Range Research, the Foundation for Range Management and Improvement[1]

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RANGE conservation, management, and improvement have made tremendous progress during the last 50 years. During that time they have advanced from the pioneering rule of thumb stage to a science based on tested knowledge. Although there are many unanswered problems and further opportunities for development, still research has laid a secure foundation for better range forage and livestock production.

The transfer of the forest reserves from the Department of Interior to the Department of Agriculture in 1905 laid the groundwork for this progress. Previously, Mr. Gifford Pinchot, Mr. A. F. Potter, and Dr. Frederick V. Coville had made a survey of the public lands and had recommended their control and regulation. It was natural, therefore, for these three to team up in developing a sounder basis of grazing for the national forests as they came to be called upon transfer of authority. Pinchot was Chief of the Forest Service. He brought Potter in to head up grazing administration. Doctor Coville was chief of the Division of Botany in the Bureau of Plant Industry. Between the three of them they planned for range studies which would facilitate efficient grazing administration on the national forests. In 1907 Dr. James T. Jardine, later Director of Research in the Department of Agriculture, and Dr. A. W. Sampson, later professor of range management at the University of California, were hired to initiate such studies.

Others were employed shortly thereafter and in 1910 the Office of Grazing Studies was formed in the Forest Service with Doctor Jardine in charge. The Great Basin Experiment Station, in the mountains of central Utah, was established in 1912. In 1915 the Santa Rita and Jornada Range Reserves in southern Arizona and New Mexico were transferred from the Bureau of Plant Industry to the Forest Service along with authority for range research on other public and private lands, as well as the national forests. The McSweeney-McNary Forest Research Act of 1928 set up an authorization which gave impetus to expansion of range research, both on forested and on untimbered ranges, public and private. In 1940 studies of grazing of forest range in the Southeast were initiated in eastern North Carolina and south Georgia and this was followed in 1944 with somewhat comparable studies in central Louisiana. These have been further expanded and provision made for range research in several other southern states, culminating this year in the initiation of work on forest grazing in Missouri. The program of establishing experimental forests and ranges followed by Congress in the last three years has been a big factor in recent expansion. Range research is now underway at all six regional forest and range experiment stations in the West and at the Central States, Southern, and Southeastern stations. Much of our work is cooperative with other federal agencies, and with the state agricultural experiment stations.

The exact acreage of native forage-producing lands, commonly called range, is difficult to determine. There are roughly 950 million acres. In times of high demand for wheat and other grains and a good price for them, some range land is plowed for cultivation. On the other hand, as cultivated fields are abandoned, especially during depressions and drought periods, they go back to native range vegetation. The best use of range lands is in furnishing cheap forage in an intergrated range-farm agricultural enterprise. Although much less productive acre for acre than cultivated pastures, in the aggregate range lands furnish a material part of the feed requirements of the nation's livestock. Nearly 75% of the sheep and goats, over one-half of the beef cattle, and large numbers of other livestock are supported for some part of the year on range lands. Nearly two-thirds of the range area is privately owned. More than one-third is forested.

There is a vast difference between western range and humid improved pastures. On western ranges where annual precipitation generally averages under 15 inches, low for plant growth at best, but where some receive only 5 inches, bunchgrasses which do not form a sod, succulent forbs or range weeds, and foliage and tender twigs of shrubs or browse largely furnish the forage. Whereas the heavy cover of turf-forming humid pasture plants can withstand close grazing, bunchgrasses on arid and semi-arid ranges grow in a thinner stand and cannot withstand such grazing.

