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IMPROVING CALIFORNIA BRUSH RANGES

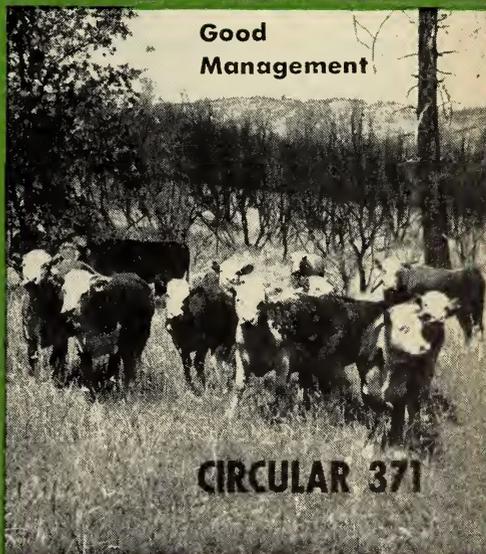
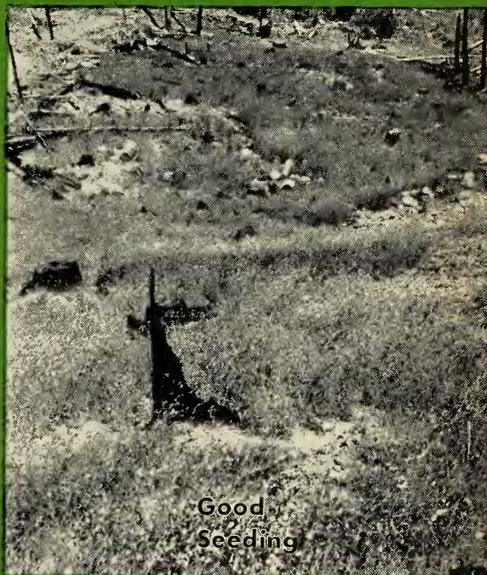
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CALIFORNIA AGRICULTURAL
EXPERIMENT STATION

MORE MEAT and MORE WOOL . . .

have been produced in California on some brushlands that have been cleared and converted into pasturage for cattle and sheep.

There are between 10 and 20 million acres of brushland in this state. While not all of this land can be cleared profitably, large areas of it will repay the time and money spent on such a project by providing support for additional stock.

In 1950, ranchers in 30 counties cleared 97,000 acres by controlled burning of brush.

A GOOD BRUSH-CLEARANCE PROGRAM . . .

must be well planned if it is to succeed. This circular will help you choose and carry out the best program for your land, through these basic steps:

- 1.** Removal of brush. This may be done by fire alone or by mechanical or chemical methods followed by fire.
- 2.** Revegetation of cleared areas. Artificial seeding may be necessary in some sections.
- 3.** Control of grazing. This requires the planning of a long-term grazing program.

SINCE 1947, WHEN THIS CIRCULAR FIRST APPEARED . . .

an important trend has become apparent in the range-improvement program. More adaptable species are being seeded, and there is a better follow-up of reburning. This is resulting in a more definite and permanent conversion from brushland to grassland.

In addition, seed of new range species has now become available commercially, at reasonable prices.

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IMPROVING CALIFORNIA BRUSH RANGES

WELL-PLANNED PROGRAMS of brush removal by individual ranchers can change certain adaptable California brushlands into valuable grasslands that produce greater crops of meat and wool.

The removal of brush is merely the first step in any sound, long-term, range-improvement plan. Just as important, if the program is to be worth the stockman's time and money, are:

1. Seeding of cleared lands with forage grasses and legumes (when natural growth is not enough to provide pasturage).
2. Planned range management, to prevent ill-timed grazing or overgrazing.
3. Continued action to suppress the

brush, by reburning or use of chemicals.

Each year, between 50,000 and 100,000 acres in California are burned over to destroy the brush. In 1950, brush was burned, under permits from the State Division of Forestry, by individuals or groups of ranchers in 30 counties.¹ The territory included about 97,000 acres with widely varying conditions of elevation, soil, brush species, and rainfall, thus indicating the wide interest in this phase of range improvement.

This circular considers the three general steps of a range-improvement program: (1) removal of brush; (2) revegetation of cleared areas; (3) control of grazing.

STEP 1: REMOVAL OF BRUSH

The first phase in a brush-removal program involves the following:

1. Choice of suitable areas where soil fertility, topography, and rainfall offer support for forage growth on cleared lands.
2. Proper clearing of the land: by fire alone on rough, steep slopes; or through use of machinery to knock down the brush, followed by fire on less steep sites.
3. Reburning of cleared lands in from two to five years to keep the brush from covering the areas again, or use of chemicals to kill the sprouts and seedlings.

Where It Pays to Remove Brush

In 1946, according to Forest Service data, California had from 10 to 20 million acres of chaparral and wooded grasslands that included large areas of little or no value for stock grazing. Some of that acreage has already been converted

to pasture, but not all brushlands can be profitably cleared. Many areas are too rough and steep to be cleared, or have insufficient fertility and rainfall to support forage crops even if brush were to be removed.

Choosing the Area. Soil, topography, and brush type are the most important factors in determining whether to remove brush from a given area. The rancher's decision to clear brush should be based upon a thorough examination of the area.

Dense stands of tall brush usually indicate a moderately fertile soil capable of supporting a grass cover. If pasturable plants are found as remnants in the brush,

¹ Amador, Butte, Calaveras, Colusa, El Dorado, Fresno, Humboldt, Kern, Kings, Lake, Madera, Mariposa, Mendocino, Monterey, Napa, Nevada, Placer, Riverside, San Diego, San Luis Obispo, Santa Clara, Shasta, Siskiyou, Sonoma, Stanislaus, Tehama, Tulare, Tuolumne, Yolo, Yuba.

or if they are growing well in the open spaces, then the entire area is likely to have equal value for producing feed if cleared. (See table 4, p. 31, for types of forage plants.) Perhaps enough seed of perennials and desirable annuals is present so that artificial seeding will be unnecessary. If there is little or no grass within the area, natural revegetation may not be adequate the first winter after the brush is removed, and seeding should therefore be planned.

A given area may include shallow, sterile soils on one slope and deeper, fertile soils on another. Since it is not always economical to clear only the favorable spots, the over-all picture must be considered in choosing lands for range improvement—balancing the probable total gain in feed resources against the cost of improvement and the possible damage by soil erosion following brush removal.

Good Removal Requires Good Methods

Brushland is cleared in four ways: by fire alone, by mechanical equipment, by a combination of the two, or by chemicals.

If the land is rough or steep, it is usually cleared by the cheapest method—

fire alone. Good soils and arable land justify the costlier method of using mechanical equipment to uproot the brush before it is destroyed by fire. This is preferable because brush is destroyed more completely by fire when mechanical equipment has been used first. It must be noted, however, that any disturbance of the soil may lead to erosion damage.

This brush-removal project is achieving results through careful, progressive, coöperative planning, thus winning public approval and legal and financial support. Community, county, and state coöperation is demonstrating that such a program can be carried on efficiently without threat to public safety and property rights.

Size of Area to Be Burned. Areas in any one burn have varied in size from less than 40 acres to more than 10,000. The program has now continued long enough so that burn sizes can be evaluated.

The aim should be to complete the burn in one day. This is the primary consideration as far as the effectiveness of the burn is concerned. A night fire creeps slowly and does not burn hotly enough to destroy the brush.

From the over-all standpoint, it should be determined whether the grazing periods on the newly seeded areas can be properly adjusted by the rancher. He must bear in mind that all stock should be kept off the seeded areas until the plants mature seed.

A third consideration is the cost per acre of putting in fire lines. Obviously this is less when natural boundaries, such as roads and streams, can be used. It is also usually less when larger acreages are involved.

A fourth point to be considered is the cost of seeding the burned area. This is important to the final success of the operation since it appears unwise to burn an acreage larger than will be seeded.

Smaller burns usually result in better control of sprouts and seedlings by deer.

The 100 million acres of land in California are divided roughly as follows:	
	Million acres
Agricultural, industrial, and urban	14
Forest and wild land:	
Desert and barren	25
Brush	10
Sagebrush	7
Grass	10
Woodland-grass	10
Noncommercial timber	7
Timber	17
	—
	100

Therefore, the size of the local deer population should be taken into account if this type of control is desired.

Use of Fire Alone. When the rancher has determined that fire alone is to be used to clear a chosen area, he must plan the operation carefully. Details should be worked out in accordance with requirements and suggestions from the representatives of the State Division of Forestry, or other fire-control agency involved. In many counties, there are local Range Improvement Committees. These, in cooperation with the Farm Advisor and State Forest Ranger, plan all burns in the area well in advance.

The first step is to apply to the local State Forest Ranger for a permit to burn at a stated time and place.

The second is to cut and clear a firebreak, by removing the brush in a strip around the area to be burned. The ranger must approve this firebreak.

It is customary for the rancher to enlist the help of neighbors, if possible, or to employ other persons, to guard against the spread of flames past the firebreak. There should be plenty of guards at the fire.

Detailed instructions on burning are not included in this circular, as varying conditions must govern the procedure, and directions are set forth by the forest ranger to cover each case.

Usually the local forest ranger, who has had experience in fire fighting, decides when conditions are suitable for burning off the area, and sets the actual date. This does not mean, under the law, that he will assume any responsibility for accidental fire damage to adjacent property. *Responsibility rests with the person to whom the permit is issued.* It is possible to take out insurance at nominal premiums.

A period of high temperature and low humidity is the most favorable for a hot, clean burn, although such weather adds to the chances that the fire may get out of control. With high humidity, on the

other hand, the burn may be light, patchy, and unsatisfactory. In dense stands of brush, the understory (ground cover) of grass and weeds is usually either scanty or absent, so that the shrubs themselves must be depended on to carry continuous and killing flames.

Depending upon local conditions, the burning is usually done sometime during the late summer months. In some instances, it has been done after the first fall rains or in the early spring, because the fire is less likely to get out of control. This practice is not always satisfactory. The burn may be incomplete, providing a poor seedbed, and allowing the development of summer weeds which delay the growth of pasturable plants. In contrast, a burn at the time of year when brush is inflammable consumes most of it and leaves a good ash that is an ideal seedbed (see top cover picture and bottom picture on opposite page).

Mechanical Method. Perhaps the outstanding example of the use of mechanical equipment alone to destroy brush is in northeastern California.

NOTE: In some counties, forest fire protection is not under direct jurisdiction of the California Division of Forestry.

1. In the following counties, the California Division of Forestry contracts protection of state responsibility areas to the county: Kern; Los Angeles; Marin; San Mateo; Santa Barbara; Ventura.

