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Practical Land Clearing on the Cumberland Plateau

University of Tennessee Agricultural Experiment Station

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PRACTICAL LAND CLEARING ON THE CUMBERLAND PLATEAU

By

J. J. Bird

Typical wild range, frequently burned, and of low timber value.

KNOXVILLE
SUMMARY

Approximately 10 percent of the Cumberland Plateau has been cleared; the population is very sparse and the average farm is too small for successful agriculture.

Agricultural development has been held up largely because of lack of large population centers, extreme deficiency of soil phosphate, and slow returns from new land.

Experimental results and farmers' experiences have demonstrated the high yielding capacity of the soil when it is properly handled for a wide variety of crops.

The major problem confronting the new settler, or the established farmer desiring to enlarge his business, is land clearing. The old method of hand-grubbing has proved too costly and slow, but in the absence of custom clearing with heavy equipment the average farmer must still depend upon some hand method. This must be inexpensive enough to admit of clearing a significant acreage and be commensurately the characteristically low new-land returns.

Experimental data on Plateau-land clearing are meager, and there is very little agreement as to the most practical methods among local farmers. A careful study of local methods has been made over a period of years, and the results are presented with certain data obtained by the Experiment Station during 1943 and 1944.

Improved pasture, requiring only semi-clearing, increases the carrying capacity sufficiently to meet all improvement costs over a period of years, and most efficiently prepares the land for row crops.

The cattle business, therefore, may profitably be adopted for at least the duration of the land-clearing period.
PRACTICAL LAND CLEARING ON THE CUMBERLAND PLATEAU

By J. J. Bird

AGRICULTURAL STATUS OF THE CUMBERLAND PLATEAU

Air travelers over the Cumberland Plateau are impressed with the expanse of wooded area in this part of Tennessee. The Plateau comprises about one-eighth of the State. Less than 10 percent is cleared, and only a small fraction of this is well farmed. It is generally considered to be a relatively unproductive region. The population is less than that of any comparable area in the State. Range law prevails over most of the region, and regular burning of the range is the accepted practice. Until recently, livestock furnished the chief source of agricultural income, and even that was meager.

The average farm in the four most typical Plateau counties—Cumberland, Fentress, Morgan, and Scott—averages 57 acres, of which 22 are cleared and fenced. Table 1, which is based on the 1940 census report, shows that the average farmer owns 1.5 head of cows and heifers 2 years old or over, 1.4 ewes 6 months old or over, and .5 head of sows and gilts to farrow. This average, of course, does not reveal the small number of relatively large operators who have made a reasonable success in this region from free use of the range. The value of all crops sold or traded is on the increase, and at present slightly exceeds the income from livestock. It is evident that the average-sized farm business in this region is too small to succeed.

The lack of immediate markets, particularly for truck crops; the difficulty of building roads in shallow sandstone country; the natural deficiency of certain soil mineral elements, especially lime and phosphate; and the characteristic low returns from new land are some of the factors which have hindered agricultural develop-

<table>
<thead>
<tr>
<th>County</th>
<th>Total acreage</th>
<th>Percent cleared acreage</th>
<th>Number of farms</th>
<th>Acres per farm</th>
<th>Livestock per farm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total</td>
<td>Cleared</td>
</tr>
<tr>
<td>Cumberland</td>
<td>434,560</td>
<td>30</td>
<td>50,722</td>
<td>2,063</td>
<td>63</td>
</tr>
<tr>
<td>Fentress</td>
<td>319,360</td>
<td>33</td>
<td>40,177</td>
<td>1,740</td>
<td>61</td>
</tr>
<tr>
<td>Morgan</td>
<td>344,960</td>
<td>29</td>
<td>36,587</td>
<td>1,632</td>
<td>61</td>
</tr>
<tr>
<td>Scott</td>
<td>351,360</td>
<td>17</td>
<td>25,817</td>
<td>1,507</td>
<td>41</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>10.6</td>
<td></td>
<td>57</td>
<td>22</td>
</tr>
</tbody>
</table>

¹Cows and heifers 2 years old or over January 1, 1940.
²Ewes over 6 months of age.
³Sows and gilts to farrow April 1, 1940.
ment. Moreover, a large proportion of the population has never been dependent on agricultural activities for a livelihood. Lumbering, coal mining, and small industries such as handle-mills have largely carried the burden of maintenance. The recent census figures indicate that 53.4 percent of farm operators worked off the farm, and over three-fourths of this number worked off the farm 100 days or more.

