Range Waterspreading as a Range Improvement Practice[1]

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Waterspreading as applied to rangeland is a multiple-purpose practice having as its primary objectives the control of soil erosion and the conservation of moisture. Associated benefits are sediment retardation, increased forage production, restoration of groundwater levels, stream flow regulation and improvement of wildlife habitat. Ephemeral runoff is diverted from eroding channels and spread over adjacent floodplains or valley floors. The principal diversion structure is usually placed upstream above the advancing headcut, permitting the gully to become stabilized and revegetated.

Waterspreading is a crude form of irrigation practiced since time immemorial to provide sufficient moisture for crops in moisture-deficient areas. It was used in Southwestern United States by the Indians long before the coming of the white man. Early ranchers in the Northern Great Plains employed waterspreading to increase forage production on native hay lands and winter ranges.

Present day waterspreading differs from that practiced by the ancients only in the refinements in design through modern engineering and hydrologic techniques. It is similar to "wild flooding" in crop irrigation practice, in that a minimum of control is applied to the water source or to obtaining a uniform spread of water over the land surface.

The degree of control applied to spreading water is governed by factors such as the smoothness of the spreading area; the gradient; the area available for spreading; the volume of water; and the characteristics of the soil in the spreading area. Arguments have been advanced for placing emphasis on the simplest form of spreading systems, although there are equally valid arguments for installing more complex controls where the conditions permit and there are obvious advantages in the utilization of all the runoff water available.

Current Studies

Much has been said and a great deal written about waterspreading on rangeland but despite the volume of verbiage we have very little information that enables us to predict the exact influences of waterspreading on the range environment. The range conservationist must rely to a great extent on empirical methods and his personal experience when installing a waterspreading system and attempting to forecast the results.

Hubbell and Gardner (1950) summarized the results of nine years of study of waterspreading at Mexican Springs on the Navajo Reservation in New Mexico. They concluded that waterspreading is an effective means of transporting sediment to areas where it can be stored in the watershed, preventing its movement to downstream water-storage reservoirs. On the basis of clipped plots, forage production was increased from three to nine times the volume produced on comparable unflooded areas. They also verified the observation, made by ranchers in the Northern Great Plains many years previously, that western wheatgrass (*Agropyron smithii*) would survive a rapid deposition of more than five inches of sediment, a depth that damaged all other range grasses. The work at Mexican Springs is the most comprehensive published to date.

More recently the waterspreading experience of the federal Agriculture and Interior Departments was assembled in the form of a manual at the request of the Foreign Operations Administration (1954). The purpose of the manual is to provide a technical subject-matter guide for the use by American technicians on foreign assignments, particularly technicians in the Near and Middle East. This manual has also been translated into Arabic for the benefit of non-English speaking technicians in some of these countries. While the manual represents an inter-agency effort in assembling waterspreading technology, it is doubtful whether the methods described will find widespread acceptance among all technicians in the contributing agencies.

Currently, the Geological Survey is conducting detailed basic-data investigations on waterspreading systems installed by the Bureau of Land Management on public lands. The systems under study are located on Willow Creek and the Little Missouri River in Montana, Muddy Creek in Wyoming, and Badger Wash in Colorado. The studies include the influence of waterspreading on stream flow and groundwater; moisture infiltration and soil permeability; rates and depths of moisture penetration in relation to storm intensity; and the relation of soil chemistry to the success of spreading systems. It is interesting to note the extreme variation found in infiltration rates on installed waterspreading systems, ranging from a trace to 6 inches of water intake per hour as determined by ring infiltrometers.[2] Also, infiltration rates appear much higher on well-grassed flooded areas than on similar adjacent soils not subject to flooding.

These studies, in addition to hydrological investigations by in-

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2. Unpublished data furnished by the Technical Coordination Branch, Water Resources Division, U. S. Geological Survey, 1955.

FIGURE 1. Aerial view of Lone Tree Reservoir on Willow Creek, Montana.