A great part of the western range area, however, was heavily grazed in the early days of settlement. Large acreages received such use even up to the mid-thirties. Without any control or regulation on the public lands, stockmen used them in any manner that they desired. This engendered considerable competition for forage. Private lands, however, were handled little, if any, better. The net result was that much of the western range became seriously deteriorated. Palatable plants were replaced by a thinner stand of less palatable plants. Low value shrubs increased greatly in density and many foreign annuals crowded in. The thinner

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plant cover opened the soil to serious erosion, especially on sloping lands, resulting in loss of much fertile top soil. Grazing capacity was greatly reduced. Even now it is little more than 50%, on the average, of what it once was, although extensive areas in the northern and central plains and more limited areas in other parts have shown considerable improvement since early days and since the droughts of 1934 and 1936.

It will be evident, therefore, that the most important problem on western ranges is restoration of forage and soil values. A considerable part of our research has been centered on this problem. Of almost equal importance is the problem of sustaining production on ranges in good condition. Fundamental ecological and physiological studies, backed by actual grazing tests, have revealed that each major range type and each productive condition of such a type has its own peculiar management requirements. These depend upon the nature and adaptability to grazing of the forage cover and the growth conditions to which the cover is subjected. The extent and character of erosion which may have taken place or is taking place also seriously affects growth conditions.

Of first importance has been overcoming overgrazing in order to stop further deterioration. Studies in several parts of the West have shown that with each stage of depletion of the range vegetation, the situation on a range area becomes more critical as regards both production of forage and restoration of the plant cover. The intensification in the micro-climate is reflected in such features as higher temperatures and greater evaporation, while more rapid runoff and more compact soil results in less absorption of moisture by the soil. The resulting erosion brings increased requirement of water for the production of an equal quantity of forage. Finally, all of these combine to cause more damage to the vegetation from prolonged dry spells.

Some plants withstand grazing better than others. Those which reproduce vegetatively ordinarily can stand heavier grazing than those which depend upon seed for reproduction. Most range plants, however, require seedling establishment once they are seriously depleted. Critical studies of carbohydrate production and storage by several range grasses in relation to growth prove that accumulation of food in the crowns and roots of the plants takes place during the decline of the current leaf and stem growth after seed production; that plants draw heavily on stored food in winter and spring before growth of grasses can be observed; that start of above-ground growth depends on food stored the previous summer; and that yield of forage is in direct relation to food production during the current summer. These studies have shown how intensity and frequency of grazing influence the start of growth, food production, forage yield, and winter survival of plants; and how too frequent or too heavy grazing at any time literally starves the plants to death.

Also, sufficient stubble in the form of basal portions of stems and partly ungrazed leaves must be left at the close of the grazing season to protect the crown of the plants from winter weather and check wind and water erosion. The exact amount of stubble to leave depends on a good many factors.

There are other phases of utilization of the forage which must be critically considered. The degree of grazing relates in part to the density of the vegetation and the plant competition and partly to danger of erosion. Utilization standards have been developed in relation to productive condition for a number of range types. The studies underlying these standards and the relationship of plant succession to range management clearly show that there are rather definite stages through which vegetation must develop in order to restore depleted range to a satisfactory condition. On seriously depleted ranges the trend is normally from low value annuals through certain perennial weed stages, and finally to conditions in which perennial grasses predominate. The trend in soil is toward a more fertile, friable condition which absorbs precipitation more readily. Underlying the whole, it is necessary to recognize and understand the various range conditions and whether the range is improving or declining in productivity as shown by density, utilization, plant vigor, soil factors, and other indicators.

It will be seen from this that practically every approach to management and improvement of the range is concerned with the knowledge of the range plants themselves, their identification, growth requirements, life history, other ecological relationships, their forage and other values, and their ability to withstand grazing. While this must be determined with regard to each of the important plants within major types, the whole problem of plant competition, plant succession, and the influence on those natural factors of grazing by livestock, game, rodents, insects, or other animal life must also be given consideration.

