Rejuvenation of Western Range Lands

by

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INTRODUCTION

Those who have come into direct contact or have been directly effected by the use of range forage in livestock production will have a much greater appreciation of the problems in range management than those to whom it is new. For the benefit of the latter, we might say that the absolute essentials of living are supplied by four basic industries, namely: farming, livestock production, forestry, and mining. All other industries, broadly considered, are merely the result of these four basic industries. Approximately one-third of the cost of living is expended on meats and the by-products of the livestock industry. Leather, wool, fats, and many others are listed among the by-products.

For successful operation, no other type of business enterprise is more exacting or more dependent upon the broad application of science than is the growing of livestock on the range and pastures. Many stockmen, to their great disadvantage, still cling to the obsolete and inefficient policies of the "Old West". These stockmen are often skeptical regarding the application of scientific principles to their business. It is realized that all scientific theory is not applicable to every condition and problem that is encountered in the stock raising business, and it is not the object of range experts to promote the application of the sciences to the exclusion of the practical elements that enter in. The object is to coordinate the principles of both in a common sense application of both, tempered by good business judgment.

The solution to the range problem is getting the largest possible use out of the range. This means making the range grow the best possible crop of forage, taking into consideration quality as well as quantity, while making this crop available at the times when the stockman needs it. Evidently the problem has two sides--the study of forage production and the devising of methods of regulating the use of the range by stock so as to utilize the largest possible amount of forage produced with the least possible reduction of the power to grow forage while conforming to the practical requirements of the stock industry.

In dealing with depleted ranges, the first necessity is to learn how the reestablishment of a growth of valuable forage plants can be brought about. Two possibilities are open. The first is to secure revegetation through natural reseeding. The second is that of replenishing the growing stock through the establishment of a growth of cultivated or introduced forage plants.

CONTROLLED vs. UNCONTROLLED GRAZING

Stock raising is today far different from what it was when range was plentiful and well-covered with choice forage. The cattle and sheepmen are no longer the monarchs of all they survey, for there is likely to be a neighbor's wire fence within sight of his door. Recent years have brought great changes in the open range. Communities have sprung up where once was open, free grassland. Private ownership has

largely replaced the free range, and all lands where there is a remote possibility of growing agricultural crops are thus occupied. This condition has pushed the stockman farther and farther on to the less desirable scab land where only sparse vegetation is found. See Fig. 1.

When this condition came about, there began a desperate struggle between the settlers, sheepmen, and cattlemen as to who would control what free grassland that remained. Even today these range wars flare up in far-flung grazing areas. The cause of the present strife is over the age-old antagonism caused by trespassing on the other man's range.

The successful stockman of today must, if he is to long continue in business, acquire and fence for protection from trespassers, enough pasture to keep his stock during early spring and fall periods when the open range is not accessable. Government agencies have accomplished a great deal in grazing control in recent years through marking out "deadlines" over which different types of stock are forbidden to pass. This has brought a degree of peace to the open range. Much adjustment has been brought about by the National Forests being opened to grazing under strict supervision. The figures in table I, below, are fairly recent and accurate.

TABLE I
CONDITION OF RANGE

Land Ownership	Condition Decreased	Condition Increased
Public Domain	75 per cent	2 per cent
Private	85 " "	10 " "
State and County	88 " "	7 " "
National Forest	5 " "	77 " "

Fig. 1
Some Baker County, Oregon Scab land.

Fig. 2
In contrast to the above picture, this shows good range land and the fat stock which it produces.

The yearly forage crop on the National Forest is utilized by stockmen who are qualified to take advantage of the forage for summer feed. As far as is consistant with the development and protection of the resources in care of the Forest Service, it seeks to utilize the forage crop on all the range and timber land to its greatest extent. Intensive utilization is necessary because of the increasing demand for summer range. Accordingly, therefore, the problem of handling stock without serious injury to the vegetation generally is of the greatest economic and ecological importance. To keep the range on a sustained yield basis and revegetate the poorer areas is oftentimes a very perplexing problem.

It was formerly believed by Forest Service officials that grazing on timber lands had a great injurious effect on other forest uses, but at the present time few people retain this idea. Several years ago a thorough Federal investigation was undertaken whose ultimate result was to disprove this theory. As a result stock has been allowed to graze on National Forest areas under strict control for some years now.

As a means of maintaining a sustained yield and to rejuvenate certain areas which had received little attention prior to this time, the following regulations were strictly enforced: the number of animals to graze any allotment regulated; the season of grazing; the allotment to be grazed; and detailed rules for salting, bedding, and other actions, including routing of the herds.

