Proper grazing and management of range area prevents invasion of the noxious brushes seen in background.

Over-utilized range area showing invasion of prickly pear and mesquite, and the absence of desirable forage. This area was completely cleared by hand-grubbing 20 years previously.
FIGURE 1
Shinnery oak — a poisonous invader which forces out desirable forage grasses. Note the association with sand sagebrush and mesquite in background.

FIGURE 2
Cedar invasion in the Edwards Plateau region. The smaller plants in the right foreground have been established from seed produced on the protected plants in the fence line.

FIGURE 3
Sand sagebrush (foreground) and mesquite combine to form dense growths over large areas in Northwest Texas.
Brush Problems on Texas Ranges

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CONSTANTLY increasing growths of noxious brushes threaten the range country of our great State. Yet, how many Texans realize that the enemy is on the march? How many have taken thought of the fact that the brush on Texas rangelands is in reality an army of merciless invaders—invaders which strike directly and with crippling force at the very heart of our range economy?

In order that we may all realize the strength of the enemy—the scope of the brush-control problem in Texas—let us consider these facts. In 1945, the money earned by Texas farmers and ranchers from livestock production amounted to more than $589 million, and this sum would be substantially greater in this year of higher prices. This huge sum was produced from grazing operations on 93.5 million acres of rangelands. But consider the fact that some 37.5 million acres of land in Texas have been seriously affected by the encroachment of various species of noxious brush—mesquite, cedar, prickly pear, creosote bush, sagebrush, blackbrush, and many others.

It is estimated that if even half of the land so infested had been available for full utilization in livestock production, Texas farmers and ranchmen during 1947 would have received an additional $18.5 million. This sum represents only half of the loss to Texans in 1 year caused by the invasion of noxious brush forms into the once-virgin grasslands of Texas! Nor is this great annual monetary loss the whole story. For even more important is the threat of increasing spoilation of Texas rangeland by these creeping invaders. No longer can Texas stockmen simply move from their ranges ahead of the brush invasion, drive their herds westward to "greener pastures." No—the great days of the free range have passed with the buffalo and the Indian, and today Texas ranchmen must make the best use of whatever lands they have. Thus, the threat of further encroachment of noxious plant species onto Texas rangelands poses the possibility of capital loss so great as to make any 1 year's loss pale into insignificance.

However, this persistent march of noxious plants onto Texas ranges has not been unchallenged. Various agencies—federal, state, and local—have picked up the gauntlet flung down by Nature and man, and have engaged themselves in the battle to free these lands of their noxious brush forms, and to restore them to their earlier productive capacities as ranges for various types of livestock.

This pamphlet is an attempt to present a clear-cut, accurate picture of the problem posed by the noxious brush invasion, and to show the urgent need for strong research and educational programs if we Texans intend to save our ranges.

Attack on the Rangelands

In 1858, according to the Texas Almanac, "in Texas it costs to raise a cow about as much as it does to raise a chicken, so plentiful is the range and so little trouble is there in looking after them." And in 1870, the USDA Yearbook also presented a picture of an almost inexhaustible range empire in speaking of the opportunities offered to stockmen by the ranges of the Southwest: "Farmers upon land costing $20 to $200 an acre, in climate requiring four or five months of winter feeding, cannot compete with stockraisers

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operating under a sky that demands no shelter and upon a soil yielding perennial supplies of green food where land is so cheap that a single stock farm includes a whole county.”

Unfortunately these pictures no longer exist. The virgin rangelands of the great Southwest have passed, and in their place have left the rangelands of today—areas which are now threatened by the encroachment of noxious plant forms (Figures 1, 2 and 3). To understand how this has come about in such a relatively short time, let us consider the original vegetation of Texas, and follow the processes whereby it has been modified, and in many instances replaced, by various noxious forms.

When the white man first came to the Texas frontier, he found a stockman-farmer’s paradise. The rolling hills of Northeast and East Texas were fairly heavily timbered, with scattered open areas of fertile soil suitable for cultivation. In the Central Texas region, reaching from the Red River to the Edwards Plateau, he found more scattered timber, with wide stretches of prairie, thickly covered with succulent forage grasses. And to the west all the way to the Rocky Mountains of New Mexico, he found the prairie rangelands—a natural ranch empire—vast, sweeping plains suited to the practices of the “free range.”

Here and there throughout Texas, the early settler found areas in which many species of present-day noxious brush forms were present. In the Edwards Plateau, for example, liveoak, shinnery oak and a few scrub cedar grew along the rocky ridges and followed the contours of the relatively few streams draining the watershed. In the dry and arid regions of the Trans-Pecos the creosote bush, prickly pear and the tarbush were to be seen. And in the Rio Grande Plain were found mesquite, huisache, guajillo and varied forms of cacti.

These noxious forms, however, were of little or no concern to Texas pioneers, for the range grasses were dominant. Texas rangeland at that time was covered by forage grasses—tall grasses, big and little bluestem, the muhly grasses, side-oats grama, buffalo grass and others—which formed a thick, tough sod, producing nutritious food for livestock in such quantities as to be almost unimaginable to the Texan of today. These grasses, with both deep and shallow root systems, occupied almost all of the ground space and took up all the available moisture, controlling would-be invaders through successful competition—literally choking out any sprouting noxious form.

Why then, we wonder, has our Texas rangeland deteriorated—and why has the process been so rapid? There are conflicting answers to these questions. But the one factor that seems definitely to have made a major contribution to the spread of various noxious brushes is man himself.

Before considering directly the part which man has played in laying Texas rangelands open to the invasion of malignant brush forms, let us consider some of the other factors instrumental in the encroachments of noxious plants. There are at least three elements, beside the human factor, which aided in effecting the invasion of noxious brushes onto previously “clean” rangelands. These are climatic phenomena (drought, flood, hard winters and the like), fire and wildlife.

Of the three, climatic phenomena are more immediately far-reaching. A prolonged drought may reduce the desirable forage plants to such an extent that the range is almost laid bare to encroachment of the noxious brush which by nature of their deeper root systems are able to withstand the drought. Similarly, hard winters tend to destroy forage grasses over wide areas that have been severely overgrazed. When these climatic variations occur following each other, as the hard winter of 1885-86 was followed by the widespread drouth of 1886 and it in turn was followed by the even more bitter winter of 1886-87, tremendous damage is done to the sod of the rangelands.

