Your Range——
Its Management

Special Report No. 2

Seventy-Fifth Anniversary
The University of Arizona

Agricultural Extension Service **Agricultural Experiment Station**

YOUR RANGE – ITS MANAGEMENT

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Foreword

No one owns land in a permanent sense. We may hold temporary title to an acre or a thousand acres but this is at best a temporary title. It does not carry with it the right to exploit or despoil the vegetation or other natural resources of that land.

The welfare of the nation and, in a larger sense, of the world depends on the welfare of all the scattered acres that make up this land upon which we depend for our very life. Let us therefore, each do the little that we may to see that the acre over which we hold temporary custodianship is passed on to the next custodian with its natural resources as well or better conserved as when it fell into our hands.

And let those of us who are called educators in the natural sciences do what we may to develop this philosophy.

Robert R. Humphrey

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Agricultural Extension Service
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Cooperative extension work in agriculture and home economics, the University of Arizona College of Agriculture and the United States Department of Agriculture cooperating. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914.

8M — July 1959 — Special Report No. 2

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Your Range—Its Management

By Jim Finley

"Know the growth habits of your grasses,
Give them a "Break"
And they will keep you from going Broke."

The American Society of Range Management was created "to promote progress in the conservation and greatest sustained use of forage and soil resources, to stimulate discussion and understanding of scientific and practical range and pasture problems, to provide a medium for the exchange of ideas and facts among society members."

Our Arizona Section of this important organization now has over 250 members, about half of whom are Arizona ranchers and half are trained technicians of high standing and experience in their field.

It is our aim to work together as a team, studying, experimenting, developing and putting into practice what we already know and also what we find by trial and error to be the best methods of using our lands and grasses to maintain their greatest sustained production.

Grass is the world's most important crop, and upon its proper use and preservation depends the future of mankind.

What a wonderful opportunity and responsibility we ranchers and scientists have and how frightening, when we consider the consequences to future generations if we fail to properly evaluate and fulfill this responsibility.

A well-considered, long-term plan of range management can, if followed out, pave the way to successful livestock ranching. It will take most of the guesses out of operating our business, and will soften the effects of a bad drought year, meaning the difference to the rancher of moderate hardship rather than disaster.

We have case history proof where in one poorly managed pasture native grass produced 300 pounds of forage per acre, while just across the fence the same type of grasses, under proper range management, with the same rainfall and soils, produced in the same year 1500 pounds of forage per acre.

This may be an extreme example, but think what it would mean to the average rancher if he could increase the production of forage on his own ranch by as much as 25 to 50 per cent without additional expense to him.

He would produce more pounds of better beef per acre with less expense for supplemental feed, less death loss, better calf crop, and less worry, while increasing the value of his ranch.

We invite you to join our Arizona Section of the American Society of Range Management, and attend our meetings where you will hear technicians and ranchers discuss and explain better range management practices as they apply to our local Arizona conditions.

You will have an opportunity to study and learn with us, how actually to grow more grass under our present low average rainfall, producing more pounds of better beef per acre, and also increasing the value of your investment in ranch property.

And last, but not least, remember that good range management keeps the rancher and his banker good friends, — The rancher doing well, and the banker knowing his security is stabilized.

Putting Conservation to Work
or
Conservation Through Utilization

By Robert R. Humphrey

Before launching into this subject let us pause just long enough to be sure we know what we have in mind when we use the term conservation. The word has two common meanings: one to save for the sake of saving; the other has a more utilitarian meaning. I shall develop this second, more practical one.

Funk and Wagnall's unabridged dictionary says, and I quote "Conservation: the preservation of material resources for economical use." This is brief and to the point. It also indicates that one can be a conservationist and at the same time make use of our natural resources. This is in exact agreement with a statement made by William Howard Taft in 1910, namely: "Conservation as an economic and political term has come to mean the preservation of our natural resources for economical use, so as to secure the greatest good to the greatest number."

I shall confine my remarks to a consideration of the application of this definition to one of our renewable natural resources, namely forage. I shall develop the thesis that it is possible to so use this resource as to conserve it.

I use the term forage in a rather broad sense as including all plants—grasses, forbs or browse—that provide feed for grazing animals of all sorts. These animals may be domestic livestock, they may be game or they may even be rodents, or such a reptile as our desert tortoise.

Grazable vegetation can be classed as either grasses, forbs or browse. On most ranges grazed by domestic livestock, grasses, or occasionally forbs, provide most of the feed. Big game animals as a general rule tend to be browse eaters. Either of these classes of animals, unless restricted as to numbers or distribution, can overgraze and despoil a range. Conversely, under what we might call conservation management, ranges can be maintained indefinitely while being grazed. In fact, many grassland ranges seem to require grazing or at least periodic removal of the dead grasses to keep

them from deteriorating. One can't go so far as to say that grasses are meant to be grazed; it is true, on the other hand, that grasses are so made, both physiologically and morphologically, as to be able to withstand controlled grazing indefinitely.

The basic morphologic reason for this grazing resistance is that grasses do not grow at the ends of the leaves and stems which are grazed off, but at the base of the leaves and at the stem nodes. As a consequence the zone of growth is largely out of the reach of grazing animals and continues to develop even though the tops of the plants may be eaten off. This same feature explains why grasses have persisted in the prairies and plains the world over despite frequently recurring grass fires.

The physiology of a perennial grass plant's resistance to grazing is so simple that one wonders why the fundamentals are not more widely known. When a perennial grass manufactures food in its leaves, part of this food is used by the plant for growth; a part is conserved or stored for future use. (It is of interest here to note that even the plant's conservation program involves utilization rather than just purposeless hoarding.) Some of this storage is in the above-ground portions of the plant, namely the leaves, stems and seeds, some is in the roots below ground. If there were a bare minimum of storage every year any grazing would weaken the plants. During normal years, however, there is a surplus over this minimum so that a portion of the leaves and stems can be removed without seriously impairing the plant's food manufacturing ability.

When grasses are overgrazed, on the other hand, this ability is impaired and, if long continued, will result in weakening and ultimate starvation of the plant. A plant is no stronger than its root system and this root system is no stronger than the leaves and stems above ground. When too much of the above-ground food-processing part of the plant is removed not enough food reaches the roots even for their adequate growth, let alone enough for storage against the following year. So, a vicious cycle is initiated. A reduced root system leads to smaller tops the next year and these to still heavier grazing and more root starvation and so again, to still smaller tops and still smaller roots until our plant passes out of the picture completely.

Shrubs and perennial forbs are less well adapted to grazing than grasses, primarily because the growing tissues are at the ends of the branches and around the periphery of the stems. When the growing stem tips are removed by grazing, recovery can only be by development of side branches. Or, if the stems are killed at ground level, as by fire, the plant is either completely killed or must stump sprout from buds at or below the ground surface. Woody plants therefore, unless they happen to be vigorous stump sprouters, are at an obvious disadvantage compared with grasses in any area swept periodically by fires. This appears to be a chief reason for many of the grassland areas of all the continents of this world.

Physiologically, shrubs and perennial forbs resemble grasses in their resistance to grazing. They, like the grasses, can withstand moderate grazing without harm. Too-long-continued heavy use, on the other hand, weakens the root system by starvation and ultimately destroys the entire plant.

In the foregoing discussion I have been talking about grazing principles; not grazing by domestic livestock, as contrasted with big game, or as contrasted with rodents. It makes no difference what kind of animals are on a range; as long as they eat plants the effect on these plants is the same. It can either be beneficial, neutral or harmful. Even after all these years we still don't have all the answers on how to graze our ranges; we do, however, have a pretty fair understanding of the principles. We do know, also, that only by continually probing by means of our research programs and by making our finds known to the public can we hope to conserve our natural resources through ever more intelligent use.

In closing, I would like to leave one thought with you. No one owns land in a permanent sense. We may hold temporary title to an acre or a thousand acres but this is at best a temporary title. It does not carry with it the right to exploit or despoil the vegetation or other natural resources of that land. The welfare of the nation and, in a larger sense, of the world, depends on the welfare of all the scattered acres that make up this land upon which we depend for our very life. Let us therefore, each do the little that we may to see that the acre over which we hold temporary custodianship is passed on to the next custodian with its natural resources as well or better conserved as when it fell into our hands. And let those of us who are called educators in the natural sciences do what we may to develop this philosophy.

History of Vegetational Changes in Arizona

By Robert R. Humphrey

The plant cover of any area is always in process of change. Sometimes, as during severe drought, these changes are rapid and readily visible; more frequently they are long-drawn-out and one may not even be aware that they are occurring.

Although drought or other factors of weather are responsible for much vegetational change, obviously other items may also be important. Man is the single other factor responsible for most vegetational change. Someone will immediately ask, what about fire. Fire is, of course, directly responsible for many of the changes that do occur. Most fires, however, are the result of man or weather and can be discussed under these headings.

Let us look briefly at some of the changes in vegetation that have occurred in the major forage or water-producing types of Arizona within roughly the last 100 years.

Spruce — Fir

There is little evidence of appreci-

able change in the high-altitude spruce-fir-aspen timber. Fires formerly occurred more frequently in the spruce-fir area than they now do. These fires were probably usually highly destructive because of the dense character of the stands and the heavy accumulation of litter. They probably occurred much less frequently, however, than fires in the lower-lying ponderosa pine.

The fires that did occur killed most of the timber on the burned area, providing an ideal site for invasion of aspen. The extensive stands of aspen in the Blue Mountains attest to this. Indoctrination of Indians and Whites into a strict no-fire program has greatly reduced the incidence of fires here and the consequent replacement of fir and spruce by aspen. If fires can continue to be controlled, the area in aspen will gradually decrease as the spruce and fir re-invade and again become dominant.

Ponderosa Pine

Changes in the ponderosa pine type have been extensive and marked. These changes appear to be largely a direct result of the fire-prevention program that has prevailed for about the last 50 years. Evidence is unmistakable and conclusive that fires did sweep through these forests at frequent intervals. Weaver, working in Arizona for the Indian Service, obtained a series of records on fire-scarred ponderosa pine trees. These records revealed that from 1831 to 1943 a fire had occurred on an average of once every 6 years.

This periodic burning was characteristic, not only of Arizona, but of forested areas throughout much of the West. Jepson in his Trees of California states "the Sierra Nevada forest, as the white man found it, was clearly the result of periodic or irregular firing continued over many thousands of years. . . . As a result the Sierra forest shows marked reactions to millenial fire conditions. . . . Indeed, the main silvical features, that is, density, reproductive power and dominance of types, are in great part expressions of the periodic fire status." Weaver concludes that "the Southwestern forests are also expressions of the periodic fire status."

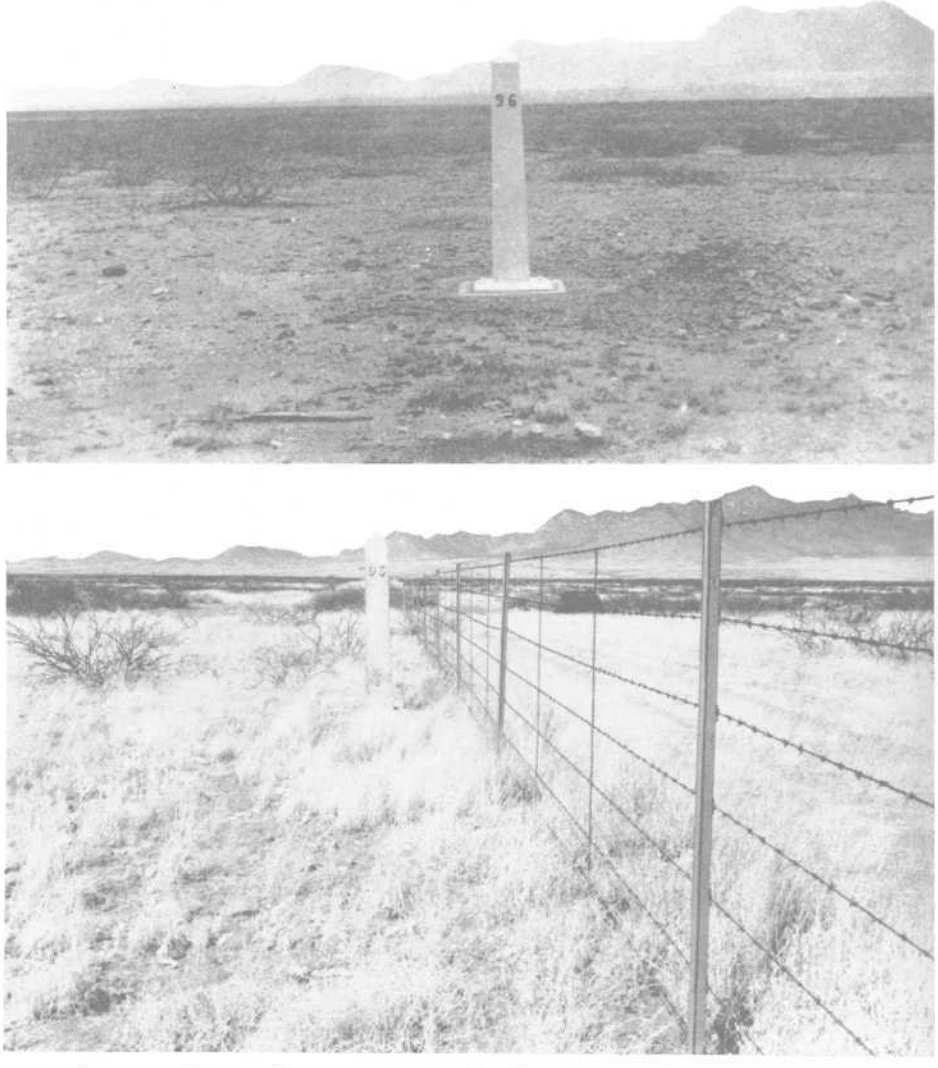
As a result of these periodic fires, litter accumulation was slight, reproduction was open and uneven-aged and the forests were carpeted for the most part with a stand of grasses. These same areas today have a heavy accumulation of needles, cones, branches and fallen logs, reproduction is spotty, thickets of "jack pine" are frequent, and relatively little grass is able to become established in the thick layer of litter. These conditions provide an ideal setting for the occurrence of uncontrollable wild fires that tend to destroy everything in their path. A paradoxical situation has thus arisen. Through control of fire, fire control has become a necessity, yet, all too often, an impossibility.

Locally, particularly in the general vicinity of Flagstaff, the original forest cover has been radically changed by heavy overcutting. Much of this area was almost clearcut, then repeatedly burned. This has resulted in delay in the establishment of pine reproduction, followed eventually by growth of rather even-aged trees, or, locally, by little or no reproduction.

Essentially all of the pine has been heavily grazed for many years. This has tended to reduce grass densities even further than the reduction effected by fire control.

Chaparral

Changes in the chaparral seem to have been limited for the most part to differences in composition of the vegetation. Most of the brush-covered land originally had more grass than at present. In some brushy areas where no measurable grass remains today, there was formerly a rather good stand of grass that tended to



Ranges do produce more feed when properly managed. These pictures taken along the U. S.-Mexican boundary tell the story. The upper photograph was taken about 1892; the lower of the same view in 1955. Note the big increase in grass after 53 years of additional grazing.

stabilize soil loss and runoff. Grasses would have been favored by the occasional fires that swept through the chaparral, killing many of the shrubs outright and killing them all back to ground level. Fire control and grazing both have undoubtedly played a part in destroying the original grasses and in developing a more or less pure stand of shrubs.

There is little evidence that chaparral has extended its range appreciably within historical time. It has become more dense where heavy logging has reduced competition for light and moisture and in this sense has extended its range to areas that were formerly dominated by pine. There has, however, been only a slight encroachment on areas that were formerly grassland.

Juniper — Pinyon Pine

Although extensive areas of juniper and pinyon pine exist today essentially unchanged from their pre-historical condition, many changes in both composition and area have occurred. Grazing has reduced grass density in most areas within reach of livestock water. There has doubtless also been some replacement of grasses by additional juniper and pinyon that have come in since initiation of the fire-control program.

The most noticeable change has been in area. Extensive areas that were formerly grassland have been invaded by juniper. The resultant vegetation in many instances consists of juniper with a grass understory. In some instances, however, the grass has largely disappeared as a result of grazing and competition by the trees for moisture.

Most of these newly invaded areas contain little pinyon pine. They can be distinguished readily from the older stands by this purity of composition and by the even-aged character of the trees. In the more recently invaded portions there also will be a large number of small trees many of which will not yet be head high.