JUSTIFICATION FOR AGRICULTURAL DEVELOPMENT

The experiences of leading farmers, and Experiment Station results over a long period, have proved the adaptability of the Plateau to the production of profitably high yields of top-quality crops. The area is characterized by an unusually favorable climate during the growing season, as indicated in figure 1, the high rainfall and relatively low temperature being particularly conducive to profitable truck-crop production. The high quality of the potato
crop has been recognized for many years, and recently the green-
bean industry has gained an important place in the agriculture of
the Plateau. Practically all truck crops appear to have possibilities
here. Also, livestock feed yields, particularly of corn, are up with
the top in the State when the crops are grown under good manage-
ment.

Recent soil surveys of parts of the Plateau would indicate that
approximately 25 percent of the land could be used in rotational
farming, and possibly another 20 percent or more might be improved
for pasture. Seedings made by the Experiment Station during the
period 1936 to 1939 on new-land slopes up to 20 percent have been
fully as productive as similar seedings on level land, and little dif-
ficulty was encountered in getting the seedings established without
noticeable erosion. The establishment of seedings on similar slopes
on old worked land has been uncertain.

Tennessee is a heavy importer of foods which, if produced with-
in the State, would relieve the now crowded shipping facilities and
would tend to bring about a more stable economy when the emer-
gency is over. The availability of cheap phosphates has removed
a one-time serious obstacle to local development. Lime also is
available at reasonable cost.

The Plateau probably is unsurpassed as a potential seed-produc-
ing area. It is relatively free from many diseases, insects, and
weeds. The use of comparatively new land for seed production can
be assured for many years, and the fairly central location in the
State is advantageous.

Evacuees from the TVA reservoir areas with money and farm
experience have settled on the Plateau within recent years, and
many more are considering such a move. Low-priced land is an
inducement, but unless the newcomers have some knowledge of
local conditions, particularly of the meager returns from new land
during the first two or three years, farm mortality will continue to
be high. Undoubtedly the agriculture of the Plateau will be most
effectively developed by the newcomer with the necessary funds and
farm experience used in connection with accurate information on
Plateau conditions.

LAND CLEARING A MAJOR PROBLEM

Trees may be considered the chief obstacle to farming on the
Plateau. The picture on the cover of this bulletin shows a typical
forest growth pastured as wild range and regularly burned. The
growth is not dense, but the customary hand methods used in
clearing have been too time-consuming, and the returns from new
land have been so limited as to make traditional methods relatively
expensive.¹

Experimental data pertaining to land clearing in this region
are meager. Land-clearing experiments now are being conducted
as an important part of the work of the recently established Plateau

¹Labor, material, and cost of clearing land on Cumberland Plateau, by Bonser, Allred, and
Experiment Station, where typical range land is available. In 1943 and 1944 some data pertaining to labor requirements of the most common local methods were obtained in connection with the clearing of land for experimental purposes. These data, together with the results of a careful study of traditional methods, warrant the making of certain recommendations which may be beneficial in view of an increased demand on the part of prospective farmers for information pertaining to land clearing in the Plateau region.

THE SMALL-FARM PROBLEM

The average prospective farmer is a small operator who must get along with limited capital, equipment, and labor. He also requires immediate income, and cannot risk a heavy investment, particularly in view of delayed returns from new land. Land clearing with him must be a gradual process and may require a special type of farming for the duration of the clearing period. The high mortality of prospective farmers in this region appears to be due to the common error of saving back too little capital in the purchase and clearing of land—the latter being a relatively far more expensive item than at first realized—and their consequent inability to wait out the period of unprofitable returns. This slow-return period, however, may be shortened materially by heavier applications of fertilizer and heavy-tool, thorough soil fitting, a method usually not possible with the average operator.

LAND CLEARING FOR IMMEDIATE ROW-CROPPING

Immediate row-cropping has been the chief object in land clearing to date. The most common local method of clearing for immediate row-cropping is illustrated in figure 2. Here the growth

Fig. 2—A typical method of land clearing on the Cumberland Plateau. The small growth was grubbed out, the intermediate growth was cut axe-handle high, the larger growth was deadened. Corn was grown the first year.
up to 6 to 8 inches is grubbed out with a mattock (stump removed), intermediate growth is cut axe-handle high, the larger growth is deadened, and corn is the first crop. This is about 100-percent bull-tongue farming. Two sproutings per season are required to keep down second growth—necessarily hand work, since the mower cannot operate here even when the area is pastured. A yield of 15 bushels of corn per acre is considered satisfactory the first year, even though phosphate at the rate of 200 to 300 pounds of 16-percent equivalent per acre is used. After 1 to 3 years in corn, followed by 2 to 3 years in lespedeza, the land will again be in corn. The necessity for cultivation during the first 2 or 3 years for sprout control where the mower cannot be used has popularized the corn crop at this stage and resulted in serious soil erosion on most of the acreage cleared. Winter cover crops under the conditions illustrated are practically unknown on such new land.