2. The California Division of Forestry contracts protection of state responsibility areas to the United States Forest Service in the following counties: Alpine; Inyo; Mono; Plumas; Sierra.

3. The following counties have no state responsibility areas: Imperial; San Francisco; Sutter.



↑
A burn was attempted on this area east of Santa Ana, Orange County, April 3, 1942. Burning brush at the wrong time of year often results in a spotty kill. (Photographed April 16, 1942.)

POOR BURN = SPOTTY KILL

CLEAN BURN = GOOD FORAGE

Grass plots seeded September 27, 1946, in a clean burn near North Fork, Madera County. (Same site as top cover picture.) Sixty acres of recommended mixture were seeded. (Photographed June 6, 1947.)



Near Alturas, Modoc County, a farmer has been very successful over the past 10 years in converting sagebrush land to grassland. He plows a field with a wheat-land plow, and seeds cereal rye for a hay crop. When he cuts the rye for hay, any seedlings of sagebrush that have germinated are included in the cut. Then he prepares a firm seedbed, and drills crested wheatgrass and a combination of Ladak alfalfa and yellow sweet clover in alternate rows 1 foot apart. The result is a good dry-land crop of hay and pasture.

Additional thousands of acres of sagebrush in Zone 6 (see p. 19) could be converted to profitable pasture by use of the same methods.

Mechanical Method Followed by Fire. An increasing amount of brush clearing is being done by bulldozer or by a steel rail used to dislodge the standing brush.

The bulldozer is a good tool because it crushes down the brush so that it is compacted and partially dried before being burned. This results in a cleaner burn. The blade of the bulldozer should be held 10 to 12 inches above the ground to prevent disturbance of the soil.

It is necessary to obtain a permit for burning an area cleared in this manner, and to work out details with the forest ranger, just as when fire alone is used. The usual firebreaks also must be provided. A good burn can then be conducted when the fire hazard is not too great.

This dual method has been successfully used in Santa Barbara County. In an area where chamise and other sprouting forms of brush predominated, the brush was removed with a bulldozer and pushed into windrows. After these had been burned, the roots were dug up with a machine developed for the purpose—a ripper which worked like a dump rake. The roots were then pushed into windrows by a bulldozer with heavy teeth, which disturbed the soil very little. When the roots had been burned, the land was ready for plowing. After a year in vetch and oats,

or sudangrass, the land was again plowed to destroy brush seedlings, and was then in condition for seeding to a permanent pasture of grasses and legumes. The cost per acre for the entire operation, at wartime prices in 1944, was \$25. This comparatively high cost was justified, because the soil is productive.

In Monterey, San Bernardino, and some other counties, another combination of mechanical equipment and fire is used to eliminate crown-sprouting chamise and other brush. Brush on the firebreaks is broken down and burned early in the season, before the standing brush becomes too inflammable. In these counties, bulldozers are used to break the standing brush; after this has been burned, the roots are turned up with a heavy disk plow. A heavy rake, similar to a bull rake, is used to pile the roots together in windrows, where they are burned. The land is then generally seeded to grain. A plowing, after the cereal crop is harvested as grain or hay, serves to kill out brush seedlings. After one or two crops of grain, the land is seeded to pasture. The cost of knocking down the brush for burning will run from \$3 to \$15 per acre. The total cost of one extensive operation in Monterey County was \$15 per acre where the cover was practically all brush. With a cover of 35 per cent oaks, the cost rose to \$28.50 per acre.

Similar practices were used on a demonstration area in Nevada County, except that range plants were to be seeded in the ash immediately after burning. Pictures on the opposite page show the mechanical operations. When the brush is knocked down in place, the resulting burn, with even distribution of ash, forms an ideal seedbed.

Before starting on a brush-clearing program involving mechanical equipment, it would be wise to visit ranches where effective equipment and methods have been developed. The Farm Advisor can help through his knowledge of local conditions.

Brush burning trial in Nevada County. General view showing distribution of the brush. (Photographed May 15, 1946.)



Close-up of same field as above, showing brush knocked down and left in place. Result is even distribution of the ash after dried brush is burned.



Equipment used for knocking down brush. Blade of bulldozer has been raised so that it can turn around. Note that soil has not been disturbed. (Photographed May 15, 1946.)



Chemical Treatment. Information on the use of chemicals is rapidly becoming available. Address inquiries to the local Farm Advisor or to the Department of Botany, Davis.

For foliage treatment, the equipment used may be knapsack, ground rig, or aircraft, including fixed-wing planes or helicopters.

For control of chamise, the best results are being obtained by treating the sprouts following the burn. Timing of the treatment is extremely important. After a July burn, chemical treatment should be applied in April of the following year. If the burn takes place in September or later, treatment should be delayed about 18 to 20 months. Material used is a low-volatile ester of 2,4-D or 2,4,5-T, at the rate of 2 pounds in 5 gallons of diesel oil, per acre.

On chamise, the recommended program would be: burn, seed, spray, graze.

The most successful foliage treatment so far has been on coastal sage. Here again, time of application is important. Much experimental work has been carried on by the Farm Advisors in Ventura and Santa Barbara counties. There has been a noticeable increase of native stipa following spraying in Ventura County.

In Santa Barbara County, 115 acres near Los Olivos were sprayed April 12, 1950. The sagebrush was growing rapidly, the new growth being about 3 inches high. A very satisfactory kill was obtained with 2 quarts of 40 per cent alkaline amine salt of 2,4-D in 6 gallons of

water, per acre, sprayed by helicopter. The cost was \$5 per acre—\$2 for material and \$3 for the application.

There is no fire hazard when sagebrush killed with 2,4-D is burned late in the season. Coastal sage areas, after burning, will support smilo, veldtgrass, and rose clover particularly well.

Surface treatment can be applied at any time of the year. It appears to be effective on toyon, digger pine, live oak, and scrub oak. One problem that has not yet been solved is that parts of the tree, or of branches, are not always killed.

For surface treatment, shallow cuts 3 to 6 inches apart are made in the bark of stems 2 inches or more in diameter, in a circle around the stem a short distance above ground level. One cubic centimeter of the amine salt of 2,4-D or 2,4,5-T is introduced into each cut by means of a 1-quart pump oil can.

A man can treat up to 8 acres a day by this method. Material costs about \$4.50 a gallon. On a 200-acre field in upper Berryessa Valley, Napa County, a total of 25 gallons of 2,4-D amine was used on live oak in 1951.

A basal spray involves spraying the lower bark with a low-volatile ester of 2 per cent 2,4,5-T in diesel oil, and is effective only on stems of small diameter. It is particularly useful in killing scattered small clumps of brush, and in clearing rights of way of utility lines. It has been effective in killing small plants of live oak, poison oak, scotch broom, and most other woody plants.

STEP 2: REVEGETATION OF CLEARED AREAS

The second phase of range improvement by brush removal is revegetation. The following considerations largely determine the success of any revegetation plan:

1. Examining the area (before burning) to determine whether artificial seeding will be needed in order to establish a

forage crop successfully (table 5, p. 33).

2. Choosing the best methods, time of planting, mixture and amount of seed, if artificial seeding is necessary.

3. Selecting the proper species of forage plants for the zone in which the cleared land is located. (See zone map on p. 19, and table, p. 20.)



Field on El Toro Ranch, Orange County, showing density of brush before burning. Such a stand usually indicates moderately fertile soil which can support a grass cover. The many stipa plants under this brush are not available to livestock. (Photographed April 30, 1943.)



REMOVAL OF THIS BRUSH

GAVE FORAGE A CHANCE

An adjacent portion of the field in upper photo, showing volunteer recovery of foothill stipa after brush burn. (Photographed April 30, 1943.)



Artificial Seeding May Be Necessary

Before an area is burned over, it should be examined carefully to determine whether artificial seeding will be necessary. In many places, seed of forage grasses and legumes must be planted to provide pasturage on the burned-over areas.

As stated earlier, dense stands of tall brush usually indicate a moderately fertile soil which can support a grass cover. Where such stands have been removed, remnants of both annual and perennial grasses and of weedy species are likely to be sparse. During the first year, while seeded plants are establishing themselves in these areas, there is little or no competition from established growth such as that which interferes with seeding on open range (see picture, opposite page).

Artificial seeding in burns is best done on a spot basis, not over the entire area. In open spaces where, before the fire, there was no coverage except grass or sparse brush, seeding is not only unnecessary, but also likely to be unsuccessful.

In any operation that is not to be continuous over the whole area, best results will come from seeding on the less exposed slopes and the deeper soils.

Natural Seeding. It may well be that sufficient seed of perennials and annuals is present in the brush to make artificial seeding unnecessary.

An example of this condition was observed on a range in Orange County. On this range of 1,000 acres, no pasturage was available for cattle because they would not go through dense brush (see top photo, page 11) either to harvest scant feed growing there or even to reach the more liberal feed growing in open spaces. After the brush was burned, in the fall of 1942, recovery of foothill stipa bunchgrass was almost immediate. In many places, including hillsides as well as swales, the grass reached a height of 3 feet (see bottom photo, page 11). There

was no evidence of soil erosion, and the 1,000 acres now carry 300 cattle for seven months of the year.

Low-growing shrubs, such as wild buckwheat, occasionally have a good understory of grasses and herbs, so that areas where such growth is present may be expected to bear a good natural cover the first year after burning.

An accidental burn of this type of brush near Temecula in Riverside County was observed in 1941, the year after burning, and in subsequent years. An excellent stand of forage came up after the first fall rains. According to conservative estimates, the burned area produced more than twice as much feed as did the unburned portions of the range. This grass defended the slopes perfectly against erosion, although the soil in that area is highly erodible, and the first winter after the fire was one of unusually heavy and severe rainfall. The essential point is that in this stand of low shrubs there were ample remnants of annual and perennial forage plants to revegetate the entire area naturally.

Artificial Seeding. Thousands of test plots have been seeded, from 1937 to 1951, in 51 California counties, by the Agricultural Extension Service and the Division of Agronomy. The University of California School of Forestry and other state and federal agencies have carried on extensive programs in recent years. A number of these were seeded in the ash of brush burns. In addition to the test plots, a considerable number of acreage seedings in brush burns were observed. More recently, extensive investigations have been conducted by the Experiment Station in cooperation with Farm Advisors and ranchers.

Judging from the tests and observations in burned areas, the ash of a heavy brush burn is an ideal medium in which to plant seed. Where the annual rainfall is such that the sown plants can survive dry summers, such seeding is successful. The ash of *grass* burns is *useless* as a seed-



Grass plots seeded December, 1944, immediately after a burn near Kelsey, El Dorado County. This hillside was covered with manzanita and poison oak. Plot at left is domestic ryegrass; at right, tall oatgrass. Note absence of volunteer plants in strip between plots. (Photographed July 10, 1945.)

bed for most seeded species because a grass fire does not kill all the seeds of resident annuals, which start vigorously in the fall and crowd out the seeded species. Center photo on cover shows growth of harding the first June after seeding, near Bridgeville, Humboldt County.