"It is estimated that through government control and regulations, the forest ranges have increased in carrying capacity from 15 to 30 per cent from 1905 to 1920." (5)

INVESTIGATION OF RANGE CONDITION

Before any plans or arrangements should be formulated toward the rejuvenation of any range lands, a thorough study should be made of the condition of the range. The evidence of unsatisfactory condition is seen in the replacement of perennial palatable species of vegetation by the less valuable plants. Thinning of the vegetative cover, increasing in number of poisonous and noxious plants, eroding of soil, and general lowering of grazing capacity are also good indicators.

For example, a large proportion of the short grasses of the Great Plains area have been replaced by weeds and shrubs of low palatability. Some of these are the sagebrush, thistle, sunflower, asters, goldenrod, and peppergrass. "In Eastern Colorado the worthless snakeweed, gumwood, and cactus now dominate large areas. Where mixed prairies once existed along the Arkansas River, the grasses have almost completely disappeared and sand sagebrush, thistle, and yucca now constitute sixty per cent of the total plant cover." (7)

In making a study of the present range condition, the inspector should decide upon the amount of time and expense he can allow to the study. Investigation can be conducted under two systems, namely:

Reconnaissance Method

This method is a rough, rapid, but fairly accurate method of determining the range condition. It makes use of human judgment which has its limitations.

The procedure is to travel over the range across the topographical features and to roughly map the area as to condition. In making this survey, it is often necessary to judge vegetation from a great distance when not covering all of the ground; therefore, it is necessary to make allowance for the denser appearance of vegetation when viewed from a small angle.

Careful note should be taken of areas where encroachment of the above-named noxious plants has taken place. The density with reference to the forage plants should be noted. Make a determination of whether the forbs are increasing or decreasing in number and what plants are replacing or being replaced by the forbs. Erosion areas and areas where plants have been killed and erosion has yet to start are all important and should be noted, as they shall be dealt with in a different manner from the reduced vegetation which characterizes most range lands.

Line-plot System

This survey method is a much more painstaking method and will produce more accurate results. The objective, in general, is to secure all facts essential to the formulating of a plan of managing the range area in question. In other

words, it is a stock-taking of the forage resources, a record of the character, extent, and accessibility of the forage types. Such information as the forage value, methods of utilization, and the improvement necessary to cause the range to produce the maximum amount of forage per acre is derived from the data gathered.

Some of the important factors to consider are the adaptability of the range unit to the class of stock grazed, determined by such factors that bear directly on grazing as does the abundance and condition of timber reproduction and its immediate need. The desirability of protecting the watershed, if present, the topography, the climate, the watering facilities and accessibilities are all of major importance in determining the course to follow in improvement of the range.

A range condition map should be made showing the areas of eroded soil, overgrazed range, areas recommended for special grazing control, recommended eradication of poison plants, and other pertinent information. A descriptive report, including all of the information and statistical information, density of forage cover by species, the adaptability of areas to stock types, recommendation of season of grazing, and degree of utilization, should be compiled.

The line-plot method is the most exact system of gaining the information desired. The mechanical procedure is to establish the area into 100 square foot plots at an interval of eight chains apart in the strips--the strips

