Water Control by Rangeland Management[1]

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Highlight

In rangeland management, water quantity and quality are related to range condition. The better the range condition, the better the water relationships. Range condition can be improved by regulating grazing, reseeding, fertilizing, type conversions, and contour furrowing and pitting. Rangelands are highly variable in nearly every respect. The range manager must understand the climatic/topographic/soil/plant/animal/water relationships for the areas under his control; he must have sound management objectives; and he must be willing to work toward those objectives in so far as is economically feasible.

From ancient times to the present, many of the problems of excessive runoff, floods, erosion, and sedimentation of streams and reservoirs have been associated with rangelands and grazing. Furthermore, much research and demonstration in the past 30 or 35 years by the universities, ranchers, and government agencies such as the U.S. Forest Service, Soil Conservation Service, and Bureau of Land Management, have shown that good range management promotes favorable plant-water relationships on watersheds. What, then, are the good range management practices that will help solve the water problems?

The overall objective in management should be to insure superior range conditions. Ranges in good condition have highly satisfactory plant/water relationships. Range condition is, in effect, range health. It can be defined as the relative position of a range with regard to an attainable standard set up by management on the basis of site potentialities. A range in good condition is well covered with a large proportion of desirable, vigorous forage plants. The amount of bare soil is no higher than normal for such sites, and there is no accelerated erosion. The infiltration capacity is high for the site, and any runoff water is as free of silt as can be expected. The high infiltration capacity permits rainwater to soak into the soil, where it becomes available to plants. In some cases water yield can be increased, and range conditions improved, by converting the vegetative cover from shrubs and trees to grasses and forbs (broad-leaved herbs). Ranges in good condition will graze approximately twice as many livestock as those in poor condition. On the other extreme, ranges in poor condition are characterized by large numbers of undesirable plants; their infiltration capacity is usually abnormally low; and accelerated erosion is currently taking place.

Controlled Grazing

The range operator has great control over grazing. He can determine the best kind of livestock to graze on a particular range, he can control the intensity of grazing by adjusting the number of animals, and he can decide when to graze. The main objectives in regulating grazing are to favor the desirable forage plants and to maintain high infiltration capacity so that water will be absorbed by the soil. The water can then be used by the plants, resulting in high forage production and profitable livestock gains, or it can go into slow-moving subsurface and base flows. Thus, the combination of a good ground-cover of desirable plants and a high infiltration capacity help regulate streamflow and reduce flood potential.

Desirable forage plants include grasses, forbs, or shrubs, all three of which grow in combination on many ranges. The range manager must know the ecology of these species, where and when they grow, their nutritional requirements, tolerance to grazing, and competitive relationships so that he can regulate grazing to favor those particular plants.

Proper selection of livestock.–Because livestock vary in their grazing habits and forage preferences, the operator can select the kinds best suited to the different kinds of forage, and use them to manipulate the plant cover. On steep slopes, sheep and goats graze better than do cattle, and with less soil disturbance. Cattle prefer grasses, sheep prefer fine grasses and forbs, and goats like to browse on shrubs. Usually a particular range is better suited to one kind of livestock than another, but in some cases, where there is a wide variety of forage and browse plants, two kinds can be grazed together advantageously, both from the standpoint of desirable plants and livestock gains.

With a knowledge of the ecology of the various range plants and the grazing habits of the different kinds of livestock, the range manager is then in a position to plan a grazing system to favor the desirable species–those he wishes to perpetuate or increase. Several satisfactory grazing systems have been developed for different kinds of ranges–for example, season-long, moderate grazing for annual plant ranges, and rest-rotation grazing for some perennial plant ranges. In some cases the best system is to withhold grazing for only a short time, to permit the desirable species to set seed, after which the range can be grazed again.

Proper intensity of grazing.–The rangeland op-

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erator must make sure that desirable forage plants are not continuously grazed too closely or they will be weakened and perhaps killed. Reduction of the leaf area past a certain point, by grazing, reduces the capacity of the plant to manufacture food for its growth activities and for storage in the roots and stems. Surplus, stored food is essential to perennials for life during cold or dry periods, and for initiating regrowth after winter and summer dormancy. Without sufficient stored food, the perennials may die.

Continued close grazing lowers production of total forage for livestock and retards volume of root growth and root penetration into the soil. This is not to say that all close grazing is bad. Sometimes it can be practiced for a short period to even up competition between desirable and undesirable plants. If this is done, however, a period of rest must follow, to give the desirable species a chance to regain vigor and produce seed. Practical experience and research have indicated that the rule-of-thumb, "take half and leave half," is a reasonably good practice for most ranges. It is sometimes difficult for an operator to follow this practice because he hates to see forage left on the ground. For the annual vegetation type range in California it was found that 500 to 800 lb/acre of current growth of forage must be left on the ground at the end of the grazing season to assure good range conditions.