Some trial plots have been subjected to a series of detailed observations for a period of eight or nine years. In Mendocino County near Yorkville, a landowner had been seeding a mixture of ryegrass, hardinggrass, and orchardgrass in brush and slashed timber ash. On October 18, 1943, the writers seeded a test plot of grasses and legumes on the ash on a southerly exposure. The plots were not fenced, and received the same grazing treatment as the remainder of the range. Table 1 gives details of the recorded data. Notes were taken the first year after seeding, in February, April, and July of 1944; in June of the second and third years; in May of the fourth year, and in July of the seventh

year. The first-year results obtained here, as elsewhere, demonstrate the slow initial development of the seeded perennial grasses and legumes. In some plots there was a grass burn rather than a brush burn, and significantly on such sites the stand of seeded species was much poorer than on the brush ash. The plants were not strong and sturdy. This statement applies particularly to smilo, harding, and the stipas. The plots were seven years old at the last reading, and, as will be seen from the last column of Table 1, a good mixture of grasses and legumes can be made up of the plants that succeeded. Subterranean clover was the outstanding legume.

On a more favorable site near Comptche in Mendocino County, a series of similar plots was seeded by broadcasting in the fresh ash of a brush burn in the fall of 1944, and still another series in the fall of 1945. Notes have been taken each year in June. No field was grazed until the July after seeding.

TABLE 1—Example of Notes Taken on Trial Plots near

Species and key numbers	February 25, 1944		April 12, 1944		July 17, 1944	
	Stand*	Height	Stand*	Height	Height	Development†
Tall oatgrass, 6	FG	inches 1-3	FG	inches 3-7	inches 36	R, Gn
Tall fescue, 8	FG	1-3	FG	3-6	24	R, Gb
Annual ryegrass, 13	G	2-6	VG	6	24	R
Perennial ryegrass, 14	G	2-6	VG	6	28	R, Gb
Birdsfoot trefoil, 16	G	½-3	G	2-4	6-20	Fl
Alfalfa, 17	G	1	G	2-3	3-12	Gn
Bur clover, 20	F	1-2	F	2	6	R, D
Smilo, 26	F	1	F	2-4	24	Fl
Hardinggrass, 28	G	1-3	G	2-6	30	R, Gb
Burnet, 30	F	1-3	F	3-5	6-20	R, Gb
Nodding stipa, 34	F	1-2	F	6	24	R, Gb
Purple stipa, 35	F	1-2	F	6	24	R, Gb
Subclover, 56	G	1-2	G	6	12	R, D
Sweetclover, 61	G	1-2	G	3	6	Gn
Orchardgrass, 63	G	2-5	G	6	30	R, Gb

* Stand: VG = very good; G = good; FG = fairly good; F = fair; P = poor; 0 = no plants found.

† Development: R = ripe; Fl = flowering; H = heading; Gn = green; Gb = green at the base; D = dead or dry.

‡ Grazed closely by rabbits.

§ Spreading.

Test plots seeded in December, 1944, on a burn near Kelsey in El Dorado County, have been observed for six years. This site has an elevation of about 2,300 feet, and an average annual rainfall of 40 inches. At the last observation, in May, 1950, the results indicated that tall oatgrass, smilo, California oatgrass, the ryegrasses, hardinggrass, burnet, the stipas, and orchardgrass are well adapted to that area. Stands of alfalfa and subterranean clover (now called "subclover" in the seed trade) were improving (see photo, p. 13).

Chamise is generally considered to occur only on the poorest soils, but there are so many thousands of acres covered with this worthless brush that seeding experiments have been conducted on it.

Test plots were seeded in November, 1946, on a burn south of State Highway 20, in Colusa County, just east of the Lake County line. Twenty-nine varieties of grasses and legumes were seeded in long, narrow plots on a severe south slope. A

drift fence prevented grazing except by the deer. The species included: two varieties of tall oatgrass (6, 6A); California bromegrass (7); tall fescues (8, 8A); ryegrasses (13, 14); birdsfoot trefoils (15, 16); alfalfas (17, 18); prairie brome (25); smilo (26); hardinggrasses (28, 28A); burnets (30, 30A); stipas (34, 35); subclovers (56, 98); yellow sweetclovers (61, 61A); orchardgrass (63); veldtgrass (91); harlan brome (100); crimson clover (101); and rose clover (102). (Figures in parentheses are key numbers. For an explanation of the key, see p. 22.)

As expected, the short-lived plants looked better the first year, but beginning with 1948 and continuing since then, the performance of smilo, harding, and the stipas has been outstanding. Alfalfa, burnet, tall fescue, and orchardgrass can still be found.

In 1949, 300 acres of a burn on the same ranch were seeded to smilo and harding. Large plots of several grasses

Yorkville, Mendocino County, Seeded October 18, 1943

June 10, 1945			June 10, 1946			May 16, 1947			April 27, 1951		
Stand*	Height	Develop- ment†	Stand*	Height	Develop- ment†	Stand*	Height	Develop- ment†	Stand*	Height	Develop- ment†
	inches			inches			inches			inches	
VG	48	Fl	VG	48	Fl	VG‡	36	Fl	F	12	H
G	36	Fl	G	24	Fl	G	24	H	F	12	Gn
G	20	Fl	G	24	H	G	20	H	P	6	H
G	24	Fl	G	18	H	G	18	J	P	6	Gn
G	8	Gn	P	8	Fl	FG‡	16	Gn	0	..	..
F	4	Gn	P	6	Gn	FG	10	Gn	0	..	..
P	6	R, D	P	6	R	P	6	Fl	F	6	R
FG	30	Gn	G	30	Fl	FG	10	Gn	FG	10	Gn
FG	24	Fl	FG	24	Fl	FG	8	Gn	G	10	Gn
G	3§	Gn	FG	12	Fl	F	6	Fl	F	3	Gn
G	30	R, Gb	G	30	Fl	G‡	24	Fl	G	18	H
F	24	R, Gb	FG	30	Fl	FG	24	H	FG	6	Gn
G	12	R	G	12	R	VG‡	15	R, Gb	VG	15	Fl
0	..	..	0	..	..	0	..	..	0	..	..
G	10	Fl	G	10	Fl	G	12	Fl	G	12	Fl

and legumes were seeded by the Farm Advisor. Satisfactory stands of the two grasses were obtained in spite of the severe winter, and the rose clover in the plots has increased each year.

Methods Used in Artificial Seeding

Planting the Seed. Seed can be broadcast by hand, by the use of a breast seeder, by an endgate seeder (if the topography and brush stumps will permit its use), by drill, by plane, or by helicopter. The method chosen will depend on the type of area involved and the complexity of the seed mixture to be planted.

Where mechanical equipment alone is used to clear the land of brush, best results will come from preparing an alfalfa-type seedbed. The seedbed must be firm. After brush has been removed from the land, and it has been disked, it should be rolled with a cultipacker or ringroller. The seed should be drilled, if possible.

Even where airplane seedings are made

on the ash, it should be emphasized that the better seedbeds insure the better stands. Where the rainfall pattern is unfavorable, the seed should be covered after planting and the seedbed firmed so that moisture will be maintained at the seed level. Recent tests in San Diego County have shown that the extra treatment made all the difference between success and failure (see photo, p. 16).

For any method chosen, preliminary tests should be made, using a given amount of seed over a measured area, to determine the proper distribution of the seed. Seeding can then be adjusted to approximately the desired rate.

Time of Planting. The seed should be sown in the ash before the fall rains.

Seasonal variations in precipitation and temperature make it very difficult to determine accurately the exact reasons for success or failure of plantings. However, successful seedings have been made as long as 14 months and even three years after the fire. Lack of invasion by resident

annuals, resulting in lack of competition for seeded species, seems to be an important factor in these instances.

Seed Mixtures. Annuals grow and mature on winter moisture at shallow depths. The roots of perennial grasses and legumes, however, extend more widely and deeply, so that most range areas will support, permanently, fewer individual plants per unit area. The problem is one of moisture and fertility limitation. Probably an ideal average composition of range forage would include perennials and desirable annuals—40 per cent legumes, 60 per cent grasses.

It is not wise to limit the opportunity of establishing long-lived perennials by mixing the seeds of perennials with heavy seedings of fast-growing annuals, such as ryegrasses or cereal rye, which start early and grow as rapidly as the resident annuals. Avoid seeding these annuals heavily in a mixture with slow-starting perennials because they will compete with

the perennials for moisture and sunlight, as do the resident species on open range. Although cereal rye develops rapidly, it is an annual and does not readily volunteer. When this species disappears, annual grasses and weeds will take over, and the chance to establish perennials will be gone (see photo, opposite page).

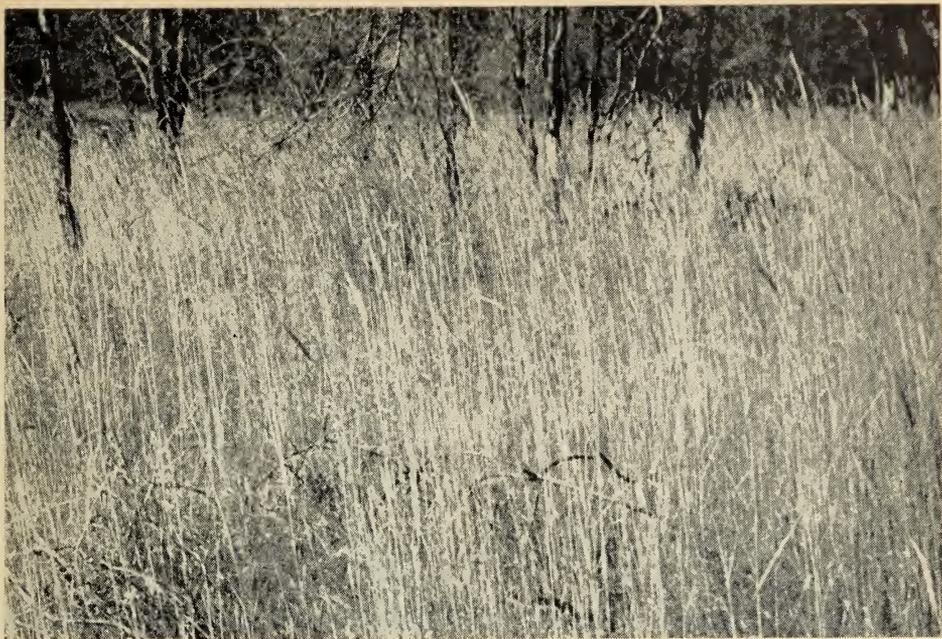
The aim should be to have enough seed of rapidly growing species in the mixture to insure 25 per cent to 50 per cent ground cover, and yet not enough to crowd out the perennial plants in the mixture. This can usually be achieved by adding ½ pound of ryegrass or 2 pounds of one of the brome grasses to the mixture.