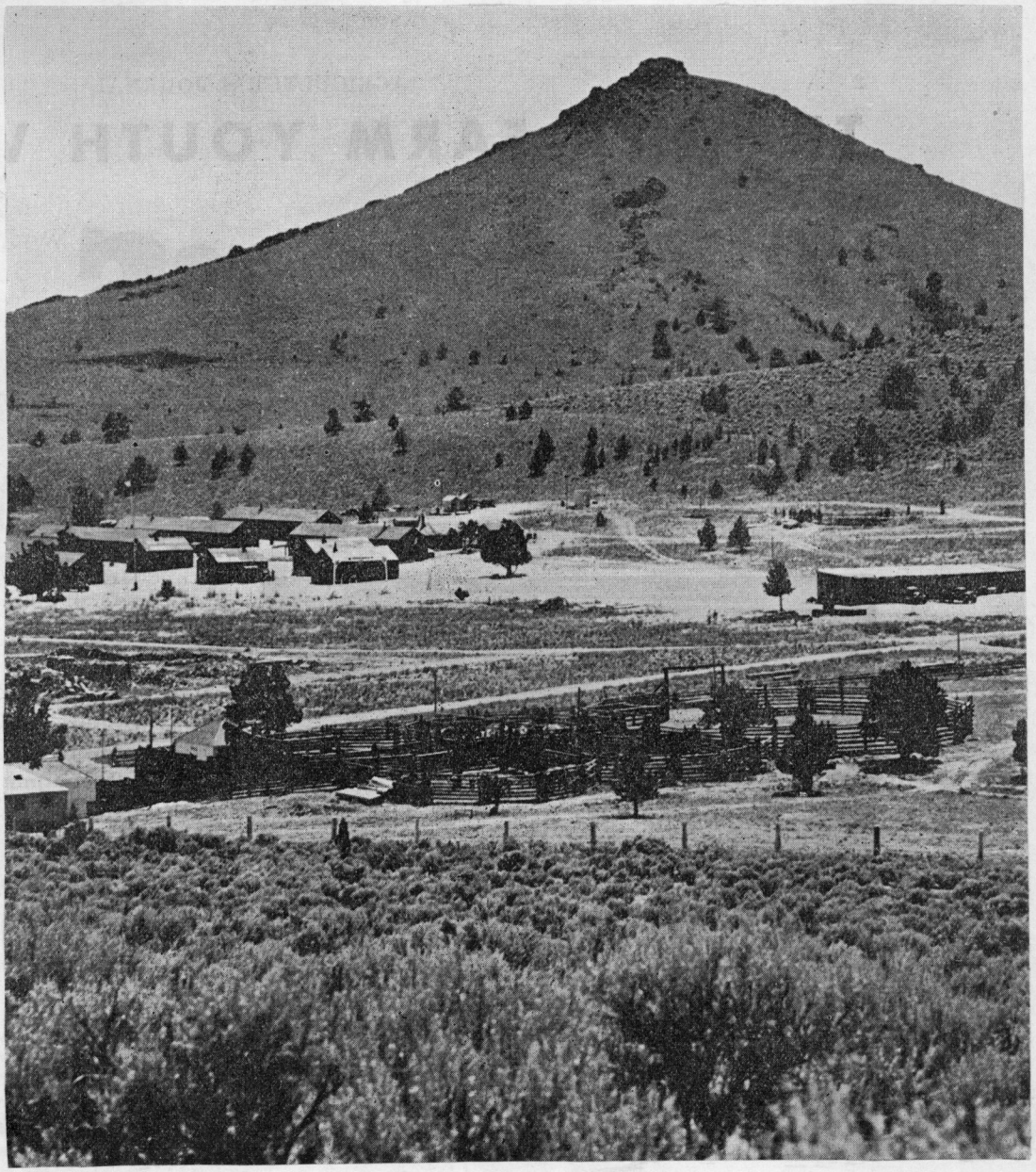


Fig. 3
Squaw Butte Experiment Station Established for Range Research. It is located in Harney County, Oregon

being eighty chains apart. The plots should be fenced off from any interference by grazing stock. The plots are inspected in a systematic manner at regular intervals of about three months throughout the first year. The types and species within the plots are noted and the density taken by the following procedure: Press the vegetation together until it completely covers the ground under it, then determine what per cent of the 100 square foot plot that species occupies. Estimate the palatability of the vegetation by the amount eaten by the stock on the area not protected. This estimate is known as the palatability rating. Estimate the amount of palatable forage per acre, and then with the information on hand it is possible to compute the grazing capacity after applying the forage acre requirement for the stock likely to graze the area.

RETROGRESSION AND SUCCESSION

Before one can make an intelligent application of the rules laid down for range survey he must know something of natural rules governing the establishment, growth, development, and reproduction of the vegetative cover. Plant retrogression is nothing more than a backward movement of the vegetation. Many factors may help to start this backward trend, and if their influences continue, the vegetation drops back from one stage to another until the earth is bare and erosion takes it over.

Plant succession is just the opposite of retro-

gression in that it is a trend toward a higher stage of growth.

When the backward movement has progressed, aided by the many destructive factors, to a condition where the ground is left bare and only rock and soil remain, only two things can take place--either the soil must be washed away by the elements or the trend must be reversed and gradually revert back to a condition of being covered by vegetation. In a study of plant growth and development we find that certain laws underlie its occupation of the land. The vegetation has a tendency to develop from an earlier type to a more advanced type, or what is known as a climax type. This tendency may be defeated by many factors, of which overgrazing is one of the most important.

If the vegetation does not reach a climax stage on the area, it will, if not retarded by outside factors, attain the highest form of growth that the site is capable of supporting. It is known that the plants, by dropping their foliage and litter, form a mat of decaying vegetation around them, which is transformed to humus and is the means of improving the soil. As the soil is improved through this process, the more exacting plants begin to make their appearance on these improved sites, and if this changing condition continues long enough without outside interruption, a climax cover will be the result.

One of the most serious handicaps toward the encouragement of succession and the prevention of retrogression is the inability of stockmen to recognize the different stages of

this transformation. It is of great importance to be able to recognize the first stage of overgrazing so that steps may be taken to remedy this condition before it has become a major problem and an expensive one. To recognize these stages, we must be able to distinguish between the plants which we call the "indicator plants" and other plants which are not true indicators.

The list of indicators below are not to be taken as complete but are the ones most common in Western states.