Neither juniper nor chaparral is particularly effective in the control of erosion. Pure stands of either are usually severely eroded between the trees or bushes where the soil receives no protection from the force of beating raindrops. This erosion will continue until the woody plants have been removed and grasses have been seeded.

Grasslands

The grasslands of Arizona have changed extensively in both area and composition since white settlement. The acreage with a grassland aspect has been reduced essentially in proportion to the increase in mesquite, juniper and a variety of smaller shrubs. Removal of these woody plants by any means automatically again gives much of this a grassland aspect; areas from which the grasses have been largely or entirely killed must be artificially reseeded to "bring back" the grasses.

The changes in composition have been even greater than those in area. Whereas the grasslands of the state were for the most part typically a stand of mixed grasses, they are largely short grasses today. In the more severely depleted areas annual weeds have replaced even the short grasses.

These changes could have been largely prevented through a better knowledge of the effects of various methods of management. Those who use the land and those non-users who administer extensive portions of it are the ones who must acquire and use this knowledge. There are, of course, exceptions in any group, but Arizona cattlemen as a whole are to be commended for their receptiveness to new ideas and their willingness to put these ideas to the test. As a result, except where hit by extended drought, our ranges as a whole have shown a consistent improvement in recent years. The earlier downward trend has been reversed and many ranchers today can again boast the belly-high grasses their forefathers wrote about.

Relation of Plant Cover to Watershed Management

By Lowell R. Rich

The classic controversy whether plants increase or decrease water supplies, like most things we argue about, cannot be settled by a plain "yes" or "no" answer. Too much depends on the kind of plant cover, climate, topography, soil and other highly variable factors.

It is common knowledge that plants grow only when provided with water and that some plants require more water than others. From this obvious fact, one is tempted to conclude that removing plant cover will cause more water to reach the stream. Yielding to this temptation neglects what experience has taught about many a slip between cup and lip. All that we should conclude is that removal of plants results in less water use by the plants. This could mean that when plants have been removed there will be more moisture in the soil, and as a result an increase in the chance for seepage flow through the soil when the next rain comes. Except — and this is a big except — that evaporation goes right on with or without plants and, except for deep soils can, given time, dry the soil just as dry or drier without plants as with them.

Another obvious fact is that if no water soaks into the ground, more water runs off over the surface. Anyone can check this by comparing the runoff from a roof with that from a lawn. The tempting conclusion is that an impervious watershed would be the best. No doubt it would yield more water, but the runoff would come just as it does from your roof — lots of it when it rains, nothing between rains — an alternation of flood and drought. If a watershed approaches imperviousness through sealing of the soil surface as a result of loss of the protective plant cover, the increased surface runoff usually causes erosion. Perhaps even worse from the rancher's standpoint is that pavement doesn't grow grass.

Well, all this is over-simplification intended only to jog our thoughts. A few measurements of what actually has happened as a result of grazing management at one location in Arizona are perhaps a lot more meaningful.

On the Sierra Ancha Experimental Forest near Globe, three large ly-

simeters (undisturbed blocks of soil in this case, each 50 x 18 feet and 3 to 6 feet deep lying on impervious bedrock and surrounded with concrete walls) were installed. The quantity of water running off over the soil surface and the amount seeping out over the bedrock have each been measured since 1935. None of these lysimeters was grazed between 1935 and 1942, and runoff was about the same for all. Beginning in 1942, one was moderately used, one was heavily used, and the other not grazed. After 5 years of this treatment, the total plant cover was 12 per cent on the ungrazed, 6 per cent on the moderately used, and 4 per cent on the heavily used lysimeter.

What happened during the next 6 years is shown by the following table. It shows the average surface runoff, seepage flow, and weight of soil lost. Average precipitation was 17.3 inches annually, of which two-thirds fell during the winter period.

Under conditions of this experiment, grazing increased surface runoff without appreciably changing seepage flow. The increase in overland flow boosted the rate of soil loss sevenfold under heavy use. In addition, surface runoff from summer storms does not stand a good chance of reaching perennial water in Arizona in quantity because of absorption in dry drainage channels and dissipation by evaporation before subsequent flows come along.

This test shows that reduction in plant cover did not influence the seepage flow, the primary source of stream-flow. Sealing of the soil surface from exposure and compaction from grazing reduced the capacity of the soil to soak up water. This caused appreciably more overland flow of water and greatly increased erosion. Generally, this result of heavy grazing and reduced plant density would be considered harmful. Less water enters the soil to produce forage, summer flood peaks are increased, and productive soil is carried away to choke stream courses and reservoirs.

Other kinds of changes in plant cover and different situations will give different results, of course. The goal of watershed research is to learn what happens under the different combinations. From this information, land managers can choose the alternatives most suitable for each given area.

Sierra Ancha Experimental Forest

Season and grazing treatment	Surface runoff Inches	Seepage Inches	Total water yield Inches	Soil loss Tons per square mile
Summer season				
Ungrazed	0.2	0.3	0.5	44
Moderate use	0.05	0.2	0.7	107
Heavy use	0.8	0.2	1.0	460
Winter season				
Ungrazed	0.0	1.0	1.0	29
Moderate use	0.0	1.1	1.1	28
Heavy use	0.1	1.0	1.1	68
Annual				
Ungrazed	0.2	1.3	1.5	73
Moderate use	0.5	1.3	1.8	135
Heavy use	0.9	1.2	2.1	528

VegetationTypes of Arizona in Relation to Grazing Use

By Hudson G. Reynolds

Many kinds of plants grow in Arizona. Diversity of growth is influenced by a wide range in elevation and annual precipitation. At Yuma, the lowest point, the elevation is only 138 feet, and rainfall averages 3.4 inches a year. On the other extreme, 11,590-foot Mount Baldy near Springerville gets more than 40 inches of annual precipitation.

Through this 11,452-foot range in elevation, five main types of vegetation are found: forests, woodlands, chaparral, grasslands, and desert shrub.

Forests — Spruce-fir-aspen forests grow on the highest, coldest, and wettest lands in Arizona. Douglas-fir and white fir come in slightly lower. At still lower elevation, extending across central Arizona, are the ponderosa pine forests.

Woodlands—Pinyon-juniper woodland surrounds most of the forest type at a slightly lower elevation. These rangelands can be used yearlong although some are used seasonally. Grazing capacities vary widely depending to a large extent on tree density. Ranges in good condition vary in capacity from 3 to 10 acres per animal-unit-month. Many ranges are declining in capacity because of the continuing invasion and thickening of juniper.

Oak woodland replaces the pinyon-juniper type in much of southeastern Arizona. Perennial grasses associated with the oaks are related more closely to species from Mexico; whereas those found in the pinyon-juniper show close relationships with gramas and blue-stems of the Great Plains.

These forest lands serve as summer grazing areas for both cattle and sheep. Openings in forest ranges, in good condition, have grazing capacities of 2 to 4 acres per animal unit month. In general the grazing season extends from May to October. Cattle are moved to the woodland and grassland ranges at lower elevation for the winter. Sheep are trailed to pastures in the irrigated valleys around Phoenix.

Chaparral — These rangelands are found at a slightly lower average elevation than the forested and pinyon-juniper ranges. Scrub oak, sumacs, and manzanita are the most conspicuous plants of the chaparral community. Where the shrub stand is fairly open, a variety of perennieal grasses can be found among the shrubs.

Ranges in good condition have a grazing capacity of 5 to 15 acres per cow month. Palatable shrubs receive most use during the winter and spring. Perennial grasses furnish valuable forage during and shortly after the summer growing season. Many lands

contain dense brush or are on steep topography, making full utilization difficult.

Grasslands — The shortgrass plains found in northern Arizona are a western extension of the Great Plains. Most important forage plants include blue, black, and sideoats gramas. Ranges are used at all times of the year by both cattle and sheep. When in good condition, the capacity of these ranges is as high as any rangeland in Arizona.

Mesquite-grass rangelands are found mainly in southeastern Arizona. Forage plants are made up of a perplexing number of gramas including blue, black, hairy, sideoats, slender, and sprucetop. Curly-mesquite and blue-stem are also common. Mesquite has invaded and lowered the capacity of many ranges. Various cacti are becoming a problem. Rangelands in good condition will carry a cow for 1 month on 4 to 8 acres. Grasslands are used primarily for breeding herds from which weaner calves are the sale product.

Desert shrub — Sagebrush or northern desert shrub ranges are found in extreme northern Arizona. Sagebrush, shadscale, and winterfat are prominent browse plants. A variety of perennial grasses are also important. The type is utilized mostly as fall-winter-spring ranges for cattle and sheep. In good condition, its grazing capacity is from 5 to 10 acres per animal month.

Nearly one-third of the vegetation of Arizona consists of the southern desert shrub type. Annual rainfall is low, temperatures high, and forage production poor. The sparse woody vegetation has little forage value. Ranges can often be used opportunistically. After especially favorable winter rainfall, annual grasses and weeds furnish abundant and nutritious forage during the early spring.

Ponderosa pine with an understory of forage-producing grasses.

Desert grassland with gramas the dominant grasses and a scattered growth of mesquites occurring largely in the drainages.

Major Aspects of the Woody Plant Problem in Arizona

By Robert R. Humphrey

Broadly speaking, Arizona's general woody plant problem is that we are growing woody species — many of them non-palatable — when we could be growing grass. These woody species won't grow without water, and usually more water than would be required to grow grasses on the same area. As the woody species become thicker and taller, they not only use more and more water; they produce less and less available feed for game or livestock. They also make it in-

creasingly difficult to see and get out either game or domestic livestock. That, in general, is the problem with which we are confronted; broken down into its companent parts we find that we have several problems rather than one.

The problems are numerous because we have several kinds of woody plants, each of which grows under a different set of conditions and may respond differently to control treatments.

First, let us look briefly at the size of the problem that faces us. There is a total of approximately 36,416,400 acres in Arizona (50% of the state) supporting woody plants of one sort or another. Nearly all of this area could be improved. This figure is conservative for it does not include the desert-shrub type of the south or blackbrush and related shrubs in the north. It includes only the following:

Type	*Acreage*	*Per cent of state*
Mesquite	7,280,000	10
Chaparral	5,827,200	8
Sagebrush	4,370,600	6
Pinyon-juniper	13,111,608	18
Ponderosa Pine	5,827,000	8
Total	36,416,400	50
State Total	72,842,240	

Thirty-five per cent of the total state area is classed as southern-desert shrub and supports such plants as creosotebush, palo verde, bur sage and various kinds of cactus. This extensive area of approximately 25,500,000 acres has not been included in this discussion since, even though there are woody plants, they do not constitute a major problem. They have been growing for thousands of years essentially where we now find them and, for practical purposes, they are the only kinds of vegetation that will grow there.

All of these types occured in the state prior to white settlement. During the period since settlement, however, the 5 problem types tabulated above have changed markedly in density and composition. Some of them have also greatly increased in area. A brief discussion of individual types will indicate the character of some of these changes and the major problems within each.

Mesquite

The mesquite with which we are principally troubled in Arizona was originally restricted largely to the main drainages and to washes that fed into these drainages from adjacent mountains. As the numbers of livestock were increased, grazing removed more and more of the grasses that formerly served as fuel for frequently recurring fires. These fires apparently were usually set by Indians, though in the early days of white settlement many were started by the settlers themselves. As this condition had prevailed since time immemorial, and as the fires often swept the country every year, it is small wonder that the grasslands were so extensive and mesquite and accompanying shrubs so scarce. It should be pointed out that grasses are well adapted by their growing habits to withstand fires. Most shrubs, on the other hand, are poorly adapted to survive under burning.

The longer mesquite or, in fact, most brushy areas go without a fire, obviously the larger the shrubs become. As they increase in size they become consistently more difficult to kill and the control methods that must be employed become more costly. Thus, in the case of mesquite, where seedlings were originally destroyed by burning, mature trees usually require expensive methods such as bulldozing, cabling, airplane spraying or individual treatment with diesel oil. In the meantime, as the trees become larger and thicker the carrying capacity of the ranges decreases until it becomes a question of whether the value of the range is sufficiently high to justify the expense of controlling the mesquite. Unfortunately, the longer we postpone tackling the problem, the worse it becomes, the greater is the acreage involved and the less will grazing returns from the range cover the costs of control.

Chaparral

Chaparral presents a somewhat different problem than mesquite. This is primarily because the areas now covered by chaparral probably always supported these same brushy species to a large extent. The present change in the type seems to have been mainly one of reduction or elimination of grasses that were originally intermixed with the shrubs.

While chaparral also appears to have been swept by fires periodically, most of the brushy species were able by one means or another to survive or to perpetuate themselves. Some of them, such as scrub oak, sprout from the base; others, as manzanita, send

Mesquite and burroweed have taken over on several million acres of Arizona rangelands and are driving out the grasses by competing for moisture.

up new seedlings within a few years after burning.

Grazing, combined with competition by the shrubs, seems to have destroyed the grasses over much of the state's chaparral-covered ranges. As a consequence, even if we can control the shrubs, it is usually necessary to reseed to grasses artificially, since there is generally no native grass seed remaining. Areas that receive enough rainfall to grow chaparral receive enough to grow an excellent stand of grass, provided the shrubs are kept under control.

Although chaparral stands can be completely cleared for a time by the use of fire, this method has its drawbacks, since chaparral frequently borders on pine timber and it may be difficult to keep chaparral burns from spreading upward into the trees. A second drawback, of course, is the ability of the shrubs to recover so that re-control at periodic intervals is required.

Sagebrush

Less attention has been paid to sagebrush in our war against undesirable shrubs, even though we do have more than four million acres of it, comprising approximately 6% of the total state area. We have neglected sagebrush, not because it does not constitute a problem, but simply because we have been busy with other shrubs that are more pressing.

Sagebrush, like most other woody species, uses moisture that could be growing grass. Although sagebrush does produce some feed for sheep during the winter months, it is generally classed as an undesirable resident of our ranges. Fortunately, it is restricted to the northern edge of the state and has not been found even at high altitudes farther south.

Sagebrush is one of the least difficult plants to control since it can be killed by burning and is rather highly susceptible to 2,4-D. It also responds rather readily to mechanical treatments such as railing, breaking with heavy rollers and pulverizing with a brushbeater or similar equipment.

When sagebrush has been removed by any effective method, forage production and consequent carrying capacity of treated ranges is increased usually from two to four times. Badly rundown ranges can be improved even more than this.

Sagebrush serves as a valuable indicator of potential grassland, even on areas where little or no grass remains. Most ranges that support sagebrush will grow crested wheatgrass or similar highly productive grasses. Any rancher who has sagebrush on his land is missing a good bet when he does not get rid of it to permit the native grasses to improve or to make it possible to re-seed to productive species.

Pinyon-juniper

From a point of view of acreage covered, pinyon and juniper are the most important of all our woody species. As noted above, roughly thirteen million acres, or 18% of the state total, supports this kind of vegetation. Although in recent years serious attempts have been made to reduce this acreage by various control methods, little is being done to restrict additional invasion of young junipers onto adjacent grassland. It has been a matter of common observation for many years that juniper, which includes the so-called cedar, has been increasing in area in much the same manner as mesquite. The reasons for this spread seem to be very nearly identical with those responsible for the spread of mesquite. Juniper invasion has been either into areas that were formerly grassland and periodically fire-swept, or into ponderosa pine stands that were formerly open and supported a floor covering of grasses. There is abundant evidence to indicate that these timbered areas also were burned periodically on an average of once every six years. These fires occurred often enough to kill young juniper seedlings before they had a chance to become established.

Young junipers in a good stand of grass have nothing to protect them against fire and are readily killed. Mature trees, on the other hand, compete with the grasses for moisture, gradually driving them out and reducing their vigor and density to a point where fires either will not run or will not be hot enough to kill the trees. As with mesquite, therefore, expensive control methods, which may cost more than the resale value of the land, must be resorted to.

Various control methods are effective, though most of them are expensive. Those that have given the best results have been hand chapping, bulldozing and cabling. Much additional research needs to be done on the possible use of herbicides. Old mature stands of juniper and pinyon pine have been controlled by cabling at a cost of about one dollar per acre in some instances. Stands of this sort in particular, probably are going to prove to be particularly susceptible to re-invasion. In a mature stand of juniper and pinyon pine, competition from the trees tends to restrict establishment of new seedlings. When the stand is opened up by removal of the old trees, however, competition is reduced to a minimum. In addition, seeds lying on the ground may be planted by the tractors or other heavy equipment used. As a result, large numbers of seedlings may become established that will ultimately have to be controlled. The most effective and economical means of effecting this control will have to be determined individually on each area.