Flooding, too, and windstorms play a part in spreading the seed of noxious forms to areas previously clean. Both of these elements tend to distribute plant seed widely. And floods are likely also to spread a layer of silt which serves as an ideal seedbed for the germination of seeds of undesirable plants.

Another element affecting the early rangelands was fire. During frontier times, great areas of Texas range were fired, sometimes by natural means, often by Indians or by the advancing white man. These early prairie fires were most spectacular affairs. They often covered thousands of acres, and burned for weeks in dry periods, causing a pall of smoke to hide the sun for days at a time. Whether they actually improved the primitive rangelands is a question which has caused considerable discussion among range specialists. Although the early-day prairie fires undoubtedly destroyed many brush forms which might otherwise have proved seed-sources for range infestation, the fires also weakened much good sod, and may well have laid the range open to infestation in this manner.

Another possible agent in spreading the noxious plant forms may have been the wildlife which flourished in the early period of range use. Birds, small rodents such as ground squirrels, cotton-tail and jack rabbits, and some larger animals such as the coyote, may well have been instrumental in spreading noxious forms of plant growth through their food habits, or droppings. Thus, all these elements—climate and climatic phenomena such as flood or windstorm; the great prairie fires of pioneer days; the abundant wildlife of the frontier—contributed in part to the spread of noxious brush. But as has been pointed out, the chief agent operative in the deterioration of Texas rangelands has been man and his over-abundance of domestic animals. Year after year they have overgrazed the native forage grasses until they died from trampling and inability to produce and store plant nutrients, and their places
were taken by inferior grass species and the nox-
ious brushes.

As the profits in ranching increased, and Texas
became a part of the Union, railheads were estab-
lished, and the Lone Star State became the beef
cattle center of the nation. The verdant prairie
ranges were ruthlessly overstocked, for when one
area was too-heavily grazed, the cattleman could
move toward the sunset—toward the boundless
“free range.” Unfortunately, all the free range was
eventually occupied. That the native forage
area was too-heavily grazed, the cattleman could
and the passenger pigeon is a tribute to their
hardiness and resiliency in the face of over-
whelming odds.

Let us consider one or two striking examples
of the changes in the appearance of the Texas
range. In 1854, less than 100 years ago, Bartlett
(Personal Narrative) gave an eyewitness description
of the Southwest Texas range area:

The whole of this district consists of gently
undulating plains, without timber save along the
margins of the streams, and is covered with the
most luxuriant of grass. The indigenous prairie
grass is tall, coarse, full of seed at the top, and
when young resembles wheat in the spring. But
in grasses the glory of the State is the mesquite
grass, found only in western Texas. It yields
a fine soft sward, preserves its verdure in the
winter, and beyond a comparison affords the
best wild pasture in the world.

Yet in 1899, not half a century after Bartlett’s
description was written, Jared Smith, an em-
ployee of the U. S. Department of Agrostology,
states of the identical area that “this same region
is now covered with brush and cactus.” And today
the whole area, with the exception of such ranches
as are maintained at considerable cost against
the encroachment of noxious forms, is justly de-
scribed by J. Frank Dobie as “chapparral country.”

Again, Smith (above) described “the entire re-
gion lying north of the Colorado and Concho
rivers” as well-grassed and watered, and relatively
unaffected by such noxious forms as prickly pear or mesquite. Yet today, a little less than 50
years later, this region shows considerable in-
festation with mesquite, prickly pear, cedar and
shinney oak. To point up the extent of infesta-
tion, it is estimated in the current biennial report
of the Department of Range and Forestry that
some 65 million acres of the 93.5 million acres of
original rangelands are now infested with
one or more species of noxious brush, and that
the remaining 28.5 million acres are in grave
danger of infestation in the immediate future!

This, then, is what is happening to the area
Bartlett described as “the best wild pasture in the
world!” The steady encroachment of noxious
brush forms has greatly reduced the amount of
forage and lowered the quality of that which
remains. It has rendered a considerable amount
of forage unavailable to livestock, and has greatly
impeded ranchmen in the handling of their herds
and flocks. And the worst aspect of this brush
invasion, so far as the long view is concerned, lies
in the deterioration of the range, the exploitation
of the soil nutrients, and the extreme likelihood
of the passing of our Texas rangelands unless im-
mediate combative steps are taken.

The Dominant Invaders

What, specifically, are those dominating invaders—these noxious brushes which are so rapidly
destroying Southwestern rangelands? A glance at
maps prepared by the Soil Conservation Service of
the U. S. Department of Agriculture (Figures 8,
9 and 10) indicates clearly that mesquite is by
far the most outstanding of the noxious forms,
having infested some 55 million acres of a total of
93.5 million acres of potential rangeland. Another
outstanding enemy of the ranchman is prickly
pear (Figure 11). Although in times of drouth or
failure of grasses this noxious growth may be
utilized as stock feed, the disadvantages to the
range and to animals which feed on prickly pear
are, as we shall see further on, far more numerous
than any advantages which it may offer as a
stock feed.

Still another form of rapidly spreading noxious
growth is scrub oak, particularly in the region of
the Edwards Plateau. Here such forms as live oak,
Spanish oak, red oak, post oak, blue oak and other
oak species have managed to distribute themselves
over many millions of acres of one-time virgin
range. Of sufficient importance to merit separate
mention is shinnery oak, a dwarf oak form widely
infesting the Edwards Plateau and extending
westward toward the Trans-Pecos area (Figure
1). Not only do the twisted, relatively low growths
of shinnery oak form grass-destuctive brush
areas, but the browse from some of these species
is poisonous to livestock if taken in quantity.

In Val Verde, Terrell, Pecos, Upton and Reagan
counties and westward—creosote and tob bush
have greatly increased upon the arid lands, robb-
ing the soils of moisture and nutrients which
might well be used to support valuable forage
grasses. Also in West, Central West and South-
west Texas, infestations of whitebrush, black-
brush and agarita have slowly spread over mil-
ions of acres of desirable grazing lands.