What constitutes a good stand of annuals would be entirely too thick for perennials.

Mixing the Seed. It is recommended that seeding in burns with a small percentage of ash areas be done on a spot basis rather than over the entire area. This prevents waste of much high-priced



Rancho Samatoguma near Guatay, San Diego County, shows desirability of some seedbed treatment after seeding on ash. Area burned August 18, 1950; seeded with a mixture of annual ryegrass, soft chess, cucamonga brome, bur clover, and rose clover, September 27, 1950. Area at left disked after seeding; center, no treatment after seeding; right, rolled with sheepfoot cultivator after seeding. (Photographed June 15, 1951.)



Cereal rye seeded in a burn in Nevada County. This dense stand will soon disappear because rye does not volunteer well. In this area, the opportunity of establishing perennials was thus lost. Compare with photo on opposite page. (Photographed May 15, 1946.)

seed. The best plan is to buy seed unmixed and prepare the desired mixture.

A "spot" or "ash mix" is broadcast only where there is a good, white, brush ash. This mixture should contain perennials chiefly. This will establish colonies of, for example, hardinggrass and rose clover on the ranch. Proper seasonal use will insure their spread. If the total area is to be seeded by plane, a "general mix" is best.

Examples of these seed mixtures are given in Table 2.

Rate of Seeding. Until recently, one handicap in the seeding program has been the scarcity of seed of the more promising species, resulting in high cost of seed per pound. Now, however, there are ample supplies of smilo, harding, tall fescue, orchardgrass, and rose clover at fairly reasonable prices. The expense is further reduced because there are many thousands of grass and legume seeds per pound (Appendix, p. 36), so that an apparently low seeding rate is really ade-

quate, especially where there is a good brush burn. The photo on page 25 shows a crop that was seeded at the rate of 4 pounds per acre, near Rescue, El Dorado County.

In the last few years, experience has shown that where conditions are favorable, a seeding rate of from 4 to 8 pounds per acre gives a satisfactory ground cover and provides severe competition for the brush seedlings if the land is not grazed the first spring after seeding.

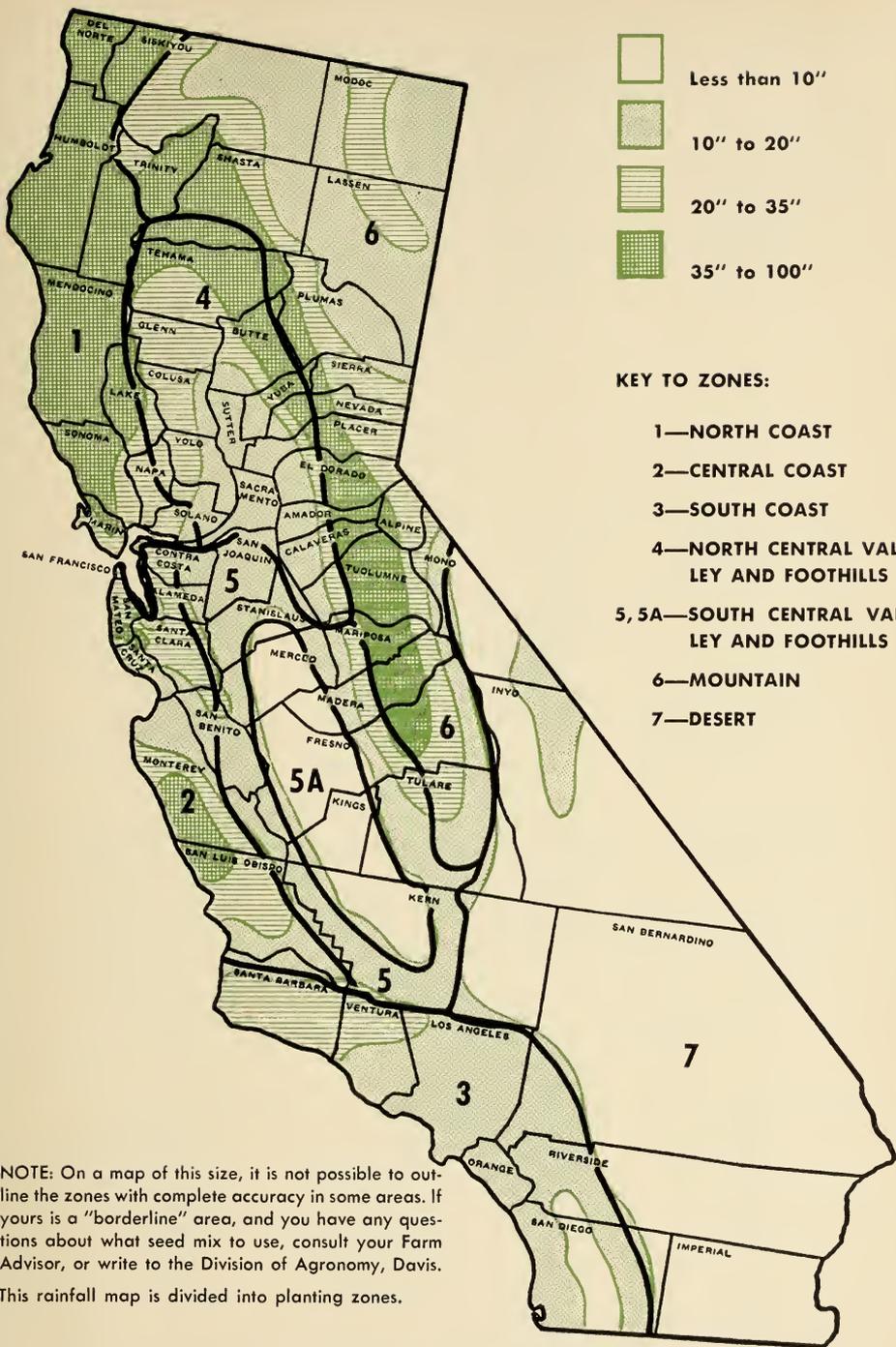
A general mix of 5 pounds of seed per acre (1 pound each of hardinggrass, smilo, alfalfa, annual ryegrass, and rose clover) will result in the distribution of about 45 seeds per square foot (see Appendix, p. 36). This is adequate where there is good ash, and a heavier rate provides no guarantee of a stand on the grass-burn areas.

Brush ash (see top cover picture) forms an ideal seedbed for such hardy perennials as harding, smilo, tall fescue, stipas, alfalfa, and birdsfoot trefoil.

TABLE 2—General Mix Suggestions for Average Sites in the Various Zones,
with Locations of Actual Plantings*

Zone	Location	Species	Proportions
1	Near Bridgeville, Humboldt County	Harding	1 : 5
		Orchardgrass	1 : 5
		Smilo	1 : 5
		Burnet	1 : 5
		Subclover	1 : 5
2	Near Pozo, San Luis Obispo County	Harding	1 : 5
		Tall fescue	1 : 5
		Orchardgrass	1 : 10
		Smilo	1 : 10
		Alfalfa	1 : 5
		Rose clover	1 : 5
3	Near Alpine, San Diego County	Veldtgrass	1 : 4
		Smilo	1 : 4
		Harding	1 : 4
		Rose clover	1 : 4
4	Near Rescue, El Dorado County	Harding	1 : 6
		Tall fescue	1 : 6
		Smilo	1 : 6
		Burnet	1 : 6
		Alfalfa	1 : 6
		Rose clover	1 : 6
5	Near Oneals, Madera County	Harding	1 : 4
		Tall fescue	1 : 4
		Smilo	1 : 4
		Rose clover	1 : 4
	Near Badger, Tulare County	Harding	1 : 6
		Tall fescue	1 : 6
		Orchardgrass	1 : 12
		Smilo	1 : 12
		Prairie brome	1 : 6
		Alfalfa	1 : 6
Rose clover	1 : 6		
6	Near Alturas, Modoc County	Crested wheatgrass	2 : 5
		Ladak alfalfa	2 : 5
		Yellow sweetclover	1 : 5

* Ryegrasses do well in most burns, but should be used with discretion (see text, pp. 16, 27). The rate of seeding (see text) will vary from 4 to 8 pounds of the mixture per acre.



NOTE: On a map of this size, it is not possible to outline the zones with complete accuracy in some areas. If yours is a "borderline" area, and you have any questions about what seed mix to use, consult your Farm Advisor, or write to the Division of Agronomy, Davis. This rainfall map is divided into planting zones.

TABLE 3—Zones for Planting in California Counties, and Recommended Species of Long- and Short-lived Grasses and Legumes

Zones	Counties included in zone*		Long-lived species	Short-lived species
ZONE 1 (North coast)	Del Norte Humboldt Marin Mendocino Sonoma	Western part of : Lake Napa Siskiyou Solano Trinity	Alfalfa Birdsfoot trefoil Burnet California oatgrass † Chewings fescue Creeping red fescue Harding Highland bentgrass Orchardgrass Purple stipa † Smilo Tall fescue Tall oatgrass	Bur clover Crimson clover Harlan brome Prairie brome Mountain brome Ryegrasses Rose clover Subclover
ZONE 2 (Central coast)	San Mateo Santa Clara Santa Cruz	Western part of : Alameda Contra Costa Monterey San Benito San Luis Obispo Northern part of : Santa Barbara	Alfalfa Birdsfoot trefoil Burnet California oatgrass † Harding Orchardgrass Smilo Stipas † Tall fescue Tall oatgrass Veldtgrass	Annual ryegrass Bur clover Crimson clover Harlan brome Mountain brome Prairie brome Rose clover Subclover Yellow sweetclover
ZONE 3 (South coast)	Orange Ventura	Western part of : Los Angeles Riverside San Diego	Alfalfa Burnet Harding Rhodesgrass Smilo Stipas † Veldtgrass	Annual ryegrass Bur clover Crimson clover Harlan brome Mountain brome Prairie brome Rose clover Subclover Yellow sweetclover
ZONE 4 (North Central Valley) (less than 35" rainfall)	Colusa Glenn Sacramento Sutter Tehama Yolo Yuba	Western part of : Amador Butte Calaveras El Dorado Nevada Placer Tuolumne Southern part of : Shasta Northern part of : Solano	Alfalfa Burnet Harding Orchardgrass Smilo Stipas † Tall fescue Veldtgrass	Bur clover Crimson clover Harlan brome Mountain brome Prairie brome Rose clover Subclover Yellow sweetclover