Where the stands are thick, however, and there is adequate grass to carry fire, control by broadcast burning may often be found to be most feasible. This secondary control must follow the initial removal closely enough to prevent the new plants from setting seeds in their turn. Once this initial re-invasion has been checked, which may be as soon as five years after the previous treatment, a considerable period of time, perhaps as much as 25 years, may conceivably elapse before subsequent treatment will be required.

It will be noted that the control of stands of pinyon and juniper, like that of all woody species, must be put on a maintenance basis. Only in this way can the initial heavy cost of control usually be justified.

Ponderosa Pine

Although the area supporting ponderosa pine and other timber species occupies no more than 8% of the state, this area poses one of our major problems. The early records all indicate that the pine stands, not only in Arizona but throughout much of the West, were formerly open and park-like with a good stand of grass as an under-story. A relatively small portion of our pine forests have this appearance today.

There seems no doubt that this change in composition and general appearance is the result almost solely of the control of fires that formerly

ran unchecked at frequent intervals. Many of these were set by Indians, others by lightning. These would occur frequently enough, however, to prevent an accumulation of litter on the ground and to keep the duff layer sufficiently thin to permit the establishment of grasses. Pine reproduction was also thinned out to a point where the trees were commonly not permitted to stagnate or to become so thick as to constitute a fire hazard. This periodic cleaning-up process largely prevented fires from crowning out and thoroughly destroying the timber, as they do so often today.

The principal problem in our pine forests is initially one of cleaning up the accumulated litter and secondly, one of maintaining the stand in a more or less clean condition. Until this is done we shall be confronted with a continued reduction in the carrying capacity of our forested lands and in an ever-increasing danger from uncontrollable fires.

These, briefly are our major woody plant problems. What should we do about them? The most economical way to tackle problems of these sorts is first, to carry on research to determine basic facts regarding them and possible solutions. Secondly, we should utilize the information we have as soon as we have enough to indicate an action program and initiate that action. We have many research data already available indicating the direction we should take in the solution of many of our brush-control problems. The machinery for effectuating an action program to utilize this research can be set in motion by all who have a stake in our range lands or who live on the lands below, and also may indirectly benefit from such an action program. Everyone benefits from land improvement programs that increase production and improve recreation facilities.

Undesirable Woody Plants in Arizona and Some Control Possibilities

By F. H. Tschirley, T. N. Johnsen, and E. M. Schmutz

Undesirable Woody Plant Types

Arizona has more than its share of undesirable woody plants. Approximately 30 million acres of grazing land are infested to some extent with undesirable woody species that compete with more desirable forage plants for moisture and growing space. Various federal and state agencies and interested individuals are actively engaged in finding methods of controlling these undesirable species. Satisfactory control measures have been worked out for some species, but little is known about others. Mechanical, chemical and biological methods of control are all being investigated and all will probably find a place in the final shrub control effort.

The major woody plant problems in Arizona in their order of importance are juniper, mesquite, chaparral, cactus, and the tarbush-whitethorn-creosote bush complex known as The Chihauhua Desert. It is found at elevations of 3000 to 4500 feet, and occupies an area of ½ million acres.

Juniper is found in the central and northern parts of the state at elevations of 5000 to 7000 feet. It now occupies approximately 13 million acres and is still spreading. Mesquite is found principally in the southern half of the state at elevations of 2700 to 5000 feet. It covers an area of approximately 9 million acres and is still invading. Loss in forage production attributable to mesquite and juniper invasion represents a major loss to ranchers of the state.

Chaparral is found principally in the central parts of the state at elevations of 4000 to 5500 feet, occupying an area of approximately 6 million acres. Chaparral is a very difficult problem from the control standpoint, since it contains a variety of species, some desirable as forage plants and others worthless. Chaparral is believed to be spreading somewhat.

Cactus is distributed throughout the state, but it is of most importance in southern Arizona at elevations below 3500 feet. The area of infestation is approximately 2 million acres.

Control Methods

Mechanical methods of control have proved practical for juniper. Chopping, bulldozing, and chaining are all effective, since the dominant juniper species are non-sprouters. To date, approximately 600,000 acres have been cleared by mechanical means Fire has been used successfully for controlling juniper, but it has not been widely employed because dense stands and extremely dry conditions are necessary for a fire to be effective. Research on the chemical control of juniper started only recently. A few herbicides have shown encouraging results in preliminary evaluation tests, but more information is needed.

A successful control method for mesquite is a basal application of diesel oil around each stem 8 to 10 inches above ground line. With careful application kills of 90 to 100 per cent can be expected. Foliage applications of herbicides on mesquite require more than one application. These treatments may be made by airplane or with ground equipment. Spring treatments in two successive years have given adequate control, but the cost is moderately high. Mechanical methods of controlling mesquite have not been widely used. Since mesquite is a sprouter, chaining is not successful as with juniper. Bulldozing is very expensive because individual trees must be lifted completely out of the ground.

No single control measure has been satisfactory for chaparral. Mechanical clearance is too expensive for a rancher. The best method at this time seems to be burning followed by the application of herbicides to the sprouts. Even so, several applications are necessary to kill scrub live oak, which is the dominant species in the chaparral type. Skunkbush and manzanita, which are quite susceptible to herbicides, can be controlled with 2,4-dichlorophenoxyacetic acid (2,4-D).

Satisfactory control measures have not been worked out for controlling extensive areas of the various species of cacti. Individual plants can be killed using high rates of 2-(2,4,5-trichlorophenoxy) propionic acid (silvex) in diesel oil at a high volume so that the entire plant is wetted. The cost is prohibitive, however, for use on extensive areas.

Research on the control of the tarbush-whitethorn-creosote bush com-

plexes has been concerned principally with herbicidal evaluation. This work has shown that high rates of 2,4,5-T gives satisfactory kills of whitethorn and tarbush, but creosote bush is more resistant. Best results are obtained with treatments during the spring growth in March and April, and during August and September, following the summer rains. Mechanical methods of control have been investigated because both creosote bush and whitethorn are vigorous sprouters, while the tarbush is a weak sprouter.

Rotation-Deferred Grazing on Dryland Ranges

By John D. Freeman

Rotation-deferred grazing is a system of grazing which provides for "deferment" (delaying grazing until seed is ripened) for each pasture every two, three, or four years in a systematic order. Anyone who has a strictly winter pasture knows how much better that pasture holds up than the ones grazed during the summer. Under the rotation-deferred system of grazing, all pastures can receive this kind of treatment. The advantage is that every pasture is grazed every year. Plants need a rest during the growing season every few years in order to build up their supply of reserve food.

Plants have their own food factory located in their leaves. Through a wonderful and mysterious process, the green coloring matter in the leaves has the ability to use energy from the sun and to transform air, water and minerals into food. This food is used by plants for growth, for reproduction, for stored energy to be used next year and to feed livestock. If plants are not allowed to manufacture food to feed themselves, they will starve to death.

Most grasses store food in their roots right after the seed is formed. The food reserve in the roots is lowest while the plants are making their most rapid growth. They are most vulnerable at this stage and, if they are grazed year after year at this time, they cannot remain vigorous and productive. Unfortunately, this is the period when they are the most nutritious and put the best gains on livestock. However, a rancher must remember that if he is to be a successful rancher he must consider himself a grass farmer. Grass is his crop. Cattle are only a means of harvesting it. His first consideration should always be for the benefit of his grasses.

New growth buds are located in the crown on sod grasses, but are from one to six inches above the crown on some of the more productive bunch grasses. If the buds are grazed off and killed, it may take half of next year's growing season for the plant to generate new buds and start growing again. If half the growing season is lost this way, you may well lose half the feed crop, also. A good rule of thumb to remember is leave half the feed for the plant and graze the other half. Each year your half will get larger. Ungrazed grass left on the range is defintely not wasted; it is invested in next year's crop and those for many years to follow.

We are blessed in most of Arizona with a climate suitable for yearlong grazing. This beats the old pitchfork method of winter feeding. But it is hard on the grasses and giving them first consideration, we must remember that even with conservative yearlong use a good range will go downhill and a poor range will be prevented from improving. Why? Because plants are living things and have to be fed like all other living things. Under yearlong grazing, the best plants — the ones we would like to have more of — don't get a chance to be well-fed. The only way they can properly feed themselves is to have a rest from grazing as often as possible during the growing season.

Under a rotation-deferred system of grazing management, a program is worked out whereby every pasture will have complete rest during the growing season as often as possible. If this complete rest during the growing season comes at least once every two or three years, the plant will maintain its vigor and be able to furnish an abundance of forage and seed for reproduction. It can stand droughts better, too.

We have learned that the greatest production on irrigated pastures can be obtained if large herds are turned into small pastures for a short period of time. Stock will graze all plants uniformly and will then be moved on to the next pasture. Plants thus have plenty of time to recuperate before they are grazed again. The principle is the same out on the dryland ranges. If cattle are shifted from one pasture to another several times a year, they do not have time to become selective in their grazing. They are more apt to graze all forage plants as they come to them.

It may require some fencing and sometimes some additional water development to get a rotation-deferred system set up and going. This additional cost is usually more than offset by the many advantages such as the necessity for fewer bulls, less maintenance at watering places, greater ease in checking on cattle, the need for fewer cowboys on larger ranches, and greater forage production.

After the system has been in effect for awhile, the cattle get used to the idea of moving. They become gentler and easier to handle. They know they are going to fresh feed and they like it. The biggest payoff is in production of better and more forage. The grasses are in better shape and the objective of all grass management programs is attained, which is the production of an ever-increasing amount of high quality forage on each acre of rangeland, and at the same time, the harvesting by grazing of a maximum amount of feed each year.

This type of grazing is not a cure for all range problems. It has its limitations, especially in rough country, but the system has many variations and can be shaped to fit the individual ranch. It has to be flexible as there are no two ranches alike.

Rotation-deferred grazing has been used for several years and has been proved successful in the Pacific Northwesi and in Texas. It is rather new in Arizona, but is gaining favor with the ranchers. It is a proven method for increasing grass production and that is what we are looking for.

Brush Land Control

By Ray Cowden

In discussing the stockman's viewpoint on brush land control, I want to emphasize that I draw completely on my own observation and experience, plus such data as I have gathered to support my views. Let it be assumed that we agree that the primary object of the livestock ranching operation is one for a livelihood, as opposed to a hobby, and that we cannot all have the same kind of grass-producing soil and under the same kind of climatic conditions.

I have lived in Arizona for almost 44 years and during that period of time I have ranched in several Arizona counties. Naturally, I have observed the changing range conditions in that 40-odd years. It is only reasonable that our livestock growers can see what is happening to their ranges. In a 20-year period our sheep numbers have declined 44% and in 1918 we had 1,700,000 beef cattle in the State of Arizona, while in 1955, 37 years later, we only have 900,000 and probably 20% of that 900,000 is in feedlots in the feeding areas. But assuming that 900,000 are still on the ranges, that is a 57% reduction in 37 years. I believe that is ample proof the feed we are producing on our ranges is declining and has been declining for many years.

It is only natural for some people to raise the question "Well, have you properly improved your ranches? Have you kept up your water developments, have you built stock trails, have you eradicated juniper, noxious weeds and other causes for range depletion?" Here is a summary of the range developments and improvements that have been made in Arizona by the coo erators under the AAA program in the past 20 years. They have developed almost 900 springs, they have built over 8,000 earthen reservoirs and tanks. They have drilled over 1300 wells and constructed t ousands of miles of fence. They have installed over 600 miles of pipelines, distributing water all over the ranches. They have also constructed spreader dams that have 13,000,000 cubic yards of dirt in them. In addition, they have built 863 concrete or metal water storage tanks for livestock purposes. About 12,000,000 acres, less than 50% of the grazing land of the State, cooperated under this program. When you realize that the National Forest lands, the Taylor grazing lands, and many others, did not qualify under the program, you can readily understand that there was a great deal more work done on the ranges than I have enumerated. After doing all this range improvement work and still having a large reduction in the numbers of livestock that our ranges are carrying, someone might say that we have been living in a drouth the past few years but let us look at the precipitation records and see what that shows us.

In my opinion, you cannot get a better cross section of range lands in Arizona than those that are on the Salt River Valley Water User's watershed of the Verde, Tonto and Salt Rivers. The water users precipitation records go back 50-odd years and if you will take them in 10 year periods, beginning with 1900, you will find out that the heaviest precipitation in any 10-year period was a little over 22 inches per year and the lowest was a little over 20 inches. This represents only a 10% variation, yet the runoff has steadily declined during this period.

During the 40 years that I have known Arizona ranches, I have had an opportunity to see the juniper slowly encroach on them, taking more and more of the production areas of the ranches. I know it is hard for us to measure the toll this takes but of course if we measure it for a period of time and look at the figures that I have presented to you, I am sure that no one can dispute that it is serious. It clearly demonstrates what a toll the intrusion of juniper has cost the rancher. Some 10 or 12 years ago we could see some ranchers beginning to try to combat it. Various methods were used and of course it looked like a very feeble effort, as any method that you might use seemed too expensive when we considered what would be accomplished by the eradication of juniper. But during that period of time the problem became more acute and I think today every rancher realizes that he must put out every possible effort that is within his means to combat juniper. Up to the present time, all the methods have been mechanical. It is my belief that we should start in with research to see if we can develop a chemical that will destroy juniper — something that might be applied with an airplane, like we do today in our forests to protect them — and at a cost that our livestock economy can afford. We all know that the Federal government goes into many cooperative enterprises with private industry and probably could develop something that would eradicate juniper. What is more important to the rancher in the western part of the United States today than a selective chemical that will eradicate juniper and what more could the Federal government do for the rancher than aid in the research that is necessary to develop that kind of a chemical?

I do not want to create the wrong impression by saying that our methods are costly and inadequate for I am sure we should continue to combat juniper in every possible way that we can, as well as urging that research be started that may aid us in our fight. By permitting juniper to continue to spread on our ranches, we are not only destroying the valuable grasses we need to feed our livestock but we are depleting the runoff from our precipitation and I think all of you are quite familiar with how valuable water is in the State of Arizona.

Many of you may know that we only farm approximately 2% of the total area of the State. About 1,200,000 acres of this are the farm lands that are located in the Salt River Project. The gross value of the farm products from the Salt River Project in 1955 was approximately $51,500,000. An adequate water supply for these farming areas is most important to every one of us ranchers as the farmes are the people who produce the feed crops that are necessary to finish our livestock before it goes to market.

If we ranchers will make an effort to acquaint the business man, the farmer, and the other citizens of our State with what a menance the juniper

is, not only to ourselves but to the economy of our entire State, probably they will be more understanding and sympathetic with us in combatting the juniper problem. In my opinion, it is most important that we point out to them that juniper is not something of value but it is a parasite and that if we do not control the spread of it, the juniper will destroy us.

To Control Mesquite Economically Start Early and Keep at It

By S. Clark Martin

Mesquite: Is it a problem? Why does it spread? What can we do about it? These are some of the questions being answered by the Rocky Mountain Forest and Range Experiment Station on the Santa Rita Experimental Range near Tucson.

Is it a problem? Mesquite definitely is a problem on the Santa Rita Experimenntal Range. There we find that as few as 25 trees per acre can cut grass production in half, while full stands reduce grass yields to almost nothing. We also know that mesquite provides poor protection against erosion and that the yields of mesquite leaves and beans by no means make up for lost grass production. Millions of acres of Arizona rangelands are affected similarly.

Why does it spread? Many factors have been responsible for the spread of mesquite. Thinned out grass stands that no longer prevent or retard the establishment of mesquite seedlings; distribution of mesquite seeds by cattle, horses, and wild animals; accelerated soil movement that helps scarify and cover mesquite seeds; and cessation of range fires due to lack of fuel plus extra precaution and prompt control, all contribute in some degree to the spread of mesquite.

What can we do about it? The mesquite-control problem varies from ranch to ranch. We don't yet have good economical control methods to fit all conditions. Until better methods are found, we must make the most of those we now have. At present, the diesel oil and grubbing hoe methods are the most reliable for use in southern Arizona. Most mesquites except those growing in washes, can be killed with diesel oil for about 5 cents a tree. Small seedlings can be killed with a grubbing hoe for even less if the walking and hunting time between seedlings is not too great. Because they are relatively expensive and slow, these methods are most useful for controlling sparse stands during the early stages of mesquite invasion. It is because these methods are not economical for use on dense stands that early control is so important. The importance of early control in keeping down costs is illustrated by the results of current studies on two southern Arizona ranches.

The studies were set up to determine the rate of invasion by mesquite in areas with light to moderate infestations. A series of rectangular plots was established in 1949 at what appeared to be the edges of mesquite invasion areas. Plots were 50 feet wide. Lengths varied from 200 to 300 feet, depending on the distance from the ridge-tops to the bases of the slopes. On each plot the location and size of each mesquite was recorded in 1949 and again in 1956.