Occasionally, the initial success of waterspreading can be attributed to the leaching of soluble salts from the upper soil layer by floodwater. If the internal drainage of the soil is deficient, the success will be short lived since subsequent floodings will soon increase the salt content in the upper layer from zones of accumulation in the subsoil. More typically, and if care is used in selecting the spreading area, the first run of water through a new system will carry surface salts deep into the subsoil and subsequent runs will continue a downward leaching. The first run of water will aid vegetation only on the area actually flooded. Subsequent runs will gradually build up the subsoil moisture until the vegetation shows a fairly uniform response over the entire spreading area. This sequence of behavior is more typical of spreading systems on fine-textured soils in the Northern Great Plains where several runs of water occur each year.

dividual watersheds, are aiding the Bureau of Land Management in the design of more efficient and economical spreading systems. As more data are accumulated it will be possible to determine in advance, with some precision, the hydraulic and water retention characteristics of designed systems and in turn predict the probable influences on the watershed.

Increasing Range Forage

As a range improvement practice, waterspreading is a means of restoring the productivity of valley lands that once were the key areas of range use. Because the forage on these lands is usually more palatable and in greater abundance, these areas bore the brunt of the heaviest grazing use and were the first to show the effects of excessive grazing. Later, as the uplands were grazed equally as heavily, accelerated runoff flowing through once protected channels in the valley floors soon caused excessive channel scouring with subsequent deepening and widening of gullies and ultimate destruction of the valley fills. Frequently the rehabilitation of the key grazing areas in the valley is the only salvation for restoring the upland ranges and retarding flood runoff into the valley gullies.

Range waterspreading has occasionally resulted in sensational increases in forage production attracting the attention of range users and the public alike. There are examples of waterspreading on the public lands where barren flats of negligible grazing capacity have been converted to dense stands of grass having a grazing capacity of one acre per A.U.M. Low-yielding mat saltsage range has been converted to grassland approaching the characteristics of hay meadows. These examples are the exceptions, representing optimum combinations of site factors for maximum vegetal response. A more realistic view of forage production by waterspreading would place the increase at from three to five times the former grazing capacity, depending upon the range type and frequency of runoff through the system.

Management of Spreading Areas

Ranges improved by waterspreading should become an integral part of the management plan for the area. Where precipitation and runoff are reasonably dependable, the spreading area may serve to meet a specific management deficiency such as supplementing summer or winter range or in providing the seasonal forage requirements for a particular age class of livestock. Under these circumstances the spreading area is usually fenced and treated as a separate management unit.

In the Southwest runoff is frequently erratic resulting in the production of a large volume of annuals at irregular intervals. The spreading area under these conditions serves principally to attract livestock from the surrounding unimproved range and is rarely fenced as a separate management unit. No effort is made to control the degree of utilization on the spreading area. The additional forage automatically benefits the surrounding range in providing some relief from grazing pressure.

Spreading areas bearing perennial forage plants must be carefully utilized in order to maintain a thrifty vigorous cover with a margin of strength to survive the periodic shock of prolonged inundation and heavy sedimentation. If possible, livestock should be excluded during flooding to avoid compacting the wet soil and to give the forage plants an opportunity for maximum response to the additional moisture. More intensive management practices can be applied to the spreading area because of its limited size and high level of forage productivity.

FIGURE 2. Aerial view looking upstream over Burnett waterspreading system on Willow Creek, Montana.

Cost of Waterspreading

No discussion of range improvements is complete without some reference to costs and the question may logically be asked whether waterspreading is a paying proposition. A full-blown economic feasibility analysis would involve an allocation of costs among the various purposes to be served by the spreading system, such as sediment control, forage production and stock water. Also, values would have to be determined for each of the direct and indirect benefits resulting from the project. A simpler and more direct approach would consider only the increased forage value on the basis of current comparable market prices, similar to the method employed in appraising real estate.

Waterspreading costs in the Bureau of Land Management have ranged from less than one dollar to as high of $20 per acre, depending upon the complexity of the system and the amount of construction involved. When converted to animal units of forage these costs have varied from $30 to $120 per animal unit of new forage. Sales of private range on a forage basis made in recent years have fluctuated widely, due to speculative elements, some going as high as $300 per animal unit but mostly in the neighborhood of $150. When waterspreading costs are compared with sales prices it would appear cheaper for the operator to create new forage production than to purchase additional land, providing, of course, that he has suitable areas for waterspreading.