A small percentage of land has been cleared for row-cropping by the use of a heavy tractor for pulling over the trees. The Cumberland Homesteads was the first sizable acreage cleared by this method on the Plateau (1934-1938). The possible justification for this method lies in the fact that a much larger stump can be pulled by the average farm tractor by this method than by that of first felling the tree. Most of the growth over 2 inches can be effectively tractor-pulled with the same chain and hook used for the heavy growth. This method unquestionably is an advance over hand-grubbing, but not sufficiently so to be a popular practice at the present time.

Some bulldozer clearing has been done on the Plateau, and this undoubtedly is the cheapest method by which a significant acreage can be brought into immediate row-cropping. The machine leaves
the land in fairly workable condition for row cropping (Fig. 4, upper), but renders the piled material difficult to burn because of the large amount of earth usually pushed into the piles. This phase of bulldozer clearing is considered by many the most expensive part of the job (Fig. 4, lower). Immediate row-cropping is possible however, without elimination of the piled material if this is windrowed. Bulldozer clearing requires a definite cash expenditure for which family labor cannot be substituted, and such custom methods may never become very popular with the farmer of average means who may have available more family labor than cash.

Fig. 4—
Upper: Sparsely covered range land cleared with bulldozer. Heavily covered range could be as effectively cleared, with the exception of more piled material. Roots have been largely pushed out.
Lower: Typical bulldozer piling of forest cover, including a large amount of earth, which renders final disposition difficult.

Considering the meager amount of Plateau land cleared up to the present time, it may be concluded that at least the three general methods of land clearing for immediate row-cropping as outlined above have proved inadequate, whether because of lack of labor,
money, or equipment, or because the increased value of improved land was not sufficient to justify the costs. It has been pointed out that new-land returns are low, regardless of cultural methods, and the traditional practice of immediate corn cropping of new land as an aid to sprout control in many cases decreases rather than increases its productivity. Under proper management, however, the productivity of the land has fully justified reasonable clearing costs.

PARTIAL CLEARING FOR PASTURE

The relatively expensive feature of Plateau land clearing for immediate row-cropping is the removal of the underground material. The elimination of this part of the clearing job greatly reduces labor, money, and equipment requirements; and gradual, low-cost, partial clearing methods appear to hold the greatest possibilities for the development of the region by the largest number of farmers.

Typical of limited-acreage partial clearing is that practiced for pasture improvement. It consists in the grubbing out of growth up to approximately 6 inches, deadening of all remaining timber to eliminate shade and permit theoretical enrichment of the soil as a result of dropped branches, and seeding for a brief pasture period after limited applications of lime and phosphate. Unless overgrazing is resorted to, sprout control depends upon hand sprouting over a 2- or 3-year period. The laborious practice of grubbing is considered essential in the control of second growth and remains a limiting factor in traditional methods of pasture improvement.

A possible improvement in range-pasture development over the foregoing tree-deadening method is that of grubbing out all growth to 8 or 10 inches and leaving all sound trees for further growth (Fig. 5). This land was grubbed in 1941, limed at the rate of 2 tons per acre, phosphated at the rate of 200 pounds 20-percent equivalent,
and seeded to a permanent pasture mixture in the spring of 1942. It was mowed once for ferns, hand-sprouted during July in 1942 and 1943, and pastured close. In carrying capacity, such pasture is considered to be increased about 3 times over the wild-range condition. Such pasture starts noticeably earlier and lasts longer. The danger to livestock from the falling of deadened trees is avoided by this method, and shade reduction can be continued while the land is in production. An insignificant acreage has been improved to date in this manner, but the method may be considered a significant pointer.

Chemicals and kudzu have possible uses in certain phases of low-cost land clearing, but local data are not available.