First or Early Weed Stage

Douglas knotweed (Polygonum douglasii)
Goosefoot, or lambs-quarters (Chenopoduim album)
Tansy mustard (Sophia incisa)
Tarweed (Madia glomerata)
Knotweed (Polygonum aviculare)
Androsace (Androsace difussa)
Gilia (Microsteris micrantha)
Peppergrass (Lepidium ramosissium)

Second or Late Weed Stage

Blue foxglove (Pentstemon procerus)
Sweet sage (Artemisia discolor)
Yarrow (Achillea lanulosa)
Aster (Aster frondeus)
Butterweed (Senecio columbianus)
Geranium (Gernaium viscosissumum)
Horse mint (Agastache urticifolia)
Large Mt. Bromegrass (Bromus marginata)

Low Larkspur (Delphinuim menziesii)

Low Peavine (Lathyrus leucanthus)

Mexican dock (Rumex mexicanus)

Rubber weed (Hymenoxys floribundi)

Sneeze weed (Helenium hoopesii)

Mixed Grass and Weed Stage

Small Mountain porcupinegrass (Stipa Minor)

Yellowbrush (Chrysothamnus lanceolatus)

Blue foxglove (Pentstemon procerus)

Geum (Geum orgonense)

Junegrass (Koeleria cristata)

Little bluegrass (Poa sandbergii)

Low loco (Astragalus decumbens)

Mountain lupine (Lupinus alpestris)

Spiked fescue (Festuca confinus)

Sweet sage (Artemisia discolor)

Yarrow (Achillea lanulosa)

Climax Herbaceous Stage

Small wheatgrass (Agropyron dasyctachyum)

Blue bunch grass (Agropyron spicatum)

Slender wheatgrass (Agropyron tenerum)

Violet wheatgrass (Agropyron violaceum)

The more samples of species that are made use of as indicators of range conditions, the more accurate will be the conclusions. For instance, if a type is merging into the early or first weed stage from a higher plant form, assurance of this fact is found in the increased abundance of several

of the most characteristic species of the early weed stage.

If the invading plants are lower in the succession than the original or predominating vegetation, the area is being misused in one or more respects. If on the other hand, the incoming vegetation is somewhat higher successively than the type as a whole, the plan of grazing is satisfactory. If the undesirable plants have crowded out the desirable permanent perennials, then measures should be taken immediately to remedy this condition. A systematic procedure of experimentation can be carried on to determine on established plots the trends of plant development.

FACTORS CAUSING RANGE DEPLETION

Many factors may affect grasslands adversely, including weather, moisture, strong wind, and competing vegetation, but a poor system of grazing is believed to be the most detrimental factor to good growth and development. The plants are sometimes literally starved to death by too early or too close cropping. In addition, excessively close grazing in the fall destroys the protection otherwise afforded the soil by the forage cover. Poor grazing practice may change the texture of the soil through heavy packing. The producing power of heavily packed soil falls off rapidly until those soils practically cease to support vegetation.

SYSTEMS OF REVEGETATION

After a range survey has been completed and the data

collected to give a fairly accurate picture of the range conditions as a whole, it then becomes necessary to determine the most logical method of revegetating the area if revegetation is necessary.

In the event that the vegetation has been destroyed down to the mineral earth, or that all the palatable forage is killed out, it is clearly a problem of artificial revegetation which will be discussed later under the proper headings. If on the other hand, it is found that the palatable forage has been depleted by controllable factors such as uncontrolled grazing, fire, or other means, then it is a case of correcting these practices that are deleterious to proper growth of range plants. If a nucleus of palatable forage still remains on the area, and even though it is being rapidly crowded out by weeds and noxious plants, if these adverse factors are corrected in time, the more valuable perennial plants will take new life. The range will change from a retrogressive trend to a successive trend, and in time the worthless vegetation will be replaced by the types of plants which originally made up the soil cover.

It may be that on some areas where depletion is not uniform, the logical thing to do would be the use of combination of artificial revegetation and also controlled grazing, which is known as natural revegetation.

Natural Revegetation

Range experimenters such as Carrier and Oakley point

Fig. 4

Native Oregon bunchgrass growing in Eastern Oregon, a good picture of what the open range looked like only a few years ago. This range was rehabilitated through protection against over grazing.

out the method of dividing pastures with a view to giving each part a rest by alternate croppings during the growing seasons. It has long been recommended as a means of increasing grazing capacities. It has been proved by experimentation that in bluegrass pastures close cropping is advantageous and will have a tendency to keep weeds out as well as produce more forage, but this is not so on non-sodforming ranges.