Mesquite-invasion plots were located on one ranch near Sonoita and on another near Arivaca. Initial numbers of mesquite on the plots on these ranches in 1949 averaged 9 and 33 trees per acre, respectively.

There were obvious differences between ranches in the distribution of mesquite along the slope. At Sonoita, the mesquites were concentrated both near the top and at the bottom of the slope with very few in the intermediate zone. The slopes are fairly long and there are very few mesquites of seed-bearing size close by. Consequently, most new mesquites must start from seed that has been carried

Rate of mesquite invasion is strongly influenced by the source of mesquite seed. In this picture, the nearest strong source of mesquite seed is almost a mile away. The rate of mesquite invasion is only 1 tree per acre per 7 years. (U. S. Forest Service photograph)

from a distance, presumably by cattle. Since cattle concentrate along the ridgetops and stream bottoms and graze the intermediate slopes least frequently, the pattern of mesquite distribution follows the pattern of livestock use.

At Arivaca, where mesquites were thicker near the bottom of the slope, a different set of conditions prevailed. For one thing, the slopes were shorter. More important, many seed-bearing trees were already established along the washes near the plots. In fact, seed trees near the bottom of the slope actually occurred within some of the plots. Seed from these trees is spread by cattle or other animals in a characteristic pattern: the farther up slope from the parent tree, the fewer the scattered seeds. Here again, the pattern of mesquite distribution is what would be expected on the basis of grazing use.

From 1949 to 1956, mesquite numbers increased by 1 mesquite per acre at the Sonita ranch and by 6 trees per acre at the Arivaca ranch. On a yearly basis, these increases amounted to only 1 tree per 7 acres at Sonita but almost 1 tree per acre at Arivaca.

What do these results mean to the rancher? On the Arivaca ranch, a stand of 33 mesquites per acre increased at the rate of 1 plant per acre per year. A 10-year eradication and control program there would require killing about 3 mesquites per acre each year to eliminate the original stand and 1 mesquite per acre to hold down the expected increase. At Sonoita, with an original stand of 9 trees per acre and a rate of increase of one-seventh plant per acre, a 10-year control program would require killing only about 1 plant per acre per year to eliminate both the original stand and the expected increase.

These figures on numbers of mesquite to be killed per acre are listed merely to show something of the size of the mesquite-control job. If you plan to kill some of your mesquite each year, you want to spend that effort where it will do the most good. You can kill more mesquites per dollar where they are thick and the time spent looking for plants to kill is small. You can grub a mesquite seedling cheaper than you can kill a mature tree with diesel oil. But, each mature seed tree you kill now may save grubbing several seedling later. Immediate benefits of mesquite control should also be considered. Control on some areas will yield more forage. Opening up other areas may make it easier to handle cattle. All costs and benefits must be considered if your mesquite-control money is to do the most good.

For another look at the size of the job, let's return to the Arivaca and Sonoita data. If 25 acres of range are required to carry a cow, the annual job in a 10-year program of mesquite control amounts to 100 mesquites per cow at Arivaca and 25 mesquites per cow at Sonoita. At 5 cents per tree, the yearly costs per cow would be $5.00 at Arivaca and $1.25 at Sonoita. And, each year control is delayed, the cost goes up about $1.00 per cow at Arivaca and $0.20 per cow at Sonoita.

These data emphasize the obvious, i.e., that the cheapest time to control mesquite is when plants are small and widely scattered. Control in the early stages of invasion is not only cheaper, but it also halts the decline in range-grazing capacity that inevitably occurs when mesquite is permitted to occupy the range. As few as 25 medium-sized mesquite trees per acre can cut forage production in half. Dense stands reduce perennial grass production to almost nothing. Regardless of the size of your own mesquite-control job, the important thing to do is to work out a practical control program and set up some time and money each year to insure that the job is done.

The diesel oil method of control consists simply of spraying or squirting diesel oil on the base of the tree at the ground line. The oil should be squirted against the trunk on all sides of the tree until the bark is thoroughly soaked and some oil flows down the bark into the soil. About a pint of oil per tree is usually enough.

The thing to remember in grubbing is that the plant must be cut off below the root crown.

Where there is a good seed source along the bottom of each small drainage, the rate of invasion is almost 1 plant per acre per year — about 6 times as fast as in Fig. 1. (U. S. Forest Service photograph)

Effect of Mesquite on Range Productivity

By Fred. H. Tschirley

If there is one factor that dominates range management practices wherever it occurs, that factor is mesquite. Directly or indirectly, mesquite plays a part in every problem the rancher must face in keeping his ranch in a state of high productivity. Drought is a major problem but it would not be so difficult to endure if mesquite were not present to absorb what little moisture does get into the soil. Declining productivity is another problem. Everyone knows that a good stand of grass controls erosion, but you can't have a good stand of grass if you have mesquite. What about reseeding? Your efforts are wasted if you try to reseed where there is a dense stand of mesquite. So you see, it is obvious that mesquite is a dominating influence. It magnifies every other problem the rancher has to face in trying to get the most from his land.

Twelve years ago, study plots were located on the Santa Rita Experimental Range southeast of Tucson to find out how much mesquite competes with native perennial grasses. Mesquite was cleared to densities of 138, 25, 16, 9, and 0 trees per acre. The production of native perennial grasses was measured for each of the 10 following years. The 10-year average showed that five times as much perennial grass was produced on the plot where all mesquite had been removed as on the plot having 138 trees per acre. The 25-tree-per-acre plot produced two and one-half times as much as the 138-tree-per-acre plot. Thus, the increase in perennial grass production was the same for the reduction from 25 to 0 trees as it was from 138 to 25 trees per acre. To put it another way, 25 mature trees on an acre reduced the perennial grass forage production by approximately 50 per cent. This means, of course, that the place to start a mesquite control program is in areas that are not yet heavily infested. It is there that cost for control is less and your investment will be most quickly returned.

Increased forage production was not the only advantage of mesquite removal. The composition of the grasses changed so that the better forage species increased on the cleared area while the poorer species decreased. There was not only more forage produced, but it was also of better quality.

In another test, an area having a very dense mesquite infestation was aerial sprayed with 2,4,5-T in 1954 and simultaneously seeded with Lehmann lovegrass. An adjacent unsprayed area was also seeded. The same area was resprayed in 1955 to control sprout growth from the mesquite. In 1956, there was 14 times as much Lehmann lovegrass produced on the sprayed portion of the pasture as on the unsprayed portion. In addition, native perennial grasses had responded to the spraying so that there was twice as much native perennial grass on the sprayed portion as on the unsprayed portion.

Both of the studies mentioned above were carried out on summer-deferred pastures. Without deferment, increases in grass production would not have been as great. This does not detract from the desirability of controlling mesquite, but emphasizes the need for good grazing management. Mesquite control is a good management practice that will increase the productiveness of your range; it should not be followed by a poor grazing management practice that prevents the maximum increase in production.

The points I have made can stand repeating. Controlling mesquite will help you live through a drought. Controlling mesquite will reverse declining productivity if the range is not overgrazed. Controlling mesquite will favor perennial grasses, which in turn control erosion, and controlling mesquite is essential to the establishment of reseeded grasses.

For any mesquite-control program, do your first work on areas that have a high potential for grass production and where mesquite is in the process of invasion. Mesquite can be effectively and economically controlled while there are only a few trees per acre and it is on such areas that you will realize the greatest return. Once a range is heavily infested, controlling mesquite is more difficult and more expensive, and the return on your investment will be proportionately less.

Effects of Juniper Invasion on Forage Production and Erosion

By Joseph F. Arnold

Ranchers have seen forage productivity of their pinyon-juniper ranges continue to decline in spite of periodic herd reductions. They have related this loss to invasions of grasslands by juniper, pinyon, and associated woody plants and the thickening up of established stands. Results of studies made in 1953-54, during the writer's affiliation with the Rocky Mountain Forest and Range Experiment Station, indicate how the spread of trees and shrubs has affected grasses and weeds by reducing density, changing composition, reducing forage production and increasing erosion.

Invasion Characteristics and Growth of Juniper-Pinyon

Transects established by Ken Parker and George Glendening in 1940, both within fenced plots and on adjacent open ranges, were remeasured in 1953. Canopy measurements of juniper, pinyon and minor understory shrubs tripled within the fenced plots during the 13 years of protection, whereas canopy measurements of trees and shrubs on the open range doubled.

The growth and spread of juniper, pinyon and long-lived shrubs was much more rapid under the protection of fenced plots than on open range. Canopy measurements were essentially the same for grazed and protected plots in 1940. Contrary to popular opinion results indicate that grazing slows up the growth and spread of juniper and pinyon.

Effects on Density

Seedling junipers and pinyons undergo a brief period of intense competition for soil moisture with perennial grasses and weeds. But as the seedling trees grow they monopolize soil moisture and space. As a result trees displace understory grasses and weeds. Perennial grasses and weeds lost ⅛ of their density between 1940 and 1953 within the fenced plots where canopy measurements of trees and shrubs increased 3 times. These results represent an average for the plots studied. In one fenced plot perennial grasses and weeds lost 70 percent of their density during 13 years of protection.

In comparison to the fenced plots the open range plots showed a 20 percent loss in density of perennial grasses and weeds where canopy measurements of overstory juniper, pinyon and shrubs doubled during the 13 year period.

Another type of investigation established the relationship between the density of overstory junipers, pinyons and shrubs and the density of grasses and weeds. It was found that the density of grasses and weeds under stands of juniper and pinyon averaging a canopy spread of 25 percent of the ground cover was only 45 percent of the density of perennial grasses and weeds under tree stands averaging a 50 percent of the density of open grasslands, and under a 75 percent canopy, only 15 percent.

Effects on Composition

Juniper and pinyon affect the composition of understory vegetation because the degree of suppression differs among different species of grasses and weeds. For example, juniper and pinyon compete more directly with perennials than annuals. In dense stands of trees the soil, which may be almost barren of perennial grasses and weeds most of the time, may become covered with annuals during a season of favorable moisture.

Juniper and pinyon compete more directly with cool-season grasses like western wheat than with warm-season grasses such as blue grama. By resuming active growth early in spring juniper and pinyon compete with western wheat grass for winter moisture. Western wheat decreases as the overstory evergreen trees monopolize deep winter moisture and space. Blue grama appears to be displaced more slowly, possibly because this species can absorb some of the summer moisture as it penetrates the soil to the root level of junipers. Perhaps because of this most juniper ranges are dominated by blue grama and are lacking in western wheat. The lack of western wheat and other cool-season grasses greatly reduces the green-feed period for many woodland ranges.

Effect on Foreign Production

Juniper and pinyon reduce forage production by reducing the density of grasses and weeds, by effecting an inferior composition and by preventing vigorous growth. A stand of juniper with a 25 percent canopy spread produces about 40 percent as much forage as an open grassland; a stand with a 50 percent spread produces 15 percent as much; and a stand with a 75 percent canopy, only 5 percent. Forage yield decreases more rapidly than forage density because overstory trees reduce the vigor of grasses and weeds as well as their density.

Removal of juniper and pinyon by bulldozing and chopping has resulted in an increase of forage production from 200 pounds per acre (average for many woodland ranges) to 650 pounds per acre. Where particularly dense stands of trees have been removed the percent increase is much greater than this. Increases of these kinds apply to woodland ranges that are deferred during the summer growing season and grazed in winter. Proper stocking and management is necessary to get maximum increases in forage yield following juniper control.

Effect on Erosion

Juniper-pinyon and chaparral are the two vegetation types reported to contribute the greatest amount of sediment to downstream dams. Ranges with an overstory of juniper and pinyon are particularly subject to erosion. Even heavy stands are open and do not have a closed canopy. As a result tree litter does not form a continuous protective cover against erosion. Soil surfaces between the trees not only lack a covering of litter but are mostly barren of perennial grasses and weeds. The exposed soil is subject to erosion.

Fenced plots enclosing both light and heavy stands of juniper-pinyon illustrate how erosion is associated with dense stands. A scattered stand of trees with a good covering of perennial grasses shows little evidence of erosion, while a dense stand occurring within the same plot and having a sparse cover of grasses will show evidence of sheet and gully erosion.

Removal of juniper and pinyon reduces erosion by restoring a good cover of perennial grasses and weeds.

Summary

Invasion of grasslands by junipers and pinyons and the growth of established stands result in: (1) reduced density of perennial grasses and weeds; (2) inferior composition; (3) reduced forage yields; and (4) increased erosion. The conclusion that juniper control is needed to correct these detrimental effects is inescapable.

The Effect of Jack Pine on Forage Production

By William L. Schroeder

The term "jack pine" refers to different kinds of trees in different parts of the country. As used in Arizona it means simply a thicket of young ponderosa pines. Yet the problems that result from this dense growth are as great as though a separate species had invaded the old established forest stand.

The growth of jack pine in our southwestern ponderosa pine forests probably does more to cut down forage production than any other single factor except drought. It is a well known fact that heavy jack pine thickets, those having from 4,000 to 7,000 stems per acre, such as occur in the McNary area of the Fort

Apache Reservation, on some other areas of the Fort Apache and San Carlos Reservations and on adjacent National Forests, produce little if any forage. These heavy thickets completely shade the ground, take all available water and build up a deep needle mat.

Grass and forage plants cannot compete under such conditions and are crowded out, thus reducing carrying capacity for game animals and domestic stock. The grasses are almost entirely replaced by highly inflammable needle mats, and by suppressed and dead pine seedings.

Many old-time cowboys on the Fort Apache Reservation have stated that in the early days cattle were easily rounded up and could be seen for a half mile or mile in the open pine timber and heavily grassed turf in the McNary area. An area like this can still be seen in the Malay Gap area of the San Carlos Reservation, where recurrent fires have kept the jack pine thickets at a minimum and the grass at a maximum.

Prescribed burning tests were started in dense ponderosa pine seedling and sapling stands on cut-over lands of the Fort Apache Reservation in 1948 and 1949. In the fall of 1950, they were continued on check plots established in cooperation with the Southwestern Forest and Range Experiment Station. The main objectives of these tests were to determine their effects on thinning the saplings, fire hazard reduction, forage production and water yield.

The grass was inventoried prior to burning and again one year and two years after. The check plots were inventoried at the same time. The grass density was low even before burning due largely to the great number of trees per acre. While the conclusions as to the effect of prescribed fire on the grass may be of limited value, the ecological change is interesting. Both the "cool" and "hot" burns reduced the grass density significantly the first year after burning. The "cool" burn recovered completely after two years but the "hot" burn had only half the density it should have had. The "cool" burn had little effect on plant numbers and there was a significant increase the second year compared to the check plots, whereas the "hot" burn reduced the number of plants considerably the first year and recovery was not as great the second year as compared to the "cool" burn. The proportional density of mountain muhly *(Muhlenbergia montana)* changed from 70% of total forage density before burning to 60% two years later on both the "cool" and "hot" burns. Squirrel tail *(Sitanion hystrix)* increased about fivefold in proportional density after two years on both burns. These results seem to indicate that on many jack pine thickets so little forage is left that artificial reseeding is necessary.

On a 1957 wild-fire area near McNary, less than 10 pounds of forage per acre was produced in the heavy thickets before the fire. After the fire and reseeding more than 1000 pounds per acre was produced. These figures are similar to results on the Hualapai Reservation where the big 1953 juniper-pinyon fire was reseeded a year after. The forage now produced by burning and reseeding this juniper jungle is many times the weight by volume produced in adjacent untreated stands.

In conclusion it can be said that these heavy jack pine thickets are out of the picture as far as forage production for game and livestock is concerned. Thinning by mechanical or prescribed fire has and will increase the native forage and where this forage is thin or has disappeared, reseeding will produce many times the forage now being produced in these jack pine areas.

Prescribed Burning

A Few of the Pros and Cons

By Robert F. Wagle

The alarm against the invasion of valuable land by "weed" shrubs and trees is being sounded today by many individuals and groups of individuals interested in the water, forage and wood production of our wild lands. Public agencies have marshalled their research forces for studies of means to control and eliminate these "weed" invaders. Fire holds an important but controversial position among the tools used in these investigations. The stands taken by various groups or individuals have ranged from a demand for complete elimination of man-made fires from public lands to a recommendation of fire as the universal tool for increasing the economic values of these lands.