Soil texture, structure, and fertility all play an important part in range forage production and in the rate of improvement. The plants on the range bind the soil against erosion, aid in the absorption of precipitation, and in turn draw upon this soil moisture for their production. If bunchgrasses are as abundant as the normal soil moisture permits, their fibrous roots interlace between the tufts under the bare soil spaces. Their spreading root system helps to keep the soil mellow and porous and facilitates moisture penetration. Such non-eroded soil is much richer than eroded soil in nitrogen and phosphorus, the water-holding capacity is greater, and the water required by plants to produce forage is less. A great many more leaves, greater stem and leaf length,

and more forage volume are produced. However, on deteriorated ranges, bunchgrasses are not abundant and the remaining range plants do not serve adequately in soil and moisture conservation.

Numerous improved practices, developed by research, are now widely applied on western range lands. These include (1) opening and closing dates which harmonize both with readiness of the range for grazing and nutritional requirements of livestock; (2) deferred and rotation grazing which permits proper use of the forage on the range as a whole, but which delays grazing until after seed dissemination or forage maturity on a different portion of the range each year; (3) improved methods for grazing sheep and goats, such as open and quiet herding and bedding them down in a new place every night to avoid damage through trampling and localized overgrazing; (4) obtaining better distribution of cattle through well placed watering facilities and better salting methods, thus bringing about more even and more effective use of the available range forage; (5) management which harmonizes grazing with forest regeneration; (6) eradication or control of many noxious plants and methods of management which minimize losses from poisonous plants; and (7) economical procedures to reduce the stand of some of the low value shrubs so that grasses can make greater growth.

The end product of proper range management is, of course, human welfare. Western agriculture is a great complex of interdependent crop farming and range grazing. This whole enterprise, involving the welfare of thousands of local communities and even metropolitan centers, reflects adversity or prosperity on the range. All too frequently the strain of improper management has resulted in reduced livestock production, increased costs, over-investment, tax delinquency, bankruptcy, deserted homes and schools, and blighted hopes. These difficulties may be escaped and communities dependent on the range resource stabilized and maintained only where improved range management is applied.

Numerous examples could be cited of increased forage and livestock production obtained from improved management developed by research. Such increases generally have come from more adequate and nutritious forage available for each animal, greater production per animal or per acre of range or both, increased calf or lamb crops, lower costs, and greater profits. This is true in the western plains, valleys, mesas, or mountain country. Improved range management practices developed by research have already brought many millions of dollars of savings and increased revenue to stockmen annually.

So far the discussion has been largely of the West. There are also possibilities for improving range management and range livestock production in the South. The heavy cover of relatively low value plants occurring on southern forest and other ranges has seldom been recognized for its true value, partly because yearlong grazing without supplemental feeding has given such poor results in livestock production. The vast area of range lands provides an enormous quantity of forage which, if properly used and coordinated with other farm production, can mean a great deal in better southern range cattle production. A few outstanding points might be mentioned. The switchcane or reed type is a relatively high capacity range type suitable for about eight month's grazing. A longer season is possible if a fresh area is grazed in the fall and winter. Although most of the wire grass and broomsedge ranges of the southern piney woods are grazed yearlong at the present time, their value is greatest in the spring and early summer. It would be best to graze such ranges for that short spring and summer period, utilizing other pasture or forage during the balance of the year. Another alternative is to provide protein and other mineral supplements to range-grazed livestock through the fall and winter periods in order to keep them in productive condition. The cooperative studies with the Bureau of Animal Industry and several state agricultural experiment stations of the chemical composition of forage plants at different growth stages and of supplemental protein, mineral, and other feed requirements are pointing the way to better yearlong nutrition of southern range animals.

Range Reseeding

The principal objective of reseeding research is to develop methods and find suitable plants for seeding or transplanting on the portion of range lands now so badly depleted that reasonably rapid natural revegetation appears improbable. About 80 million acres of western range lands fall within this category. Another objective, especially important in the piney woods section of the South, is to establish plants which will lengthen the season of palatable and nutritious range forage and thereby reduce the feeding of costly supplements, now essential for sustained livestock production.