In grazing western non-sod ranges, care must be taken that an excess number of animals are not allowed to graze any particular area. It is difficult to estimate the number the area will carry if the owner has not had the opportunity to observe stock on the area before. A study can be made of the plots laid out in the range survey, and the data can be compiled to determine the grazing capacity to a fairly accurate degree. The first step is to estimate the average density of the different species of plants on all the plots and average this density. Estimate the palatability of each type, based on the amount eaten by stock. Multiply the average density of each type by its palatability rating. Sum up this factor for each type and the resultant total is the Forage Acre Factor.

Multiply the forage acre factor by the number of acres on the area and the result gives the number of acres available for grazing. Multiply the forage acre factor by the number of acres on the area, and the result will be the number of sheep or cattle advisable to graze on the area.

Since it is a very difficult problem for the operator to decide on the number of animals with which to stock

the range unless he has made an intensive survey, it is always a good rule to understock the range until such a time as observations of results can be made.

The problem is complicated because of the many factors affecting the result such as the variability of forage density, varied amounts of yearly forage production caused by drought, temperature and other adverse influences. Other factors of equal importance as they affect the grazing problem are: the ability of the vegetation to resist grazing and continue to develop; the distribution of watering places for the stock; the condition of the stock and their requirements.

In any well-planned method of grazing, two objects must be kept in mind. One is the cropping of the vegetation at a time in the season when growth and reproduction will be interfered with as little as possible. The other is to utilize the vegetation when the forage is the most valuable, which is usually in the fore-part of the grazing season. To quote from a man of wide range experience, "Few plants, even when grazed closely early in the spring, are appreciably weakened by being closely grazed early every third or fourth year." (2)

This early spring grazing must, however, be tempered with good judgment as the grass can be materially harmed by grazing before the grass has been able to start a good growth. When the more highly relished and desirable non-sodforming plants start to decrease in number then it is time to give the area a rest from grazing. It has been pointed out by ex-

perimentation that through a deferred grazing plan the areas needing such treatment can be rested without decreasing the amount of stock on them.

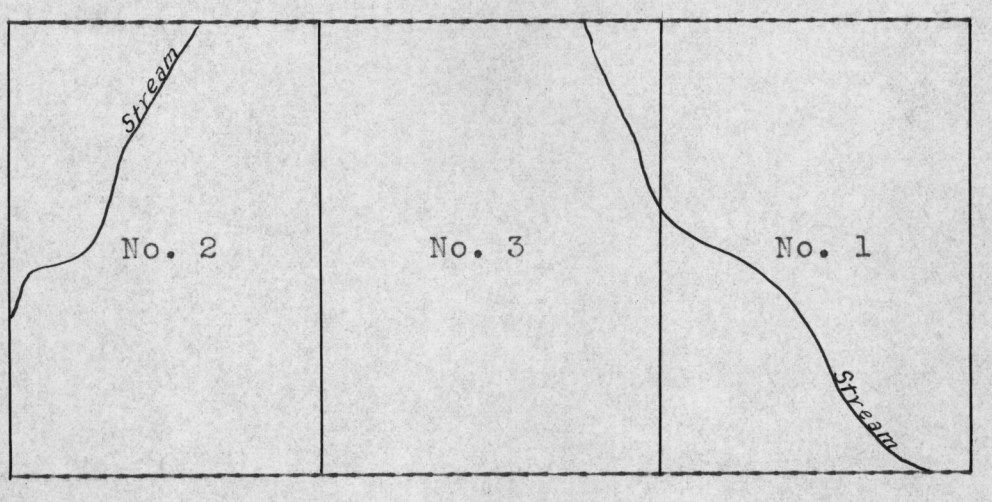
The plan the writer has drawn out to explain this system is similar to the original experimental plan. It is recommended only for lands that support vegetation of similar growth habits.

Let it be assumed that the depleted pasture consists of three hundred acres of non-sodforming range. If watering facilities will permit, it is divided by fencing into three 100 acre tracts. Each enclosure will be grazed during the season, but not simultaneously. If enclosure No. 3 is found to be the most seriously depleted and tract No. 1 in the best condition, No. 1 would be grazed first in the spring. Tract No. 2 would be grazed next, followed by tract No. 3.

The area that is grazed first must be allowed plenty of time to produce a second crop of foliage and store food for seed production before the end of the growing season. The other areas may be grazed after the seeds have been produced and disseminated. The forage is drier and less palatable when grazed at the latter part of the grazing season, but is nevertheless very good forage. The next season the grazing of enclosures should be in the same order as the first year, as this arrangement permits the seedlings on area No. 3 to become well-established before cropping.

The diagram of Fig. 5 fully explains the system.