TABLE 3 (Continued)—Zones for Planting in California Counties, and Recommended Species of Long- and Short-lived Grasses and Legumes

Zones	Counties included in zone*	Long-lived species	Short-lived species	
ZONE 5 (South Central Valley) (less than 20" rainfall)	Kings Merced San Joaquin Stanislaus Eastern part of: Alameda Contra Costa Monterey San Benito San Luis Obispo	Western part of: Fresno Kern Madera Mariposa Tulare	Alfalfa Burnet Goar tall fescue Harding Smilo Stipas† Veldtgrass	Annual ryegrass Bur clover Rose clover Subclover
ZONE 6 (Mountain)	Alpine Lassen Modoc Plumas Sierra Northern part of: Shasta Western part of: Mono	Eastern part of: Amador Calaveras El Dorado Fresno Madera Mariposa Nevada Placer Siskiyou Trinity Tulare Tuolumne	Up to 3,000 feet elevation OR 35" or more rainfall	
			Alfalfa Birdsfoot trefoil Burnet Harding Orchardgrass Smilo Tall fescue Tall oatgrass Timothy	Bur clover Crimson clover Harlan brome Mountain brome Prairie brome Ryegrasses Rose clover Subclover Yellow sweetclover
			Over 3,000 feet elevation AND less than 20" rainfall	
			Crested wheatgrass Intermediate wheatgrass Ladak alfalfa Orchardgrass Smooth brome Tall fescue	Mountain brome Yellow sweetclover
ZONE 7† (Desert)	Imperial Eastern part of: Inyo Kern Los Angeles Mono	Riverside San Bernardino San Diego		

* Counties listed alphabetically for convenience. Consult your local Farm Advisor for mixture to be used.

† Indicates species not yet available commercially but which are included since they will be on the market shortly.

‡ There is no discussion of brush removal for Zones 7 and 5A.

Choosing the Right Forage Plants

Since 1937, more than 200 species of forage plants have been tested in trial plots in 51 counties. Each of the species has been assigned a permanent key number, as shown in the Appendix, page 36.

These key numbers are the same as those listed in Extension Circular 129, "Improving California Ranges" (1943), but species and varieties that have been added since 1943 have been given new key numbers. Those listed in the Appendix, with their key numbers, are given in the recommendations in Table 3, page 20. The importance of the key numbers is illustrated by reference to No. 25. The scientific name of this grass is *Bromus catharticus* Vahl. (*Bromus unioloides* Kunth). This scientific name also applies to the rescuegrasses of the southwestern United States, many of which are annuals. No. 25, however, is a perennial strain of *B. catharticus* that was introduced from New Zealand to California. It is much better adapted to California conditions than are many of the "rescuegrasses" that are on the market. The seed was collected by Wayne H. Fisher on a trip to New Zealand, and he gave it to L. G. Goar of the Division of Agronomy, as part of a large collection of grasses and legumes. In New Zealand it is commonly called prairiegrass. The writers suggest the common name prairie brome (or brome 25) for this certified strain, to avoid confusion with the rescuegrasses.

Species Recommended for Certain Zones. Many of the plants are limited in their distribution, others are widely adaptable. Zones have been set up in the state, as a result of the test plots and acreage seedings observed. A map outlining the seven zones into which the state has been divided is shown on page 19. Table 3 (p. 20) lists short- and long-lived species adapted to each zone.

The recommended species described below are listed alphabetically by their

common names. When a species has a key number, it is given in parentheses following the name. Scientific names of the various species are listed in an Appendix beginning on page 36. Table 4, page 31, gives growth habits and grazing use of the main types of range forage plants.

Long-lived Perennials

GRASSES

California Oatgrass (9)—This native perennial bunchgrass forms a rather low-growing tuft of basal leafage. The stems usually break at the crown when mature. It is palatable and nutritious. Its natural distribution extends from Monterey County north in the coast ranges, and along the Sierran foothills above 2,000 feet. Seedling development is extremely slow, and germination is usually low. A strain with a higher percentage of germination has recently been selected. Seed may be available within the next few years.

Chewings Fescue (11B)—This bunchgrass has fine, basal leafiness. In Zone 1, where it is adapted, it does well under moist or dry conditions. Main growth occurs in spring and early summer. Chewings fescue is high in palatability, and makes a good combination with highland bentgrass as a competitor for Klamath weed. Seed is available.

Crested Wheatgrass (1)—This is a hardy, drought-resistant, perennial bunchgrass, native to the cold, dry plains of Russia and Siberia. It is known in the seed trade as Standard crested wheatgrass.

Standard crested wheatgrass can grow at low temperatures, and makes early, rapid spring growth. During hot weather it becomes dormant, thus protecting itself against drought. It does well in its zone of adaptation on almost any soil ranging from light sandy loam to heavy clay.

In California it has done well only in Zone 6 (elevations above 3,000 feet). In Modoc and Siskiyou counties it is being

used in combination with Ladak alfalfa and yellow blossom sweetclover to seed reclaimed sagebrush land. Seed is commercially available.

Hardinggrass (28)—This perennial grows in large, dense, leafy tufts. Once established, it is very persistent although it is a poor competitor during the seedling stages. It is one of the few perennials to make good growth in winter when most other plants are dormant, but it will not survive the cold winters of northeastern California. It grows best on heavy, black soils and deep volcanic loams, but will produce well on lighter soils underlain by heavier strata. Though tall and rather coarse, its abundant leaves are relished by all classes of livestock.

It is one of the best and most durable dry-land grasses. It is especially useful for seeding in the ash of brush burns.

Grown in combination with dry-land alfalfa, it has done exceptionally well in the coastal areas from Monterey to Del Norte County, and in the Sierra foothill ranges above the 15-inch rainfall belt.

Highland Bentgrass (112)—This is another perennial adapted chiefly to the north coast area (zone 1) of California. It has fine, basal leafiness that is fairly palatable. It provides good spring and early summer forage under moist to dry conditions, and is a good competitor for Klamath weed. Seed is available.

Intermediate Wheatgrass (109)—This perennial spreads by means of underground stems and produces an open sod. Although adapted to about the same climatic conditions as crested wheatgrass (zone 6), it is not so drought-tolerant as the latter. It requires 15 inches or more annual rainfall. It has strong seedling vigor, and is thus better able to compete with resident weeds than are most perennials. It has done well in trials in Lassen County. Seed of this species is still difficult to obtain.

Lomasgrass (113)—A variety of blue wildrye, this is a long-lived, early maturing bunchgrass, native to California. Na-

tive plants are somewhat sparse-leaved. Domesticated strains are somewhat better in this respect. Soil Conservation Service tests indicate it can be established on prepared sites, but little information is available with regard to seeding it in the ash of burns. Although the species appears to have some promise, the Agronomy Division is not recommending its use pending results of further field tests.

Orchardgrass (63)—This perennial is readily distinguished by its large, circular bunches, folded leaf blades, and flattened sheaths (especially at the base of the stems). The shape of the flower head has suggested the English name of "cocksfoot." It has remained popular in pasture mixtures here because it is hardy, persistent, aggressive, and, in the earlier stages, is relished by all classes of livestock including sheep.

Orchardgrass has proved widely adaptable for range use. It is not quite so drought-tolerant as tall fescue, but will tolerate more shade. Akaroa (63A), a new strain, appears to be slightly more productive than common orchardgrass, but may not be so drought-tolerant. It is more subject to winter heaving than is common. Seed is commercially available.

Redtop (105)—A hardy perennial, it has a creeping habit of growth which makes a coarse, loose tuft. It is a wet-land type of grass, but will withstand considerable drought. Although primarily adapted to mountain meadows and pastures, it may have a place as a sod-former in seepage areas where it will furnish late feed. Its normal maturity dates are similar to those of timothy. It is not adapted for general use on dry-range seedings. Seed is available.

Rhodesgrass (67)—This perennial, fine-stemmed, leafy grass grows to an average height of nearly 3 feet under favorable conditions. It spreads by running branches which root and produce tufts at the joints. It will not withstand winter temperatures below 18° F. It is especially suited for use on sandy sites south of the

Tehachapi although it survives in warm sites, at elevations below 1,500 feet, as far north as Modesto.

Sherman Big Bluegrass (103)—A variety of big bluegrass native to the Palouse prairie, this is a robust, perennial bunchgrass adapted for use in California at elevations above 1,500 feet. The plants are tufted, vigorous, about 2 to 4 feet tall, and have numerous basal leaves. The fibrous roots penetrate deeply. It starts growth in early spring and continues into the fall. It seems particularly adapted for use on adverse soil and climatic sites. Although trials in the central foothills of the Sierra indicate this as a promising species for seeding brush burns, recent tests in Arizona showed that it is the least palatable of the grasses tested. Seed is commercially available.

Smilo (26)—Because it has been difficult to obtain stands of smilo on prepared sites, use of this valuable grass has been extremely limited. Following numerous trials in the ash of burned brush, however, the certified strain can now be recommended, especially on chamise burns, since successful stands are almost invariably obtained under such conditions. Smilo has about the same climatic tolerance as hardinggrass, but should be used on lighter soils. It will not survive severe winters. It is palatable, drought-resistant, and long-lived, and, given a chance, it volunteers well. It is a tall, leafy bunchgrass with an extensive root system.

Treatment of the seed in pure Clorox for one hour materially improves germination. Treatment is not recommended for general range use, however, because in most winters it is better to have seeds germinating over a long period to avoid loss of the crop through unfavorable climatic conditions following germination.

Smilo has been grown successfully from San Diego to Humboldt County on the coast ranges, and from Kern to Shasta at intermediate elevations in the Sierra ranges. Seed is now commercially available.

Smooth Brome—A perennial, tall-growing, leafy grass that spreads by underground, creeping rootstocks. These tend to become sod-bound in a few years so that renovation is necessary for best results. Although popular as a hay and pasture plant in northeastern California, it has never found a place in any part of the state where winters are mild and summer temperatures high. General use, therefore, is not recommended. In the northeastern counties it frequently is grown to advantage dry-land in association with Ladak alfalfa. The Lincoln strain (64) has looked particularly promising in Zone 6. Seed is available.

Stipas—Nodding stipa (34) and purple stipa (35) are among the hardiest of the native California bunchgrasses. They have a wide adaptation, in the coast ranges from San Diego to Del Norte counties, and similarly in the Sierra Nevada foothill area from south to north. Nodding stipa, the hardier and more drought-resistant grass, extends beyond the tree line of the woodland-grass association.