Continued close grazing may also result in unfavorable changes in the plant cover, leading toward a reduction in the desirable species and an increase in the undesirables. When this happens the vegetation usually thins and the amount of bare soil increases. Futhermore, the undesirable species are often "weedy" plants with taproots, which are not so effective in protecting and binding the soil as are the fibrous roots of grasses.

A primary ill effect of continued close grazing, in so far as soil-water relations are concerned, is that the plant cover is reduced to the point at which it is no longer effective in protecting the soil against compaction. Compaction results when soil particles are packed together by force exerted on the soil. On rangelands the two principal compacting forces are livestock and beating rain on bare soil. Cows standing at rest exert a pressure of about 24 psi under each hoof, and sheep 9 lb. This force is greater when the animals are walking. Raindrops can also produce forces of considerable magnitude. For example, a 2-inch rain falling at a velocity of 20 mph on bare soil exerts 138 foot-lb/ft^2 of kinetic energy. The principal effect of compaction is that the pore spaces in the surface one-half inch or so of soil are reduced, thereby causing the soil to lose its infiltration capacity, so that water can no longer penetrate as it should. If precipitation cannot infiltrate the soil, it runs off the surface. On overgrazed land, which is not well protected by plant materials, accelerated erosion is almost inevitable. Furthermore water that never enters the soil does not become available for normal plant growth. Thus, a vicious cycle is established: Insufficient plant cover—soil compaction—poor infiltration capacity—less soil moisture—surface runoff—accelerated erosion—still less plant cover, etc. The best way either to break this cycle or prevent its development is to graze moderately so that the soil is well covered as on ranges in good condition. The amount of forage produced on rangelands normally fluctuates from year to year, sometimes greatly. To prevent too close grazing, particular care should be taken to adjust the stocking rate in accordance with the current growth of forage.

When grazing is not strictly controlled, those ranges grazed by sheep and goats are usually more closely utilized than those stocked with cattle. The amount of forage required by the smaller animals is less than that for cattle. Smaller animals can move about and graze rapidly, thus getting a fill even when the forage is quite scarce. The final result may be very close grazing. Since goats can be forced, by sparse forage, into taking the greatest variety of plants, it is sometimes wise to change from goats to sheep or from sheep to cattle to prevent too close grazing. Changing to cattle almost always results in lighter grazing and more favorable plant-soil relationships. However, when a range is covered with plants palatable to goats but not to sheep or cattle, it would be more profitable to stay with goats, but regulate grazing carefully to the carrying capacity.

When two kinds of animals graze on the same range, some plants will be grazed by both. In this case, to prevent overgrazing, allowable utilization of the range must be based on the supply of those species subjected to overlap.

Proper grazing season.–Some ranges can be grazed yearlong but others are seasonal. Animals are sometimes placed on seasonal ranges too early, when the forage is short and the soil is wet and most subject to compaction. This is often done because supplemental feeds are in short supply and are expensive. Therefore, it is wise to store a supply of hay to feed the animals until the range is far enough along so that the animals can get a fill in the normal grazing period.

Not all soils are equally subject to compaction, however. For example, a sandy loam soil is not so easily compacted as a clay loam. If the operator has a choice, he would be wise to place animals on the sandy loam during periods when the soil is wet. Later, when the soil is drier and not so subject to compaction, the animals could be moved to the areas of clay loam.

Reducing Shrubs and Trees

Millions of acres of rangelands in the western United States are in poor condition because of an increase in undesirable shrubs and trees. These plants have increased because grazing has reduced the competitive effects of the more desirable grasses and forbs, and because of fire prevention. Several species of sagebrush throughout the West, mesquite and juniper in the Southwest, numerous woodland-grass and chaparral shrubs in California, and many others now infest perhaps one-fourth of all the rangelands in the United States.

Most of the shrubs and trees are low in palatability, and crowd out more desirable grasses and forbs. Some species, such as juniper, produce inhibitors that prevent growth of much herbaceous vegetation in the understory. The juniper itself does not produce enough needle fall to cover and protect the soil against raindrop impact. As a result, accelerated surface runoff and erosion in dense stands of juniper can be very severe.

Perhaps the greatest opportunity for increasing water yield from rangelands lies in reducing the number of shrubs and trees and substituting grasses and forbs. Achieving this goal, however, will depend on the amount of rainfall and other factors. Generally, shrubs and trees are deep-rooted while the grasses and forbs are relatively shallow-rooted. The amount of water transpired by plants depends in part upon the amount available and upon the depth of soil occupied by the roots. Shallow-rooted species obviously use less water than do deep-rooted species that can tap a greater supply of water. Thus, on deep soils, substitution of shallow-rooted grasses and forbs for deep-rooted shrubs and trees offers a definite possibility for increasing water yield. Since less water is transpired by the shallow-rooted species, less precipitation is needed to fill the soil to storage capacity, thus the water yield from the watershed may be increased. The increase to be expected from converting a shrub or tree cover to grasses and forbs is the difference in water consumption capacity of the two types of cover. A recent study in California, where the mean annual rainfall is 25 inches (with none in July through September) showed that an oak woodland used 20 inches/year while annual grasses and forbs used only 15 inches. After conversion from oak woodland to grasses on an experimental watershed, the measured increase in water yield was 4.5 inches/year. Total herbaceous production was increased two or three times over the original amount. Other studies have shown an increase of 2 inches in water yield after chamise brush was converted to annual grasses in an area where average annual rainfall was about 18 inches.