The above-mentioned forms although of out-
standing importance, are only a few of the nox-
iuous brushes which have invaded the virgin prairie
lands of the Southwest. All over Texas, the prob-
lem of brush control exists to a greater or less
degree. Yaupon, catclaw, hog plum, persimmon,
huisache, granjeno, Brazil bush, cedar, soapbrush,
false willow, McCartney rose, blackjack oak,
retama—all of these noxious plant forms and
many others occur in various combinations
throughout Texas (Figures 3 and 4). Their re-
 lentless advance in the face of determined efforts
to destroy them may well spell the doom of the
greatest rangelands which the world has ever
known.

Foremost among the noxious plant forms of
Texas is the mesquite, which varies in growth
from very large trees in regions of sufficient moisture to low, creeping forms in the sandy, semi-arid regions around Lubbock and to solid thicket stands (Figure 5) in other areas. J. Frank Dobie has said of mesquite that "it is sterilizing an empire into unproductiveness." Describing the virgin prairie of his boyhood, in the area southwest of San Antonio, he says: "As a bare-legged boy some 40 years ago (about 1901, since these words were written in 1943) I used to ride horseback in South Texas across what was known as 'the hay pasture.' Somebody had at some time mowed prairie hay from it. It was several thousand acres in extent and was mostly prairie. Today only a 'brush hand' armored with leather can penetrate the mesquite thickets on this land."

Again, Jared Smith wrote in 1899: "Twenty years ago it was hard to find a mesquite (tree) on the open prairie that was larger than a small shrub. The only places where they occurred of any size were in the valleys and the 'timber islands'—small scattered groves at intervals on the prairies. . ." Smith also tells of a Dr. Deryee of Corpus Christi, who told him that "thirty years ago (about 1869) the country between there and the Rio Grande was entirely open . . . with only here and there a bunch of mesquite . . ." These remarks would indicate that mesquite infestation was relatively light as late as 1850. And since the increase has been rapid and heavy since that time, the most logical conclusion is that the utilization of Texas rangelands during the stockmen's "good old days" contributed in no small degree to the growth of this plant.

Research carried on at the Texas Agricultural Experiment Station substation at Spur indicates clearly that the success which mesquite has had in establishing itself on Texas ranges is due to its growth habit. Results showed that mesquite forms a bud zone (Figure 7) which usually lies anywhere from a few inches to as much as a foot or more below the ground level, depending on how much soil or litter may have accumulated at the base of the plant. The roots spread from below this bud zone, and the bud zone itself contains a number of eyelets, much like those of the common potato. An injury to the upper part of the tree—such as cutting of the trunk, or burning—seems to stimulate the eyelets, and they sprout, sending up as many as a dozen or more shoots from a single bud zone (Figure 6). Hence, it is most difficult to kill a mesquite by burning after it has reached a year or more of age. For the great likelihood is that although the old growth may be destroyed, new growth in much more luxuriant quantities will sprout. Even repeated burnings do not seem to exhaust the root-node of its eyelet-shoots, and for this reason it seems doubtful that the prairie fires of the old days were actually agents in preventing the spread of the mesquite.

A view endorsed by many range specialists is that the grass turf of the virgin prairie was itself the agent which held mesquite and other noxious brushes in check. Under normal conditions, the mesquite reproduces by means of its seeds, which are small and bean-shaped, held in a pod similar to that of the garden lima. These "mesquite beans" as they are called, are familiar to every Texan, and, as has been established by experiments carried on at Spur, are readily eaten by livestock. Of considerable interest is the fact that experiments indicate that a large percentage of these seeds will germinate after passing through the digestive tracts of animals. Thus, much of the spread of mesquite nowadays is attributable to animal droppings. However, on the virgin turf of early times, even though buffalo, antelope or the first stock brought in by the white man may have spread germinable mesquite beans rather widely—the beans had a difficult time in developing. The mat of grasses was so thick and heavy, as compared with the sparse turf of today, that many beans must have failed to reach the soil below, or were destroyed. Of the relatively few which did reach the soil, only a very small percentage could survive the competition with the sturdy root systems of the native prairie grasses. Such at least is the viewpoint held by modern range specialists and many ranchmen. Dobie phrases this idea clearly:

The grass that made the prairie fires possible was, I am sure, a (far more) potent agent in checking the spread of mesquite. . . . When white men over-grazed the country, they left the soil exposed to beans; also, with grass scarce, stock ate every mesquite bean found—and then dropped the seed where the rootlets could, upon germination, get into the ground. The white man sowed with over-grazing; he is now reaping thickets of mesquite. . . .

Investigations carried on by a number of ecologists indicate that as mesquite moves into an area it tends to appear first in lowlands of deep soils and later in higher grazing lands. And such has been the spread of this weed-tree that in the past 75 years it has become one of the more common noxious plant forms in the Southwest. And though it has partially destroyed millions of acres of valuable rangeland, it is defended by a number of ranchmen on several grounds. It is argued that since the beans are edible by livestock, mesquite may on occasion prove to be invaluable in feeding a herd through a critical period. Again, the larger mesquite are frequently considered desirable as shade trees. Another argument is advanced that mesquite aid in supporting grasses in their vicinity because the deep root systems serve as channels to draw underground water to the surface during time of drouth.

These views are not upheld by modern range management specialists, nor in the main by the majority of Texas ranchmen, who have by this time had the opportunity to observe the deterioration of the range under the onslaught of mesquite invasion.
FIGURE 4
The McCartney rose is a serious problem on rangelands along the Gulf Coast. It forms large clumps and can reduce the amount of usable range considerably.

FIGURE 5
Many-stemmed mesquite thicket which in time closes out grazing and impedes the handling of livestock.

FIGURE 6
Rapid sprouting of mesquite shown by 11-months growth from stump cut at ground level.
Consider the assertion that mesquite furnishes valuable forage. A study by the Southwestern Forest and Range Experiment Station at Tucson, Arizona, established that forage production from perennial grasses alone on plots free of mesquite averaged two and one-half times as much as the total forage production from both mesquite and grasses on areas containing mesquite. Hence, with the exception of years of great drought, it is likely that the value of mesquite as forage is obviously greatly overestimated. And since there is no way for the ranchman of today to compare how well a virgin, mesquite-free turf would stand prolonged drought (as compared with the sparse turf of our rangelands of today), it is quite difficult to make any sort of case for the mesquite as a feed tree in opposition to good, heavy grasses (Figure 12).