**LABOR AND COSTS**

Local land-clearing labor and cost estimates, either for immediate row-cropping or pasture improvement by customary methods, vary widely, but remain discouraging. As reported by Bonser, Allred, and Mantle, in the monograph previously referred to, complete clearing for pasture (girdling and brush removal by grubbing) ranged from $3.10 to $44.50 per acre on the basis of farm wages during the period 1934-1943. It is evident that little acreage will be cleared at costs above $25.00 by the farmer of average means. However, the relative cheapness of bringing wild land into production by way of partial clearing for pasture deserves special consideration, particularly the possibilities of shrubbing rather than grubbing, coupled with efficient sprout-control methods.

Specific labor requirements were obtained by the Experiment Station in 1943 on 40 acres, covering 4 methods of clearing under 2 common types of growth (table 2). Plot 1 was selected because of a very thick growth commonly found in areas where firing occurred 6 to 8 years previously and where no fire had occurred since. It contained, per acre, 194 trees 3 inches or over in diameter. Plot 2 represented the more common type, more thickly timbered with the larger growth, and contained 338 trees per acre 3 inches or over in diameter. Plot 1, however, had more total standing material when everything under 3 inches was counted. Two men were selected to do the hand work who could apply themselves steadily for 8 hours at reasonable exertion. Local practice indicated that even though trees compete noticeably with grass, fair results with pasture seedings are regularly obtained under some shade. Since the cost of preparing for the seeding mounts with the number and increasing size of the trees removed, the rule was established that all growth under 8 and 12 inches should be removed. Very little shade was left under the latter conditions—and removal of growth under 8 inches is typical of local practice.

The acre with 194 trees above 3 inches required 58 man-hours to shrub and 2 hours to log with man and team, brush burned as cleared, all growth under 12 inches removed at ground level. This small growth required relatively little time to remove. The clearing of plot 2 was noticeably more difficult. But when the brush was
LAND CLEARING ON CUMBERLAND PLATEAU

Table 2—Relation of forest-cover density to labor required in clearing by various methods.

<table>
<thead>
<tr>
<th>Tree diameter 30 inches above ground</th>
<th>Plot 1</th>
<th>Plot 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 3 inches</td>
<td>Very thick</td>
<td>Very few</td>
</tr>
<tr>
<td>3 to 6 inches</td>
<td>171</td>
<td>234</td>
</tr>
<tr>
<td>6 to 8 inches</td>
<td>13</td>
<td>61</td>
</tr>
<tr>
<td>8 to 12 inches</td>
<td>2</td>
<td>23</td>
</tr>
<tr>
<td>Over 12 inches</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>Total 3 inches and over</td>
<td>194</td>
<td>338</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Labor requirement per acre</th>
<th>Hours</th>
<th>Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ground-level cutting under 12 inches; brush in round piles and burned as cleared—typical local method</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>Bunching logs, team and man</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>2. Ground-level cutting under 12 inches; brush windrowed, not burned</td>
<td></td>
<td>56</td>
</tr>
<tr>
<td>Bunching logs, team and man</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>63</td>
</tr>
<tr>
<td>3. Ground-level cutting under 8 inches; brush windrowed, not burned</td>
<td></td>
<td>38</td>
</tr>
<tr>
<td>Bunching logs, team and man</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>42</td>
</tr>
<tr>
<td>4. Grubbed under 8 inches; brush windrowed, not burned</td>
<td></td>
<td>182</td>
</tr>
<tr>
<td>Bunching logs, team and man</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>190</td>
</tr>
<tr>
<td>5. Same as No. 4, except brush piled in round piles and burned as cleared</td>
<td></td>
<td>220</td>
</tr>
<tr>
<td>Bunching logs and stumps, team and man</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>228</td>
</tr>
<tr>
<td>6. All growth pulled as completely as possible with 45-horsepower farm tractor and removed to edge of clearing; dynamite used to loosen soil on stumps:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Man-hours</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>Horse-hours</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Tractor-hours</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>7. Bulldozer clearing; all growth piled, not burned (Final disposition of trees and brush rendered difficult because of piled earth. Data on latter phase not available).</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

windrowed for later burning on plot 2, actually less time was required to shrub-clear this heavily timbered piece. Hauling off logs required 7 hours with man and team on plot 1.

Burning the brush in round piles as the shrubbing progressed proved definitely more time-consuming than windrowning for burning when dry. Immediate burning in round piles tended toward inefficiency on the part of the shrubber, the green material requiring constant re-piling of the butt ends for complete consumption. It was also impossible to avoid burning the leaf coverage a good deal
Fig. 6—

Top: Typical range shrubbed and piled in windrows for later burning.