The amount of increase in water yield achieved by converting from deep-rooted to shallow-rooted species depends, of course, upon the amount of precipitation and available moisture, soil depth, and rooting depth. Conversion in arid areas where the rainfall is less than 15 inches or so may not produce any increase in water yield. In fact, water yield may drop if the infiltration capacity is increased so that more rainwater soaks into the soil and is used by herbaceous plants. However, where satisfactory conversion can be made, and the range is properly used, water yield and quality will be higher than before.

Several methods of conversion have been worked out for different types of brush, and no one method can be prescribed for all types. In some cases the brush can be smashed or chained over, then burned, reseeded, and sprayed with herbicides. Once a satisfactory conversion has been made, it is important to graze judiciously in order to maintain the new forage crop in good condition, in a favorable plant-water relationship.

Reseeding and Fertilizing

Many poor ranges can be improved by reseeding and fertilizing, either singly or in combination. Usually the main objective of reseeding is to increase forage by introducing more palatable and nutritious species of grasses and forbs. The effect on water yield will depend in part on the type of cover being replaced, soil depth, and the root habits of the plants. If reseeding increases forage production, it can also increase the infiltration capacity so that surface runoff is decreased, and streamflow made more stable. The yield will be lower, but the water will be of higher quality.

Reseeding should be attempted only where research or experience in the community has shown that it can be done successfully. It is not a simple operation, and it costs several dollars per acre. Reseeding requires careful seedbed preparation and planting, and proper grazing management after a stand is established.

Fertilization is also complicated. First, the need for fertilizers and the results to be expected must be determined. In some cases the increase in forage production would not be sufficient to pay for the cost of fertilizers. In other cases, such as many of the annual plant ranges, the increases in forage yield and soil coverage can be very great indeed. Since plants vary in their nutritional requirements, it is sometimes possible to fertilize so that certain species are favored over others; for example, a fertilizer high in phosphorus might markedly increase legumes, while one high in nitrogen might favor grasses. However, if fertilization brings about heavier utilization of the forage, and the soil is not better protected against compaction, the fertilization may not be worthwhile in so far as quantity and quality of water are concerned.

Mechanical Means of Water Control

The surface runoff on some ranges is so rapid that little rainwater enters the soil, to become available for plant growth. Contour furrowing and pitting are two means of holding water and giving it time to soak in where it can be used to increase total plant growth. If controlled grazing can serve the same purpose, however, it is more practical.

Small contour furrows, from 4 to 6 inches in cross-section, and spaced not more than 5 ft apart, are usually more effective than larger or more widely spaced furrows. The small furrows regrass quickly and hold the water where it is of most benefit. The amount of range improvement from furrowing will vary with soil condition, amount and frequency of the rainfall, and the kind and condition of the vegetation. If the contours are carefully installed in selected places, they can reduce runoff very markedly This, in turn, increases forage which, if grazed properly, can further reduce surface runoff and erosion. Contour furrows should be constructed with the advice of an agricultural engineer.

Range pitting is also an effective water conservation practice in arid regions of sporadic rainfall, where most of it may be lost from surface runoff. This technique has worked particularly well on some of the short-grass ranges in Wyoming. The equipment commonly used for pitting is a heavy, 18-inch, oneway disk plow, with the alternate disks 20 inches in diameter and mounted 2 inches off center. The equipment scoops out shallow, discontinuous pits about 16 inches apart. The water-holding capacity of the pits on an acre is about 0.3 inch of rainfall. In arid areas this is sufficient to have a measurable effect on forage growth or the establishment of new seedlings after reseeding. Range pitting has a number of advantages over contour furrowing. Pitting does not need to be exactly on the contour, and since the depressions are small, there is little danger of accelerating erosion.

The principal value of both contour furrowing and pitting is that they make possible the maximum infiltration of intermittent rains during the dry season when the forage cover may be sparse and full utilization of moisture is vital.

Roads and Trails

Roads and trails cause a great deal of surface runoff and erosion in many places. Roads, particularly, are bad since they are compacted, and allow practically no infiltration of water. The water must therefore go into surface runoff, possibly resulting in severe erosion. For this reason, roads and trails should be carefully placed and constructed, and should be held to a minimum number.