The viewpoint calling for complete elimination of man-made fires and rapid control of wildfires is the result of a history of catastrophic fires, extending into the present, involving the loss of hundreds of lives and millions of dollars of personal and public property in the form of whole towns, farms, ranches, livestock, wildlife and timber. These losses called for extreme fire-control and prevention measures and resulted in a nationwide educational program to obtain the support of public opinion.

The gains made in fire control have not eliminated catastrophic fires and losses from such fires, but they have cut down their numbers and size and have greatly reduced the losses. Economic studies show also that much of the present-day forest values and wood-industry stability are due to these fire-control and fire-prevention measures. In fact, in many forest areas private interests, individually and in cooperative groups, have formed their own fire-protective organizations which supplement Federal and State fire-control systems.

Unfortunately, the history of catastrophic fires and the subsequent development of policies of complete fire control backed by public opinion, have resulted in overwhelming prejudice against the use of fire in any form on public lands. This prejudice has prevented the normal development of information on the possible beneficial effects of fire as a tool for modifying plant cover.

In the course of time, observations made before and after fires in many local areas in the Southern, Southwestern and Pacific coast states indicated that the effects of fire on land values were not all bad. In addition, experimental work in some areas, notably

in the southern pine region, proved that fire was a valuable tool that could, through its effect on vegetation, improve the economic value of the land. These observations are responsible for the viewpoint, held by many local groups in the areas concerned, that fire should immediately be used extensively and intensively to improve local conditions. Unfortunately, this viewpoint is based largely on observation and opinion supported by only limited local or no experimental data. With the possible exception of the southern pine region, predictions cannot yet be made with certainty on the effect of fire on plant cover. This is particularly true in mountainous areas where soil, temperature, water and wind conditions vary greatly, often within small areas.

In the Southwestern and Pacific coast states the conclusions reached by Weaver summarize the arguments set forth by the advocates of a broad-scale prescribed burning program. Weaver, in the ponderosa pine stands of the Southwest, dated various fire-scarred stump sections selected at random. He found that in some areas fires burned as frequently as once each 4.8 years and one section from the Kaibab National Forest showed an average fire frequency of one each 11.9 years as far back as the year 1708.

Weaver states that "Older whites and Indians remember when the ground under the ponderosa pines was grassy, open and parklike, with but few windfalls, snags, and other debris." He also states that on certain areas similar conditions exist today, and believes these conditions are due to the incidence of frequent surface fires.

Observations made by Weaver and others in the Southwestern forests indicate that fire exclusion and control by man has resulted in the following:

(1) On better sites good tree growth occurs despite crowded stand conditions.

(2) On poor sites, growth stagnation has developed, and thinning to improve growth presents a serious cost problem.

(3) Tolerant, understory climax species have invaded or increased over extensive areas.

(4) Logging of overstory pine has resulted in areas being taken over by undesirable associated species.

(5) Dense understory reproduction in fire-protected areas competes seriously with overstory trees for limited moisture.

(6) Grass and forage plants cannot compete with dense coniferous reproduction over large areas and forage for game and domestic animals has decreased.

(7) Fire hazard has increased tremendously.

Observations made on Indian reservation ponderosa pine forests in the Southwest after prescribed burning made during periods of low fire hazard indicate that:

(1) Burning has reduced fire damage and cost of fire control.

(2) Burning has resulted in silvicultural benefits in thinning dense reproduction although the results were not uniform.

(3) Soil damage (duff removal) was confined to areas of heavy fuel concentration.

(4) Vigorous pine reproduction came into burned areas.

(5) Douglas fir seedlings and saplings were killed in areas where they were dominant and supplanted by ponderosa pine reproduction.

Prescribed burning, by ranchers and others, in Arizona rangeland invaded by juniper and pinyon pine effectively controls these species and favors the increase of forage plants in some areas while in others the results leave much to be desired. Prescribed burns have been made in chaparral stands also, but here again conflicting results have been obtained. Due to the sprouting characteristics of some of the species, the improvements obtained seem to be largely temporary and ephemeral.

In general, the evidence indicates that fire can be a valuable tool for improving land values in many areas of the Southwest. It also indicates that prescribed burning does not always result in land improvement. The marked scarcity of analyses of the effects of prescribed burning under different conditions and in different plant associations makes it difficult at this time to appraise the advantages and disadvantages of the method. Sound evaluations and research on the problem are sorely needed. Experimental prescribed burning should be greatly broadened and extensive and intensive studies carried out to determine how, why, when and where such burns should be made. These studies should include analyses of effects on land values.

Research is needed also on the effect of fire on vegetation in relation to soil-vegetation cover types, soil, climate, available water, water-shed erosion, seed germination, plant establishment and growth rate, fire hazards existing before burning and created by burning, and costs of burning Knowledge acquired thus would establish a basis for determining how, why, when and where to burn. Only through acquiring information of these sorts can results be predicted in terms of total cost and economic returns.

Controlled Burning in Ponderosa Pine Stands of the Fort Apache Indian Reservation

By Harry R. Kallander

For many ages man has made a practice of setting the woods afire. We have accounts of this from Asia and Africa as well as North America. Burning may be done for many purposes in the forest: for its regeneration, control of disease or insects, to improve grazing or to protect the forest from its own fuel energy that has accumulated on the forest floor in the form of needles, branches, cones, sloughing bark and also in

the trees themselves while either living or dead. Often the ignited dead fuel heats the live tree branches to the kindling point and sometimes without dependence upon the dead fuel on the ground fire may travel through and kill a large portion of a forest. Thus the living green portions of the forest can cause great fire damage, particularly in areas of heavy over-stocking. There is no need to discuss here the cycles of fire that visited the primeval ponderosa pine forests.

The ponderosa pine belt of the Fort Apache Reservation lies at elevations of about 6,000 to 8,500 feet stretching in an arc about 70 miles long. It comprises a commercial forest area of about 400,000 acres. A paralleling belt of equal area of pine woodland, juniper and brush lies southward at a lower elevation. Occasional patches of good pine are found here in cool canyon bottoms and north facing slopes. All areas below about 7,500 feet have the woodland type on many south and west exposures.

A particular characteristic of the pine forest is an abundance of seedlings and saplings at elevations of 7,800 feet or so and lower. Summer rains appear in July and August which permit a high survival rate. 20,000 stems per acre can readily be found and in the logged-over land around McNary, 4,000 or 5,000 stems at age 30 years, can be counted per acre in the understory. The Blue Mountain Controlled Burn study plots operated jointly by the U. S. Forest Service and the Indian Service Forestry Branch found about 5,000 stems per acre including an overstory of 7,000 board feet of saw timber twelve inches D.B.H. and over. A generous stocking per acre here would be about 800 to 1,000 stems.

Another interesting feature of the western portion of this forest and in all of the southern fringes of the entire forest is the resurgence of juniper species, especially alligator juniper. In many places this juniper is seriously competing for the ground. The former position of juniper in the primeval forest was on rocky ridges where the natural fires were not intense enough and where pine did not supply the necessary amount of needle fall to carry sufficient fire. The adaptability of alligator juniper is evidenced by its endurance of shade in dense pole stands of pine. Juniper fruit is a common bird diet. The stones are dropped by roosting birds resulting in dense clumps of these trees springing up around pines, oaks and cottonwoods.

Alligator juniper in its long association with the pines has developed the ability to sprout and resprout after fires. However, we find that after its first sprouting its survival percentage diminishes considerably and in the fire cycle of three to seven years apart in moderate to heavy needle fall it loses its hold in the pine stands. Fire control by foresters in the last three decades is the principal cause of the juniper invasion in the large pine fringe area of the reservation.

In the better sites of pine there has been a high survival rate of seedlings in the heavily grazed areas. Lacking competition from grass and the freedom from fires has resulted in abnormal densities of these young trees. On the Maverick Logging Unit, where an abundance of grass exists, an abnormally dense stand of seedlings and saplings is surviving where foresters once thought the sod would serve well to control the thicket problem. On lesser areas and to complicate the picture, a normal pine reproduction stand exists where the sod is strong, such as around Horsehoe Cienega east of McNary.

During the years of fire protection a formidable mass of heavy fuel has been accumulating in the form of windfalls, cull logs left from logging and tree tops and stumps. On the Blue Mountain plots cull logs left in 1924 are still recognizable and are in a very inflammable state. The weight of dead fuel per acre of all kinds on the plots experimentally burned in 1950 was 8.6 tons. Of this, 68% of the large fuel and 49% of the needle and twig fuel was removed by fire.

A very considerable economic loss to the owners of merchantable pine timber stands is from Western Red Rot. An authority on this tree disease states that the principal source of spores of this fungus comes from infections on down wood material six inches or more in diameter. Thus it appears that fire exclusion is an excellent piece of social security for *Polyporus ellisianus.*

A look at a cross section of an average sapling in one of our pine thickets requires one to have a glass to count the rings. Thirty-year-old stems about the thickness of a man's thumb are very common. Such is the outlook for young pines where one would suffice in the space where five or ten are standing. It is true that quality timber is grown in dense stands. It is also true that intermediate timber crops in the form of small stems three or four inches in diameter and over are an important factor in the future forest economy. These points, however, do not justify the large overstocking with which we are now being continually faced.

In 1948 the Indian Service Forestry Branch began testing controlled fires in dense stands to determine the feasibility of fire use in forest fuel reduction. Background information was mainly from U. S. Forest Service burning operations in the southern states and from the work of Harold Weaver on the Colville Indian Reservation in Washington.

The major objective has been the reduction of fuel accumulations and pruning and thinning the understory pines in order to reduce the chances of large destructive fires. Silvicultural, forage and hydrological aspects are of secondary importance. The White Mountain Apache Tribal Council unanimously approved the program in 1948.

From 1948 through January of 1956, 118,000 acres were treated with fire and 12,000 acres have been reburned. This work was done in the areas of highest fire incidence. During November and December of 1950, 65,000 acres were treated. In 1954 during the same months 42,000 acres were covered. The results have been a 90% or more reduction in fire occurrances in the 1950 burn area. The major objectives of the work have exceeded expectations and have been achieved at a cost of about six cents per acre.

From observations of grass in these burns, part of the grass plants are killed and some are weakened. In some places vigorous new plants appear, especially in ash beds. The pruning of understory branches and thinning admits more light and precipitation to the soil and thickets become more accessible to stock. The

outlook for forage production appears greatly improved.

Because of the arrangement and quality of dead fuels and presence of previous fire scars on standing trees, some timber is burned down and new fire scars are started on other trees. This will continue until the excessive tonnage of fuels is eventually reduced. Very little burning down of trees occurs in logged-over areas.

Thinning of thickets has so far been conservative. In small areas thinning is excessive. On the average the understory is still somewhat over-stocked even after burning. Perhaps future work with fire and cutting operations will combine to obtain the stand density desired.

The technique of applying fire is briefly as follows: Dry cold weather is necessary. The fuel may be as dry as it can get, usually a minimum of 7% by hazard stick measurement. Frosts at night are desirable; maximum day temperature should be 70° or 72° F. November 10 has been the earliest starting date. There is a tremendous reduction in fire intensity in November as compared to peak season that is often overlooked by foresters. By that time surface fuel temperature has been reduced by about 50°. Cool air, even though dry, has considerable heat absorption capacity by reason of its greater density. A free fire in late autumn rarely spots and its rate of spread is very slow. In 1950 a fire in the Chediski area traveled nine miles in 30 days or about one third mile per day.

The principle of "descending fire" should be kept in mind during fire application. This means against the wind or down hill. Burning should commence against a secure backstop such as aspen stands, roads or streams. In steep country ridges are ignited so that fires will reach canyon bottoms nearly simultaneously on each side. Usually a fire at night may ascend moderate slopes without damage. It should be remembered that some fires will not move as expected and if an uphill run takes place it should be at night. On flat areas parallel strips of fire may be laid at right angles to prevailing wind direction at 25- to 100-yard intervials. In case of high winds the fires have no more than 25 or 100 yards to run before they meet an adjacent down-wind burn. On Horse Mesa in 1954 this method was used, completing the work much more quickly. A five man crew would set approximately 5,000 fires per day using drip torches or throwing ordinary household matches. In rough country only ridge tops were ignited and on windy days only on the down-wind end of the ridge.

At the present time plans are to continue the work to cover the entire reservation pine area and repeat on three- to seven-year cycles where necessary.

It appears that a system of fire as a silvicultural tool is as feasible in ponderosa pine as in pinelands of the south.

"Key" Grasses Tell the Story

By Bruce Branscomb

A practical tool employed by range specialists, that every cowman can apply, is the use of "key" grass species as indicators of proper livestock management on grazed ranges. A grazing unit is made up of different grass species growing together in "communities," and range cattle show a different preference for each species. When a pasture is being used the preferred or key grasses are sought out and selectively grazed first. The condition of these key species tells if the area is being properly used or overgrazed.

When we talk about "key" species we do not always mean those grasses on the range that are most preferred by grazing animals. Every range has its "ice-cream grasses" that normally do not occur in any degree of abundance. Such plants are really out of place on that range. They are growing by a quirk of nature which put them in an area that is unsuited to their sustained production under practical grazing pressures, and cannot support them in abundance under a degree of grazing that is practical.

Key species usually cure well, and provide good feed through the fall and winter months when the other grasses are low in palatability and nutritive value. The key species are the most desirable forage plants that will grow abundantly in the area. When they are overused and lost, the carrying capacity of the range is reduced. A good to excellent range is one that will continue to produce an abundance of key grasses year in and year out; consequently, for a ranch management system to be of optimum value, the grazing management must be based on the continued production of these grasses.

"Your Range — Its Management" in the June CAT dealt with the dynamics of Arizona's grasslands. In that article Dr. H. G. Reynolds pointed out some of the ways by which the species composition of a grass range is changed. Too often the change is not a good one, and will result in a downhill trend in range condition. Dr. Reynolds called attention to the fact that when preferred or key grasses are grazed too closely, they die out and may be replaced by grasses of lower forage value. In many instances these grasses are not replaced at all, or noxious shrubs become established where the grasses once grew. Either way, the final product is the same: a total loss of the feed that was once available. In an earlier article, (May, 1956) Dr. Ira Judd discussed the percentage of a grass plant that should be left after grazing if the plant is to continue producing forage on a sustained-yield basis. Both of these previous articles point up the fundamentals that serve as a foundation for the key species concept of proper range livestock management. However, in order for the rancher to apply this concept, it is necessary that he know which grasses are the key species on his particular ranch.

Few grazing tests have been run to find out just which grass a cow will eat first when she has a choice of several on the range. One such experiment was conducted by E. B. LeViness on the Boquillas Ranch at Fairbank, in southeastern Arizona. This ranch lies on the western slope of the Dragoon Mountains in Cochise County, at elevations of 4000 to 5500 feet.

The vegetation on this ranch is typical of that on many ranches in this part of the state. Three range types are found within its boundaries; these types, and the principal grasses occurring in them in order of their abundance, are:

Desert Shrub: black grama, Rothrock grama, panic grass, plains lovegrass, Arizona cottontop, sprucetop grama, tobosa, and sand dropseed.

Desert Grassland: black grama, blue grama, sprucetop grama, tobosa, Rothrock grama, plains lovegrass, hairy grama, fluff grass, sideoats grama, and panic grass.

Oak Woodland: blue grama, hairy grama, black grama, sideoats grama, plains lovegrass, sprucetop grama, and Rothrock grama.

A number of other grasses grew in the area, but occurred too sparsely to be of any particular importance. The trees and shrubs are the same as those on ranges throughout much of southern Arizona, namely: whitethorn, burroweed, blackbrush, creosote bush, bear grass, prickly-pear, cholla, mesquite, yucca, Emory oak, and Mexican blue oak. Mr. LeViness measured the amount of grazing on each grass on the ranch and found that of the 18 perennial grass species present, five were grazed most heavily. These five grasses, ranked in order of their relative abundance, were: black grama, blue grama, hairy grama, sideoats grama and sand dropseed. It was also noted that livestock preferred these grasses in the order given. Two of these, black grama and blue grama, because of their combined abundance, palatability, and high nutritive value, were considered the key species.

This type range should be stocked to only the number of cows that will properly graze these two grasses. When they are used properly, the grazed stubble of these grasses will usually average 3 to 4 inches high. If less than 3 inches of stubble remains after grazing, the range is overstocked, regardless of how much of the other grasses are left. Grasses growing in association with the key species are either less valuable, and will eventually replace the better forage if the key species are grazed too closely, or will not stand practical grazing pressure, and so will be driven out.