Fig. 5 Diagram of Deferred System



Area No. 2 To Be Grazed	Area No. 3 To Be Grazed	Area No. 1 To Be Grazed
Summer 1921	Autumn 1921	Spring 1921
Summer 1922	Autumn 1922	Spring 1922
Autumn 1923	Spring 1923	Summer 1923
Autumn 1924	Spring 1924	Summer 1924
Spring 1925	Summer 1925	Autumn 1925
Spring 1926	Summer 1926	Autumn 1926

As the whole pasture is rejuvenated, the rotation grazing should be continued in order to keep the vegetation increasing at all times. The grazing system proposed will usually increase the carrying capacity of bunchgrass pastures without decreasing the number of stock grazed before the partition fence was put in. It has been proved through experimentation at the New Mexico State Experiment Station that from 50 to 100 per cent increase in vegetation will be attained within three seasons of such deferred grazing.

Rejuvenation of the range under adverse conditions, such as extreme depletion and erosion, may be a slow process if left to natural revegetation. At the outset the soil must be built up by the duff from the lower plants that make up the cover before the other more valuable plants can gain a foothold. The longer the range is misused by long and continuous grazing with a surplus of stock, the shorter and more rapid will be the retrogression period, and the longer it will take the progressive action to begin. The rich top layer of soil will be carried away by the run-off of rains and snow water without the vegetation to retard it.

In the event that the soil has been packed hard by the feet of stock an added handicap to plant revegetation exists. If the plants are cropped exceedingly low, they are unable to send up shoots to produce seeds, especially if this cropping is continuous and excessive. If the early stage of overgrazing is noticed in time, natural revegetation methods may be used and the process of regeneration is comparatively inexpensive and rapid, but if the land has reached the erosion stage a more intensive action must be reverted to.

ARTIFICIAL SEEDING OF RANGELAND

It is not to be thought that artificial seeding is a satisfactory substitute for proper range management, but as a last resort it is a method of repairing the damage done. W. A. Dayton and C. L. Forsling said, "Even on areas where there is little hope for natural revegetation artificial

range seeding should not be undertaken unless grazing can be restricted long enough to allow the introduced vegetation to become well established." (8)

After vegetation has become well established, grazing should be regulated to a degree that will make it possible to maintain the stand. It is best to keep livestock off during the first season and until late the second season. During the first season the tender shoots produce but little forage and severe injury is likely to occur from trampling of grazing animals. By late summer of the second year, the young growth has attained a size and vigor that enables it to withstand light or moderate grazing.

Artificial reseeding may sometimes be employed as a supplemental measure in the management of range or other lands. The cost of supplemental seeding can be figured on a much more favorable basis. The seeding of eroded spots in cut-over timber land, and the seeding of certain areas to control poisonous plants may be given as examples of supplemental seeding. Engram has reported a number of successful seedings of logged-over and burned-over lands in the Cascade region of western Oregon. (9)

The initial cost of seeding operations includes the cost of the seed plus the cost of seeding. The cost varies with the quality of seed and the amount of seed required to give a satisfactory stand, together with the cost of the seed.

For Kentucky bluegrass, the cost of seed is at least 24 cents per pound and about 15 pounds per acre is re-

quired. Other species of seed may be more expensive than that of Kentucky bluegrass. It is the usual thing to plant a mixture of seeds to keep the cost of the operation as low as possible. A less expensive seed is mixed with the more expensive ones with the assumption that the higher priced vegetation will spread after being once established, while the less valuable plants will tend to aid in soil protection.

The cost for the entire operation is based on several items, including transportation, scattering seed, and soil treatment, The cost of equipment must also be figured in, although it may not be used up in the operation. The cost of transporting the seed, except in extreme cases, will not exceed 40 to 50 cents per acre, usually less. An experienced man can sow not less than 10 acres each day with a hand seeder or broadcast by hand. Sowing should not be over 40 cents per acre. A wooden-pegged harrow can be constructed on the site and used to prepare the ground and cover the seed for about 50 cents per acre.

Altitude and Growing Season

Altitude effects the length of the growing season and this in turn materially influences the success of the growth of many species of plants. As altitude increases the growing season becomes shorter. Where the season is less than 100 days, only the most hardy plants can survive. At high elevations plants are likely to make slow growth and development. "Artificial reseeding of Timothy, Kentucky blue-