As to whether mesquite holds soil moisture, prevents runoff or draws moisture to the surface in times of drought there is some discussion. Studies indicate that it requires 1,727 pounds of water to produce 1 pound of dry mesquite matter, three times as much water as is needed to produce a pound of little bluestem grass! Mesquite roots on older trees may range as much as 50-75 feet from the base of the tree, running in all directions—as one old-timer put it, “like a rattler headed for a dog-hole!” Examinations of mesquite root systems by investigators at Spur show these feeders from 6 to 12 inches beneath the surface of the soil, and in even a moderate stand of mesquite form a network of channels which constantly remove water and soil nutrients from the openings between the trees.

The whole problem of the mesquite infestation of our Southwestern ranges may be summarized simply: Mesquite-free soils mean more water supply for grass growth, since it no longer is demanded by the greedy mesquite. More water means more grass. More grass, if not overgrazed, means more litter on the ground. More litter means less puddling, less sheet erosion, less water loss through runoff. Less water loss means more water, and still more grass. And the steady increase in grass means that in time a firm turf of native forage grasses can be produced—a turf which, as in the early days, is capable of utilizing efficiently every drop of rain that falls. Therefore, it is imperative that the mesquite be destroyed if our ranges are ever to be restored to anything approximating their one-time grazing capacity.

We have written of mesquite at this length because it is certainly “ranchman’s enemy number 1” in terms of the proportionate acreage of rangelands which it infests as well as in terms of the difficulty of eradication. However, there are other noxious forms which are also instrumental in crowding forage grasses off the ranges, in depleting the nutritional content of the soil, in encouraging erosion and in impeding the handling of livestock.

Foremost among these are the various cacti of Texas, particularly the prickly pear (Figure 11) with which all Texans are familiar. Here again, as with mesquite, there is some argument against eradication on the ground that this cactus can be utilized as a forage crop to good advantage, particularly during adverse range conditions such as drought. The practice in dealing with all spined species is to burn the spines off with a device called a “pear burner” and to allow the stock to graze the burned cactus. Although many ranchmen argue that herds have been carried through critical periods by the burned pear, the old question arises of whether the range would have supported the herds in far more efficient fashion had the existence of the prickly pear not sapped the strength of the forage grasses.

In heavily infested prickly pear areas in Texas—primarily the Rio Grande Plain, the Rolling Plains, the High Plains, and portions of the Edwards Plateau—it is not uncommon to find as much as 20 percent of the range occupied by this pest. And a number of ranges have been tabulated in which as high as 50-75 percent of the soil is covered with prickly pear.

How has it spread? There are several answers to this question. In the first place, each stem of prickly pear is capable of self-propagation, and even after burning any portion of such a stem which may remain green is a potential colonizer. Also the prickly pear produces seed which are spread by jack rabbits to a considerable extent. It is interesting to note that the germination quality of prickly pear seed is actually increased from passing through the digestive tract of the rabbits, tests on pellets containing seed proving a 50 percent germination increase over naturally-scattered seed. Some prickly pear tends to creep, with roots extending many feet outward from the original plant and lying just under the surface of the soil. In these ways the infestation has spread until some 60 million acres of Texas range is troubled with prickly pear.

Most of the noxious effects upon the forage grasses and the soil of the rangelands attributed above to the mesquite are also attributable to the prickly pear. And, like the mesquite, the major problem of eradication is to insure complete kills. For since each stem may become a new plant if it comes in contact with the ground, such methods as scraping, raking or cabling pastures are fraught with the possibility of intensifying the infestation instead of cleaning out the noxious growth of this plant.

Still another serious form of noxious brush invader is the oak group. Oak infestation poses a unique problem in that it brings with it a tendency to cedar infestation as well as to infestations of a number of minor types of noxious undergrowths. These latter forms are believed to follow the oak areas as a result of the droppings of birds, and an oak infestation soon becomes
an area which is almost impenetrable because of the thick undergrowth of cedar and other noxious brush forms. The effect on the area as a grazing locality is easily imagined.

Let us now consider the general effects of these and other noxious brushes on the range of Texas. In the first place, it is obvious that the noxious growths rob valuable forage grasses of both water and soil nutrients. The relative thickness of the infestation in any given area determines just how greatly the forage grasses suffer from the encroachments of the invaders.

Also, these noxious brushes cast considerable shade, which retards the development of forage grasses. These valuable cover grasses—bluestems, grama, curly mesquite and others—require sunlight for most effective development. Findings at the Spur substation indicate that grass grown in full sunlight averaged 20.4 percent more starches and sugars than grasses grown in heavy shade, and that there was a definite reduction in the indigestible crude fibers in those grasses which were developed in the full sunlight. It takes little imagination, also, to see that the combination of shade plus the continuous reduction in water and in soil nutrients, which would be the result of heavy infestation of noxious brushes, would be highly detrimental to the development and feeding value of the forage grasses.

Another over-all effect of noxious brush invasion on our Texas rangelands is the impediment which such growths offer in the handling of livestock. In dense chaparral there is a constant injury and loss rate among livestock because of the spines and thorns of the growths, which open the way to screwworm infestation and other infections among the animals on pasture. Also the physical problem of handling the livestock is intensified in heavy brush, as the animals tend to become wilder and more difficult to deal with in direct proportion to the density of growth on their grazing lands.

Still another detrimental effect of noxious brush growth—and one which may well be of greatest importance in the long-range view—is the tendency toward erosion occasioned by brush infestation. As the noxious forms overcome the resistance of the low-growing grasses and other herbaceous plants which form the normal forage cover, the soil tends to become exposed and bare, for the brush lacks the fibrous roots which hold and bind the soil. Raindrops, striking this soil form tiny splashes and "puddles," dissolving the surface soil and spreading a thin layer of silt which effectively seals the soil against further water absorption. Recurrence of dry periods forms these soils into "hardpan," and as the vegetation continues to give way, the area becomes subject to both sheet and gully erosion. It takes only a few years to remove an inch of good soil, but according to soil scientists it requires 100 years to restore it!