Although black grama and blue grama were considered key species on this particular ranch, they would not necessarily be in all areas where they occur. Therefore, to manage his range properly a cowman should learn to recognize the key grasses on his particular ranch. In many cases the key species are not now the most abundant grasses in the community. Ranges in only fair or poor condition for example, will show a decided lack of the better forage grasses. In such instances the "range potential" should be considered, and the key species of the area when in good or excellent condition should be the guide. If it is economically possible, the stocking rate should be geared to increase the proportion of these key grasses. This may mean fewer animals, but will result in the long run in a greater total production of both beef and forage.

A handy guide to Arizona range grasses has been published by the University of Arizona Agricultural Experiment Station, and it is available to ranchers for the asking. The title is "Arizona Range Grasses." Ariz. Agri-Expt. Station Bull. No. 298. This handbook is written in nontechnical language, contains information about the grazing value and management of each species, and has a detailed illustration of each grass plant for easy identification. Write to the Mailing Bureau, University of Arizona, Tucson, and ask them to send you a copy.

The County Agent, Extension Specialist, or S. C. S. Range Technician in your area can help you to determine what your range potential is and which grasses on your range are the key species. Learn to know these grasses; keep an eye on them as indicators of whether your stocking rate is such that the range condition is slipping or coming up. Key species are good tools to use when managing your grazing herd in a system that will upgrade your range.

Plant Materials Center Pushes Range Reseeding Trials

By Louis P. Hamilton

The former Soil Conservation Nursery, now operated by the University of Arizona, has changed its name to the Plant Materials Center. The initial testing of grasses, legumes and other plants is still performed at the Center, which is located north of the overpass on the Casa Grande Highway five miles northwest of Tucson. However, the experimental plantings of the Center do not stop there. Louis Hamilton, the nursery manager, and Dr. R. R. Humphrey, who oversees the nursery operations, are anxious to establish as many good reseedings as they can on range problem areas. Although the Center has had a hand in numerous trial seedings scattered over the state in the past, Hamilton feels that these plants have had one big drawback. Under "cafeteria style," free choice grazing, the more palatable grasses such as Boer lovegrass, blue grama and crested wheatgrass were frequently lost through too close grazing. Perhaps of more significance is the fact that such useful grasses as Lehmann lovegrass, Turkestan bluestem and spike muhly, that are relatively easy to reseed, are not grazed till the more palatable grasses have been damaged through too close grazing.

Must we forego the use of these grasses which give us the most dependable stands? The Plant Materials Center and the Soil Conservation Service which is supporting the Center, do not think so. Through teamwork their technicians hope to work with ranch cooperators to establish some field-size plantings big enough to make it practical to fit management of the seeding into the ranch plan along with other range pastures. Thus a pure stand planting can be grazed at the proper time and to the extent desired.

These larger plantings, which are carried out as part of the Soil Conservation Service operations, call on

the Plant Materials Center for seed and for as near a foolproof method of seeding as it is practical to use. The University is not overlooking any new plants either. The Plant Materials Center receives any new plant introductions such as the new creeping alfalfas which may have promise, and also the good native grasses and legumes.

It would take years of research, some of which is now being started by the U. S. Agricultural Research Service at the Mesa Experimental Farm, to work out methods for near foolproof seeding. There is much to be learned from experience. Last year for example, three trial plantings behaved quite differently with respect to fertilizer applied to give a boost to the young seedlings. Some soils, as might be expected, gave a response, others did not. To gain a better understanding of fertilizer rates that might be desirable, Louis Hamilton and Dr. Thomas Tucker of the Agricultural Chemistry and Soils Department of the University brought in soil samples from field plots. Dr. Tucker and his assistants grew grass in the greenhouse to observe the response of grasses on the different soils to nitrogen and phosphorus. Applications in the field will be guided by tests of this sort.

Water conservation really paid off in the trial seeding at Earnest Chilson's ranch south of Meteor Crater last summer. Cattlemen in that area will remember all too well how scant was the rainfall in northern Arizona last August. The pitting plow that Ells Hendricks and Jim Burrell rigged up made pits that held the water from a single good rain. A light shower a few days later brought up good stands of several native grasses in the pits, but there only. Even good deep pits can't beat the drought if they catch only one rain, but in this instance they showed their worth in helping to obtain a stand.

The severe effect of competition from six-week's needlegrama, threeawn and Russian thistle, as well as from the numerous weeds in an abandoned field, is seldom realized by the rancher. Blading the seeds of these weeds in to a windrow has resulted in some very good stands of grass on the bladed areas between. Plans call for combining this treatment with fertilizing and pitting this season to follow up some promising leads obtained in spite of the drought last year. Such reseeding isn't cheap but even expensive methods may pay off in the long run on highly productive land.

Rodents, especially rats and rabbits, are rough on trial seedlings. Persistence with poison grain discourages rats but rabbits damage the plantings severely. The greatest damage is to the smaller plants. That is one reason why it is hoped fertilizer will develop larger, more robust grasses.

The Plant Materials Center is testing numerous irrigated pasture grasses and legumes also. There are numerous strains of Alta fescue, orchard grass, Harding grass, and the bloatfree bird'sfoot trefoil under observation. Management, including adequate fertilization is the key to good irrigated pastures. When applied to improved plant materials, pastures will be that much better. The University of Arizona is cooperating with the Agricultural Research Administration to develop better grasses for both pasture and range.

Chaparral in Pinal Mountains burned and reseeded to weeping lovegrass. Reseeding of burned or other depleted ranges can be highly successful.

Range Improvement Through Reseeding

By Louis P. Hamilton

Reseeding offers the key to restoring badly deteriorated ranges in Arizona to full production. The University of Arizona Plant Materials Center, continuing earlier work of the Soil Conservation Nursery at Tucson, is attempting to find the best adapted range species and suitable methods of seed-bed preparation, accompanied by water conservation, for reseeding on Arizona rangelands.

Since reseeding is an expensive operation, careful consideration should be given to site selection. Natural recovery of vegetation from reduced grazing pressure during the growing season, or removal of brush competition alone may be less costly and more practical than reseeding in some instances.

If sites are selected carefully, successful reseeding can increase forage production manyfold. Also, many reseeding species, notably lovegrasses in the south and crested wheatgrass in the north, produce early spring and

late fall green feed if moisture is available.

Several planting requirements must be observed regardless of the site. The most important are:

1. *Protect new seedlings.*—A newly-seeded area must be protected from grazing at least two growing seasons. Newly-seeded grasses remain green later in the fall than do native grasses and green up earlier in the spring. Livestock concentrate on this young grass in the fall and spring even in the presence of ample nutritious existing native forage.

2. *Reduce competition.*—Competing vegetative growth, whether annual or perennial, must be reduced. The competing effect of juniper, mesquite, and chaparral brush is well known. Abandoned farmlands invariably come up to heavy stands of Russian thistle, lambsquarter, and other weeds. On deteriorated rangelands of the south, annual needle grama and annual threeawn compete severely for moisture.

Mechanical methods of weed control are the most practical for most situations. The undesirable weed seeds can be covered up in the furrowing or pitting processes prior to seed maturation. Blading the seed into windrows offers an effective method on fairly level land free of brush. Chemical control of some weeds is possible.

3. *Provide for water conservation.*—Seedbed preparation must generally provide for water conservation. At the higher elevations it may consist only of weed control though on abandoned farmlands terracing of steep slopes is desirable. In pitting, large pits should be made on soils of low permeability, whereas smaller pits are acceptable on sandy soils. Interruptions in contour furrows are effective in preventing erosion. Tight clay subsoils benefit from ripping that fractures the hard layer and allows improved water storage.

The principles of sound grazing use apply to new seedings as well as native ranges. Lehmann lovegrass is more fully utilized if livestock can be concentrated on it in the spring. Also, native grasses have a chance to regain their vigor. In the fall, cured native grasses and Lehmann's are taken about equally. Boer lovegrass is grazed as readily as the better native grasses at any season of the year.

Available commercial seed of recommended species is listed in tables I and II. Reseeding with Boer lovegrass and the native grasses is more hazardous than with Lehmann lovegrass. Thus, Lehmann's is more widely used in the desert grassland at elevations up to 4,500 feet with rainfall of 11 to 18 inches. Methods of water retention and planting that will provide more favorable conditions for the young seedlings of the native grasses, Boer, and Wilman lovegrass are needed.

Typical areas where these species should be reseeded are (1) denuded ranges supporting annual grama, threeawn, Rothrock grama, burroweed and scattered mesquite; (2) areas cleared of (a) creosote bush, whitethorn, and tarbush, (b) mesquite, (c) creosote bush, palo verde and crucifixion thorn; and (3) burned areas in oak brush, manzanita, sumac and wild olive cover.

Under more favorable conditions the use of Lehmann's lovegrass may not be recommended and Boer lovegrass and the native grasses become less of a gamble.

Weeping lovegrass has been widely used on burned areas in oak brush, mountain-laurel, manzanita and mountain-mahogany. This is mainly because of the lesser cost and demonstrated ability to obtain a stand.

Crested wheatgrass, intermediate wheatgrass, and smooth brome offer the best reseeding possibilities where ponderosa pine predominates. Crested wheatgrass becomes increasingly less productive with decreased precipitation and western wheatgrass should be substituted below the transition from ponderosa pine to pinyon-juniper.

High quality seed should be planted. Locally collected strains of western wheatgrass are preferable to those of midwest origin. Turkestan bluestem, Caucasian bluestem, spike muhly, and sideoats grama offer substitutes in the western wheatgrass areas when suitable western wheatgrass seed is not available.

To date there has been little success in the drier portions of the shortgrass plains above the Mogollon rim. Sideoats, blue grama, sand dropseed, and Indian ricegrass offer some promise.

Table 1.—Species adapted in southeastern and central Arizona in 11″-14″ rainfall areas — 10°-15° minimum temperatures.

Kind of Grass	Cost of seed per acre compared to Lehmann lovegrass	Stand expectancy
Lehmann lovegrass	1x ($1.00-$2.00)	Good to very good
Boer lovegrass	2x	Fair to good
Wilman lovegrass	2x	Fair
Turkestan bluestem	3x	Fair to good
Arizona cottontop	3x	Fair to good
Black grama	2x	Good to very good
Bush muhly	5x	Poor to fair
Sand or spike dropseed	¼x	Fair

Table 2.—Species adapted in southeastern and central Arizona in areas of 15″-18″ rainfall where temperatures occasionally drop close to zero.

Kind of Grass	Relative cost per acre compared to Boer lovegrass	Stand expectancy
Boer lovegrass	1x ($2.50-$5.00)	Good
Weeping lovegrass	½x	Poor to fair
Turkestan bluestem	1x	Fair to good
Arizona cottontop	1x	Fair to good
Black grama	1x	Good
Sand or spike dropseed	1/5x	Poor to fair
Sideoats grama	2x	Fair to good
Blue grama	1x	Fair to good
Plains lovegrass	2x	Poor to fair
Sand lovegrass	½x	Poor to fair

Range Reseeding Practices in Arizona

By Hudson G. Reynolds

Reseeding can be an important part of a range management program. It is not a cure for all range problems. Used widely along with other improvement practices, it can help improve the productivity of many rangelands. Much still remains to be learned about reseeding of Arizona rangelands. However, a good beginning has been made, and many areas have been reseeded successfully. Eventually, as more experience is accumulated, reseeding should play an important role in restoring depleted rangelands of Arizona to their full productive capacity. This paper outlines briefly what we know at present about selecting sites for reseeding, the best procedure to use, and the results that can be expected.

Why Reseed

The primary purpose of reseeding is to restore forage production on lands where the native cover has been destroyed and where there is little chance of recovery by better range management practices. Reseeding can satisfy other objectives as well. The green feed period in the spring or fall can be lengthened. "Hospital pastures" or finishing ranges can be made available. Special lambing or calving areas can be provided. For most satisfying results and longtime benefits, careful consideration should be given to fitting reseeding into the overall plans of range management for the ranch.

Where to Reseed

There are several range types in Arizona that can be reseeded successfully. In the ponderosa pine type in central Arizona, there are many opengrasses. These sites can be restored ings that formerly supported bunchby reseeding (fig. 1). Many large openings in the more moist part of the pinyon-juniper type can also be reseeded, provided care is exercised in the selection of sites. In the "Strip Country" of northern Arizona, ranges now containing only big sagebrush can be restored to perennial grasses. Finally, in southeastern Arizona deter- type can be improved by reseeding. In the other range types such as the drier parts of the juniper, the chaparral, desert shrub, and creosote-bush, techniques have not yet been completely worked out for successful reseeding.

Selecting Sites and Species

Within the range types where reseeding can be practiced, some sites are better suited for reseeding than others. As a cardinal principle, the iorated sites in the desert grassland best sites should always be seeded first. In general, these are the sites having the highest rainfall and the best soils. Also, they give the best returns on the investment.

Rainfall is adequate for reseeding throughout the ponderosa pine type. However, in the pinyon-juniper and sagebrush types, sites should be selected where annual rainfall exceeds 15 inches. Also, on desert grassland sites, at least 11 inches of annual rainfall should be available. In general, success of reseeding will increase with amount of rainfall. Some failures will also occur in spite of careful site selection. Distribution and amount of rainfall are highly variable and plantings may be unsuccessful during dry years.

Soils best for reseeding are those of a medium texture, with a depth of $1 per acre. Accordingly, the original investment can be paid out in a reasonable length of time.

Methods, cost, and returns vary so 2 feet or more, 4 to 6 inches of sandy surface, and heavier subsoil.

Selection of species for reseeding varies considerably with range type. In the ponderosa pine type, crested wheatgrass and intermediate wheatgrass are most reliable. For sagebrush and pinyon-juniper ranges, crested and bluestem wheatgrasses are the best species. On desert grassland sites, Lehmann's and Boer Lovegrasses have given most consistent success (fig. 2).

How to Reseed

Competing vegetation should al ways be removed as the first step ir

Figure 1.

This formerly deteriorated meadow in the ponderosa pine type of northern Arizona has been restored by reseeding to intermediate wheatgrass. Three years after planting, herbage yields were about 900 pounds per acre. (U. S. Forest Service photograph)

reseeding. This is usually accomplished by disc plowing to a depth of 2 to 4 inches. Properly done, the result is a permeable surface layer of loose soil particles overlying a firm soil of higher water-holding capacity. On rocky ground, "brushland" plows give the best results. In more level areas, a wheatland type disc plow does an excellent job. In the desert grassland type, an eccentric disc is often used to pit the soil. This provides a seedbed that holds rainfall.

Good viable seed should be planted at the proper rate, depth, and time. For example, wheatgrasses should be planted at about 4 to 8 pounds per acre at about ½ to 1 inch depth, while 1 to 2 pounds per acre of lovegrass at ¼ to ½ inch depth is sufficient. Rate of seeding and depth of planting are best controlled with a grain drill or a cultipacker seeder. The best time for planting is in May or June just before the summer rains.

Management Practices and Returns

Reseeded stands should be used carefully. They should be deferred for 1 or 2 years until newly planted stands are well established. Grazing should be moderate at all times, removing 50 percent or less of the herbage available (fig. 3). Moreover, grazing should be evenly distributed by such practices as fencing, water development, and salting.

Reseeding requires considerable investment in range improvement but the returns are also good. At present, costs range from $4 to $10 per acre. Annual returns vary from 25 cents to $1 per acre. Accordingly, the original investment can be paid out in a reasonable length of time.

Methods, cost, and returns vary so widely with locations that it is best to consult your local agricultural extension office before undertaking any reseeding program. The successful pioneering ventures to date certainly justify looking into reseeding as a possibility for improving your range.

Information on reseeding Arizona ranges has been summarized and published. U. S. Department of Agriculture Handbook No. 89, "Seeding in the Southwestern Pine Zone for Forage Improvement and Soil Protection," summarizes species and methods for seeding the higher elevations. Arizona Agricultural Experiment Station Bulletin 249, "Reseeding Desert Grassland Ranges in Southern Arizona," summarizes the same type of information for the semi-desert grassland type of southern and southwestern Arizona. These bulletins can be obtained from the Rocky Mountain Forest and Range Experiment tSation, Fort Collins, Colorado. Bulletin 249 can also be obtained through your county agent.

Figure 2.

Lehmann lovegrass is well adapted for reseeding in the desert grassland. Removal of mesquite and reseeding increased forage severalfold at this site on the Santa Rita Experimental Range in southern Arizona. (U. S. Forest Service photograph)

Figure 3.

Crested wheatgrass planted on suitable sites in the pinyon-juniper type provides excellent grazing returns. To remove 45 percent of the herbage, this area has been grazed at a rate of 1.2 to 5.3 acres per cow month. Weight gains averaged about 2 pounds per cow day.