Middle: Heavy leaf cover on same ground which may be preserved by disking between the brush windrows before burning.

Bottom: Heavy leaf cover practically blown away one year after shrubbing. This may be prevented by immediate disking before burning.
of the time. Getting rid of brush was most efficiently accomplished when the shrubbing and piling were separate operations and the brush was windrowed and allowed to dry and pack for more effective burning (Fig. 6, top). The time required to fire properly piled dry windrows was insignificant. Approximately 40 extra man-hours were required to pile and burn with the grubbing than were required by the windrow method, as indicated in items 4 and 5, table 2. Practical windrow spacing was found to vary from 50 to 100 feet. Preservation of the leaf cover shown in figure 6, middle, by disk before burning was facilitated by windrowing the brush. Areas undisked lost the greater part of the leaf cover by wind in less than a year (Fig. 6, bottom).

Ground-level shrubbing of all growth under 8 inches, on plot 2, required 38 man-hours and 4 man- and team-hours, as compared with 56 and 7 hours for the 12-inch growth. This is the low-cost method. It is becoming more popular as a means of getting started on a seeding with the expectation of removing more of the shade as soon as possible. This also permits an increased growth of the remaining sound trees which are considered a part of the farm crop by those practicing this method.

As indicated previously, the clearing of land for immediate row-cropping requires the removal of most of the underground growth. Conventional hand-grubbing of all growth under 8 inches required 182 man-hours per acre and 8 man- and team-hours, or nearly 5 times the labor required for shrubbing. It required 55 minutes by a practiced individual to grub out the average standing 10-inch tree, and 2 men 8 minutes to cut the same-sized tree at ground level (Fig. 7). A large part of the extra labor required in grubbing operations was due to the increased amount of heavy material for removal.

Pulling the trees with a 45-horsepower farm tractor reduced the man labor approximately 50 percent under hand grubbing, but did not materially reduce the total cost when the tractor was charged at $2.00 per hour. Disposal of stumps carrying from 18 to 30 inches of soil proved a labor-consuming feature of this type of clearing (Fig. 3). Removing stump soil with dynamite was unsatisfactory, but shaking the soil loose before pulling by the use of 2 or 3 half-stick charges was worth while. The filling of stump holes after tree pulling required considerable labor in the absence of a bulldozer.

Bulldozer-clearing costs have not been studied by the Experiment Station, but, as observed locally, a machine cost of $10.50 per acre appears about average under an hourly charge of $3.50. This does not include the final disposition of trees and brush, essentially hand work. As pointed out, windrowing forest material for later disposal makes possible immediate row-cropping over a large part of the area being cleared. Undoubtedly the larger operators will use the bulldozer to an ever-increasing extent during the next few years, particularly if low-cost custom clearing develops.
It is evident that the low labor requirement for ground-level shrubbing of all growth under 8 or 12 inches places relatively large-scale clearing, of this type, at least, within the scope of family labor. Even at a normal farm wage of 20 cents per man- or horse-hour, land could be prepared for disking at a cost of approximately $10.00 per acre. This cost may be reduced still further through the sale of chemical wood and other wood products. The same hourly rate applied to the actual time required to clear completely for row-

cropping by grubbing made an acre cost of $41.20. This cost is prohibitive for the average farmer. As a result, complete clearing by grubbing has been limited in most cases to family labor units of 1 to 5 acres. On the other hand, the apparently cheap partial clearing by shrubbing for pasture has not met with the success it deserves, largely because of the increased problem of sprout control and the free use of the range for pasture.

**PRACTICAL SPROUT CONTROL**

Since pasture operations are not hindered by growth left underground, and the cost of shrubbing is within the reach of the average
LAND CLEARING ON CUMBERLAND PLATEAU

Fig. 8—Sprout control by overgrazing, and duration of stumps.

Overgrazing eliminated sprouts within 2 to 3 years after seeding in 1931. The large white oak stump at left was still fairly solid in 1944, and the black oak stump at right was practically decayed. Hickory stumps disappeared during the first 5 years.

The speed of stump decay is conditioned by many factors, but local experience indicates that large oak stumps are not easily removed under 10 years when cut at the usual height. There is some evidence that stumps cut at ground level to allow the soil to work over them will decay faster.

Of the mechanical means of sprout control, the use of the mower twice a season for 2 or 3 years has proved effective. The mower is not yet usable, however, on the majority of partial clearings because tree growth has not been sufficiently thinned. Furthermore, the mower is not adapted to the removal of sprouts from stumps and deadened trees, and therefore is only partially effective where trees are not removed level with the ground.