Each species has been subjected to selection at Davis, and the foundation seed for each is a blend of 12 superior strains. This blend assures wide adaptation. It is recommended that some of each species be sown in a mixture since the species hybridize, developing a moderate stand of field hybrids of strong vigor and late summer green growth. The technique of seed production is nearing solution. Commercial quantities of seed are now beginning to appear.

Tall Fescue—This selection is out of meadow fescue, but more drought-tolerant, thriftier, and taller in growth than the parent, with more basal leaves. Selections of tall fescue have now replaced meadow fescue for dry ranges in California. A long season of growth and high production of forage have resulted in its extensive use and wide popularity. It has proved useful on the range in areas of 20 inches of rainfall or more. It will reseed itself.

Alta fescue (8) is an Oregon certified strain. Kentucky 31 (8A) is a strain certified by the Kentucky Crop Improvement Association. Goar strain (8B) was developed in California. For California range use, these are all superior to meadow fescue. Goar tall fescue has very strong seedling vigor, and may be more alkali- and heat-tolerant than the others.

Tall fescue strains are late winter, spring, and summer growers. The plant goes into dormancy late, after the soil moisture has been exhausted. Seed of all three strains is commercially available.

Tall Oatgrass (6)—This is a fairly hardy, upright, perennial bunchgrass, growing 30 to 60 inches tall, and producing many leaves. It has an open head, or panicle, resembling that of cultivated oats, although the seed is smaller and much more chaffy. It prefers well-drained soil and seems to do well on light sandy

or gravelly land. It does not like the shade. It starts growth early in the fall and is considered a winter grower. Tall oatgrass has done well in dry-land tests in coastal areas of California and at higher elevations in the Sierra. For best results, the species should be used under a rotational or controlled grazing program. The Tualatin strain (6A) is an improved, comparatively nonshattering strain developed in Oregon. It has done well in California tests. The species has been observed to reseed in coastal, central, and northern California. Seed is commercially available.

Tall Wheatgrass—Notable among the newer grasses being tried in the mountain zone is this tall, vigorous bunchgrass. Although it is very alkali-tolerant, its palatability is low if it is grown under extremely alkaline conditions. On fairly neutral soils it appears to have the same



This area near Rescue, El Dorado County, was seeded at the rate of 4 pounds per acre, by the State Division of Forestry. The mix used was the same as the one shown in Table 2 (p. 18) for Zone 4. Brush was burned standing, and bulldozed to knock down burnt stems. Area was seeded by plane. (Photographed July 9, 1951.)

degree of palatability as other wheat-grasses. Very little seed is available commercially.

Timothy (106)—This is a perennial and, like redtop, a northern species. It is frequently used as a hay and pasture plant in high areas of cold winter and moderate summer temperatures, but has never been durable when used in a mixed pasture in the lower elevations of the state. Seed is available commercially.

Veldtgrass (91)—Native to South Africa, this grass has done particularly well in sandy soils in the south and central coastal areas.

A two-acre planting seeded in 1942 near Corona del Mar, Orange County, has now spread over two more acres. Other successful acreage seedings have been observed in San Diego, Ventura, and Santa Barbara counties. Recent tests indicate its range of usefulness extends as far north as Humboldt County, on light soils.

Perennial veldt is very palatable and drought-resistant, but it is not so long-lived as the stipas or smilo. Because the seeds on the panicles (heads) ripen over a very long period, it is difficult to obtain large seed yields. Thus seed is likely to be high-priced, but the fact that it volunteers readily will help compensate for the initial high cost.

Veldtgrass seed can be obtained occasionally from Australia. One imported strain is known as "Unarlee" (91A). Limited supplies of the California strain (91) are now available.

Wheatgrasses—In addition to the wheatgrasses described above, a number of other species are coming into prominence for pasture use in cold regions. Most of these, such as pubescent wheatgrass and slender wheatgrass, are now being tested thoroughly in Zones 1 and 6. Consult your Farm Advisor for current results and recommendations.

LEGUMES

Alfalfa—California Common (17) is proving a valuable perennial legume for

use on better dry-range sites. If the plants are to persist on such sites, however, rodents must be controlled. Also, alfalfa should be used on soil at least 3 feet deep, and in areas having an annual rainfall of 15 inches or more. At higher elevations in northern counties, either a local strain of California Common or Ladak (18) should be used to obtain the necessary cold resistance or hardiness.

Broadleaf or Erect Birdsfoot Trefoil (15)—The species is extremely variable but, in general, shows a more erect type of growth than does the narrowleaf. As indicated by the common name, broadleaf trefoil has wider leaflets that tend to be shorter than those of narrowleaf trefoil. Flowers of the broadleaf type may also be somewhat larger. In regions of cold winters, broadleaf trefoil may survive where the narrowleaf type is severely damaged or entirely killed.

Narrowleaf or Prostrate Birdsfoot Trefoil (16)—It is a perennial legume which, in some respects, resembles a fine-stemmed, fine-leaved alfalfa. Stems vary in habit of growth but usually are creeping or spreading, seldom erect. New shoots develop from a crown similar to alfalfa, but they are much more branching. Leaves are arranged in groups of five leaflets, three at the end of a short branch, or petiole, and two on opposite sides at the base of the petiole or at the point of attachment with the main stem.

Until more is known regarding the comparative adaptation of these species, only general recommendations can be made. It appears that the narrowleaf type should be used under very alkaline conditions; the adaptation of broadleaf trefoil to alkali is unknown. At higher elevations, in the absence of alkali, the broadleaf type may be used. Under all other situations requiring trefoil, a mixture of the two types may be advisable.

In the Blocksburg area of Humboldt County, the narrowleaf strain has persisted under heavy use, whereas the broadleaf has disappeared.

Neither species of trefoil is as drought-tolerant as alfalfa under range conditions.

OTHER SPECIES

Burnet (30)—Burnet is a perennial herb and member of the rose family. It is as palatable and nutritious as filaree, and stays green all summer if moisture is available. It volunteers well and has strong seedling vigor. A tap-rooted perennial, it tends to rosette near the ground. This crowding habit allows it to withstand heavy grazing and makes it a strong competitor against weedy annuals. In Humboldt County it has been used as a good competitor for Klamath weed. It can be expected to yield well on good soils. Burnet begins to grow with the first winter rains, and continues to do so until about midsummer when it goes into dormancy. Because of its taproot, it is very susceptible to rodent damage. Wherever the soil is deep, other deep-rooted species, such as alfalfa, have been more productive. In difficult sites, burnet may find wider usage. Seed is available.

Short-lived Perennials and Desirable Annuals

GRASSES

Annual Ryegrass (13)—Practically all the cultivated ryegrasses originate in two species: *Lolium multiflorum*, most commonly called "Italian ryegrass" or "annual ryegrass," and *L. perenne*, generally called "perennial ryegrass," or "English ryegrass." Both are short-lived grasses. Commercial seed now marketed here is most commonly known as either Western-grown or domestic ryegrass, and it is fairly certain that this contains a considerable percentage of hybrids with perennial ryegrass. In any event, parent plants have been known to survive in California for three or four years.

All strains of annual ryegrass can be distinguished from perennial ryegrass by the emerging leaves which, in the annual, are rolled, and in the perennial, folded.

Generally, there are short awns on annual ryegrass seeds and not on perennial.

Annual ryegrass is more stemmy and less leafy than perennial. It is popular as a range plant in California because it is palatable, makes excellent winter and early spring growth, and has high production. Annual ryegrass affords strong competition for the perennials used in the same mixture, so that the ryegrass should be seeded sparingly (1 pound or less to the acre). If it is desired to thicken the cover after the perennials have become established, this may be done by broadcasting the annual ryegrass seed over the pasture. Seed is available.

California or Mountain Bromegrass (7)—This is a tall, erect bunchgrass, moderately leafy. It is resident throughout most of the state as a short-lived perennial, or as an annual where the rainfall is low. It is a winter and spring grower. Mountain bromegrass (*Bromus marginatus*) is often impossible to distinguish from California bromegrass (*B. carinatus*) because of intergrading types. In areas where California brome is adapted, commercial seed of mountain brome will usually give a satisfactory performance. Seed is commercially available.

Harlan Brome (100)—Harlan brome originated in the University grass gardens in Berkeley, and was presumably introduced from Chile where it is native.

It is a palatable, aggressive plant. Because it is a short-lived perennial, it will act as an annual under unfavorable conditions. However, it reseeds well, and thus maintains itself on ranges where it is adapted. It has been observed to set seed on stems only 2 inches in height. Harlan brome will probably be used to supplement some of the domestic ryegrass currently being used to seed the range, especially in the 25- to 30-inch rainfall belt. It has done particularly well in the Wooden Valley area of Napa County. A winter and spring grower, it is available commercially in limited amounts.

Perennial Ryegrass (14)—Perennial, or English, ryegrass is fully as palatable as domestic, bears more basal leafage, but does not produce so high a yield. It is desirable because it grows later in the summer. This grass is no longer used in some areas (notably the central coast) because of rust injury. Seed is commercially available.

Prairie Brome (25)—This strain was first grown in California at the Meloland Experiment Station of the University of California, in the Imperial Valley, from seed obtained from New Zealand.

Prairie brome, a medium-tall, leafy bunchgrass, is a strong winter grower. It has performed particularly well on coastal ranges, and elsewhere on good soils with 20 inches of rainfall or more. It is definitely distinct from and superior, in California, to any of the "rescue-grasses" of the southwestern United States, with which it has been compared. Prairie brome seed is available commercially.

Soft Chess—This is the principal annual bromegrass throughout the Sierra foothills, Great Valley, and Coast Range of California. It came into the state with the flocks and herds of Father Serra in the early Mission Period, as did bur clover and other annuals. Soft chess is of major importance for range forage. It is palatable at all stages of growth, and usually retains many nonshattered, nutritious seeds on the mature, dry plants. If seed were available, this species would replace ryegrass as the desirable annual to be used in mixtures on chamise burns.

LEGUMES

Bur Clover (20)—A winter annual, this legume is common to most range areas except the granitic soils in the Sierra foothills on the east side of the San Joaquin Valley. It is one of California's most valuable resident legume range species. The green plants of winter and spring as well as the dried plants and burs of summer are valuable high-protein feed. Bur

clover does not usually require seeding except where natural stands have been eliminated by cultivation, spraying, or encroachment of brush. Seed is available commercially.

Crimson Clover (101)—This is a winter annual legume that is readily distinguishable by the bright crimson color of the blossoms. Although it is not a heavy producer under California range conditions, it has demonstrated an ability to reseed itself. It has performed particularly well in the intermediate elevations of the Sierra. Seed is commercially available.