Lehmann's Lovegrass, Pros and Cons

By Robert R. Humphrey

Is it possible to introduce a grass on southern Arizona rangelands that is too aggressive? It is so hard to get the growth we would like on our native grasses and so hard also to establish others by reseeding that the answer to this question would seem to be no. But is it? Let us look into the facts a little.

Reseeding on most of our ranges, particularly at the lower, drier elevations is difficult. Rainfall is uncertain and soil moisture may drop below seedling requirements soon after germination, killing the young plants. Or, seedlings that appear to be established may be unable to live through from the time of germination to the next rainy season.

Most of our native Arizona grasses can be reseeded successfully if the job is done carefully and if rainfall conditions are right. Many of these grasses are difficult to establish in average or poorer than average rainfall years. Most of the introduced species are also difficult to seed successfully under these conditions. On our hotter, drier grassland ranges one grass has stood out above all others in most of the seeding trials made to date. This is Lehmann's lovegrass, a drought-hardy perennial introduced from South Africa. Lehmann's lovegrass is extremely aggressive and is proving well adapted to the desert grassland ranges of the State.

Advantages and Disadvantages

Lehmann's has two chief advantages. It is rather easily established and provides green feed in the winter and spring when most of the native grasses are largely dormant. It does, however, have certain disadvantages. During the early summer months before the July-August rains it has very little forage value. Because of its aggressive nature it may crowd out or prevent an increase in some of the more palatable native grasses. Cattle grazing an area that contains both Lehmann's lovegrass and native species select and may severely overgraze the natives while leaving the lovegrass largely untouched.

During the summer when native grasses are growing and during the fall when both Lehmann's and the native species are dried up, little use is made of the lovegrass. Green leaves around the base are used to some extent but the dry tops are left almost entirely alone. For these reasons, Lehmann's lovegrass will have the greatest value where better species are not already present or cannot readily be established, or where additional spring feed is needed.

Lehmann's lovegrass forms rather dense stands of vigorous plants that compete with the native species for moisture. This competition, when coupled with the preference cattle show for the native grasses during the summer months may tend to drive out the native species. Many such areas could be revegetated by the native species under sound range management were the lovegrass not introduced. Once the lovegrass has been brought in, however, it is doubtful whether the native grasses will again be of much value as forage producers on these areas. The few that remain tend to be selectively grazed to their further harm and to the benefit of the lovegrass.

It should not be inferred from the foregoing that Lehmann's has no place in reseeding programs on southern Arizona ranges. Quite the contrary, for it has a definite place where there is a shortage of spring forage. It is highly effective, also, in erosion control and may often be reseeded with ease on rapidly eroding ranges. From a forage production standpoint it may also be of great value in seeding denuded areas or areas where the native grasses are so depleted that they can be brought back slowly or not at all by management and where reseeding to other species does not seem practicable.

Lehmann's should be introduced with caution, on the other hand, where the native grasses can be restored by management or where a summer-grazing species is required. Lehmann's is a prolific seeder and, unlike most of our southwestern grasses, establishes itself and spreads very readily from seed. Once established, unless killed by freezing, drought or heavy grazing, it may be permanent on ranges where it is adapted. It would be well to keep in mind what happened in Australia when the prickly pear cactus was introduced on a continent where it had never grown before and where it had no parasitic or other enemies. It quite literally took the country and cost many millions of dollars to bring under control. Lehmann's lovegrass probably won't do that but it does look as though we have a grass on our hands that we don't want in all the places where it can and, apparently, is going to grow.

Mesquite has made a good start on many of our southern Arizona ranges in driving out our native grasses; is Lehmann's lovegrass going to finish the job?

Lehmann lovegrass on the western outwash plain of the Santa Rita Mountains. This is an aggressive grass and easily established on many sites.

ant Problems

G. Wilson

Approximately 300 species of poisonous plants are listed for Arizona. Many of them are merely suspected; others are definitely known as livestock killers. We need to know a great deal more about these plants.

Let's discuss a few of the more serious poisonous plants we should be wary of. Locoweed *(Astragalus* spp. and *Oxytropis* spp.) is prevalent over most of the state. These plants can be recognized by their pinnately-compound leaves and narrow bunches of pea-like flowers. Locoweeds green up early in the spring and usually grow in a rounded bunch. Some of the species grow on soils containing selenium and can be further recognized by a disagreeable odor. Non-selenium locoweed symptoms are adequately described by the common name. Selenium poisoning, although not very prevalent in Arizona, may take either chronic or acute forms ranging all the way from general uneasiness to paralysis.

Another serious form of poisoning results when animals consume plants that have an unusually high nitrate content. The oxygen-carrying power of the blood is reduced and death is fairly rapid. Many plants such as ground cherry, annual goldeneye, pigweed, tumbleweed, and other annuals growing under ideal moisture conditions will take up sufficient nitrate from the soil to be toxic.

Each year animal losses result from prussic acid (hydrocyanic acid) poisoning. Stunted Johnsongrass is one of the main offenders. Arrowgrass *(Triglochin* spp.) a grasslike plant which grows in moist sites in the northeastern portion of the state, is known to be toxic at all stages of growth. Wild cherry *(Prunus* spp.) and mountain mahogany *(Cercocarpus* spp.) also build up toxic quantities of prussic acid under certain conditions.

Erosion Control Through Water Spreading

By Norman H. French

Perhaps no other state in the entire United States has had more natural water spreading than Arizona. The general topography and type of rainfall in Arizona make water spreading of primary importance for natural forage production. It is nature's method of distributing intermittent flood flow of water over large areas to produce forage.

Early records indicate that, through natural water spreading, a heavy growth of vegetation was produced on the flood plain bottoms of the major river drainages in Arizona. Most of this heavy growth consisted of grass. The predominant grasses were giant sacaton, tobosa, vine mesquite, and alkali sacaton.

United States Department of Agriculture Bulletin No. 201 published in 1905, entitled "Native Pasture Grasses of the United States," described the dominant grass species in the river bottoms of the Southwest as forming a dense growth six to eight feet high through which it was difficult to ride horseback. This description was made primarily in reference to the sacaton flats in the Santa Cruz drainage. Much of this area is now characterized by bare ground, alkali tolerant plants, and mesquite.

Professor J. J. Thornber of the University of Arizona in a bulletin published in 1910 entitled "The Grazing Ranges of Arizona," states, "On many areas where sacaton was once fairly abundant, it now occurs only sparsely because of overgrazing. Under this heavy grazing, trails are trampled through stands of sacaton, and tussocks are formed. When overgrazing is continued, rain and flood water cuts the trails deeper and deeper until the grass tussocks are left high and dry; and eventually die from lack of water." At the present time it is difficult to find even scattered remnants of sacaton which, as indicated, was the major or dominant species of the natural water spreading areas in Arizona.

Destruction of Natural Water Spreading Sites

Earlier records indicate that there were possibly over 1,000,000 acres of grasslands in flood plain or natural water spreading areas. These were "key" areas to many livestock operations since they provided green forage during the spring and early summer as well as a reserve of dry forage during the remainder of the year and during drouth periods. In effect, they were the means of providing rotational or deferred grazing over much of the central and southern Arizona rangelands. The few natural water spreading areas which remain in grass today show a marked change of grass species and a considerable reduction in volume growth. The bulk of the former water spreading areas are at present in varying stages of serious erosion. Many of these areas have been completely destroyed by erosive forces or are in a serious state of depletion. In their present condition they have little or no value for grazing or for anything else, yet they contribute large amounts of silt to irrigation and stock water developments and cause immense damage to downstream irrigated farms and installations.

Who or what caused the destruction of these grasslands is not the important problem now. The problem is, can this destruction be stopped and how can these eroded and barren flats be returned to their formed productive condition?

Peak Floods Reduced by Detention Dams

Since water spreading was the original key to the forage production on these areas it must also be the means by which these areas are to return to a productive state. If we think of water spreading as the utilization of runoff water to provide forage, and consider the continuing destruction of the alluvial flats which were formerly in a good state of production, the possibility of reconverting these flats to their former state appears insurmountable. The job is enormous and very expensive, yet it is not impossible or impracticable. The first step that must be taken in the recovery process is restriction and regulation of livestock use. The second step is gaining control of the flood waters so that peak flows can be reduced to the volumes which can safely be distributed over the flood plain bottoms. In order to distribute these waters, it is necessary to eliminate the effects of serious erosion by doing structurally what was formerly accomplished by vegetation. Control of flood water and distribution of these waters are accomplished by means of detention dams and spreader dikes.

A detention dam is one that stores no water, except for very brief periods of time, but checks flood water and reduces the peak volume flows to amounts that can be spread economically and effectively. Following reduction of peak flows, it is then necessary to plug all channels throughout the water-spreading flat and force the flood waters to spread out as they formerly did. This can be done by a series of dikes, dams or plugs. Structures across cuts and channels in the flats must be so located, and the flow of water so calculated that the systems will operate automatically and without severe damage to the structures during heavy runoff periods.

In several instances where federal agencies have cooperated with local ranchers in control of erosion and in distributing the flood waters over the natural flat areas, results have been most promising. A picture taken several years ago of a flat in southeastern Arizona shows the area practically barren of vegetation and seriously eroded. After a water-control program was initiated that forced water out onto the normal flood bottom areas, striking changes have taken place. The deep cuts have filled with silt, and native grasses are again covering the entire flat. Valuable forage is now being produced even during years of extremely low rainfall.

The possibilities for increasing forage production through water spreading are practically unlimited in many areas of the state. Water spreading is also the most practical method for controlling erosion and stopping the movement of silt by flood waters to downstream storage reservoirs. It is an expensive procedure, however, and requires careful analysis by technically trained people, and above all close cooperation between range users and the agencies which administer the lands.

Salting for Better Livestock Distribution

By John W. Bohning

How to get cattle properly distributed is one of the big range management problems confronting most Arizona stockmen. The problem varies with type of country, kinds of forage, and even time of year. In mountainous country, it may be steep slopes, rough canyons, or rocky breaks that prevent efficient use of the range. On semi-desert ranges the topography may not be severe, but distance between watering places may prevent cattle from utilizing much of the available forage. Even on gentle topography, areas close to water may be consistently overused while more remote areas are used lightly or not at all. On much rangeland of the Southwest, the low productivity of the land does not justify making heavy investments in improvements. Water is seldom available in all the places it is needed. Fences are often prohibitively expensive. Riding to push the cattle into areas of unused forage is costly, too—and not always effective. Hence, there is a definite need for more economical methods of promoting more even use of the range.

The advantages of using salt to improve cattle distribution have been recognized for at least 40 years. On mountainous range, the greatest value of salting away from water may be to get cattle on pockets of feed that otherwise would be ungrazed or only partially grazed. Where there are marked changes in elevation, salt may help move cattle in conformity with forage development throughout the season. It can also help get cattle into areas of unused forage during the winter or during drought. Salting is not a cure-all for distribution problems, but it works well as a complementary practice in the overall grazing management picture.

What can be expected if you use salt to increase the efficiency of forage utilization? On the Jornada Experi-

mental Range in Southern New Mexico, overuse was substantially reduced on the areas near water when salt blocks were placed at distances of 1 to 4 miles from water. Accompanying this reduction in overuse was an increase in the use of more remote areas. Salting was also used to encourage cattle to graze areas of less palatable plants. For example, the use of tobosa grass was increased from 30 to 50 per cent by placing salt on the tobosa grass flats. Adjacent black grama range got the benefit of some relief from grazing. Small dirt tanks have also been used to draw cattle to tobosa flats, but water plus salting on the flats promotes even better use of tobosa during the relatively short summer season when it is most readily taken by cattle.

An argument against salting away from water has been the fear that wide distribution of cows would affect the next year's calf drop. To check this, calf crops obtained over a 6-year period when salting was at water were compared with calf crops obtained during a 7-year period when salting was away from water. There was no appreciable difference. On the average fewer bulls were used when salting away from water.

Within the last 10 years, self-fed mixtures of salt and cottonseed meal have become very popular. These mixtures are commonly fed primarily to supply protein to the livestock ration, the amount of supplement consumed being regulated by the ratio of salt to meal in the mixture. For most economical use, as a protein supplement, salt-meal mix should be fed with an abundant supply of roughage such as dry grass.

Feeding salt-meal mixtures has been found to improve cattle distribution. In a test of this on the Jornada Range, results obtained by placing salt-meal mixture only away from water were compared with those where the mixture was placed both at and away from water. Salt-meal in a 1 to 4 ratio was used to make the mix more attractive to cattle, yet regulate consumption to about one-and-one-half pounds per cow per day. When salt-meal was available both at and away from water, 30 percent of the area received heavy use, 32 percent was grazed to a proper degree, and 36 percent was lightly used. When salt-meal was fed only away from water, only 15 percent of the area was heavily used; 59 percent was properly used; and 26 percent was lightly used. Where salt-meal was available both at and away from water, 80 percent of all meal taken was consumed at the watering places. The reluctance of cattle to leave water was definitely reflected in the larger area heavily grazed and the smaller area properly grazed.

Where cattle are encouraged to consume relatively large amounts of salt in the form of salt-meal, salt poisoning can possibly occur if stock water is not adequate. However, in this study, feeding stations were as far as 3 miles from water. No symptoms of salt poisoning were observed. Cattle took about a half pound of salt per day when salt-meal was available in unlimited quantities, and did not go directly to water after eating their fill of meal but continued to graze for several hours.

Nearly every ranch has a livestock distribution problem. Whether it is mountainous or not, there is seldom enough water and fencing to insure proper use of all available forage. Forage on some areas may be unused because forage on others is more palatable. Placement of salt should be used as a tool to complement fences and water developments, and to lessen the amount of riding otherwise necessary to obtain even use of forage. When supplementing is desirable or necessary, a salt-meal mix can (1) improve the pattern of grazing and (2) draw the stock out to a supply of roughage. By these practices a stockman can raise the efficiency of his operation and at the same time improve the resources upon which he is dependent for his livelihood.

A Rancher's Viewpoint

By John G. Babbitt

Range management in Arizona is similar to managemnent in other states, although there are factors involved that in my opinion make it much more difficult than in most other areas. Basically, Arizona has a dry climate and is situated in quite a southerly latitude. The combination of these conditions makes for considerable difficulty in adequately putting into effect what I consider to be the four cardinal principles of good range management; namely: Proper stocking; good distribution through the development of adequate stock water; forage preservation through the elimination of undesirable brush and related woody plants; and increasing available forage by reseeding.

Proper stocking in Arizona is complicated by low rainfall and the consequent low carrying capacity of our lands. Furthermore, our precipitation is erratic, with great variation in rainfall from year to year. An example of this occurred this fall when some areas of the state received more rain in 48 hours than they had received in the previous two years.

Certain desert ranges in Arizona that are dependent almost entirely on annuals, such as afilaria, may go three or four years without any appreciable forage production, and then have a spring season that will provide an abundance of the finest possible feed for a few months. This is an extreme case, but it illustrates the fact that in Arizona we must be able to vary our cow numbers very materially to stock our ranges properly.

Good distribution through the development of adequate stock water is a serious and costly problem. Generally speaking, the carrying capacity of ranches in the state is low. A section that will carry eight cows the year around is good by our standards. Moreover, carrying capacities will more often be lower than this. It therefore takes a large area to make a ranch. On such a tract of land there will be little, if any, natural water. Most water must be imounded in earthen dams that go dry in times of drouth.

A not too unusual example of what many Arizona ranchers have to control in regard to stock water, is typified by a ranch of our's containing 175,000 acres at only one permanent

water source. This is a well over a thousand feet deep which was discovered only after repeated failures. Nonetheless, this is one of the finest ranches in our area, even though expensive pipelines and water trucks are our constant companions. Our earthen dams on this ranch must be unusually large and well located because of the high rate of evaporation we experience.

The invasion of our ranges by undesirable shrubs and plants is another major range management problem in Arizona. In our lower elevations it is mesquite. In the woodland areas it is juniper. And in our highest elevations we have jackpine thickets choking out our forage and depleting our runoff. Some progress has been made on the elimination of the first two invaders, but jackpine thinning has barely been scratched. However, the urgent necessity for more water in our irrigation reservoirs will undoubtedly force additional research into the possibilities of controlled burning and other thinning procedures for jackpine thickets.

Reseeding our Arizona ranches is a particularly tough problem because of our semi-arid climate. Ranchmen are interested, but the results to date are generally not encouraging. Additional research, I am sure, will gradually improve the chances for successful reseeding; but Arizona does not offer the opportunities to increase carrying capacity by reseeding that most other states do. Natural reseeding through deferred use is a much more practical approach to the problem here to date.