The most effective and economical method of sprout control observed under all conditions of clearing is by the use of goats. The animals prefer sprout growth and weeds to tame pasture plants. Complete control of broomsedge on a bluegrass-white clover pasture farmer, the matter of sprout control justifies special consideration.

Sprout growth following shrubbing can be definitely controlled with a minimum of hand labor by overgrazing (Fig. 8). This method is open to the objection of underfeeding the cattle while in the process. Very little hand-sprouting was necessary on the pasture illustrated, which was shrubbed, limed, phosphated, and seeded in 1931. Sprouts disappeared within 2 to 3 years. Figure 8 also illustrates something of the length of life of various kinds of stumps commonly found on the Plateau. All hickory stumps disappeared 4 to 5 years after clearing and seeding. Large white oak stumps were still solid in 1944, 13 years after clearing. Black oak stumps were removable with the heavy disk.

Of the mechanical means of sprout control, the use of the mower twice a season for 2 or 3 years has proved effective. The mower is not yet usable, however, on the majority of partial clearings because tree growth has not been sufficiently thinned. Furthermore, the mower is not adapted to the removal of sprouts from stumps and deadened trees, and therefore is only partially effective where trees are not removed level with the ground.

The most effective and economical method of sprout control observed under all conditions of clearing is by the use of goats. The animals prefer sprout growth and weeds to tame pasture plants. Complete control of broomsedge on a bluegrass-white clover pasture
was attained by milk goats under experimental control during 1941 and 1942 near Crossville. They have been used effectively in preparing land for the clearing operation by destroying all young growth up to 5 or 6 feet in height and weakening a large percentage of the heavier growth by girdling and defoliating.

The effect of the goat system of sprout control is illustrated in figure 9. The upper picture shows 1-year sprout growth on grubbed and on shrubbed land which occurred during the dry season of 1943. Under more normal growing conditions the difference in sprout growth following grubbing and shrubbing is greater than that shown in the illustration, and it is evident that without efficient sprout control the low-cost method of shrubbing will not become popular. The pasture land, shown in the lower picture, was shrubbed in 1938, given 3 tractor diskings with a standard disk, liberally limed and phosphated, and seeded, and sprouts were completely controlled with goats at the rate of 1 goat per acre. During the first
Fig. 10—

Top: Typical second growth 2 years after shrubbing; no control.

Middle: Left half similar to above; right half worked only with the special cutaway disk and seeded to soybeans and millet.

Bottom: Soybeans and millet as first crop on this land. Second-growth sprouts practically nonexistent; season dry.
season, the sprouts persisted; some control was noticeable the second year, and no sprouts emerged the third year. It is the opinion of the owner that far less than one goat per acre will fully control sprouts after shrubbing. It should be pointed out that the early season’s sprout growth under goat grazing appears to gain on the goats during the first 2 years, but it is during the latter part of the season, when sprouts have ceased growing and are storing food reserves, that the goats make their chief gain. Fencing is necessary for goats, but if properly handled they can be confined by a 4-foot fence.

Sprout growth is so rapid following shrubbing that 4 or 5 years’ unchecked growth will require almost as much labor as the original shrubbing required. A unique method of mechanically attacking sprout growth before it became too far advanced is illustrated in figure 10. This land was shrubbed 2 years previously and neglected. The top photograph shows the sprout growth that occurred during the seasons 1941, 1942, and part of 1943. Most of the trees were cut at ground level when originally shrubbed and permitted the use of a medium-weight, cutaway, tractor-drawn disk. After 5 diskings in different directions, most of the smaller growth was sufficiently loosened and chopped up to permit removal with the ordinary dump rake. Sprout growth was so well controlled that an excellent crop of soybeans and millet was produced during the dry season of 1943, as indicated in the two lower photographs. No sprouts were observable in this field during the crop season, and in the observation of the writer this method required the least labor per acre to eradicate the heavy growth indicated. This local experiment was the first of its kind observed. The method will prove efficient under similar circumstances for workers having access to the special type of disk and tractor power. Most of the crowns and roots, of course, were left underground, and the area would be unsatisfactory for immediate row-cropping.

IMPLEMENTS

The axe, brush hook, and crosscut saw are the traditional local land-clearing implements and are practical, particularly for shrubbing. Power saws eventually may relieve the difficult task of removing trees at ground level, with the possibility of disposing of all the shade before seeding for pasture. Experimental studies of the power saw in Plateau-land clearing have not yet been made, but the portable power circular and chain saws appear promising.

