Rotation Burning: A Forage Management System for Longleaf Pine-Bluestem Ranges

V. L. DUVALL AND L. B. WHITAKER
Southern Forest Experiment Station, Forest Service, U.S. Department of Agriculture, Alexandria, Louisiana.

Highlight

In a Louisiana test, heavy utilization during growing seasons following fires applied at 3-year intervals improved forage palatability and nutritive content; the ensuing 2 years of lighter use restored plant vigor. Burning also top-killed brush and aided herbage growth by removing pine litter. Cows with calves gained weight throughout the growing season on rotation-burned range.

A forage management system known as rotation burning has been developed for cattle ranges in the longleaf pine-bluestem type. This paper describes the system and explains how it affected range vegetation and cattle in a 6-year test.

The primary objective of rotation burning is to increase forage value during summer and fall. A secondary purpose is to improve distribution of grazing.

Although herbage is generally abundant on longleaf pine-bluestem ranges, palatability and nutritive value are low during much of the year. Spring growth is rapid; frequently 60 percent or more of the annual forage supply is produced before mid-June, but by then nutritive content on moderately grazed range is usually inadequate for most classes of cattle. Also, animals tend to avoid areas where grass makes rank growth, and overgraze the regrowth from areas cropped earlier.

Rotation burning, as developed and tested to date, consists of two steps: (1) dividing a range unit by firelines into three subunits of approximately equal grazing capacity, and (2) burning one subunit per year in a 3-year rotation. Fire destroys plant debris and improves availability of new herbage, causing cattle to concentrate on freshly burned range. Close grazing of new growth keeps vegetation palatable and nutritious; hence, use remains heavy throughout most of the growing season.

Burning the second subunit shifts intense use and sharply reduces grazing on the unit burned previously. Thus, without interior fencing, heavy grazing on each subunit during 1 year of the rotation is followed by 2 years of relatively light use.

The system is based on several studies. Campbell and Cassady (1951) reported that cattle grazed burned areas much more intensely than adjacent unburned range. Campbell et al. (1954) found protein content of grass on unburned, ungrazed range inadequate for breeding herds except during the brief young-leaf stage. Burning increased protein content of early growth, but where fire was not followed by close utilization this benefit was short-lived. Duncan and Epps (1958) noted that the full-leaf and mature greenleaf stages of the main bluestem grasses were nutritionally deficient, particularly in protein, for dry cows as well as those with calves.

Cassady (1953) found that herbage clipped closely 15 times during the growing season contained adequate protein for cows with calves. Samples representative of the cattle diet on unburned, moderately grazed range became deficient in protein by July. Although repeated close harvesting kept protein content high, it reduced grass production, not only during the season of harvest but through a succeeding year of complete protection.

These findings suggested that a specialized grazing system, combining periodic burning and heavy utilization, might resolve the problem of low forage values during summer and fall. A 3-year burning rotation appeared to be a logical choice. Burning one-third of the range each year promised to intensify grazing sufficiently to maintain relatively high palatability and nutritive content, while permitting cattle to obtain most of their forage from newly burned range. It would also provide 2 years of comparatively light use to allow recovery of plant vigor lost during heavy grazing.

Also considered in devising the rotation burning system were possible effects of fire on soil properties. Wahlenberg et al. (1939) reported that soil was not materially degraded by annual controlled burning. Heyward and Barnette (1934) found indications that frequent burning of longleaf pine forests improved surface soil chemically by increasing nitrogen, replaceable calcium, and organic matter.

Procedure

Rotation burning began in 1956 on the Palustris Experimental Forest in central Louisiana. By 1958 tests involved four range units, varying from 570 to 590 acres. Most of the range was relatively open cutover forest land, but several areas supported artificially regenerated pine 2 to 7 years old.

Range vegetation was relatively uniform. Principal grasses were slender bluestem (*Andropogon tener*) and pinehill bluestem (*A. divergens*). Other common grasses included panicums (*Panicum* spp.), paspalums (*Paspalum* spp.), and miscellaneous bluestems (*A. ternarius, A. subtenius, A. elliottii,* and *A. virginicus*). Swamp sunflower (*Helianthus angustifolius*) and grassleaf goldaster (*Chrysopsis graminifolia*) were the most important perennial forbs. Legumes and grasslike plants were common but produced little palatable herbage. Prior to the study, herbage averaged a little over a ton (air-dry) per acre.