Science Fights Back

We can thus see that range specialists find themselves confronted with a three-fold problem. First, efficient and economical ways must be found to remove the noxious plant forms from infested range areas. Second, once these growths are removed, landowners must be encouraged to utilize the forage value of the range to a maximum capacity and to exercise sufficient care in doing so to avoid reinfestation with noxious plants. Third, techniques of building up "run-down" ranges, and restoring cleared ranges to productivity must be developed. Indeed the problem is a big one, and it is only through the cooperation of the range specialist, the landowner and the legislator who may make funds available for range management and development purposes that good results will be obtained.

For the sake of understanding how the work of noxious brush eradication or control is carried on, let us consider some of the techniques employed in Texas. These methods by which modern science meets the challenge fall, broadly speaking, into two classes—brush control by mechanical means and brush control by chemical means.

Before discussing the attack which the scientist in the field of range management makes upon these noxious growths, let us mention a third agency widely employed, but under criticism from range conservation specialists. This agency is fire. Although the practice of "burning off" the ranges in an effort to control or eradicate woody forms is commonly employed by some ranchmen and farmers, scientific observations on burning tend to indicate that in many areas the use of fire may be more harmful to the range economy than beneficial (Figure 13).

Obviously uncontrolled burning is very destructive to forage grasses, killing the growth and roots as well, and baking the soil into a hardpan which encourages erosion. Controlled burning, even under ideal conditions, should be done under the supervision of men well trained in fire management. Much more experimentation with fire as an agent of eradicating or controlling noxious brush forms in general will have to be carried on before any definite conclusions as to the desirability of burning off the range are available.

Mechanical Attack

Far better results than those obtained by burning have been achieved by range specialists, ranchmen and farmers through the use of mechanical means of eradicating noxious plant and brush forms. These mechanical techniques are as yet far from perfected. For, as is the case in all lines of scientific endeavor, there is a long history of trial and error behind the development of modern range-improvement tools, and the ultimate in performance is not yet in view.
FIGURE 7
Section of a mesquite stump. The wart-like structures are the buds which produce sprouts when the top is killed or removed.

FIGURE 9
FIGURE 10

FIGURE 11
Heavy infestation of prickly pear and mesquite on rangeland once entirely free of brush.
As might be imagined, one of the earliest heavy machines to be used in an effort to control noxious brush growths was the old-fashioned bulldozer, with its "cats" treads and heavy, scraping blade. Offhand, it might seem that bulldozing would work perfectly in disposing of noxious brush, but actually there are several disadvantages.

In the first place, the bulldozer sweeps up surface growth only, and when it is used in an effort to control mesquite infestation, it succeeds only in cutting off the tops of the small and medium-sized mesquite. It does not remove the bud zone, which contains the sprouting eyelets, and considerable sprouting follows most bulldozer opera-

![Image](https://via.placeholder.com/150)

FIGURE 12
This range in Southwest Texas was a heavily-grazed horse pasture. It now shows considerable improvement under moderate stocking despite several years of low rainfall following treatment of the brush. An increasing cover of hairy grama protects the soil from erosion and affords grazing animals palatable forage. Other desirable grasses, protected from over-grazing by the prickly pear, provide a valuable seed source for revegetation.

sections. Also, in sweeping the debris across the surface of the pasture, the bulldozer scatters the beans of the mesquite, and frequently manages in this way to infest relatively clean areas.

Used against cactus infestation, the bulldozer is somewhat more effective, but here again there is danger that the operation may prove to be abortive. For any stems or portions of stems which may be lightly covered with soil by the bulldozer blade, or which may be scattered over clean areas, will sprout, and a new colony of cactus will thus be established.

However, a number of improvements on the old-fashioned bulldozer have been made in recent years. One such machine is the "tree dozer," which has been used successfully in mesquite eradication at the Spur substation and on the King Ranch. This machine, developed primarily to combat mesquite infestation, is an extra-powerful bulldozer with a plow-like attachment and lift. It is so devised that it penetrates beneath the surface of the ground and brings the all-

important bud zone to the surface. This effectively destroys the tree and relieves all possibility of sprouting.

Another interesting bulldozer-like machine is a mesquite-eradicating machine developed by J. S. Bridwell of Wichita Falls. This machine, similar in effect to the tree-dozer, is designed to cut, pull, push over, or dig out mesquite, getting at the bud zone of the tree in each case.

Such modern bulldozer adaptations are much more successful than the old-fashioned bulldozer in eradicating various types of noxious brush growths from Texas ranges. Unfortunately, they are expensive to buy, operate and maintain, and as yet relatively few cooperative brush-control projects have been begun in Texas. Hence, the use of these modern brush-control machines is beyond the pocketbook of the average ranchman, and much land that might otherwise be cleared of brush by them remains infested. The rough range of cost of bulldozing, estimated on a contract basis, is from $4 to $15 per acre, depending on the terrain and the density of the infestation as well as other factors. If the ranchman owns his own equipment and provides his own labor, he may be able to reduce the cost by 15 to 20 percent.

Besides the bulldozer and its modern adaptations, there are nowadays several other kinds of mechanical devices in operation as brush-control measures. Among these are various types and sizes of brush cutters, root cutters, root plows, power saws, mowers, "stinger blades" (a form of root cutter), cabling devices and other ingenious mechanical devices. All of these vary in effectiveness, but are in the main improvements over the simple bulldozer. Some are better adapted than others for specific types of infestations, or for certain types of soils upon which infestations may occur. Yet none really meets superior standards of desirability in terms of completeness of eradication of noxious forms.

Perhaps the brush cutters, root plows and power saws when used in intelligent combination provide the most effective means of eradicating noxious plant forms. Several types of brush cutters are now in operation on Texas ranges, the most effective being the heavy and light rolling cutters (Figure 15), which have been utilized successfully at the substation at Beeville. These machines consist of large hollow drums to which are affixed parallel blades. The drums can be filled with water to give them whatever weight may be necessary to effect slight soil penetration (light cutters generally run to a maximum weight of 10,000 pounds; heavy cutters 22,000 pounds). These cutters are dragged by tractors, and roll along, in the manner of a lawn roller, cutting and crushing the brush as they go over it. Heavy cutters are capable of crushing down or cutting the largest blackbrush bushes, medium mesquite or huisache trees, and virtually all other noxious brush. The light cutters, are, of course, used in less heavy infestations, or where the brush forms are small-
er. The litter thus formed deteriorates rapidly and forms an excellent base for forage grasses, as it remains on top of the ground and prevents the runoff of water, and the corresponding erosion. Brush cutters, however, have their disadvantages. As they make but little penetration of the soil, the likelihood of sprouts is great, particularly from such forms as mesquite and prickly pear. For this reason, after-measures are necessary, and in some instances smaller cutters, known as maintainers, are used to keep down the returning noxious forms. Also brush cutters are quite expensive, a heavy cutter-maintainer-tractor combination involving as much as a $10,000-$15,000 investment. Such a cost makes the use of brush cutters out of question for the average ranchman.