The most significant advance in the use of implements has been the shift from the bulltongue and plow to the disk for fitting newly cleared land. Disk-fitting of such land is best suited to pasture development and largely accounts for the change, since neither the plow nor the bulltongue can be used following shrubbing. The absence of sod on range land also increases the efficiency of the disk.

The standard team disk has been used effectively on small areas of the Plateau where 6 to 8 diskings could be given. The disk facilitates the covering of level-cut stumps with soil, and rides over such
stumps without delay or damage to equipment. Commercial-sized land-fitting operations, however, require tractor power and special-type disks for efficiency.

Two such disks are illustrated in figure 11. Both of these types have been used at the Experiment Station and deserve high recommendation. The medium-weight cutaway type can be pulled by the average farm tractor, and also has proved its worth in general farm land-fitting operations. The heavy-type, single-section, weighing 2000 pounds, requires at least a 45-horsepower tractor for operation. Twice over with this disk puts the land in excellent condition for finishing with a light standard disk, and may be considered an essential in large-scale clearing and fitting operations on the Plateau. The practicalness of this implement has also been well demonstrated in the clearing operations of the Cumberland Homesteads, the Cumberland Mountain Potato Company, and elsewhere.

![Recommended disk types for fitting shrubbed land without plowing.](image)

**Upper:** Medium-weight cutaway, easily pulled by average tractor; 4 or 5 operations required.

**Lower:** Heavy-weight cutaway, single section, weighing 2000 pounds, requiring a 45-horsepower tractor; 2 or 3 operations required.
PRACTICAL LAND CLEARING THROUGH THE USE OF CATTLE

Considering the expense of clearing land for row-cropping by any method, the necessity of investing as little as possible in the clearing operation in view of the low returns from new land, and the physical impossibility of preparing a significant acreage of new land for row-cropping by the usual hand methods, forces the conclusion that the average farmer can convert a sizable acreage of Plateau range land into crop production most efficiently through the pasture route, even though it requires the adoption of a livestock program for the duration of the clearing period. For any piece of land it will evidently be from 5 to 10 years following shrubbing before the level-cut stumps and roots will yield to the disk plow or heavy disk. If this period can be made profitable or if all costs involved—shrubbing, fencing, liming, phosphating, soil fitting, and seeding—can be met by livestock returns even without a net profit,

Table 3—Estimated comparative returns from unimproved and improved Plateau range pasture over ten-year period.

<table>
<thead>
<tr>
<th>Item</th>
<th>160 acres</th>
<th>Unimproved range</th>
<th>Improved range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carrying capacity, number head</td>
<td>5</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Total weight gain 10 years</td>
<td>10,000 lbs.</td>
<td>30,000 lbs.</td>
<td></td>
</tr>
<tr>
<td>Total value, @ 9¢ per pound</td>
<td>$900.00</td>
<td>$2700.00</td>
<td></td>
</tr>
<tr>
<td>Value of land improvement</td>
<td></td>
<td>$2500.00</td>
<td></td>
</tr>
<tr>
<td>Total gain</td>
<td>$900.00</td>
<td>$5200.00</td>
<td></td>
</tr>
<tr>
<td>Costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Materials:</td>
<td></td>
<td>$175.00</td>
<td>500.00</td>
</tr>
<tr>
<td>Fence, one-half cost, 20-years life</td>
<td></td>
<td>$500.00</td>
<td></td>
</tr>
<tr>
<td>Lime, 200 tons @ $2.50 delivered</td>
<td>250.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phosphate, 40 tons @ $20.00 (2 applications, 20 tons each)</td>
<td></td>
<td>800.00</td>
<td></td>
</tr>
<tr>
<td>Seed</td>
<td>400.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cost of materials</td>
<td></td>
<td>$1875.00</td>
<td></td>
</tr>
<tr>
<td>Labor and custom tractor work:</td>
<td></td>
<td>$1260.00</td>
<td>250.00</td>
</tr>
<tr>
<td>Clearing ground-level under 12 inches, 6300 hours @ 20¢</td>
<td></td>
<td>600.00</td>
<td></td>
</tr>
<tr>
<td>Fencing, 50¢ per rod</td>
<td>100.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land preparation, 4 tractor diskings, 1 cultipacking with last disking, 400 acres, @ $1.50 per acre</td>
<td></td>
<td>2210.00</td>
<td></td>
</tr>
<tr>
<td>Drilling lime, phosphate, and seed, @ 50¢ per man and team</td>
<td>175.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cost of labor and tractor hire</td>
<td></td>
<td>$4260.00</td>
<td></td>
</tr>
<tr>
<td>Taxes</td>
<td>50.00</td>
<td>175.00</td>
<td></td>
</tr>
<tr>
<td>Total cost</td>
<td>$50.00</td>
<td>$4260.00</td>
<td></td>
</tr>
<tr>
<td>Labor earnings</td>
<td>$850.00</td>
<td>$940.00</td>
<td></td>
</tr>
<tr>
<td>Labor value that may be furnished by the family if tractor is owned</td>
<td></td>
<td>$2060.00</td>
<td></td>
</tr>
<tr>
<td>Total possible labor-income equivalent</td>
<td>$850.00</td>
<td>$3000.00</td>
<td></td>
</tr>
</tbody>
</table>
the method may be considered successful, since the land then will be ready for row crops, will have improved measurably in productivity, and will have increased in salable value.