Ranges were stocked yearlong with breeding herds. Cows were typical native stock—various mixtures of British beef breeds, Jersey, and Brahman. Bulls were purebred Shorthorns. The utilization objective was the same in all units: 40 to 50 percent average of three subunits. Breeding was regulated for winter calving. During late fall, winter, and early spring, herds received various supplemental rations, mainly cottonseed cake. Because forage is deficient in phosphorus all year, steamed bonemeal was furnished continuously. Cows and calves in two range units were weighed periodically throughout one rotation.

Subunits consisting entirely of cutover land were burned in early May by free-running headfire. Burning was timed to destroy herbage when palatability of normal spring growth started to decline. Subunits containing regenerated pines were burned in early March by low-intensity backfire to avoid damaging trees. Rotation burning began in planted slash pines at age 4, in planted longleaf pines at age 8, and in seeded loblolly pines at age 7.

Herbage production and forage utilization were determined on three range units by clipping one cluster of four 3.1- by 3.1-foot quadrats per 15 acres. One quadrat per cluster was caged yearlong to measure herbage production. The remaining three quadrats were open to grazing. Measurements of residual herbage on open quadrats were used to compute forage utilization. All quadrats were clipped in late winter immediately before herbage growth began, then relocated to avoid reharvesting the same areas.

Measurements on subunits burned in May were confined to herbage that grew after the fires. All other determinations were of seasonlong production and yearlong utilization. Measurements were for one rotation on two units and for two consecutive rotations on the other unit.

Composition of vegetation was estimated ocularly. In addition, a 20-acre unburned block in one range unit served as a control area for assessing effects of rotation burning on herbage yield and botanical composition. At the close of the study, frequency of major herbaceous species was determined on the control area and on an adjacent area that had been burned twice at a 3-year interval. Frequency quadrats were 3.1 feet square, spaced 50 feet apart on 500-foot transects.

Results

Cattle began concentrating on newly burned range within 1 to 4 weeks, depending on burning date and earliness of grass growth. Grazing usually remained uniformly heavy until late summer, and cattle demonstrated little selectivity among grass species (Figure 1). Unburned subunits were grazed moderately in early spring, but lightly during late spring and early summer. By June, early maturing grasses — particularly slender bluestem — were rank and unpalatable on unburned areas (Figure 2).

After fall-flowering grasses reached the late boot stage — usually in late August—grazing

FIGURE 1. Spring-burned range in summer shows the uniform utilization and leafy condition of the grasses.

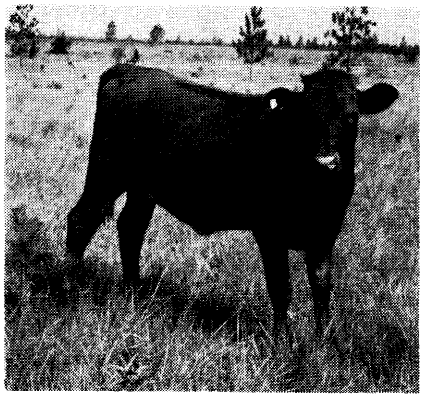

FIGURE 2. On 2-year rough much of the herbage was rank and unpalatable by early June.

declined on burned range and increased on unburned subunits. Cattle selected seedheads in considerable quantity during this period, taking plants on burned and unburned range about equally. After seeds shattered, utilization again intensified on burned areas. Cattle grazed burned areas intermittently throughout the winter, eating mature herbage and new leaves that emerged during periods of warm weather.

In general, rotation burning improved grazing distribution. Cattle were periodically attracted to places that had been little used under continuous moderate grazing. Also, burning reduced utilization on large sections that had been moderately overgrazed. On small areas that had been heavily overgrazed for many years, however, use remained heavy despite burning. These sites were largely occupied by carpetgrass (*Axonopus affinis*), a stoloniferous invader that cattle prefer to newly burned bluestem vegetation.

Herbage Production and Utilization

The spring and summer of 1956 were dry. Herbage yield was below average and the proportion consumed by cattle was unusually high. Utilization on burned subunits varied from 89 to 98 percent and averaged 92 percent. It averaged 29 percent on unburned range.