Rose Clover (102)—The foundation seed of rose clover, a winter annual, is derived from an introduction from Turkey. It appears to be less sensitive to low temperatures and fewer hours of daylight than either bur clover or subclover, and therefore grows more rapidly than either of them in cool weather. It prefers well-drained soils. It has done particularly well on the reddish soils and granitic soils in the Sierra foothills.

Rose clover is a true clover. It has the widest adaptation of any range legume tried in California, and will supplement bur clover where it is difficult to obtain satisfactory stands or growth of the latter. This clover remains green one or two weeks longer than midseason subclover, and is especially useful on poor soils that are slightly acid, such as those in zones 1, 4, and 5. It is also doing well in burn seedings in zones 2 and 3. Seed is now available commercially.

Spanish Clover—This is a native, annual legume that in some years provides an abundance of good summer feed. It flowers from May to October. This and related species are widely distributed in California, and are found in the open areas of brush fields. It has not been tried extensively in brush burns. Seed may be available in certain years.

Subterranean Clover or Subclover—This annual has climatic preferences and a growth season similar to those of

bur clover. The plant is low-growing, soft, and woolly, all parts being covered by fairly long, soft hairs. Each leaf is formed of three heart-shaped, faintly toothed leaflets, and is carried on a long stalk. After seeds form, the stems bend down and grow until the seed head is pushed into the soil. Subclover does well in acid soils if enough phosphorus is available. In coastal areas north of Carmel, and in the Central Valley, a mixture of Mt. Barker and Tallarook generally succeeds.

The Mt. Barker strain (midseason, 56) is generally used although Tallarook (late season, 98) is also doing well on the north coast. Early Dwalganup (97) should be retested for adaptation in areas of rainfall of less than 15 inches. Seed of Mt. Barker and Tallarook strains is available commercially. An additional 40 strains have been tested by the Agronomy Division for two years, at Davis and in Humboldt County. Hills Small and Samaria look very good. Undoubtedly new strains will appear on the market in the future. Subclovers are noted for their ability to produce seed under conditions of heavy grazing.

Sweetclovers—Both yellow blossom sweetclover (61) and white sweetclover have survived in tests in most areas of California. The latter has been observed growing on raw earth cuts under very adverse conditions at elevations up to

5,000 feet. In general, however, the palatability of the sweetclovers in the fresh, green state is low, and they are not readily grazed unless there is a shortage of feed. The sweetclovers are biennials, but do not reseed themselves under range conditions.

Madrid yellow sweetclover (61A) appears to be the best variety for California conditions.

OTHER SPECIES

Filaree—There are three common species: Cutleaf or Redstem, Whitestem, and Broadleaf. At least one species will usually be found on most California ranges. All three are annual herbs of the geranium family and are considered good stock feed, either green or dry, since the plants are usually high in protein. The resident seeds germinate with the fall rains, providing late winter and early spring green feed. The plants usually mature by the first of June, and dry up. Redstem is considered the best forage species of the three. Ordinarily, it will not be necessary to include filaree in range seed mixtures since it volunteers readily. It might be included in seed mixtures being sown on reclaimed brush fields in instances where prior examination has shown that the brush has choked out most resident forage species. Seed is commercially available from time to time.

STEP 3: CONTROL OF GRAZING

The third phase of a planned program to change brush-covered areas into productive grasslands—the control of grazing—is of much importance. Without it, both the process of clearing brush from the land and the revegetation of such areas will fail of complete economic success.

To carry out this part of the threefold plan for improving range lands, the rancher should give much time and thought to the following four factors:

1. Adjust grazing practices. On any ranch this is usually desirable.
2. Plan a long-term grazing program. The rotational grazing plan, herein described, calls for dividing the range into fenced or controlled fields.
3. Discontinue grazing before burning or reburning an area to provide a mat of dry grass to carry the ground fire.
4. Graze a newly seeded burn area *after* the forage plants have matured—set seed and begun to dry up.

Grazing Management Is Important

Adjusted grazing is essential to insure permanent stands of forage. On most ranges, in fact, whether or not they have been burned off and converted to grasslands, planned grazing has been found desirable.

In general, seeded plants adapted to an area will survive and flourish under the same grazing practices that serve to improve the natural vegetation. On the other hand, they will gradually be eliminated by the same practices that tend to destroy the best species of natural forage plants.

When the rancher opens new range areas by the removal of brush, he has both an added responsibility and an improved opportunity to produce more meat and wool: he can make adjustments that will not only increase feed resources but also prolong the season of grazing.

Proper seasonal use of the range should lie somewhere between continuous close cropping, which weakens and gradually removes the desirable annuals and perennials, and too light grazing, which tends to build up a heavy litter and increase the undesirable, weedy annuals.

Planning the Long-term Grazing Program

No fixed rules can be outlined for a range domain such as California, with its wide variations in climate, soil, and elevation. A grazing-management plan must be based on individual ranch conditions; the type and abundance of forage plants and their distribution over the given area; and the practical necessities, such as cross-fencing and providing stock-watering facilities.

Obviously, the seasonal green feed produced by winter rains should be converted into meat and wool while at its best. On the other hand, the perennials and better late-maturing annuals (such as bur clover and soft chess) should be al-

lowed to set some seed, and thus increase their percentage in the forage. This requires a balanced grazing program.

Outlining the Program. For the most effective over-all operation, the rancher should not burn, in any one season, an area larger than can be placed under controlled grazing, to assure a permanent revegetation.

To establish growth of forage on burns, there should be no grazing the first spring until the perennials have set seed. It has been found that perennials and desirable annuals can be maintained better under a system of seasonal rotational grazing (table 4).

The successful operators, who have followed a brush-control program for five years or longer, have made their range subdivisions correspond roughly with the areas to be burned. Topography or watering facilities or north and south slopes may keep this plan from being copied precisely, but a good brush-control program should follow it as closely as possible.

Seasonal Rotation Grazing. A three-year rotation plan has been found practical to apply and effective in improving the range.

In carrying out such a plan, the rancher divides his range area into at least three fields, either by actual fencing and cross-fencing, or by herding and drift-fencing to keep stock from certain portions of the range. The plan must also include adequate watering facilities in each field. This is how the plan works:

The first year, the rancher grazes field number 1 early, and removes the stock before the surface soil moisture is exhausted in the spring, keeping the animals in the other fields.

The second year, he applies the same treatment to the second field, using the first and third fields for later grazing.

The third year, he applies this practice to the third field, turning the animals then into the first and second fields.

Such a grazing cycle should serve to

TABLE 4—Main Types of Range Forage Plants, Their Growth Characteristics, and Grazing-management Requirements

Plants	Long-lived perennials	Desirable annuals or short-lived perennials	Weedy annuals
TYPE:			
Grasses	Harding, stipa, tall fescue, California oatgrass, smilo	Ryegrass Soft chess Mountain brome	Foxtail Ripgut
Legumes	Alfalfa Birdsfoot trefoil	Bur clover, rose clover, sweetclover	
CHARACTERISTICS:			
Seedling development	Very slow	Fairly rapid	Rapid
Ability to compete first year	Poor	Good	Excellent
Seasonal use	Green early in fall, mature late in spring	Intermediate	Mature early; obnoxious when ripe
MANAGEMENT REQUIREMENTS:			
To establish on burns	No grazing first spring and summer	As for perennials	
To maintain	Seasonal rotation system of grazing (see text, p. 30)	As for perennials	
To reduce			Graze or mow in early spring to prevent seeding

keep a proper balance of forage species in all three fields, although certain factors complicate a too-rigid application of this scheme. For example: the feed on north slopes is green later in the spring than that on exposed south slopes; and on swales and seeps, the feed remains green much later. Thus, in planning cross-fencing and stock-watering facilities, these topographic factors, as well as the

varying plant populations peculiar to them, must be taken into account.

A knowledge of range forage plants will aid the operator in managing grazing areas. Table 4 should prove helpful; it lists examples of long-lived perennials, desirable annuals or short-lived perennials, and weedy annuals, as well as their characteristics and management requirements under grazing conditions.



General view of artificially seeded area in burn near Weed, Siskiyou County. This brush field was burned in the fall of 1939, and the ridgetops were seeded to crested wheatgrass, ryegrass, tall oatgrass, and smooth brome. The latter two are prominent in the picture. (Photographed June 24, 1942.)

BURNING OPENS GOOD SEED AREA

DOES NOT KILL NATIVE PLANTS

Some field as shown in picture above. The native bunchgrass is western stipa. The plants were not killed by the fire. A 6-inch rule is at base of stipa plant in right foreground. (Photographed June 24, 1942.)



Value of Grazing Periods Shown

To Aid in Elimination of Brush. If fire is to be used to clear brush from the land, the selected area should not be grazed at all during the year it is burned. This treatment (p. 34) will provide an understory of grasses to help carry the flames and make a clean burn. This also applies to reburning.

To Establish Forage. Time and intensity of grazing should be determined by the percentage stand of annual grasses in the mixture.

If annual grasses, such as ryegrass, predominate, the freshly seeded area should be subjected to an intensive grazing for a short period just before the ryegrass begins to head out. The grazing should be severe enough to retard the ryegrass. Livestock should be removed before the last spring rains. The perennials, such as hardinggrass, will then continue to develop and produce some seed.

If perennials predominate, and this is desirable for a first-year stand on a seeded burn, stock should be kept off the freshly seeded area at least until the grasses have begun to set seed. Possibly grazing should be deferred until the fall rains, as the plants may be poorly rooted where ash was abundant in the seedbed. A grazing in the fall will serve to trample the new seed crop into the soil and help thicken the stand.

The value of adjusted grazing in a seeded area was demonstrated north of Weed, Siskiyou County. An area of 3,000 acres there was burned in the fall of 1939; the ridgetops were seeded to crested wheatgrass, perennial ryegrass, tall oatgrass, and smooth brome. This acreage, together with an additional 2,000 acres not burned, has been carrying 700 head of cattle from November 1 to May 1 of each year. Confining the grazing to that period has resulted in an increased stand of seeded species (see top photo, opposite page) even in this area of low rainfall

(approximately 12.1 inches annually). It was also significant that the fire did not kill the native bunchgrass (see bottom photo, opposite page).

To Maintain Forage. An area that is burned or reburned should not be grazed until the next year (June to August, varying with local conditions); then perennials will have a chance to develop and mature seed (table 5).

TABLE 5—Recommended Grazing Management for Area to Be Cleared of Brush.

FIRST YEAR	Keep stock off. Burn in summer. Seed burned area if necessary.
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SECOND YEAR	If perennial grasses predominate, graze after they have set seed, whether artificially seeded or not.
-------------	---

If annual grasses predominate, graze heavily for a short period before the last spring rains. Remove stock before soil moisture is exhausted.