Root plows and power saws, used in combinations, provide a fairly efficient method of clearing rangeland of noxious forms of brush. In particular, root plows are of value in dealing with mesquite, as they enable the operator to get far enough underground the surface to get at the vital bud zone. In experiments carried on at the Beeville substation, mobile rotating power saws have been used effectively to cut brush at ground level; then root plows (Figure 14) are brought into the pastures to turn up the roots that remain. Such operations are, of course, very costly, and, as they disturb such turf as exists, they also tend to deplete the range temporarily. They are valuable if it is desired to set up a seedbed for good forage grasses. But unless careful grazing procedures are followed after clearing and reseeding, the overstocking of the range during the first year or two after reseeding will simply cause a new infestation of noxious plant forms.

Mowers are helpful in keeping smaller forms of noxious brush down. However, in the big problem of clearing heavily-infested ranges, or in dealing with such tough brushes as cedar, juniper, mesquite, blackbrush or prickly pear, they are of no value, even if the terrain were such as to permit their operation. “Stinger” blade adaptation of the bulldozer principle (Figure 16) is used widely on mesquite infestations. This machine has been used with some success in the early mechanical and chemical experiments on mesquite carried on by the Amarillo Conservation Experiment Station. This device involves a sharp cutting blade mounted on a bulldozer frame and equipped with a lift device. The machine is driven up to the individual tree and the sharp blade penetrates the soil to a depth well below the bud zone, cutting through both horizontal and tap roots. The lift then is put into operation and the tree is thrown bodily out of the ground.

“Cabling”—a technique of dragging one or more heavy cables between two tractors (Figure 17) across a pasture—and “railing”—similar to cabling except that an iron or steel rail of sufficient weight is used—are common ways of attempting brush control. These methods are within the purse of almost every ranchman but unfortunately they are not too efficient, as the more resilient trees and brush simply bend without breaking or becoming uprooted (Figure 18). For mesquite infestation, cabling and railing are adaptable only under specialized conditions.

It is hard to estimate the direct cost per acre of eradicating and controlling the various species of noxious growth by the various mechanical means. For such cost involves a great many factors: the density of infestation and the type of shrubs predominant; the type of soil where the operation is carried on and the relative moisture content at the time; the topography of the area to be treated; the method of treatment used; labor costs in the area; whether the landowner owns and operates his own equipment, and other miscellaneous factors. Investigations carried on at the Spur substation indicate that while most of these methods of control have been accepted and found valuable under favorable conditions, they are nevertheless too laborious and costly to realistically cope with the mesquite problem.

However, mechanical means of noxious brush control are after all relatively effective, when they are within reach of the ranchman’s pocketbook. And at the present time, they are among the most available techniques of control of these noxious brushes, and must be utilized to the fullest extent whenever possible if the range is to be preserved at all. The Production and Marketing Administration (formerly the Agricultural Adjustment Administration) of the U. S. Department of Agriculture, has assisted farmers and ranchmen financially in the treatment of various brushes on their range lands.

Chemical Warfare

Although, up to the present, mechanical means of combating noxious brush forms have led the way in practical field application, range special-
FIGURE 14
Large, heavy root cutter used for solid plowing 8 to 24 inches deep in eradicating thick stands of mesquite. Courtesy, U. S. Soil Conservation Service, Fort Worth, Texas.

FIGURE 15
A heavy, rolling type cutter in operation in a thick stand of blackbrush, mesquite, granjeno and liveoak in South Texas. The heavier cutters will cut brush up to 6 inches in diameter. Courtesy, Texas Extension Service.

FIGURE 16
ists are now looking to chemistry as the “white hope” of the future. Experiments with various types of chemicals as eradication and control agents were made as far back as 20 years ago, but it is only in recent years that certain chemicals have begun to come to the fore in the battle against noxious plant growth.

Ideally, a chemical agent should be selective in nature (i.e., act only upon the noxious forms against which it was aimed without disturbing desirable forage grasses or growths), cheap, easily applied with existing equipment, a sure killer and preventive agent against re-growth, and non-toxic to livestock, wildlife or man. Unfortunately, no such ideal, over-all type of chemical agent has yet been developed. However, much experimentation has been done and is being done in this field. And today a number of chemical agents have been found which operate with some degree of efficiency as noxious brush eradication and control measures. Chief among these are kerosene and various fuel oils, used either singly or in combination; ammonium sulfamate (sold under the trade name “ammate”); sodium chlorate, zinc chloride and other chlorides and chlorates; sodium arsenite and other arsenic compounds; and 2,4-D and 2,4,5-T recently developed hormone-type compounds which act as growth regulators and which show considerable promise as indicators of the direction to be taken by further chemical research.

Kerosene, both pure and mixed with various fuel oils such as motor (crank-case) oil or Diesel oil, has long been used as an agent for eradicating mesquite, post oak, blackjack oak and other noxious tree forms. Although various methods of application have been tried, the most effective technique tried at Spur in dealing with mesquite is to apply the oil around the lower six inches of the mesquite trunk. Kerosene may also be applied at the base of the tree, using a small trench if need be to insure that the oil penetrates below the surface to the vital bud zone. If the bud zone is thoroughly permeated, a kill is assured, for mesquite does not sprout from the roots.

Ammate has been tried with varying degrees of success on many types of noxious plant forms. So far it seems most effective against blackjack oak, post oak and other hardwood species. It has been tried as a spray on various types of sprouting forms of noxious growths, but no definite conclusions can be drawn at present from the results obtained, which ranged from poor to good under widely variable conditions. This compound, however, offers a considerable field for further study and experimentation.