In 1957 rainfall was near average, and herbage was more plentiful than in 1956. Utilization averaged 68 percent on recently burned subunits while on those burned in 1956 it was 36 percent.

Production in 1958 was slightly higher than in 1957. Utilization averaged 66 percent on newly burned subunits, 33 percent on those burned in 1957, and 17 percent on those burned in 1956.

The pattern during the second rotation was similar. For the two rotations, utilization averaged 78 percent during the first year, 31 percent during the second year, and 18 percent during the third year after burning (Table 1).

On burned range herbage production was highest in the final year of rotation, averaging 2,588 pounds (air-dry) per acre. This was 735 pounds per acre more than first-year production and 438 pounds more than second-year production. Low yields during the first season after burning were largely due to destruction of currently produced herbage by May fires. Although quantity of new growth burned was not determined, Cassady (1953) showed that grass produced by late April or early May varied from 483 to 1,126 pounds per acre. Cattle utilized some of this forage before the fires, but most was sacrificed to improve the quality of subsequent growth.

Herbage in the second year

Table 1. Production and utilization of air-dry herbage on rotation-burned range.

Range unit	First year[1]		Second year		Third year		Average, 3 years	
	Production	Utilization	Production	Utilization	Production	Utilization	Production	Utilization
	Lbs./acre	Percent	Lbs./acre	Percent	Lbs./acre	Percent	Lbs./acre	Percent
Southwest	2,054	77	2,376	29	2,892	21	2,441	42
Southeast	1,770	78	2,228	26	2,693	17	2,230	40
Northeast[2]	1,736	79	1,847	38	2,179	17	1,921	45
Average, all units	1,853	78	2,150	31	2,588	18	2,197	42

[1]Data apply only to herbage produced after burning.
[2]Averages for two consecutive rotations. Other unit averages are for one rotation.

after burning exceeded that during the first year by almost 300 pounds per acre. When new herbage burned at the outset of rotation is considered, however, production was probably lowest during the second year. Thus, a season of intense grazing apparently depressed grass growth. The increase of 438 pounds per acre between the second and third years after burning was presumably a response to reduced grazing. Herbage during the third year after burning was not significantly less than on the unburned check, where it averaged 2,775 pounds per acre. Thus, vigor lost by vegetation under heavy grazing was largely recovered by the end of a rotation.

Cattle Weights

Rotation burning caused the desired improvement in grazing values. Cattle generally gained weight throughout the growing season, whereas cows on unburned range rarely gain weight before calves are weaned. In herds receiving no supplemental feed except minerals between May and November, cows nursing calves were 57 pounds per head heavier on August weaning dates than in April. This represented recovery of more than 40 percent of the weight lost during the previous winter. These cows gained an additional 77 pounds per head between weaning date and November, when they averaged 850 pounds (Table 2).

Calf weights increased 221 pounds per head from April until weaning, or 1.89 pounds per head per day. Weaning weights averaged 425 pounds per calf.

Dry cows gained 161 pounds per head during spring and early summer. Because weights increased rapidly during this period, gains in late summer and early fall were only 37 pounds per head. November weights averaged 938 pounds, or 88 pounds per head more than cows that weaned calves.

Table 2. Average cattle weights on rotation-burned ranges in spring, summer, and fall.

Range unit and Period	Cows, with Calves	Cows, dry	Calves
	— Pounds per head —		
Northwest			
April	717	728	230
August	770	901	469
November	860	947	——
Southwest			
April	715	754	177
August	776	901	379
November	840	925	——
Average			
April	716	740	204
August	773	901	425
November	850	938	——

Vegetational Responses

Despite periodic heavy grazing, net effects of rotation burning on forage vegetation were beneficial. Fire improved botanical composition by minimizing the proportion of cutover muhly (*Muhlenbergia expansa*), a coarse, unpalatable perennial of low fire-tolerance (Figure 3). On grazed, unburned range, the frequency of cutover muhly was 50 percent, while on the adjacent range burned twice in consecutive rotations the frequency was slightly more than 1 percent.

Following fire, poorjo (*Diodia teres*) and slimspike threeawn (*Aristida longispica*) quickly invaded openings between perennial grasses. These species decreased rapidly as the rotation progressed, however, and were scarce during the final year. On burned areas they were utilized during spring and early summer along with perennial vegetation.