What returns may be expected from low-cost pasture improvement of Plateau range land? In free-range country any improvement must start with fencing. The question may well be asked, "What degree of range-land improvement justifies fencing?" Table 3 presents a comparison of estimated incomes from 100 acres of wild and low-cost improved range pasture over a 10-year period.

Only estimates are available of the carrying capacity of wild-range pasture and the average annual gain per head of growing animals during the full pasture period. The average of local estimates indicates that 20 acres of wild range per head are necessary for an average gain in growing animals of 200 pounds. Using this as a basis and excluding mortality of animals—since data are not available—the 10-year return at 9 cents per pound would be approximately $850.00 from 100 acres of wild range after deduction of costs.

It is also the conservative estimate by local cattlemen that low-cost pasture improvement, such as shrubbing all growth under 8 or 12 inches, liming, phosphating, and seeding, increases the carrying capacity at least 3 times. On this basis, 100 acres would return $2700 in beef over the 10 years, the land would increase in salable value at least $2500 at local figures, and a total possible equivalent labor income of $3000 could be obtained if all the work was done by the family, after allowing for necessary cash costs of improvement. Furthermore, the land would be in a relatively high state of productivity for the beginning of cultivated crops. Additional profits also should be realized through the controlled breeding program and decrease in disease and theft. This hypothetical case is presented merely to indicate the practicability of land clearing by the use of cattle, and particularly to present the possibility of relatively large-scale clearing within the range of the average farmer's cash and labor supply.

SUGGESTED LAND-CLEARING PROCEDURE WITH CATTLE

On the basis of studies and observations on the Cumberland Plateau, the following land-clearing procedure is recommended during normal times, whether livestock is to be the eventual business or not:

1. Fence the area to be improved, using, if necessary, a low woven wire with barbed wire.

2. Hand-grub or use the bulldozer on the minimum acreage necessary for row crops—5 to 10 acres on the average 100-acre tract.

3. Shrub the remainder at ground level, taking out all trees under 8 or 12 inches, depending on the thickness of the timber stand. As little shade as possible should remain, and sufficient trees should be taken out to allow movement of disk, lime spreader, drill, and mower.
4. If too much shade remains from trees over 12 inches in diameter, remove as necessary 30 inches high, after establishment of pasture—or trees may be deadened if of no timber value.

5. Windrow all brush where it is thick enough to burn well. Allow it to dry and pack. In typical range, windrows may be from 50 to 100 feet apart. All butt ends of brush should be placed in the center of the brush row, and burned when the wind is in line with the row. Brush piling should be a separate operation.

6. The ground cover of leaves should be preserved by disk ing between the brush rows before burning.

7. The land should be fitted with a heavy cutaway disk, finished if necessary with a standard disk. Three to six diskings will be necessary, operated in different directions. Disking should start in the spring and continue until August.

8. Lime should be applied during the disk ing operation at the rate of 2 tons per acre.

9. Phosphate at the rate of 400 pounds or more of 20-percent equivalent and seed near the first of August with a permanent-pasture mixture containing at least orchard grass, bluegrass, timothy, redtop, red clover, and white clover. Lespedeza should be seeded the following spring. Re-phosphate frequently if possible.

10. Keep sprouts under control with goats at the rate of one or less per acre, or by two mowings during each of the first two seasons.

11. Cut out remainder of timber as convenient after pasture is established.

12. Row-crop 5 to 10 years after original improvement.
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