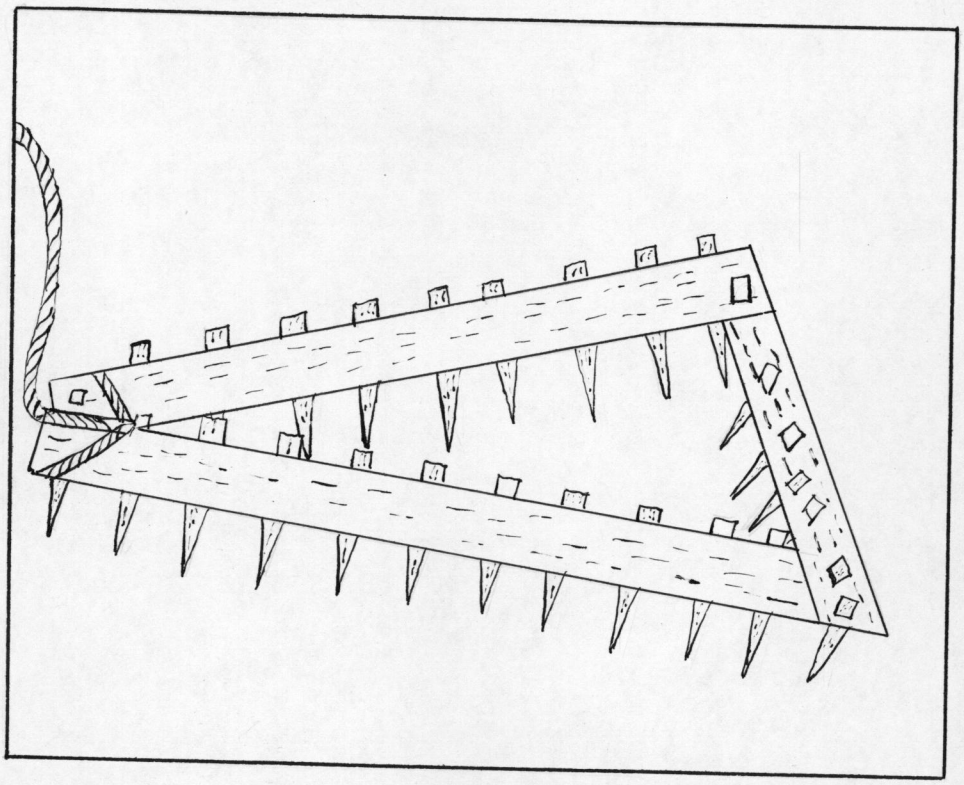


Fig. 6

A Wooden Peg "A" Harrow for use in packed soils; it can be constructed by one man in three hours. It is usually dragged over the ground by one horse. The rope is attached to the saddle horn. After seeding the ground a brush "drag" is often dragged over the ground in similar manner to cover the seed.

grass, and Red top at 4,800 to 7,880 feet elevation in the Blue Mountains of eastern Oregon resulted in average deficiency of 50 per cent in height growth, nearly 60 per cent in density, 76 per cent of estimated yield, and 85 per cent in seed viability." (8)

Choice of Species

Of first importance in selection of plants for range is to obtain seed from those plants that are adapted to the area. The ability of plants to become established, resist grazing, and improve the stand under adverse conditions depends upon their method of reproduction.

Suggested Range Species

Kentucky bluegrass (Poa pratensis)

This grass will give good results on mountain grazing land where the annual precipitation averages 15 inches, especially on limestone soil. It is excellent forage for all livestock. Its chief drawback is that it takes a long time to become established and the seed is comparatively expensive. Indications are that this grass seed germinates better with light, and the seed should be lightly covered with soil.

Canada bluegrass (Poa compressa)

This species is a hardy perennial resembling Kentucky bluegrass in appearance, forage value, and growth habit. It grows in a great variety of soils, and will become established on drier sites than will Kentucky bluegrass. Although

not having been tried as much as Kentucky bluegrass, it is known to grow well on western ranges.

Red top (Agrostis palustris)

This grass is variable in size and becomes accustomed to a variety of sites. It usually grows in wet sites under such conditions and particularly on wet, acid soil. With these kinds of conditions it is a fast growing plant, but does poorly on drier sites.

Quack grass (Agropyron repens)

Quack grass is sometimes called the couch grass, but is a species of wheatgrass. Because of its aggressive growth and the difficulty of eradication, it is well known. It requires a fairly moist soil. It is not affected by cold winters or hot, dry summers.

Cultivated and Introduced Species

Timothy (Phleum pratense)

Orchard grass (Dactylis glomerata)

Italian ryegrass (Lolium multifloruim)

Tall or Meadow fescue (Festuca elatior)

Sheep fescue (Festuca oviana)

Crested wheatgrass (Agropyron cristatum)

Smilo grass (Oryzopsis miliacea)

Tall oatgrass (Arrhenatherum elatuis)

Native Grasses

Big mountain bromegrass (Bromus carinatus)

Violet wheatgrass (Agropyron violaceum)

Slender wheatgrass (Agropyron tenerum)

Fig. 7

Large mountain bromegrass artificially reseeded on the Wasatch Plateau, Utah at an elevation of 8,850 feet.

Fig. 8

Sheep grazing an open slope where the forage is knee deep, showing the result of good grazing practice.