FIGURE 3. Cutover muhly on range unburned for 10 years. Cattle rejected muhly herbage when confined to this plot until utilization reached 70 percent.

White eupatorium (*Eupatorium album*), a perennial forb that ordinarily occurs in modest quantities on most unburned sites, increased substantially on newly burned units. Like the annual invaders, it decreased during the two subsequent years. Cattle grazed white eupatorium sparingly, if at all.

With the exceptions noted, no important changes in botanical composition were observed. After two consecutive rotations, frequency was 100 percent for both pinehill bluestem and slender bluestem on burned subunits as well as on the unburned control area. Big bluestem (*Andropogon gerardii*) and switchgrass (*Panicum virgatum*) increased slightly on both the burned subunits and the control area but contributed little forage.

Fire aided herbage growth by top-killing shrubs and small hardwood trees. On regenerated areas burning prevented buildup of pine litter, which seriously impairs forage production.

Discussion

Rotation burning raises nutrient content of herbage sufficiently for cows nursing calves to gain satisfactorily during summer, when forage quality on unburned, moderately grazed range is usually inadequate. Dry cows grazing rotation-burned range gain during fall, although forage quality is lower than in summer. These summer and fall gains are vital, for in winter nutritive value of rough is so low that even dry cows receiving relatively generous supplemental rations generally lose weight. Unless cattle recover winter losses during the growing season, herd condition degenerates

and productivity declines. This applies especially to cows that calve in winter. If they are to reproduce regularly and raise calves successfully, they must enter the calving period in good condition, for winter weight losses usually average about 150 pounds per cow in well-managed herds.

In addition to raising forage quality, rotation burning controls undesirable vegetation and improves distribution of grazing. It also increases herbage production on forested range by eliminating accumulated litter, thereby compensating for burning of usable forage and for the growth-depressing effects of intense grazing.

Most specialized forage management systems require extensive fencing, but rotation burning regulates grazing intensity without cross-fences. Although burning costs vary, depending on degree of control needed to prevent damage to vegetation, they are usually well below those of constructing and maintaining cross-fences. Burning is cheapest on cutover land. During spring, large areas can be burned quickly by headfire without damaging desirable herbaceous cover, provided soil moisture content is moderately high. Moreover, intense fires are best for top-killing scrub hardwoods.

On timbered range, careful control of fire intensity is essential to avoid injuring pines. This presents no special problem, however, for prescribed burning is widely used in managing southern pine forests (Biswell, 1958). Many foresters control-burn pine stands regularly at 3- or 4-year intervals, once trees are large enough to escape injury by fire. Hence, prospects are good for integrating range and forest burning programs and equitably prorating costs between the two.

The responses of cattle and the short-term reactions of range vegetation to rotation burning appear reasonably conclusive, but several questions remain. Long-term influences of intermittent intense grazing on forage vegetation should be determined. The effects of periodic heavy grazing on soil properties, especially infiltration rate and water-holding capacity, should also be studied.

Rotation burning is continuing on the Palustris Experimental Forest to permit further evaluation of the system and its compatability with other land-use objectives. Effects on soil of grazing intensities and fire are being analyzed. A 4-year burning rotation also is being evaluated; it is better suited to certain pine management situations.

Summary

A system of burning one-third of the range in winter or early spring in a 3-year rotation improves grazing on longleaf pine-bluestem ranges, both cutover and timbered.

In a 6-year test in central Louisiana, cattle obtained most of their forage from recently burned range. Utilization of herbage grown during seasons following fire averaged 78 percent. In the second and third years after fire, utilization averaged 31 and 18 percent. Intense grazing following fire reduced herbage production, but the 2 years of relatively light use apparently restored plant vigor. Herbage produced during the final year of rotation was essentially the same as on unburned, moderately grazed range.

Rotation burning generally improved range vegetation and grazing distribution. Fire top-killed scrub hardwood and minimized the proportion of cutover muhly, an unpalatable perennial. It also eliminated pine litter accumulations, which retard grass growth.

Cows grazing rotation-burned range generally gained during summer and fall, when forage values on unburned, moderately grazed range are usually too low to sustain body weight. Cows with calves gained 57 pounds per head from April to August weaning dates, and 77 pounds between August and November. During these periods dry cows gained 161 and 37 pounds per head. When combined with adequate winter supplementation, rotation burning permits efficient yearlong beef production on native forage.

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