THIRD YEAR	Graze early. Remove stock before soil moisture is exhausted.
------------	--

FOURTH YEAR	Keep stock off all year. Reburn in late summer. Reseed certain areas if necessary.
-------------	--

FIFTH YEAR	Treat as in second year.
------------	--------------------------

SIXTH YEAR	Treat as in third year.
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A seasonal rotation grazing system (see p. 30) will help maintain the forage plants at a maximum level consistent with high returns in animal products.

To Help Destroy Brush. Grazing animals readily take brush sprouts and seedlings during the summer period. Therefore, the summer following the fire, livestock will kill some of the brush at the time the seeded forage plants are dry.

Reburning Aids Brush Control

For effective control of sprouting brush, two or more fires appear to be essential unless machinery is used. Numerous brush seedlings often become established following fire. Many species sprout from the crown. The area should be reburned before the seedlings reach maturity and produce a crop of seed. The time interval varies with species and climate, but in general, reburning may be required in from two to five years after the first burning for brush removal. The second burn will kill some more sprouting plants and many brush seedlings.

Method of Reburning. On any burn, most satisfactory results are secured from a continuous ground fire. The area should be left ungrazed the year it is to be reburned, as a good mat of dry grass will carry an effective ground fire and is the best known means of doing a good job. Though such a fire should be amply protected to keep it from escaping, it is less risky than the original burning of either standing or bulldozed brush. A permit for burning must be obtained from the forest ranger or local fire-control agency.

Reburning two or three times at two- to five-year intervals will neither greatly reduce the annual plants nor seriously injure perennial grasses and legumes. An area to be reburned in the fall should not be grazed until the following summer, after the perennial grasses have matured their seeds. This results in more total feed, and a thickening of the stand of grasses.

It has been found that if the burned brush is largely of the sprouting type, such as chamise and certain species of manzanita, sprouts will emerge from the crowns the year after the first burning. Only in a very hot fire will the crowns be entirely killed. The nonsprouting forms will have cast an abundant crop of seeds, and some of these, such as wild lilac and mountain balm, will germinate readily after a burn.

The sprouting forms will generally begin to produce seed by the third year, and seedlings from both sprouting and nonsprouting forms will produce seed by the fifth year. A good ground fire in a second burning should destroy the seedlings that have come up since the original fire. It will also kill the crown sprouts and further weaken the roots and crowns of the sprouting shrubs.

Goats have often been used to complete the eradication of brush by browsing upon young sprouts. Deer, and even cattle and sheep, relish the shoots of many species.

Desirability of Reburning. Failure to reburn may result in economic loss, as an example in western Colusa County illustrates. In 1946, a small area with a dense stand of chamise was burned. In addition to trial plots, several acres were seeded to a mixture of grasses and legumes (see discussion, p. 14). Many of the species did very well the first year. In 1950, however, it was evident that the regrowth of sprouting chamise and the encroaching brush seedlings should be reburned if the smilo plants were to survive. Since this was not done, some of the benefit of the first burning was lost through regrowth of the chamise (see opposite page, top photo).

The value of reburning, on the other hand, was demonstrated on a ranch north of Hopland in Mendocino County. The brush there included chamise, wild lilac, cascara, manzanita, scrub oak, and toyon. There was a sparse cover of pinegrass, purple stipa, and foothill stipa, as well



Regrowth of chamise four years after the initial burn. There is a fair stand of smilo scattered through the brush, but failure to reburn will allow the chamise to take over the site again. (Photographed March 8, 1950.)

FAILURE TO REBURN

LOSES THIS DIVIDEND

Volunteer recovery of grasses one year after a reburn near Hopland, Mendocino County. Envelope in foreground is at base of foothill stipa plant. (Photographed June 12, 1942.)



as a number of other perennial grasses including certain fescue grasses, perennial bluegrasses, and melicgrasses, and a good population of annuals.

The ranch consists of 3,000 acres, 100 of which were burned in 1937. In 1941, these 100 acres were reburned, with an additional 50 acres of new burn. The lower photo on page 35 shows the stand of foothill stipa in this area in 1942. Pinegrass invaded the poorer soil

sites. The ranch now grazes 900 to 950 ewes, their lambs, and an undetermined deer population. It must be emphasized that brush burning was only part of the conversion from brush- to grassland. Ten years ago, the range was divided into only two fields. Now, in the 3,000 acres, there are seven fields with stock-watering facilities well distributed in each. Grazing management, except for the deer, is well regulated.

APPENDIX

The following list includes common and scientific names of shrubs, legumes, grasses, and herbs mentioned in this circular, with key numbers of those used for seeding, and estimated seed numbers on a per-pound and per-square-foot basis.

Common name	Scientific name	Key number*	Approx. no. seeds per lb. (in thousands)	Approx. no. seeds per sq. ft., broadcast at 1 lb. per acre
Alfalfa				
Common or Chilean	<i>Medicago sativa</i>	17	220	5.0
Ladak	<i>M. sativa</i> var. <i>Ladak</i>	18	220	5.0
Birdsfoot trefoil	<i>Lotus corniculatus</i>	.	.	.
Broadleaf, or erect		15	500	11.5
Narrowleaf, or prostrate		16	500	11.5
Bluegrasses	<i>Poa</i> spp.			
Bromegrass				
California	<i>Bromus carinatus</i>			
Cucamonga	<i>B. carinatus</i> var.			
Harlan	<i>B. stamineus</i>	100	72	1.7
Mountain	<i>B. marginatus</i>	7	142	3.2
Prairie	<i>B. catharticus</i>	25	68	1.6
Smooth (Lincoln strain)	<i>B. inermis</i>	64	137	3.0
Bur clover	<i>Medicago hispida</i>	20	209	4.8
Burnet	<i>Sanguisorba minor</i>	30	90	2.3
California oatgrass	<i>Danthonia californica</i>	9	145†	3.3
Cascara	<i>Rhamnus purshiana</i>			
Cereal rye	<i>Secale cereale</i>		18	0.4
Chamise	<i>Adenostoma fasciculatum</i>			
Coastal sage	<i>Artemisia californica</i>			
Crimson clover	<i>Trifolium incarnatum</i>	101	140	3.0
Digger pine	<i>Pinus sabiniana</i>			

* Numbers are those assigned to the varieties used in range trials throughout the state.

† Low germination.

APPENDIX—(Continued)

Common name	Scientific name	Key number*	Approx. no. seeds per lb. (in thousands)	Approx. no. seeds per sq. ft., broadcast at 1 lb. per acre
Fescue	<i>Festuca</i> spp.			
Chewings	<i>F. rubra</i> var. <i>commutata</i>	11B	615	14.1
Creeping red	<i>F. rubra</i>	11A	615	14.1
Tall:	<i>F. arundinacea</i>			
Alta		8	227	5.2
Goar		8B	227	5.2
Kentucky 31		8A	227	5.2
Filaree	<i>Erodium</i> spp.		240	5.5
Foxtail	<i>Festuca</i> spp.			
Hardinggrass	<i>Phalaris tuberosa</i>	28	350	8.0
Highland bentgrass	<i>Agrostis tenuis</i>	112	9,072	208.3
Live oak	<i>Quercus wislizenii</i>			
Lomasgrass	<i>Elymus glaucus</i>	113	137	3.0
Manzanita	<i>Arctostaphylos</i> spp.			
Melicgrasses	<i>Melica</i> spp.			
Mountain balm	<i>Eriodictyon</i> spp.			
Oak	<i>Quercus</i> sp.			
Oats	<i>Avena sativa</i>			
Orchardgrass	<i>Dactylis glomerata</i>			
Common		63	590	13.9
Akaroa		63A	590	13.9
Pinegrass	<i>Calamagrostis rubescens</i>			
Poison oak	<i>Rhus diversiloba</i>			
Redtop	<i>Agrostis alba</i>	105	4,990	114.5
Ripgut	<i>Bromus rigidus</i>			
Rhodesgrass	<i>Chloris gayana</i>	67	1,700†	39.0
Rose clover	<i>Trifolium hirtum</i>	102	177	3.9
Ryegrass				
Annual	<i>Lolium multiflorum</i>	13	227	5.2
Perennial	<i>L. perenne</i>	14	330	7.5
Scotch broom	<i>Cytisus scoparius</i>			
Scrub oak	<i>Quercus dumosa</i>			
Sherman big bluegrass	<i>Poa ampla</i>	103	882	20.2
Smilo	<i>Oryzopsis miliacea</i>	26	1,000	23.0
Soft chess	<i>Bromus mollis</i>			
Spanish clover	<i>Lotus americanus</i>			
Stipa	<i>Stipa</i> spp.			
Foothill	<i>S. lepida</i>	33		
Nodding	<i>S. cernua</i>	34	224	5.1
Purple	<i>S. pulchra</i>	35	108	2.5
Western	<i>S. occidentalis</i>			
Subclover	<i>Trifolium subterraneum</i>			
Early Dwalganup		97		
Mt. Barker		56	72	1.6
Tallarook		98	55	1.2

APPENDIX—(Continued)

Common name	Scientific name	Key number*	Approx. no. seeds per lb. (in thousands)	Approx. no. seeds per sq. ft., broadcast at 1 lb. per acre
Sudangrass.....	<i>Sorghum vulgare</i> var. sudanense			
Sweetclover.....	<i>Melilotus</i> spp.			
Madrid yellow blossom.....	<i>M. officinalis</i> var. Madrid	61A	250	5.7
Yellow blossom, common.....	<i>M. officinalis</i>	61	250	5.7
Tall oatgrass.....	<i>Arrhenatherum elatius</i>			
Common.....	.....	6	150	3.4
Tualatin.....	.....	6A	150	3.4
Timothy.....	<i>Phleum pratense</i>	106	1,200	27.5
Toyon.....	<i>Photinia arbutifolia</i>			
Veldtgrass.....	<i>Ehrharta calycina</i>	91, 91A	531 †	12.3
Vetch.....	<i>Vicia sativa</i>		8	0.1
Wheatgrass.....	<i>Agropyron</i> spp.			
Crested.....	<i>A. desertorum</i>	1	193	4.4
Intermediate.....	<i>A. intermedium</i>	109	88	2.0
Pubescent.....	<i>A. trichophorum</i>		100	2.3
Slender.....	<i>A. pauciflorum</i>	4		
Tall.....	<i>A. elongatum</i>		79	1.8
Western.....	<i>A. smithii</i>	2	110	2.5
Wild buckwheat.....	<i>Eriogonum</i> spp.			
Wild lilac.....	<i>Ceanothus</i> sp.			
Yerba Santa.....	<i>Eriodictyon</i> spp.			

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