There is one facet to this reseeding problem that has been almost entirely overlooked, but which in my opinion offers the rangemen the greatest possibilities for improving ranges, not only in Arizona but all over the West. This is browse reseeding. Palatable browses are perfect tools for the range manager. Many of them have a high protein content, and they retain this content much better than grasses during the winter and early spring months. Cattle wintered on good chamiza and cliffrose ranges come out of the winter fat even when grass is short. The shrubs are available when the grasses are covered with snow. In terms of range distribution, cattle on a good browse range get their protein everywhere instead of around a feed bunk consuming costly feed. Even in the summer months, during times of drouth, cattle will turn to browse rather than grubbing out dried up grasses. I realize well the difficulties involved in reseeding these plants, but am sure that their propagation merits a great deal of investigation.

Good range management in Arizona is a real challenge, but ranching here has many compensations. We are not involved in the farming problems and winter feeding difficulties that beset many of our neighbors. Our cattle are nearly free of diseases and pests and we have the finest climate in the world in which to live, to name but few of the advantages of ranching in our wonderful state.

Supplementing the Cow Herd

By Al Lane

Range forage is most likely to become inadequate in protein, phosphorous and vitamin A. By late winter and spring both the protein and phosphorus in the forage will drop to where they contain only 1/6 the amount present when the forage is first matured. The vitamin A by that time is completely gone and has been for some months. Cattle under these conditions then are feeding on a limited nutrition diet. This actual limitation of the feed depends on three things: (1) the exact elements that are lacking, such as the essential minerals; (2) the length of time that these elements have been deficient in the forage; and (3) the age of animal and the type of production. Older animals can stand longer periods on limited nutrition and a dry cow will maintain herself longer on a short feed supply than a wet cow.

This inadequate or limited nutrition causes several pronounced effects in the herd. The cows are likely to become alternate breeders, taking an extra year to get back into condition before they will breed again. This means that they are dropping a calf only every other year and the herd average will be a 50% calf crop.

On this inadequate nutritive level the cows are at least 200 pounds lighter than they would be where they were having an adequate feed supply. This does not mean a maximum feed supply but only that the essential ingredients be available to maintain the cow and allow her to reproduce.

Calves are later and lighter under these limitations. Also, the cow in the spring of the year when the bulls are turned out is in no condition to breed during the months of May, June and July. No matter what the condition of the bulls, the cows will not conceive. As the new feed supply develops in the summer the cow's condition improves, she builds up her level of protein, phosphorus and vitamin A and will breed. Instead, however, of having a late February or March calf the calf comes in May. Obviously this calf will be lighter at weaning time in the fall.

The cow that receives an adequate level of minerals, vitamins and protein suffers no harmful effects even though her total feed supply may be short. These, then, are the things we must consider first rather than her total feed supply.

In an adequate supplementation program the cow herd is given the necessary ingredients to meet her minimum daily requirements. This means around ¾ pound of digestible protein, between 7½ and 9 pounds total digestible nutrients; plus an adequate level of phosphorus, calcium and vitamin A. With a good supplemental program that meets these requirements, a cow will have a longer productive life, she will stay in better shape and will produce more and heavier calves. New Mexico research work has shown that a herd of 1000-pound cows on a range that is adequate in these essential ingredients produced a 90% calf crop and weaned 400-pound calves. By adding 30% more cows to the same range feed supply, the cows dropped to 650-700 pound weights, gave only a 40% calf crop, and the calves weighed only 300 pounds at weaning. On the range that was adequate in feed, 30% of the forage went to the production of the calf. On the inadequate range only 10% of the forage went for calf production.

We have based our knowledge in the past on the limits of phosphorus

and protein on analysis of range feed. We recognize, however, that this is only partially adequate because the digestibility of the protein and phosphorus declines much faster than the total crude element. For example, the range forage may drop to 2½% crude-protein by the spring of the year, but of this 2½% almost none of the protein is digestible.

Usually these nutritional deficiencies do not show but they exist nevertheless, and by adding the necessary protein, phosphorus and vitamin A, the herd will be more productive, the calf crop will be increased and the weight greater. The real test of your supplement is in greater production. By using this yardstick, a range with adequate feed will show no advantage at all in supplemental feeding. If the cows continue to be in good shape, do not be concerned about supplementation, but if the cows are going down hill then supplement to maintain the cows in good condition.

Guard against so-called "California disease," the result of too much bull-power and too little supplementation. Actually it is not a case of too much bull-power but of all the money being spent for bulls, none left over to supplement the cows. These high powered bulls can't breed a cow herd that is too poor to conceive.

Many times when the forage supply is good the cow herd will be just as well off having nothing more than range vegetation. Too often, however, climatic conditions are such that the expected feed supply did not materialize and to maintain the numbers that are present in the herd and still keep that herd productive, supplemental feeding must be used. We see a real advantage in supplemental feeding where the range forage is inadequate for long periods. Usually that inadequate period is during the vital time in a cow's life, which is breeding season and when the cow is nursing a young calf.

Below is a chart showing the increase in calf crop and weaning weights from a supplemented herd against a non-supplemented herd operating under the same conditions.

You will notice that the supplemented herd produced 115 pounds more beef than the non-supplemented herd. At 17c a pound this represents approximately $18.50 more beef from each cow in the herd. At the present price, the 365 pounds of supplement used would be about $11.50 worth of supplement, which leaves $7.00 per head to the advantage of the supplemented herd which must pay for additional labor and financing. This covers an eleven-year period in California.

	Suppl.	**None**
% pregnancy	90.4	75.4
% Calf crop	83.0	66.5
Weaning weight	464	406
Lbs. ofcalf/cow	385	270
Lbs. of supplement	365	

Here are a few guides for a good supplemental program, realizing that any feed or material put out on the range to overcome existing deficiencies is a supplemental feed. We are talking in broader terms than just a protein supplement.

(1) Use the kind and amount of feed that will economically overcome the existing deficiency. In some cases this means protein, other times phosphorus or other minerals and vitamin A.

(2) When supplemental feeding is necessary it is better to feed over a long period of time than to feed heavily for a short time. This means that the rancher must anticipate what the demands of his herd are rather than wait until the cow herd is in such bad shape that no practical amount of feed will bring the herd to good condition.

(3) On browse or mixed browse and grass ranges, grain can be substituted for part of the cottonseed meal in a normal protein supplement. Because of the higher level of protein in the browse and because energy may be limited, grain can be used if the price is less than the price of cottonseed meal.

(4) Wind loss in some areas on ground feeds has been found to be as high as 25%. If there is any appreciable wind loss, it is cheaper to use pelleted feed.

(5) If the range feed has been dry for five or six months, feed a supplement. Very likely both phosphorus and vitamin A will have become inadequate and it may be necessary to use a protein supplement as well.

(6) If your practice is to breed yearlings and calves out as two-year-olds, extra supplemental feed is needed on those young heifers. Otherwise there is a possibility of them becoming sterile or missing the next calf. Properly fed and managed, however, this practice can equal three-fourths of a calf more in the productive life of the cow over breeding two-year-olds.

(7) Vitamin A is essential not only to calving but milk production and a mature cow needs about 30,000 units of vitamin A daily. Vitamin A is stored for 3 to 6 months after green feed is exhausted and usually adding 15,000 to 20,000 units a day will keep her vitamin A reservoir from running dry. One-half pound of high quality dehydrated alfalfa per day will supply that amount of vitamin A (carotene).

Listed below are some examples of simple range supplements to be used in the late winter and spring when there is nothing but old forage to graze. The protein and phosphorus, particularly in dry grass, will be very low and the vitamin A completely exhausted.

You will notice on the grass range that it is two parts cottonseed meal and one part dehydrated alfalfa. On the grass-browse range where the browse will supply some additional protein, the same ratio was kept between cottonseed and dehydrated alfalfa but one part of grain has been added. On the typical browse range the green spring forage eliminates the necessity of adding vitamin A. The protein level will also be considerably higher, so the supplement consists of two parts of cottonseed meal and three parts of grain.

Let me emphasize this point. A good supplemental feed program will never take care of a poor range management program. If the range is properly managed and only moderately stocked, the need for a yearly supplemental program does not exist. Yet there will still be times when the feed supply is not adequate and supplemental feeding will be necessary. Very likely the first need will be for additional phosphorus in the form of steamed bone meal, dicalcium phos-

Type of Forage	**C.S.M.**	**Dehy.**	**Grain**	**Salt**	**Protein**
Grass	2 parts	1 part		30%	34%
Grass-Browse	2 parts	1 part	1 part	30%	28%
Browse	2 parts		3 parts	30%	22.5%

phate or some other suitable source during the breeding season. Remember that a supplemental feed program is just that — it is to supplement the range feed and is not adequate itself. If two pounds of supplemental feed are used daily, it still provides only about 1/5 or 1/6 of the total digestible nutrients that the cow needs every day. She still has to get out and rustle for the other 5/6 of her daily requirements.

Range Livestock Distribution

By E. S. (Jack) Humphrey

A long subject for short consideration! Let's start with the one basic law: No Two Ranches Can Be The Same. This means that no two ranches can be worked with the same outline. Once this is understood, then the various trail signs can be read and each trail followed so far as that trail is helpful on the particular ranch being considered. These signs will read something as follows:

1. Natural drift of the cattle on this range. Do the cattle know the range or are they newcomers?

2. Location of feed. Balance of grasses and browse. Seasonal palatability of the various feed types.

3. Type or breed of cattle to use the range.

With these apparently simple signs each man must consider his own range in conjunction with its appraised year-round carrying capacity, this appraisal said to be based on a ten-year average. Granted there probably never has been an "average year" in Arizona but then all our mentors speak in terms of averages. If we are to conserve our appraised carrying capacity then we must store up standing feed in good years to balance out the poor years which we know will come. The purpose of range livestock distribution is to retain this good and bad year balance through conserving root strength and seed crop reserve.

We have seen the sign of natural drift of the cattle. If their drift is followed, it will be found that on any range the cattle seasonally follow a pretty regular movement. Humans do the same. Cattle are constantly moving to the most palatable feed at each change of feed growth. Some feeds are soft, strong and palatable at one season and others at other seasons. Some feeds grow during warm weather and some grow during the colder seasons. Nature seems to have made the cool-growing season feeds the stronger and at the same time the more palatable for use during the period of greatest need and least supply. Nature has also overlapped their growing seasons so that cool-growing feeds are still growing and palatable when warmer-growing types are coming into supply. Herein lies the danger of uncontrolled livestock distribution. Cattle will continue to work on the cool-growing, more palatable feed as long as it is available and thus give the less palatable, less strong, warmer-growing types a real chance to grow strong and make seed while the better types are eaten down and no chance is given for storing strength in the root systems and no chance for maturing a seed crop. This system forces a range to change from good seasonable balance to a range which is strictly a one-season — a warm-season — range.

Sure, I know, some of the swivel chair managers will say move them around with salt placement. That has never worked with me. Did you ever try to move a bunch out of good winter browse to a dry stand of galleta with salt placement? Or try to move them from greening galleta growth back into oak brush which has not yet started to put out with salt placement? The salt may disappear with weathering but the cattle do not change.

And then there is the forced change with controlled water. Can do if the waters are not open so a cow can smell them. Fence off an open water and the old cow which knows the range may graze near it until she just has to drink and then a trot to the nearest available water, spend a couple of hours getting a real water fill and then start back to the grazing she wants near the water which has been closed. The cow that does not know the range will graze there within scent of that closed water and if you are not riding you will probably find her too late to save her. If waters can be made non-existent then water can be used to shift cattle, but we always have to remember that a cow smells water a long way off and once she gets to it she is apt to stay there "in hopes" unless past experience on that range has taught her that once the water is closed there is no hope there.

So we get back to our trail signs. Natural drift will let the cattle point out the seasonal areas of the range — it is up to us to keep them this way and to keep them in balance. If we can learn from watching our own cattle we will come to know the location of feed and waters; the seasonal palatability and strength of our various feed types (even though we do not know the names). Once we know this, then we must study our cattle to learn if they have the feet, the legs the will to live by which they can handle the distances and the footing to keep in condition on the range as it is. We have to study the grass-browse balance to know if we have the 60-40 balance needed by *Bos taurus* or if the browse is such that we need to bring it in balance by bringing in some *Bos indicus*, with its different digestive system and different needs.

We come now to active range livestock distribution. From here on I can give only what has worked best for me in keeping the less good plants and weeds from crowding out the better. Rather than trying to give medium use to the range at all times, it has worked better over the long haul to stock heavily for short periods so that the weeds and the poorer feed types (which are mostly annuals) will be eaten down along with the good and so stopped from making a seed crop. Then I have found it best to move to another area. This is done by good fencing and by trying to shift grazing areas about every three months at such times as to make the moves come in the middle of the seed-setting season spring and fall. This gives the one area a chance to drop seed not eaten before the move and the other area a chance to have enough seed partially matured to insure some drop before the cattle can clean it all. These shifts are alternated so that no area has the shift made at the same time each year. This means that at all times a visitor can look at one area and say "over grazed" and at another and think he is not using his feed. But the balance comes in the good years and poor years, providing either kind does not

continue too long .

Right now the dry, poor type of season has continued too long. According to the way I figure our range condition the appraisers for both state and federal lands seem to make their appraisal on what I would call 80% as a normal. On this basis our ranges were above normal from September 1951 to June 1954 with the exception of December 1953 and April and May of 1954. During that period we were understocked but feed was accumulating. On the same basis our ranges have been below their appraisal norm from July 1954 to date with the exception of January 1956 when they hit an exact 80% of normal. During this period the range has been overstocked but the holdover feed has helped up to this past winter when we could definitely say, "This dry spell can quit any time it wants to."

Sounds simple, and it would be if we had regularity of weather cycles. But we do not have. I suppose I am a relative newcomer, as I came to Arizona only 46 years ago, but in that time I have never seen a year, unless memory fails me, when some area in the state was not experiencing a drouth and some other area had normal feed or above. The last of March an editorial in the Arizona Republic said that with the most recent rain all Arizona ranges were now set for a good feed year — the assurance was signed, sealed and delivered. A good deal of this country up here is wondering just where they got that idea for we can certainly use not just one more rain but several. Those are things that make any law of range livestock distribution untenable except as a directional sign; also the thing that keeps us from getting bored with the cattle business which our dudes call "a way of life."

Grazing Sheep on Arizona Rangelands

By H. B. Embach

In this present year of 1958, the grazing of sheep on Arizona rangelands is entirely a summer proposition and confined to Apache, Conconino, Navajo and Yavapai counties, above the Mogollon Rim.

The methods of handling range sheep have changed very little since the 1870's insofar as the actual range operation is concerned. We still use two men to the band, one a herder and the other a camp tender who moves the camp, packs the burros and generally cooks for the two of them. Under the direction of the owner of the outfit, camps are moved every three days so that the sheep are on fresh feed and to permit the best possible utilization of all the available grass and weeds.

Sheep outfits are smaller than they were in the early days of the present century, and as a general rule the individual bands of sheep are made up with fewer numbers of ewes. There are more and better water facilities than we used to have, and the ranges are fenced for each outfit. Probably the most notable change, however, is the change in the time of lambing. Approximately 95 percent of the present Arizona range sheep population (excluding the Navajo Indian sheep) lamb in alfalfa pastures in central Arizona in October and November. After the lambs are shipped in early April, the ewes go home to the summer ranges as dry sheep. This makes the summer range operations quite a little easier than years ago when practically all of the Arizona range sheep lambed in February or May and the lambs were in the bands all summer.

The majority of our Arizona range sheep are still trailed back and forth between the central valleys and the summer ranges, and considerable sums of money have been spent through the years by the sheepmen in water facilities on the driveways, to provide wells and pumping plants, spring improvement or other storage facilities, and corrals.

Most of the range sheep graze on national forest permits during the summer months, the season being usually June 1 to September 30 each year. As soon as the sheep reach their summer ranges, or sometimes before they get there and are still on the trail, the bucks are put in the bands and remain with the ewes some 30 to 40 days, depending on the date the owner wants to start lambing in the alfalfa pastures in central Arizona.

Climatic conditions during the summer have a direct effect on lamb crop and length and condition of wool. Sheep require a little more care in handling than any other class of livestock and have to be under control at all times, night and day. Proper range management therefore is very vital to successful operations both on the summer range and in the winter pastures where feed is rather expensive. The financial outcome of the year's operations is more or less dependent upon what happens to the ewes on their summer ranges.

Sheep grazing in cut-over ponderosa pine in northern Arizona.

* This is a publication of the Agricultural Extension Service, University of Arizona. See your local County Agricultural Agent or County Home Agent for other farm and home information.