Selection of Suitable Areas

While waterspreading has probably received an unwarranted amount of publicity as a cure-all for depleted ranges, the area subject to improvement through this practice is necessarily limited to locations favored by suitable topographic and other physical attributes. It has been estimated that the total area of public land suitable for waterspreading is less than 3½ million acres of which about 750,000 acres have been developed to date. No current estimates are available on the area of land in other ownerships available for waterspreading. Provided no conflict in use of land exists, the first factors governing selection obviously are a supply of water and a suitable area of land on which water can be spread at a reasonably uniform rate. Generally, the slope of the area should not exceed 3 percent but here again soil permeability and smoothness of the area will determine how steep or how flat the area can be.

In considering the water supply, a precipitation pattern in which most of the rainfall occurs during the growing season offers the best opportunities for waterspreading. Areas subject to summer thunder showers and rain storms of high intensity, such as are typical of some of the western states, usually are the most advantageous for waterspreading. This statement does not rule out valuable spreading results on sagebrush lands of the Pacific Northwest with rainfall principally in the winter.

Some measurement of the volume and frequency of the runoff produced by such storms is essential to the proper design of the spreading systems. Several formulae are available for determining runoff from watersheds having various characteristics. The method most commonly used is the Slope-Area formula which depends in part upon empirical methods of determining maximum runoff of past storms of high intensity. Of great importance are both stream gauging and weather stations, although typically in range country such stations are far removed from waterspreading sites. In employing such precipitation and runoff data one has to depend upon extrapolated results. While there are obvious pitfalls the reliability of these methods exceeds the best educated guess that the conservationist can make. When the area of the spreading system is a known quantity it is certainly equally as important to have knowledge of the maximum volume of water which the spreading area must receive and carry without undue damage.

Another important factor is water quality. All too frequently runoff from western rangeland carries with it a quantity of dissolved salts which, if allowed to drain into normal water courses, would be carried down to larger streams and rivers and ultimately to the sea. When trapped in waterspreading systems the salts permeate the soil and add to a zone already high in salt content, or are carried back to the surface again by capillarity. The same problems in handling excessive salts in agricultural irrigation are common to range waterspreading, although not in the same degree because of the smaller volume of water applied. If there is a suspicion of high salt content in the water supply for spreading, ultimate failure and monetary loss can be avoided by laboratory analysis of water quality. Unless soil permeability and internal drainage are especially favorable, water of high salt content should not be used.

Having considered the character of the water supply, the conservationist must turn his attention to the soil characteristics of the spreading area. Test holes, excavated to a depth of at least 5 feet, are necessary to properly evaluate texture and structure, the two most important properties. Friable, sandy loams constitute the optimum soil type for range waterspreading, although a wide range of soil types, from clay loams to fine gravelly loams can be benefited by waterspreading. The chemical characteristics of the soil type will have a profound effect upon permeability. Here again it would be well to have accurate determinations made of the soluble salt content of the soil type proposed for waterspreading. This determination is all the more important in the event the water supply is also of a quality bordering the threshold of usability. The cumulative effects of increasing the salt content through successive years of waterspreading will ultimately disperse the clay components of the soil to the extent that the infiltration characteristics are destroyed and the soil surface is almost sealed to moisture penetration.

The permeability of soils in systems proposed for waterspreading can be determined in a reasonably simple manner through the employment of ring infiltrometers. Complete reliance should not be placed in the infiltration aspects of soils alone, but must be considered in relation to texture, structure and chemical makeup. Initial infiltration rates will have a great influence upon the computed retention and other hydraulic characteristics of the spreading site and ultimately upon the design of the spreading system including the height and spacing of dikes. There is some evidence that the infiltration characteristics improve in the years following the installation of a spreading system as the vegetal cover responds to the increased moisture and the roots penetrate deeply into the soil. Even though the physical characteristics of the soil are not appreciably altered, the retarding effect of vegetation upon the spreading water will increase absorption and subsequent penetration into the soil.

Summary

Range waterspreading is a multiple-purpose conservation practice of limited application due to the specific requirements of land and water. It is a desirable range improvement practice from the standpoint of forage production since highly productive valley lands can be restored to a key position in grazing use. Waterspreading areas must become integral parts of general range management plans and receive intensive management practices to maintain a high level of productivity. As a range improvement practice, waterspreading is a paying proposition in the production of an increased forage supply. To insure success all of the physical factors of the site must be carefully studied before an attempt is made to install a waterspreading system.

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