Sodium chlorate, zinc chloride and other chlorides and chlorates have been used considerably in various experiments with weed and noxious brush control, but few results are obtainable as yet.

Sodium arsenite and other arsenic compounds have been found by investigators to be very effective killing agents, even against such resistant forms as mesquite. Also, investigations carried on at the Sonora substation on certain infested areas showed that prickly pear could be killed by spraying with a formulation of this chemical. Unfortunately, sodium arsenite is extremely poisonous, both to livestock and to man, and considerable time must elapse between its use and the time when the range may once more be considered safe for livestock.

Chief among the chemical agents which are looked upon with great hope by range specialists as agents for the control and eradication of noxious brush forms are 2,4-D and the closely related 2,4,5-T. These compounds are hormone-type sprays which act as growth regulators and inhibitors upon the noxious forms without showing great injury to forage grasses. It is this selectivity of operation which makes them so highly desirable. Experiments carried on in the past few years indicate that these compounds and similar ones are the most likely chemical forms to be found available as control and eradication agents in the near future.

Various methods of applying chemical agents have been utilized, with varying results in terms of percentage of kill obtained. The ground pour and basin methods, as the names imply, involve the construction of shallow troughs near the base of the noxious plant form to allow a liquid solution of the chemical to saturate the ground to a depth sufficient to insure kills of sprouting forms. Frilling, or girdling larger trees with axe-gashes, then pouring poison chemical compound into the gashes is a technique practiced with considerable success on certain species, such as the hardwoods where sodium arsenite, ammate, kerosene or kerosene mixtures are used as poison agents. For wide-spraying forms of noxious shrubs, or for forms which do not lend themselves easily to frilling or girdling, various tools such as the “Cornell tree tool” and the “poison axe” have been invented. These tools utilize the technique of hole-boring, punching or gashing the tree, and are so designed that a certain amount of liquid poison flows through the tool into the hole or gash at the time of the impact.

Crown drenches, foliage sprays and dusts are techniques of non-selective applications of chemical compounds in an effort to kill off all noxious forms, or certain specific noxious forms known to be susceptible to the chemical agent utilized. 2,4-D, 2,4,5-T and other chemicals lend themselves well to spray and for machines, to airplane spraying under proper conditions of climate, and to hand-operated pumps and sprays. Investigations at the Spur substation indicate that the great drawback to sprays and dusts is that while death of the above-ground growth generally takes place even in such sturdy forms as mesquite or blackbrush, the root systems are not killed, and heavy sprouting tends to occur. These techniques of application, like the chemical agents themselves, provide fertile fields for further research.

Of course, it is obvious that these chemical
treatments lend themselves most effectively to combinations with the mechanical means. For example, a power saw may be used to cut the noxious brush from an area, and a crew follows the saw operator to paint the stumpage with sodium arsenite or some other chemical agent which effects the kill of the root system. Again, cutters or other mechanical devices may be used to remove original noxious brush, with sprays, fogs, dusts or other chemical treatments used as follow-up devices for destroying such sprout growths as may arise.

Of course, the chief problems involved in treatment of noxious brush by chemical means are to discover safe, cheap and selective chemicals. To date, the 2,4-D and 2,4,5-T hormone-type sprays seem to offer the most promise, although they are not at present effective agents for preventing regrowth. Experiments carried on with McCartney roses, sagebrush and minor underbrush indicate effective kills to ground level with these chemicals; but the great need at present is to find a sure-fire inhibitor of sprouts.

Another matter to be taken into consideration in the war against noxious plants is the effect which control methods have upon desirable forage vegetation—forage grasses and browse plants. Obviously, any non-selective spray which destroys desirable farm crops or forage plants is not worthwhile, as in ridding the range of noxious forms it also rids it of desirable forms.

Also, combination techniques involving either chemical or mechanical means of controlling noxious brush growths may be harmful to desirable forage. Bulldozing or cabling, for example, are often followed by grazing the range with goats or sheep, to feed on the sprouts following the operation, and thus to control regrowth. This technique seems to work in the livestock region of the Edwards Plateau, and in areas infested by nontoxic varieties of shinnery oak, especially if the large areas are divided into small pastures. Here the woody plants are the chief forage for goats, which control sprouting effectively. In other areas, however, such a practice is detrimental to the range because of the tendency of the stock to refuse the brush when grass is available, and thus to overgraze the range area already weakened by the noxious brush infestation.

Such problems as these merely serve to point out the necessity for further research in the field of noxious brush eradication and control and for study in the techniques of proper utilization of rangelands once such eradication has been achieved.

**The Strategy of the Future**

When we pause to consider the tremendous scope of the problem of eradication and control of noxious brush on the rangelands of Texas, it becomes obvious that the surface has hardly been scratched. A great deal of the work which has been carried on in the past has been of the investigative and descriptive variety, and there has been little or no correlation of results. Also, in the past few years new fields of investigation, such as the field of chemical attack, have opened up; and not enough time has yet elapsed for definite results to be obtained in the studies set up on these modern bases. All in all, a "broad-gauge" look at the problem indicates that a tremendous expansion in the general investigations now being carried on must be paralleled with both quantitative and applied research, if the ranges of the Lone Star State are to be restored to desirable productivity.

Consider a few statistics: Range ecologists of the U. S. Department of Agriculture estimated in 1943 that cedar and mesquite alone on some 51 million acres in Texas cost ranchmen about $40 million each year in lost income; and reduce the State's potential meat production some 400 million pounds annually! The loss to the State in tax money is commensurate. In the present mesquite area, beef production is now about 626.5 million pounds per year. After clearing and improving the range it would be possible to produce an estimated 993 million pounds per year—a gain of 366.5 million pounds (as this is written, top-quality beef sell on the Fort Worth market at approximately 28 cents per pound!). In the cedar area, noxious brush control and improvement would produce an estimated gain in beef of 35.9 million pounds annually. Together, the overall gain in pounds annually is estimated at the approximate figure of 400 million pounds mentioned above. At present market prices the dollar increases would represent approximately $2.25 per acre over the entire 51 million acres—a total loss to Texas from these two noxious shrub pests alone of about $115 million during the year 1948! A yearly expenditure of one-tenth of 1 percent of such a sum, if devoted to research and the application of research results, would achieve great strides in breaking the hold on Texas rangelands of the noxious brush forms which are sapping their economic value as well as their life strength. It is quite possible, also, that future developments along chemurgic lines might cut the total outlay for a high-quality research program considerably.