In choosing the best time to seed, the most important consideration should be the ample supply of moisture from the time of the seed germination until the grasses have become established. Late fall sowing has given best results in eastern Oregon in the Wallowa Mountains and also in Utah and in the Pacific Northwest. In the Southwest, spring sowing is quite common in that it is a time of frequent showers and the sites remain moist throughout the summer.

POISON PLANTS

Despite the fact that several volumes could be written concerning poison plants, the writer believes no range study would be complete without giving a few thoughts to these very important inhabitants of the range. Giving due credit to the great improvements made in range management recently, we realize that many problems still face the stockman in his effort to produce livestock. The poison plant problem is one of the most serious in the far west where losses of stock each year mount up into thousands of dollars. Loco kills from year to year 5 to 50 per cent of the stock poisoned on the western ranges.

To prevent this heavy loss, stockmen must familiarize themselves with these plants and so control the stock as to prevent them eating the poison plants. In improvement or rejuvenation of the range, it is highly desireable to rid the range of these worthless plants, as they are of no value for forage and are highly dangerous to stock. Where excessive grazing and overstocking has been the practice, poison plants

are apt to be numerous.

The usual method of dealing with them is the less expensive, but it is also the less efficient; however, fencing is a fairly safe way of controlling stock losses from these plants. The best method of ridding the range of these plants is to grub them up and destroy them. In this method you not only get rid of the noxious plants, but also dig up the soil, making a good seed bed for reseeding.

Where native forage plants are not adequate to re-seed areas, the tendency is for worthless plants to come in and for the Larkspur to become reestablished. Where growing conditions are favorable, it is advisable to sow the seed of some native forage plants or the more promising cultivated species, since this insures earlier improvement of the range and tends to restrict re-infestation by noxious plants. "In a test conducted by W. H. Scalan and Robert Reed on the North Fork division of the Holy Cross National Forest, Colorado, the seed of Redtop and Orchard grass was sown in some small gulches where Monkshood, Larkspur, and False hellebore grew. No effort was made to thin out the native vegetation prior to seeding. Where the ground was sufficiently wet, the Redtop crowded out the weeds. On the drier areas, although a good stand of Redtop was obtained, it was mixed with the False hellebore, which the Redtop seemed unable to displace." (10)

TRANSPLANTING TO CHECK EROSION

Still another problem that the stockman must solve is the problem of erosion. Although not as dangerous to

stock or outstanding except in its worst stage, nevertheless it is an undermining agency that will eat away the rich top soil and leave nothing but unproductive gullies. On the Wasatch Plateau in Central Utah, three weedy plants were experimented with in a transplanting operation in an effort to stop erosion. Sweet sagebrush (Artemisia incompta), Western yarrow (Achillea lanulosa), Rydberg penstemon (Pentstemon rydbergii) were used in this transplanting project. "They all have vigorous root stocks, are easily established and spread to form a dense turf. The expense involved and the slow rate of spread of these species render transplanting of questionable value as compared to seeding of the areas." (11)

Where the natural plant cover on the headwaters of streams in mountainous country has been depleted by overgrazing or other causes, erosion usually sets in immediately. A system of small rills or shoestring gullies ordinarily forms on the upper slopes of the watershed with sheet erosion taking place between them. These usually form larger gullies below.

Erosion of this character does a great deal of damage by depleting the soil on the mountain slopes and adding sediment to the streams. It may be necessary where erosion has reached such a stage of destructiveness as to make seeding impossible, to construct dams to form an obstruction across gullies. After the onrush of water is stopped, seeding or transplanting may take place with some degree of success. If the plants are able to establish themselves, they will usually choke up the gullies by their spreading growth and erosion will eventually be halted. It is sometimes necessary

to exclude all stock from the eroded area during the time in which the new vegetation is being established.

Of the several species tried out in sowing or planting for erosion control in several range experiments on the Wasatch Plateau, the native grasses gave the best results. Obviously, under any method or using any species, some productive soil must be available to sustain the new growth. Where the soil has been partially depleted the species of less exacting plants would be the logical choice in planting or seeding. Where the native vegetation has been destroyed and the soil still remains in good condition, almost any species suited to the climate and moisture on the area will be acceptable for planting. Higher costs are usually justified in planting for watershed protection than for forage production.

CONCLUSION

In this paper the writer has tried to give as clear a conception of the problems of range rejuvenation as possible without leaving out too many of the factors affecting the operation. It should be remembered that range rejuvenation is not a single task of reseeding the areas, but the regulation of grazing, stocking, fencing, and many other elements which have a direct bearing on whether or not the effort will be successful. All these things have been mentioned in this thesis and must be thought over and a plan of action in the rejuvenation of the part of the western range lands in which the reader is interested compiled, coordinated and finally

drawn up. There are still many undeveloped possibilities such as further trials with native range plants and the search for foreign plants which will aid us in our objective of putting our rangeland on a permanent sustained yield basis.

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