Range reseeding in its present state of development is a product of research largely of the last decade and a half, although early work laid part of the foundation.

Early studies developed procedures suitable for reseeding mountain meadows which had especially favorable soil and moisture conditions. Costs were relatively high, but the increased forage production usually justified the cost. Limited studies in other types gave some leads for successful seeding.

The need for regrassing abandoned cultivated fields and depleted range lands in the northern Great Plains led to intensive studies in that area, beginning in the early thirties. The critical shortage of forage and the serious erosion on foothill ranges grazed in spring and fall emphasized the necessity for more intensive funda-

mental studies which would develop procedures adapted to arid and semi-arid ranges. Accordingly, such studies were undertaken in the mid-thirties in the valleys and foothills of the Intermountain Region. Similar intensive studies were extended to other parts of the West and to the South in 1945.

Ranges have been analyzed to learn how differences in soil, climate, and other factors affected possibilities for reseeding. Studies were then concentrated on sites which showed the most promise for success.

Intensive studies have been made to determine adaptability of species, varieties, and strains for the various range conditions, drawing on native plants and introduced from foreign lands which grow naturally under similar ecological conditions. Forage plants introduced or developed by the Bureau of Plant Industry, Soils, and Agricultural Engineering or tested in nurseries by the Soil Conservation Service have been included in the range studies. The adaptability studies provide first for planting these plants in row plots on specially prepared seed beds within representative range types and conditions. Such plots are weeded to give the plants every opportunity to show whether they can grow under the climatic and soil conditions prevailing. Survivors are then seeded in larger plots under natural range conditions in a manner as near as possible to that used in large scale plantings within the type. No attempt is made to reduce the competition or provide especially favorable conditions unless such procedures would be used in actual reseeding practice. Plants which prove successful in these latter tests can be confidently recommended for large-scale seeding on comparable sites.

Critical study has also been made of seeding methods especially adapted to range conditions, including how much seed to plant of each species, depth required to attain satisfactory establishment, best season of year for planting, what machines to use in planting and to reduce competition, and other comparable features. These investigations have developed procedures especially adapted for most efficient and economical establishment of each species under different site classifications. When conducted on relatively large areas they have determined costs. The extensive seedings of stockmen, National Forest Administration, Soil Conservation Service, Bureau of Land Management, or other agencies, especially those on a pilot test basis, in direct cooperation with our range reseeding research personnel, have been a major factor in the final determination of reseeding methods and procedures, and their economic feasibility. Several large-scale reseedings, too, have served as experimental grazing areas where the true forage value of the various plants and the best management practices could be determined.

Such experiments throughout the 11 western states have shown what to seed, where to seed, when to seed, and how to seed many range types and conditions. Also, these studies are showing how best to graze reseeded areas.

As a result of these studies, we know how a number of range types which have been so badly depleted that they will require 30 to 50 years to recover naturally, can be seeded economically and made productive in from one to three years. Already over 5 million acres of depleted western range lands and abandoned cultivated fields have been seeded successfully at reasonable cost. Seedings have increased forage production 5 to 10 times, some 15 to 20 times.

Although range research has made considerable progress in developing answers to grazing management and reseeding problems in the West, especially in the last 10 or 12 years, there are still many problems unanswered or only partly answered. Much information, now available in only rough form, must be refined. Because of the great variation of vegetation, soils, and climatic characteristics—from the desert lands supporting sparse vegetation to the highly productive mountain meadows—there is need for a great deal more information on practices that will give optimum production on all major range types. The wide variation too in productive condition on deteriorated ranges presents many unanswered problems relating to range restoration through management and reseeding. Studies too should be extended to many important range areas not previously investigated; among them, the expansive brush areas and the Pinon-Juniper ranges of the West, the woodland ranges of the southern Piedmont, and the southern prairies. These offer opportunities for greater range livestock production that can be fully realized only with the advance in knowledge which may best be accomplished with the help of research.