The problem of a sound range improvement program for Texas, then, involves two parallel aspects: One, adequate and economical methods of eradicating and controlling noxious brush forms must be developed. Two, a strong educational program based on proper land utilization must be carried on hand in hand with the eradication techniques. It will obviously do no good to found a research program on either of these factors if the other is neglected. If sound and reasonable ways of eradicating the noxious species of plants are not developed, there can never be any great degree of range improvement.

Obviously, the first step in a comprehensive program is the study of methods. A great deal of experimentation must be done in this field—investigation of the effectiveness and cost of various
FIGURE 17
Cabling is an economical and fairly effective method of brush control under certain conditions.

FIGURE 18
Area following a cabling operation. Smaller, more limber plants (center) cannot be treated successfully with this method.

FIGURE 19
Good rangeland in the Edwards Plateau. The presence of the taller grasses and the excellent grass cover on this site are mute testimony of good management practices.
chemical formulations, of mechanical devices and of combinations of mechanical and chemical means of brush eradication and control. In addition, studies in proper management of the range before and after treatment will have to be made, if satisfactory programs are to be established. Studies in succession of plants, and in the growth of forage grasses following treatment must be undertaken. Experiments leading to information regarding the effects of chemical treatment upon forage grasses and herbs, and upon the soil, must be carried on. Studies of moisture retention following removal of brush must be made. All these projects must be undertaken if an over-all understanding is to be reached, and if any sound techniques are to be developed.

Such projects as these outlined have already been begun at College Station and at the substation at Spur, Winter Haven, Beeville, Sonora and Stephenville. Also, many demonstration areas are being mapped out on privately owned ranches throughout Texas, through the cooperation of the owners. Thus, a very encouraging beginning is under way. But in order that sound methods of brush control which utilize both scientific knowledge and practical ways of applying that knowledge can be developed, a great deal of time and money will have to be spent in experimentation, and a large personnel will be needed for this work.

For example, in the newly-developed field of chemical treatment of noxious brush forms, a great mass of experimental data must be assembled. Information is needed as to what chemicals are available, the effect of seasonal application of chemicals, the relative effectiveness of liquids, sprays or dusts applied with hand, machine or airplane sprayers. Anatomical studies of main stems, leaves and roots of noxious forms must be carried on to determine the path of movement of various chemicals. Cost factors for various types of chemical treatments must be investigated. Intensive concentration of experimentation must be made on certain localized noxious forms, such as sand sagebrush, McCartney rose, blackbrush, creosote bush or shinnery oak. The effects of chemicals upon desirable forage plants and farm crops adjacent to range lands should be known before treatments can be applied. Further, the basic relationships between plants such as competition and survival should be thoroughly understood.

Also, much investigation needs to be carried on with mechanical means of eradicating and controlling noxious forms. Although machines have been widely used for some time, they are far from perfect in the results they give, and they are very expensive methods of treatment. Thus, studies are needed in the field of effectiveness of different mechanical devices, in terms of longevity and utility of machines, and in terms of operating costs in different localities on different types of soils and under different weather and terrain conditions.

Much study is needed in the field of combination treatment—the utilization of both chemical and mechanical treatment for controlling or eradicating noxious brush forms. Study in comparing the effect of combination treatments on herbaceous plants and soils with either mechanical or chemical treatment is needed. Also, studies in combination treatment at various locations within the State, and on various outstanding noxious forms such as mesquite, sand sagebrush, blackbrush and oak are of great importance.

Another possibility which must not be overlooked is biological control—the use of such agents as insects and fungi. Several of these agents are known to attack the various species of brush, but they do not seem to damage the brush in its natural state. Also, the bad effect of insects or fungi on useful plants is a major factor limiting their use.

The chemurgic approach has been undertaken by some agencies. To date no outstanding results have been obtained other than those which are already in production at other locations. One should not conclude, however, that this field has been exhausted, since increasingly more interest is being shown by some agencies.

Let us now think for a moment of some of the factors which would be brought to the attention of Texas landowners by a soundly-based educational problem. In the first place, ranchers might well be informed as to the most desirable species of forage grasses, and how to utilize them for the improvement of the range. Today is an age of science—and an age of specific knowledge. The modern Texas ranchman would not hesitate to say that he finds it profitable to study the breeds of cattle, sheep, goats or horses which he raises. Why should he not find it equally profitable to be informed specifically as to the important and desirable forage plants which form the very basis of subsistence for these modern, highly-bred animals of his (Figure 19).

A good brush eradication and control program should make the spreading of such information a must among its activities. For it is only a part of a larger whole. The whole involves every factor pertaining to the welfare of the rangelands—sound scientific knowledge on the part of the landowner; practical and desirable utilization of the range in terms of the numbers and kinds of livestock raised; proper seasonal use of range according to area and forage crops; attention to wildlife management, and attention to the vitally important factor of establishing our rangelands on a self-supporting, sustained-yield basis. All these factors must be made a part of the research and the educational program sponsored by those interested in noxious brush eradication and control.

It's Up to Texans

Yes—it's up to Texans—to pull together in a mighty effort to restore Texas ranges, to rebuild the livestock economy of Texas which has made
the Lone Star State famous in song and story. When we stop to consider the fact that the livestock industry of our State involves 20 million head of animals, 33.5 million acres of land, and a capital investment of approximately $4 billion, we begin to realize the size and importance of the problem. Increased grazing due to brush eradication and control measures properly instituted, and adequately followed up by modern range management practices, could increase our State's revenue from livestock production many million dollars annually. The soils of our Texas rangelands are the basis for our livestock industry's prosperity—they must be properly utilized and properly cared for.

Without a strong, scientifically-planned and scientifically-executed research program and a carefully correlated educational program based on experimental findings, our multi-million-dollar livestock industry is in all probability doomed to slow deterioration. Texas range improvement specialists, Texas soil conservation scientists, Texas landowners and those Texas lawmakers whose duty it is to administer wisely the public funds of the State must work in close cooperation if the range problems are to be solved.

It's up to Texans to save Texas rangelands.

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