X	X	X	X	X	X	X	X	X	20.00	---	20	60+

O – Probable failure.
X – Probable success.
[1]Approximate installation cost per square yard on prepared site.
[2]Based on 1980 materials cost.
[3]Based on estimated labor cost of $10/hr.
[4]Treatment should work if clay is nonswelling.
[5]Treatment may work if clay is deflocculated.

Table 3. Types and approximate costs of water storages used on water-harvesting systems.

Tank type	Approximate cost[1] in $/1000 gal.
Prefabricated tanks (wood, steel, fiberglass, butyl bags, etc.)	200-400
Steel rim	
(a) Elastomeric lining	200
(b) Polyvinyl chloride plastic sheeting	160
(c) Composite lining of asphalted fabric-polyethylene-asphalted fabric	150
(d) Concrete	100-200
Excavated earthen tank	
(a) Exposed elastomeric lining	130
(b) Exposed composite lining of asphalted fabric-polyethylene-asphalted fabric	100
(c) Buried lining	130
Plastered concrete	110

[1]Based on 20000-gallon tank; labor costs for installation estimated a $10/hr.

There is no best or standard type or size of water-harvesting system. The specific techniques and materials used depend upon factors such as soil type, topography, general climatic conditions, quantity of water required, labor and equipment available and the frequency and size of precipitation events (Frasier and Myers 1983). Typical water-harvesting systems used to provide livestock water consist of a catchment area of 700 to 2500 yd^2, with storage facilities of from 10000 to 80000 gal. All water-harvesting systems require a periodic maintenance program to insure optimum performance.

ECONOMICS OF WATER DEVELOPMENT

Providing animal drinking water is an expensive range improvement practice. Using compound interest annuity tables and a project life of 20 years, an interest rate of:

6% needs an annual return of $88 per $1000 of improvement;
10% needs an annual return of $115 per $1000 of improvement; and
15% needs an annual return of $160 per $1000 of improvement.

Many users of our rangelands receive benefits derived from improved management of the land. It is very difficult to measure benefits of range water development to the recreational user or the hunter of wildlife and waterfowl. It is also unrealistic to insist that a practice must be paid for only by benefits to the livestock operator. One of the greatest benefits to be derived from proper management is the protection of the soil resource. The soil is most easily protected by maintaining a plant cover on the land. Range water development is a viable means of improving the utilization of the forage resource while protecting the soil resource.

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